RADIO & ELECTRONICS CONSTRUCTOR

DECEMBER 1979
Volume 33 No. 4

Published Monthly
(3rd of preceding Month)

First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141
Telegrams Databux, London

Annual Subscription: £7.50, Eire and Overseas £8.50 (U.S.A. and Canada $20.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers, please pay by cheque or International Money Order.

Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

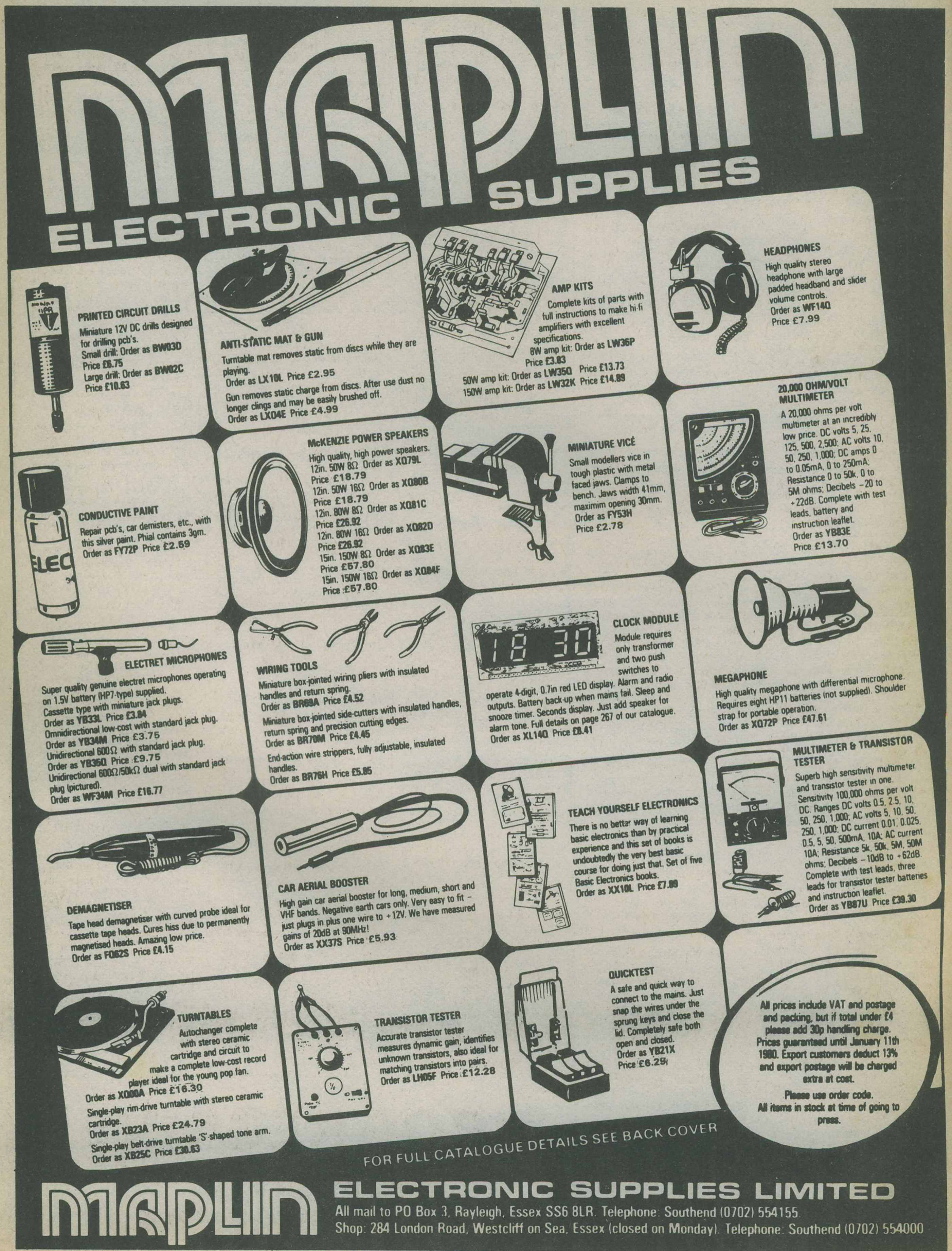
Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production— Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN.

The *Radio & Electronics Constructor* is printed by Swale Press Ltd.

THE JANUARY ISSUE WILL BE PUBLISHED ON 5th DECEMBER



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18 30
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High quality megaphone with differential microphone. Requires eight HP11 batteries (not supplied). Shoulder strap for portable operation. Order as XQ72P Price £47.61
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MOTORS

1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3 rpm Motors **32p.** 12VDC 5 Pole Model Motors **37p.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4 rpm Geared Motors **95p.**

SEMICONDUCTORS

C106D 400V 2.5A SCR **20p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** TBA800 **50p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** LM3400 **40p.** AD161/2 **70p.** 2N3055 **38p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** IN4005 **10 for 35p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds **8p each.** 0.5" 7 segement Led display. Comm. Cathode, green, full spec. **85p each.**

PROJECT BOXES

Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **54p.** 95 x 71 x 35mm **65p.** 115 x 95 x 37mm **75p.**

AMP MULTIWAY IN-LINE PLUGS AND SOCKETS,

3 way **35p,** 6 way **45p,** 12 way **55p, per pair.**

CHANGEOVER REED SWITCH

2½" Long **35p.** Glass Mercury Switch ½" x ⅜", long leads, **35p.**

MULTIMETERS

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MORSE KEYS

Beginners practice key **£1.05.** All metal fully adjustable type. **£2.60.**

MINIATURE LEVEL METERS

1 Centre Zero 17 x 17mm **75p.** 2 (scaled 0-10) 28 x 25mm **75p.** 3 Grundig 40 x 27mm **£1.25.**

JVC NIVICO STEREO CASSETTE MECHANISM.

Music centre type. Rev. counter, remote operation **£13.50 and £1.00 p&p.**

JUMPER TEST LEAD SETS

10 pairs of leads with various coloured croc clips each end (20 clips) **90p per set.**

TRANSFORMERS

All 240VAC Primary (postage per transformer is shown after price). MINIATURE RANGE: 6-0-6V 100mA, 9-0-9V 75mA and 12-0-12V 50mA **all 79p** each (15p). 0-6V. 280mA **£1.20 (20p).** 12V 500mA **99p (22p).** 12V 2 amp **£2.75 (45p).** 15-0-15V 3 amp Transformer at **£2.85 (54p).** 30-0-30V 1 amp **£2.85 (54p).** 20-0 20V 2 amp **£3.65 (54p).** 0-12-15-20-24-30V 2 amp **£4.75 (54p).** 20V 2.5 amp **£2.45 (54p).**

TRIAC/XENON PULSE TRANSFORMERS

1:1 (gpo style) **30p.** 1:1 plus 1 sub. min. pcb mounting type **60p each.**

MICROPHONES

Min. tie pin. Omni, uses deaf aid battery (supplied), **£4.95.** ECM105 low cost condenser, Omni, 600 ohms, on/off switch, standard jack plug, **£2.95.** EM507 Condenser, uni, 600 ohms, 30-18kHz., highly polished metal body **£7.96p.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-17khz., attractive black metal body **£7.75p.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromes copper body, **£12.95.** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35X10mm **40p.** GRUNDIG electric inserts with FET preamp, 3-6VDC operation **£1.00.**

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240VAC 800 watts max. wall mounting, has built in photo cell for automatic switch on when dark **£4.50**

RIBBON CABLE

8 way single strand miniature **22p per metre.**

SPEAKERS

5" Round 8 ohms 5 watts **£1.35.** 6" round 6 watt 8 ohms with cambric surround **£2.75.** Elac 8" 8 ohm long throw speaker, 18 watts twin cone **£4.75.** Mid-Range 5" speaker 850-7khz 20 watts **£1.45.**

STEREO FM/GRAM TUNER AMPLIFIER CHASSIS, VHF and AM. Bass, treble and volume controls, Gram. 8-track inputs, headphone output jack, 3 watts per channel with power supply. **£14.95 and £1.20 p&p** (CCT supplied).

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Ferranti 0-600VAC 3.5" square **£2.95.** Japanese type 60 x 47 x 33mm clear plastic type; 50 micro, 100 micro, 1Ma, 2 amp, 25 volts, 300 VAC, 'S', 'VU', all **£5.25 each.** Larger type 110 x 82 x 35mm; 50 micro, 100 micro **£6.35 each.**

CAR STEREO SPEAKERS

Shelf mounting in black plastic pods with 5" 5 watt speaker available in 4 or 8 ohms **only £3.95 per pair.**

MURATA MA401

40kHz Transducers. Rec./Sender **£3.50 pair.**

ELECTRICAL ITEMS

13 amp 3 pin plugs plastic **27p,** rubber **62p,** 13 amp rubber extension sockets **42p,** 12 way flexible terminal blocks; 2 amp **20p,** 5 amp **24p,** 10 amp **33p,** 15 amp **47p.** Standard batten (BC lampholders **27p.**

PUSH BUTTON TV TUNERS

UHF, not varicap, transistorised new **£2.25**

TELEPHONE PICK UP COIL

Sucker type with lead and 3.5mm plug **62p.**

RELAYS

Plastic Encap. Reed Relay, 0.1 matrix. 1kΩ coil, 9-12VDC normally open, **35p.** Miniature encapsulated reed relay 0.1 matrix mounting, single pole make, operates on 12VDC **50p each.** Continental series, sealed plastic case relays, 24VDC 3pole change over 5 amp contacts, new **65p.** Printed circuit Mtg., Reed relay, single make, 20mm x 5mm, 6-9VDC. coil, **33p each.** Metal Cased Reed Relay, 50 x 45 x 17mm, has 4 heavy duty make reed inserts, operates on 12VDC **35p each.** Magnets ½" long ⅛" thick with fixing hole, 10 for **40p.**

Dalo 33PC Etch Resist printed circuit maker pen, with spare tip, **79p.**

TERMS:

Cash with Order (Official Orders welcomed from colleges etc). 30p postage please unless otherwise shown. VAT inclusive.

S.a.e. for illustrated lists.

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Switch Cleaner 226gm **60p.** Freezer 226gm **70p.** Silicone Grease 226gm **70p.** Foam Cleanser 370gm **60p.** Plastic Seal 145gm **60p.** Excel Polish 240gm **47p.** Aero Klene 170gm **55p.** Aero Duster 200gm **70p.**

SURPLUS BOARDS

No. 1. this has at least 11 C106 (50V 2.5A) plastic SCR's, one relay a unijunction transistor and tantalum capacitors **£1.95.** No. 2 I.F. Boards, these are a complete I.F. board assembly made for car radios, 465Khz, full set of I.F.'s and oscillator coils, trimmers etc., **40p each.** No. 3 Board with two BDY60 Power Transistors, **45p each.**

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SWITCHED TYPE, plugs into 13 amp socket, has 3-4.5-6-7.5 and 9 volt DC out at either 100 or 40 0mA, switchable **£3.45.** HC244R STABILISED SUPPLY, 3-6-7.5-9 volts DC out at 400mA max., with on/off switch, polarity reversing switch and voltage selector switch, fully regulated to supply exact voltage from no load to max. current **£4.95.**

AMPHENOL CONNECTORS

(PL259) PLUGS 47p. Chassis sockets **42p.** Elbows PL259/SO239 **90p.** Double in line male connector (2XPL259) **65p.** Plug reducers **13p.** PL259 Dummy load, 52 ohms 1 watt with indicator bulb **95p.**

BUZZERS

MINIATURE SOLID STATE BUZZERS, 33 x 17 x 15mm white plastic case, output at three feet 70db (approx), low consumption only 15mA, four voltage types available, 6-9-12 or 24VDC, **80p each.** LOUD 12VDC BUZZER, Cream plastic case, 50mm diam. x 30mm high **63p.** GPO OPEN TYPE BUZZER, adjustable works 6-12VDC **27p.** 12VDC siren, all metal, rotary type, high pitched wail, **£7.50.**

TOOLS

SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p each).**

Good Quality snub nosed pliers, insulated handles, 5" **£1.45.**

Antex Model C 15 watt soldering irons, 240VAC **£3.95**

Antex Model CX 17 watt soldering irons, 240VAC **£3.95.**

Antex Model X25 25 watt soldering irons, 240VAC **£3.95.**

Antex ST3 iron stands, suits all above models **£1.65.**

Antex heat shunts **12p each.**

Servisol Solder Mop **50p each.**

Neon Tester Screwdrivers 8" long **43p each.**

Miyarna IC test clips 16 pin **£1.95.**

SWITCHES

Sub. miniature toggles; SPST (8 x 5 x 7mm) **52p.** DPT (8 x 7 x 7mm) **62p.** DPT centre off 12 x 11 x 9mm **77p.** PUSH-SWITCHES, 16 x 6mm, red top, push to make **14p each,** push to break version (black top) **16p each.**

G.P.O. Telephone handsets **£1.95p.** Electrolytic Caps, can type, 2,200mfd and 2,200mfd 50VDC **35p each.**

MICRO SWITCHES

Standard button operated 28 x 25 x 8mm make or break, new **15p each.** Roller operated version of the latter, New **19p each.** Light action micro, 3 amp make or break 35 x 20 x 7mm, **12p each.** Cherry plunger operated micro, 2 normally open, 2 normally closed, plunger 20mm long (40 x 30 x 18mm) **25p each.**

PUSH BUTTON UNITS

6 way, 3 DPDT, 3 4 pole c/o **55p,** 8 way, 5 DPDT, 3 4 pole c/o **70p.** RANK ARENA magnetic cartridge preamplifier modules, new with connection details **£1.95p.**

TAPE HEADS

Mono cassette **£1.75.** Stereo cassette **£3.90.** Standard 8 track stereo **£1.95.** BSR MN1330 ¼ track **50p.** BSR SRP90 ¼ track **£1.95.** TD10 tape head assembly – 2 heads both ¼ track R/P with built in erase, mounted on bracket **£1.20.**

PROGRESSIVE RADIO

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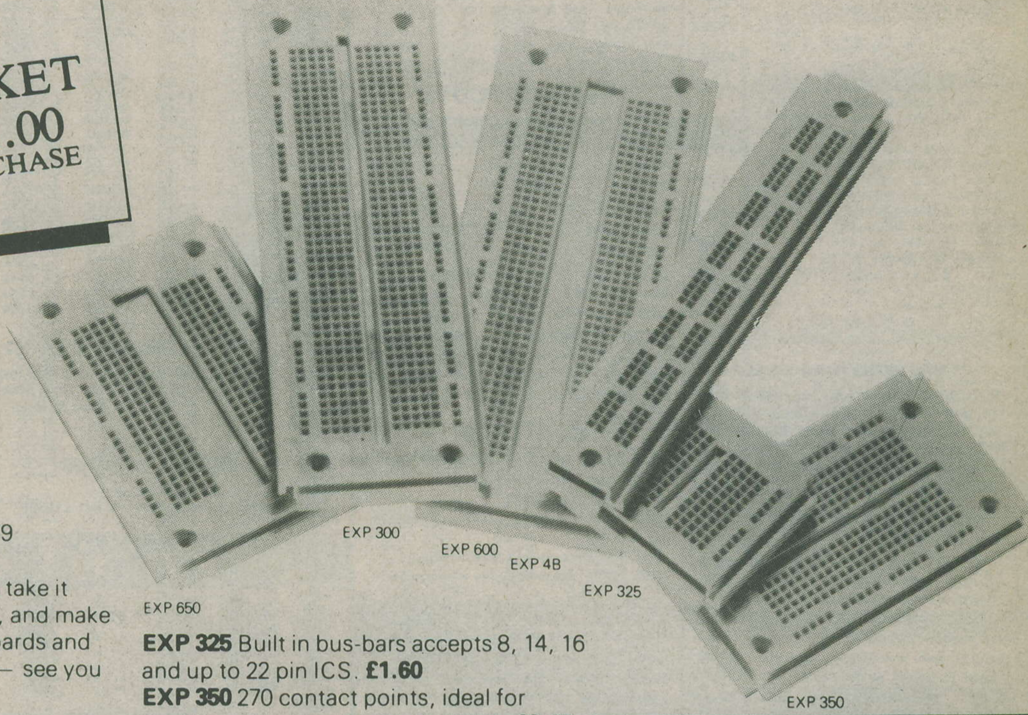

All over Britain, hobbyists are discovering Britain's Best Breadboard Buys. At the London Breadboard exhibition '79 on Stand Nos. F1, F2 and G1, G2, CSC will be exhibiting their full range of breadboards.

Here is your chance to obtain a special ticket for Breadboard '79 worth £1.00 absolutely FREE.

Cut out the coupon below and take it along to one of our listed dealers, and make a purchase of any of our breadboards and receive your special FREE ticket — see you at Breadboard '79.

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LONDON
Rastra Electronics Ltd., 279-281 King Street, Hammersmith, London W6
Cubegate Ltd., Audio Electronics, 301 Edgware Road, London W2 1BN
Technomatic Ltd., 17 Burnley Road, London NW10 1ED
Precision Instrument Labs., Instrument House, 727 Old Kent Road, London SE15

MANCHESTER
Shudehill Supply Co., 53 Shudehill, Manchester M4 4AW

BUCKINGHAMSHIRE
West Hyde Development, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET
Best Electronics (Slough) Ltd., Unit 4 Farnburn Ave., Slough, Bucks SL1 4XU

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Lawtronics, 13a High Street, Edenbridge, Kent TN8 5AX

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Aitken Bros., 35 High Bridge, Newcastle upon Tyne

SCOTLAND
Marshalls, 85 West Regent Street, Glasgow G2
F. Brown & Co., 45 George IV Bridge, Edinburgh EH1 1E3

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EXP 4B An extra 4 bus-bars in one unit. **£2.30**
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EXP 600 6" centre channel makes this the Microprocessor Breadboard. **£6.30**
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PB100 Kit form breadboard recommended for students and educational uses. **£11.80**
The above prices do not include P&P and 15% VAT

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4 ways to order Experimentor Systems

1. EXP 300PC which includes one item. A matchboard pre-drilled PCB — £1.32
2. EXP 302 which includes three items. Three 50-sheet scratchboard workpads — £1.68
3. EXP 303 which includes three items. Two matchboards and an EXP 300 solderless breadboard - £8.60
4. EXP 304 which includes four items. Two matchboards and EXP 300 breadboard and a scratchboard workpad — £9.30

This coupon entitles the holder to a free ticket worth £1.00 to Breadboard '79, with the purchase of any listed breadboards

1. EXP 325 £2.70	Qnty. Reqd.	2. EXP 350 £4.48	Qnty. Reqd.
3. EXP 650 £5.00	Qnty. Reqd.	4. EXP 4B £3.50	Qnty. Reqd.
5. EXP 300 £7.78	Qnty. Reqd.	6. EXP 600 £8.39	Qnty. Reqd.
7. PB6 £11.73	Qnty. Reqd.	8. PB 100 £14.72	Qnty. Reqd.

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1. EXP 300PC £2.38	Qnty. Reqd.	2. EXP 302 £2.79	Qnty. Reqd.
3. EXP 303 £11.04	Qnty. Reqd.	4. EXP 304 £11.85	Qnty. Reqd.

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K104—18 BC182B N.P.N. 60 Volt	£1.00
K105—50 IN4148 Silicon Diode	£1.00
K106—18 BC184L N.P.N. Low Noise	£1.00
K107—18 BC213L P.N.P. General Purpose	£1.00
K108—8 2N5060 30N .8A SCR	£1.00
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K114—15 XK6116 (BF241) N.P.N. 200 MHz	£1.00
K115—18 SP1218 (2N3702) P.N.P. Gen. Purpose	£1.00
K117—10 BF450 P.N.P. T.V. IF Amp.	£1.00
K118—16 ME4101 N.P.N. 60V Low Noise	£1.00
K124—50 .02uF Disc Ceramics	£1.00
K125—200 1k 5% ¼W. CF Resistors	£1.00

1,000 RESISTORS £2.50!!

New stock just arrived — Carbon Film 2% and 5%, ¼W and ½W, all brand new, but have pre-formed leads, ideal for PC mntg. Enormous range of popular mixed values for just **£2.50/1,000, £11/5,000 £50/25,000.**

LINEAR IC BARGAIN

We have just received a large consignment of popular linear IC's that have failed the manufacturers stringent tests. However, on checking through a few hundred we have found that quite a large proportion tested in a simple oscillator circuit are functional, so are offering them in packs as follows:

TYPE	*PACKAGE*	*%GOOD*	*QTY*	*PRICE*
702	14DIL	65	25	£1.20
709	8DIL	75	20	£1.20
709	14DIL	50	30	£1.20
710	TO99	30	40	£1.20
710	14DIL	30	40	£1.20
720	14DIL	80	20	£1.20
741	TO99	40	25	£1.20
748	TO99	70	15	£1.20

Connection-data is supplied. One of each pack, **£8.50**

3W AMP MODULE

Ready built and tested, this handy amplifier will prove very useful around the workshop. Just requires 17V ac source (and 8R spkr) as bridge rect and smoothing cap are mounted on the PCB. The 4 transistor circuit provides enough sensitivity for most applications. Supplied complete with circuit diagram and wiring details. Only **£1.75.** Suitable transformer **£2.20.**

TRANSFORMERS

PA 100V line speaker type. Pri tapped 0.625W — 10W in 5 steps. Sec 4 or 8 ohm **£1.75** 10/**£15** 100/**£110**

Mains pri, 3 sec windings, 8, 25 and 40V, each at 100mA. A selection of voltages from 8 to 73V is therefore obtainable. 57x48x36mm with flying leads. **£1.50**

Mains pri, sec 40V @ 250mA **£1.75**

CLOCK CASE BARGAIN

Z472 Oval format, overall size 130x-68x87mm deep, with built in stand. Rear panel drilled to accept 4 switches and alarm **60p**

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FEATURES INCLUDE:

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VERO OFFCUTS

Packs of 100 sq ins of good size pieces about 4 x 3" in the following types:

K541 0.1" copper clad **£1.50**
K542 0.15" copper clad **£1.60**
K544 0.1" plain **£1.50**

Also pieces 2½x1" — 10/**£1.20** 100/**£9**
17x3¾"x0.1" sheets — 10/**£16.50**

Large range of Standard Veroboard and boxes/cases in stock. Details in catalogue, **45p**

SCOOP! Verobox type 2522, unused but has 3 ½" holes in one end and 1 ⅜" hole the other, so instead of £3.96, we are selling these at **£1.85**

SWITCHES

Push-button banks — 20 types listed on Bargain List No. 8, free with cat (45p) or send SAE. Samples:

W473 3 interlocking 4PCO + 2 independent, **70p**

W481 5 interlocking 4PCO **70p**

Both types supplied with free knobs!

W106 DPCO slide switch 23x15x7mm 10/**£1.20;** 100/**£9**

W107 SPCO min slide switch with 2 wires attached. 10/**80p** 100/**£6.**

W508 SPCO 5A microswitch with 29mm lever 20x12x6mm **38p** 10/**£3.00**

W302 Rocker switch on/off 10A white. **22p** 10/**£1.80.**

W305 Rocker SPCO, centre off, 10A rating, white **30p** 10/**£2.30** 100/**£19.**

AERIALS

X901 Telescopic 8 sections 970mm long extended, 175mm collapsed. Swivel joint. 2BA fixing hole in base. **75p**

X904 Ferrite rod 140mm x 9mm LW/MW/coupling coils, each independently moveable **64p**

X905 As above, but LW/coupling coil together on moveable former **55p**

BUZZERS & MOTORS

Z401 Powerful 6V DC, all metal construction. 50mm dia x 20mm **70p**

Z402 Miniature type, 3-9V, only 22x-15x16mm. Very neat **65p**

Z450 Miniature 6V DC motor, high quality type 32mm dia x 25mm high, with 12mm spindle. Only **£1**

Z451 12V high torque motor 30mm dia x 40mm high, with 10mm spindle. **65p**

Z452 6V DC motor with gearbox giving final shaft speed 700 rpm. Spindle is threaded OBA. Ex-equip **£1**

Z453 As above, but 300 rpm and unthreaded spindle **£1.**

VU METERS

Voo2 Twin type. 2 meters 40x40mm and driver board, supplied with circuit and connexion data. **£3.50**

Voo3 New type, just in. Twin type moulded in one piece, 80x40mm (No driver board but suitable circuit supplied) **£2.50**

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TRANSISTORS

AC128	24p	BC213	9p	BF115	32p	BFY77	10p
AD149	58p	BC213L	9p	BF127	38p	BR101	30p
AD161	42p	BC213L	9p	BF159	25p	BRY39	32p
AD162	42p	BC214	9p	BF164	22p	BSY52	30p
BC107	9p	BC214B	9p	BF166	32p	BU105/02	£1.50
TO5 leg)	6p	BC214B	9p	BF167	26p	BU108	£1.80
BC108	9p	BC214L	9p	BF178	24p	BU124	£1.82
BC109	9p	(TO5 lead)	8p	BF180	29p	BU126	£1.50
BC125	10p	BC268A	25p	BF182	29p	BU204	£1.50
BC126	10p	BC301	42p	BF183	29p	BU205	£1.35
BC147B	7p	BC307B	10p	BF194	10p	BU206	£1.75
BC149	8p	BC308A	10p	BF194A	12p	BU208	£1.75
BC153	10p	BC309	10p	BF195	10p	GET872	15p
BC161	42p	BC441	36p	BF195C	12p	GET881	15p
BC177	18p	BC460	36p	BF200	28p	OC45	28p
BC178	18p	BC547	12p	BF224J	15p	OC71	25p
BC182	9p	BC558A	13p	BF241	12p	OS72	35p
BC182L	9p	BCY42	30p	BF257	28p	OC76	36p
BC183	9p	BCY70	17p	BF259	29p	TIP29A	44p
BC183B	9p	BCY71	18p	BF262	29p	TIP31A	36p
BC183L	9p	BCY72	15p	BF263	30p	TIP32A	40p
BC184	9p	BD116	54p	BF337	30p	TIP32C	70p
BC184L	9p	BBD131	35p	BFT41	11p	TIP33A	65p
BC212	9p	BD132	35p	BFX84	22p	TIP41A	45p
BC212B	9p	BD135	34p	BFX89	50p	TIP42A	40p
BC212L	9p	BD136	34p	BFY50	20p	TIP3055	65p
BC212LA	9p	BD183	75p	BFY51	20p	TIS43	34p
		BDY20	£1.05	BFY52	20p	2N3055	48p

400m/w ZENER DIODES *Low Price*

3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 6V8, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 13V5, 15V, 16V, 18V, 20V, 22V, 24V, 27V, 30V, 33V.

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14	DIL	13p
16	DIL	15p
18	DIL	18p
20	DIL	22p
22	DIL	23p
24	DIL	24p
28	DIL	28p
40	DIL	40p

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1.5Amp 50V	32p
400V	43p
800V	58p
2.0Amp 50V	35p
100V	44p
400V	50p
6.0Amp 50V	70p
200V	78p
400V	85p
10.0Amp 50V	£1.87
400V	£2.79
600V	£3.54
25.0Amp 50V	£1.95
400V	£2.99
600V	£4.50

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100Ω to 1Meg Vertical or Horizontal
Price: **6p each.** 100 any mix **£4.50**

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LOG: 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2 **27p each**
LIN: 470Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2 **10 for £2.50**
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½W at 40C, 1/3W at 70C. E12 series only i.e. 2.2Ω, 2.7Ω 3.3Ω, 3.9Ω, 4.7Ω, 5.6Ω 6.8Ω 8.2Ω, 10Ω etc.

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TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC126	£0.21	BC148	£0.08	BC550	£0.16	BU105	£1.84	ZTX108	£0.11
AC127	£0.21	BC149	£0.08	BC556	£0.16	BU105/02	£2.24	ZTX109	£0.11
AC128	£0.18	BC157	£0.12	BC557	£0.15	BU204	£1.61	ZTX300	£0.13
AC128K	£0.30	BC159	£0.12	BC558	£0.14	BU205	£1.61	ZTX500	£0.14
AC132	£0.23	BC159	£0.12	BC559	£0.16	BU208/02	£2.58	2N1613	£0.23
AC134	£0.23	BC167	£0.14	BD115	£0.58	MJE2955	£1.04	2N1711	£0.23
AC137	£0.23	BC168	£0.14	BD116	£0.92	MJE3055	£0.69	2N1889	£0.51
AC141	£0.25	BC169	£0.10	BD121	£0.75	MJE3440	£0.60	2N1890	£0.51
AC141K	£0.35	BC169C	£0.12	BD124	£0.81	MPE102	£0.35	2N1893	£0.35
AC142	£0.23	BC170	£0.10	BD131	£0.40	MPF104	£0.40	2N2147	£0.86
AC176	£0.21	BC171	£0.10	BD132	£0.40	MPF105	£0.40	2N2148	£0.81
AC176K	£0.30	BC172	£0.10	BD133	£0.46	MPSA05	£0.23	2N2160	£1.15
AC178	£0.29	BC173	£0.10	BD135	£0.44	MPSA06	£0.23	2N2192	£0.44
AC179	£0.29	BC177	£0.18	BD136	£0.40	MPSA55	£0.23	2N2193	£0.44
AC180	£0.23	BC178	£0.18	BD137	£0.40	MPSA56	£0.23	2N2194	£0.44
AC180K	£0.32	BC180	£0.29	BD138	£0.41	OC22	£1.73	2N2217	£0.25
AC181	£0.23	BC181	£0.10	BD139	£0.41	OC23	£1.73	2N2218	£0.25
AC181K	£0.32	BC182L	£0.10	BD140	£0.41	OC24	£1.55	2N2218A	£0.23
AC187	£0.21	BC183	£0.10	BD155	£0.92	OC25	£1.15	2N2219	£0.23
AC187K	£0.32	BC183L	£0.10	BD175	£0.69	OC26	£1.15	2N2219A	£0.25
AC188	£0.21	BC184	£0.10	BD176	£0.69	OC28	£0.92	2N2904	£0.23
AC188K	£0.32	BC207	£0.13	BD177	£0.78	OC29	£1.09	2N2904A	£0.24
AD140	£0.69	BC208	£0.13	BD178	£0.78	OC35	£1.03	2N2905	£0.20
AD142	£0.98	BC209	£0.14	BD179	£0.86	OC36	£1.03	2N2905A	£0.23
AD143	£0.86	BC212	£0.10	BD203	£0.92	OC70	£0.27	2N2906	£0.18
AD149	£0.69	BC212L	£0.10	BD204	£0.92	OC71	£0.17	2N2906A	£0.21
AD161	£0.40	BC213	£0.10	BDY20	£0.92	TIC44	£0.33	2N2907	£0.23
AD162	£0.40	BC213L	£0.10	BF457	£0.43	TIC45	£0.40	2N2907A	£0.25
AD161/162MP	£0.81	BC214	£0.10	BF458	£0.43	TIP29A	£0.46	2N2926G	£0.10
AF124	£0.35	BC214L	£0.10	BF459	£0.44	TIP29B	£0.48	2N2926Y	£0.09
AF125	£0.35	BC227	£0.18	BF594	£0.35	TIP29C	£0.51	2N2926O	£0.09
AF126	£0.35	BC238	£0.18	BF596	£0.32	TIP30A	£0.46	2N2926R	£0.09
AF127	£0.37	BC251	£0.17	BFR39	£0.28	TIP30B	£0.48	2N2926B	£0.09
AF139	£0.40	BC251A	£0.18	BFR40	£0.29	TIP30C	£0.50	2N3053	£0.18
AF186	£0.58	BC301	£0.32	BFR79	£0.32	TIP31A	£0.46	2N3054	£0.46
AF239	£0.47	BC302	£0.33	BFR80	£0.32	TIP31B	£0.48	2N3055	£0.46
AL102	£1.38	BC303	£0.32	BFX29	£0.25	TIP31C	£0.50	2N3614	£1.15
AL103	£1.36	BC304	£0.44	BFX30	£0.35	TIP32A	£0.46	2N3615	£1.21
AU104	£1.61	BC327	£0.18	BFX84	£0.25	TIP32B	£0.48	2N3616	£1.21
AU110	£1.61	BC328	£0.17	BFX85	£0.28	TIP32C	£0.50	2N3646	£0.10
AU113	£1.61	BC337	£0.17	BFX86	£0.29	TIP41A	£0.50	2N3702	£0.09
BC107A	£0.09	BC338	£0.17	BFX87	£0.25	TIP41B	£0.52	2N3703	£0.09
BC107B	£0.10	BC440	£0.35	BFX88	£0.25	TIP41C	£0.55	2N3704	£0.08
BC107C	£0.12	BC441	£0.35	BFY50	£0.15	TIP42A	£0.50	2N3705	£0.08
BC108A	£0.09	BC460	£0.44	BFY51	£0.18	TIP42B	£0.52	2N3706	£0.09
BC108B	£0.11	BC461	£0.44	BFY52	£0.18	TIP42C	£0.55	2N3707	£0.09
BC108C	£0.12	BC477	£0.23	BIP19	£0.44	TIP2955	£0.69	2N3708	£0.08
BC109A	£0.09	BC478	£0.23	BIP20	£0.44	TIS43	£.025	2N3709	£0.08
BC109B	£0.10	BC479	£0.23	BIP19/20MP	£0.92	TIS90	£0.20	2N3710	£0.08
BC109C	£0.12	BC547	£0.12	BRY39	£0.51	UT46	£0.23	2N3711	£0.08
BC147	£0.08	BC548	£0.12			ZTX107	£0.11	2N3819	£0.21
		BC549	£0.12					2N3820	£0.40

74 SERIES TTL ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7426	£0.26	7470	£0.28	74105	£0.43	74153	£0.71
7401	£0.12	7427	£0.27	7472	£0.23	74107	£0.27	74164	£0.78
7402	£0.12	7428	£0.29	7473	£0.28	74110	£0.41	74165	£0.78
7403	£0.12	7430	£0.12	7474	£0.28	74111	£0.66	74166	£0.89
7404	£0.12	7432	£0.25	7475	£0.33	74118	£0.92	74174	£0.74
7405	£0.12	7433	£0.34	7476	£0.28	74119	£1.35	74175	£0.71
7406	£0.25	7437	£0.25	7480	£0.50	74121	£0.27	74176	£0.66
7407	£0.25	7438	£0.24	7481	£0.97	74122	£0.44	74177	£0.66
7408	£0.14	7440	£0.13	7482	£0.78	74123	£0.46	74180	£1.72
7409	£0.14	7441	£0.57	7483	£0.55	74136	£0.59	74181	£0.66
7410	£0.12	7442	£0.46	7484	£1.01	74141	£0.63	74182	£0.80
7411	£0.19	7443	£0.80	7485	£0.78	74145	£0.63	74184	£0.80
7412	£0.17	7444	£0.80	7486	£0.25	74150	£0.78	74190	£0.78
7413	£0.27	7445	£0.74	7489	£1.95	74151	£0.55	74191	£0.71
7414	£0.57	7446	£0.69	7490	£0.36	74153	£0.55	74192	£0.69
7416	£0.26	7447	£0.55	7491	£0.73	74154	£0.94	74193	£0.66
7417	£0.26	7448	£0.64	7492	£0.40	74155	£0.57	74194	£0.71
7420	£0.12	7450	£0.12	7493	£0.34	74156	£0.57	74195	£0.69
7421	£0.23	7451	£0.12	7494	£0.86	74157	£0.57	74196	£1.20
7422	£0.18	7453	£0.12	7495	£0.57	74160	£0.66	74197	£1.20
7423	£0.24	7454	£0.12	7496	£0.57	74161	£0.71	74198	£2.12
7425	£0.21	7460	£0.12	74100	£0.97	74162	£0.71	74199	£2.12
				74104	£0.44				

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.16	CD4015	£0.87	CD4026	£1.38	CD4043	£1.01	CD4070	£0.19
CD4001	£0.17	CD4016	£0.48	CD4027	£0.57	CD4044	£0.94	CD4071	£0.19
CD4002	£0.18	CD4017	£0.86	CD4028	£0.78	CD4045	£1.61	CD4072	£0.19
CD4006	£1.05	CD4018	£0.97	CD4029	£0.97	CD4046	£1.49	CD4081	£0.19
CD4007	£0.19	CD4019	£0.48	CD4030	£0.55	CD4047	£1.00	CD4082	£0.20
CD4008	£1.05	CD4020	£1.03	CD4031	£2.30	CD4049	£0.48	CD4510	£1.13
CD4009	£0.51	CD4021	£0.94	CD4035	£1.15	CD4050	£0.48	CD4511	£1.09
CD4010	£0.55	CD4022	£0.94	CD4037	£1.09	CD4054	£1.26	CD4516	£1.15
CD4011	£0.17	CD4023	£0.17	CD4040	£1.01	CD4055	£1.15	CD4518	£1.15
CD4012	£0.18	CD4024	£0.74	CD4041	£0.87	CD4056	£1.55	CD4520	£1.15
CD4013	£0.48	CD4025	£0.17	CD4042	£0.82	CD4069	£0.19	CD4014	£0.92

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.92	CA3140	£0.80	MC1350	£1.38	709P	£0.29	SN76110	£1.72
CD3014	£1.55	LM301	£0.33	MC1352	£1.61	UA710C	£0.46	SN76115	£2.18
CA3018	£0.74	LM304	£1.84	MC1469	£3.39	72710	£0.34	SN76660	£0.86
CA3020	£1.95	LM308	£1.15	MC1496	£1.03	UA711C	£0.36	SL414A	£2.24
CA3028	£0.92	LM309	£1.72	NE536	£3.05	72711	£0.36	TAA550B	£0.40
CA3035	£1.61	LM320 5v	£1.72	NE550	£1.09	UA723C	£0.52	TAA621A	£2.30
CA3036	£1.15	LM320 12	£1.72	NE555	£0.27	72723	£0.52	TAA621B	£2.87
CA3042	£1.72	LM320 15	£1.72	NE556	£0.69	UA741C	£0.27	TAA661	£1.72
CA3043	£2.12	LM320 24	£1.72	NE565	£1.38	72741	£0.27	TAD100	£1.49
CA3046	£0.80	LM380	£0.97	NE566	£1.38	741P	£0.23	TBA540	£2.41
CA3052	£1.84	LM381	£1.66	NE567	£1.95	UA747C	£0.69	TBA810S	£0.86
CA3054	£1.26	LM3900	£0.66	UA702C	£0.52	72747	£0.69	TBA810	£1.12
CA3075	£1.72	MC1303L	£0.97	72702	£0.52	UA748	£0.40	TBA820	£0.80
CA3081	£1.72	MC1304	£2.18	UA703	£0.28	72748	£0.40	TBA9200	£2.87
CA3089	£2.30	MC1310	£1.09	UA709	£0.28	748P	£0.40	TCA270S	2.30
CA3090	£4.14	MC1312	£2.18	72709	£0.52	SN76013N	£2.01	TBA800	£0.92
CA3123	£2.18					SN76023	£2.01		
CA3130	£1.06								

THYRISTORS

Volts	No:	Price	Volts	No:	Price
50	THY1A/50	£0.29	50	THY7A/50	£0.41
100	THY1A/100	£0.32	100	THY7A/100	£0.58
200	THY1A/200	£0.36	200	THY7A/200	£0.65
400	THY1A/400	£0.43	400	THY7A/400	£0.71
600	THY1A/600	£0.51	600	THY7A/600	£0.89
800	THY1A/800	£0.66	800	THY7A/800	£1.05
50	THY3A/50	£0.32	50	THY10A/50	£0.58
100	THY3A/100	£0.34	100	THY10A/100	£0.65
200	THY3A/200	0.37	200	THY10A/200	£0.71
400	THY3A/400	£0.48	400	THY10A/400	£0.80
600	THY3A/600	£0.57	600	THY10A/600	£1.13
800	THY3A/800	£0.74	800	THY10A/800	£1.40
50	THY5A/50	£0.41	50	THY16A/50	£0.62
100	THY5A/100	£0.51	100	THY16A/100	£0.66
200	THY5A/200	£0.57	200	THY16A/200	£0.71
400	THY5A/400	£0.65	400	THY16A/400	£0.88
600	THY5A/600	£0.79	600	THY16A/600	£1.03
800	THY5A/800	£0.93	800	THY16A/800	£1.59

SILICON RECTIFIERS

200mA	Price	10 Amp	Price
IS920 50v	£0.07	IS10/50 50v	£0.21
IS921 100v	£0.08	IS10/100 100v	£0.24
IS922 150v	£0.09	IS10/200 200v	£0.26
IS923 200v	£0.10	IS10/400 400v	£0.40
IS924 300v	£0.11	IS10/600 600v	£0.48
1 Amp	**Price**	IS10/800 800v	£0.58
IN4001 50v	£0.05	IS10/1000 1000v	£0.69
IN4002 100v	£0.05	IS10/1200 1200v	£0.79
IN4003 200v	£0.07		
IN4004 400v	£0.08	**30 Amp**	**Price**
IN4005 600v	£0.09	IS30/50 50v	£0.64
IN4006 800v	£0.10	IS30/100 100v	£0.79
IN4007 1000v	£0.11	IS30/200 200v	£1.06
1.5 Amp	**Price**	IS30/400 400v	£1.43
ISO15 50v	£0.10	IS30/600 600v	£2.02
ISO20 100v	£0.11	IS30/800 800v	£2.23
ISO21 200v	£0.12	IS30/1000 1000v	£2.65
ISO23 400v	£0.14	IS30/1200 1200v	£3.31
ISO25 600v	£0.16		
ISO27 800v	£0.18		
ISO29 1000v	£0.23		
ISO31 1200v	£0.28	**60 Amp**	**Price**
3 Amp	**Price**	IS70/50 50v	£0.86
IN5400 50v	£0.16	IS70/100 100v	£0.96
IN5401 100v	£0.17	IS70/200 200v	£1.38
IN5402 200v	£0.18	IS70/400 400v	£2.01
IN5404 400v	£0.19	IS70/600 600v	£2.58
IN5406 600v	£0.24	IS70/800 800v	£2.87
IN5407 800v	£0.28	IS70/1000 1000v	£3.45
IN5408 1000v	£0.34		

AUDIO MODULES

Amplifiers

AL20 5 watt amplifier module £3.73
AL30A 7-10 watt amplifier module £4.35
AL60 15-25 watt amplifier module £5.39
AL80 35 watt amplifier module £8.44
AL120 50 watt amplifier module £13.74
AL250 125 watt amplifier module £19.24

Pre amplifiers

PA12 Stereo pre-amplifier module .. £8.94
PA100 Stereo pre-amplifier £18.45
PA200 Stereo pre-amplifier £19.07
MM100 Mono pre-amplifier £13.00
MM100G Mono pre-amp for guitar .. £13.00

Power Supplies

PS12 Power supply (24 volts DC) .. £1.72
SPM80 Stabilised power supply (33v) £5.06
SPM120/45 Stabilised power supply (45v) £6.67
SPM120/55 Stabilised power supply (55v) £6.67
SPM120/65 Stabilised power supply (65v) £6.67
SG30 Power supply for equaliser ... £4.47

Miscellaneous

MPA30 Stereo magnetic cartridge 7 pre-amp £4.42
S.450 Stereo tuner £26.72
Stereo 30 complete 7 watt stereo amplifier board £22.66
BP124 Siren alarm module 5 watts £4.02
GE100MKII 10 channel mono graphic equaliser £23.00

LED's

1501 125 Red £0.11
1502 125 Green £0.16
1503 125 Yellow £0.16
1504 2 Red £0.11
1505 2 Green £0.16
1506 2 Yellow £0.16
1509 2 Clear £0.12

SUPER Hi-Brite Type

1521 3mm (125) Red £0.11
1522 5mm (2) Red £0.11
1514 ORP 12 Light dependent resistor £0.63
1520 OCP71 Photo transistor £0.40

CLIPS

1508/.125 pack of 5, /125 clips £0.17
1508 2 pack of 5 .2 clips £0.20

DISPLAYS

DL703 7 segment D.P. left (.30" height) common anode Red single digit O'NO 1523 .... £0.80
DL707 7 segment D.P left (0.3" height) common anode Red single digit O'NO 1510 .... £0.92
DL527 7 segment D.P. left (.50" **height) common anode Red two-digit** reflector O'NO 1524 .... £1.96
DL727 7 segment D.P right (.510" height) common anode Red two-digit light pipe O'NO 1521 .... £2.53
DL747 7 segment D.P. left (.630" height) common anode Red single-digit light pipe O'NO: 1511 ..... £1.72

OPTO ISOLATORS

Isolation Breakdown Voltage 1500 continuous fwd current 100mA.
CIL74 Single channel 6 pin DIP standard type optically coupled with infra red LED emitter and NPN silicon photo transistor O/NO: 1497 .... £0.57
CILD74 Multi channel 8 pin DIP two isolated channels O/NO: 1498 .. £1.15
CIL074 Multi channel 16 pin DIP four isolated channels O'NO: 1499 £2.53

2nd GRADE LED PACK

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 .... £1.72

SOCKETS

1611	8 pin DIL	£0.09
1612	14 pin DIL	£0.11
1613	16 pin DIL	£0.12
1720	18 pin DIL	£0.18
1721	20 pin DIL	£0.20
1722	22 pin DIL	£0.22
1614	24 pin DIL	£0.24
1615	28 pin DIL	£0.26
1723	40 pin DIL	£0.34
1616	TO18 transistor	£0.13
1617	TO2 transistor	£0.37
16117	TO5 transistor	£0.13
1724	14 pin DIL Wire wrap gold plated Cambion.	£0.25

G.P. SWITCHING TRANSISTORS

TO 18 sim to 2N706/8 BSY27/28/95A All usable devices no open and shorts **Also available in PNP sim. to 2N290/ BCY70 20 for 57p, 50 for £1.15, 100 for £2.07, 500 for £9.20, 1,000 for £16.10 — when ordering state NPN/PNP.**

SILICON DIODES G.P.

300mW 40PIV (min) sub min FULLY TESTED ideal for Organ builders 30 for 57p, 100 for £1.72, 500 for £5.75, 1,000 for £10.35.

METAL FOIL CAPACITOR PAK

Containing 50 metal foil capacitors — like Mullard C280 series — mixed values ranging from 01uF-2.2uF complete with identification sheet **O/NO: 16204 £1.38.**

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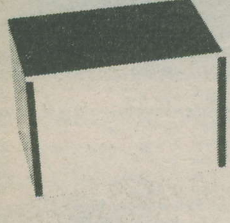
1622 Transistors Germ and Silicon Rectifiers-Diodes-Triacs-Thyristors ICs and Zeners. ALL NEW & CODED. Approx 100 pieces offering the amateur a fantastic bargain PAK and an enormous saving £2.56.

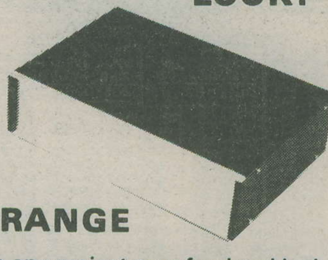
TERMS: *Cash with order, Cheques, P.O.'s payable to* **BI-PAK** *at above address*
Access and Barclaycard accepted — **GIRO A/c No. 3887006**
All prices include VAT. Add 35p for Postage per order

Access

BARCLAYCARD

DO YOUR PROJECTS LACK THE PROFESSIONAL LOOK?





IF SO, TRY OUR HB RANGE

Instrument cases to give any project a professional look. The four separate top, bottom and end panels are made of black p.v.c. coated steel. Front panel and top and bottom trim are satin anodised aluminium for a neat finish; back panel is in plain aluminium. The whole case, including screws, comes in a flat package and may be assembled in minutes.

DIMENSIONS IN INCHES

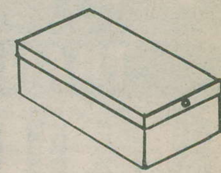
Model	Width	Depth	Height	Price
HB1	9	6	3	£4.87
HB2	9	6	4½	£5.27
HB3	9	6	6	£5.63
HB4	12	8	3	£5.98
HB5	12	8	4½	£6.80
HB6	12	8	6	£7.26

ALUMINIUM BOXES

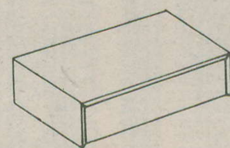
Aluminium box with lid and screws.

Model	Length	Width	Height	Price
AL1	3	2	1	52p
AL2	4	3	1½	62p
AL3	4	3	2	72p
AL4	6	4	2	81p
AL5	6	4	3	94p
AL6	8	6	2	£1.27
AL7	8	6	3	£1.43

(Dimensions in inches)



INSTRUMENT CASES



BC Range consists of black P.V.C. coated steel top cover with bevelled front edge, u-shaped aluminium chassis and two fixing screws.

Model	Length	Width	Height	Price
BC1	6	4½	2	£1.61
BC2	6	4	3½	£1.74
BC3	8	5½	2½	£1.99
BC4	10	6½	3	£2.60

(Dimensions in inches)

SHEET ALUMINIUM

Gauge	4 x 6	6 x 9	8 x 12
16	29p	57p	£1.02
18	20p	42p	69p
20	17p	32p	52p

AXIAL CAPACITORS

1/25v	4p	125/10v	7p
2.2/63v	4p	150/25v	6p
3.3/50	4p	160/25v	6p
4.7/40v	4p	220/16v	8p
10/25v	4p	220/25v	8p
15/16v	5p	220/63v	9p
22/10v	5p	330/10v	9p
22/16v	5p	330/25v	9p
22/25v	5p	330/63v	12p
33/35v	5p	470/6.3v	9p
33/50v	5p	470/16v	12p
47/25v	5p	470/40v	15p
47/16v	5p	680/6.3v	12p
47/50v	6p	1000/6.3v	15p
50/25p	5p	1000/16v	20p
100/10v	5p	1500/25v	20p
100/16v	5p	2200/10v	20p
100/63v	8p	3300/16v	25p
4700/10v	25p		

TTL

7400	10p	7438	19p	7494	43p
7401	12p	7440	12p	7495	37p
7402	12p	7441	50p	74107	20p
7404	12p	7442	38p	74121	26p
7405	12p	7446	51p	74122	34p
7406	25p	7447	43p	74123	42p
7408	14p	7450	12p	74132	48p
7409	14p	7451	12p	74141	56p
7410	10p	7470	26p	74151	38p
7411	15p	7472	22p	74153	38p
7412	16p	7474	23p	74154	60p
7414	42p	7475	24p	74160	45p
7416	22p	7476	19p	74164	60p
7420	12p	7485	50p	74174	55p
7421	20p	7486	21p	74175	55p
7427	20p	7489	£1.25	74192	48p
7430	13p	7490	32p	74193	48p
7432	17p	7491	30p	74194	43p
7437	18p	7492	30p	74196	48p
		7493	25p		

Single sided, copper clad, printed circuit board. 2⅝ x 8¼ Price: 10p
4½ x 9 Price: 25p

25 Mixed Rubber Grommets Price 16p

16mm screw-on cab. feet. Set of four Price: 5p

14mm square self adhesive feet. Set of four Price: 15p

Din Plugs 5 pin 180° Price 10p

Din Sockets 5 pin 180°. Standard metal type Price: 10p

Magnetic earpieces with 3.5mm plug Price: 12p

Reed Switches Price: 5p

Wire Neons 90 volts Price: 4p

75mm diam. 15 ohm Speaker Price: 60p

125mm x 78mm Oval 50 ohm Speaker Price: 75p

Latchswitch 2p 2w Price: 10p

DPDT Slide Switches Price: 12p

Green Phono Plugs Price: 6p

Bridge Rectifiers

W005 50v 1A Price: 25p

W04 400v 1A Price: 28p

Red L.E.D.s .2 inch Price: 8p

Green L.E.D.s 2 inch Price: 12p

Ceramic Filters 6MHz, SEF 6.0MB Price: 20p

Colour T.V. Crystals 4.433619MHz Price: 90p

PP3 Battery connecting leads Price: 6p

20mm chassis mounting fuse holders Price: 6p

20mm Panel Mounting F/H Price: 17p

DL500 Displays Common Cathode .5 inch displays Price: 75p

1p 12w Rotary Switches Price: 41p

RADIAL CAPACITORS

.47/50v	4p	220/50v	9p
1/50v	4p	220/63v	9p
2.2/25v	4p	330/10v	8p
10/40v	4p	330/25v	8p
10/50v	5p	330/50v	9p
15/16v	5p	330/63v	9p
22/25v	5p	470/6.3v	8p
22/50v	6p	470/16v	9p
33/63v	6p	470/25v	10p
47/16v	6p	1000/16v	20p
47/35v	6p	1000/25v	21p
100/35v	6p	1000/35v	23p
220/16v	8p	2200/10v	23p
220/40v	8p	3300/6.3v	24p

TRANSISTORS

AD161/2 MP	75p	BC182LB	9p	BF194	12p
BC107	9p	BC183A	10p	BF195	12p
BC108A	10p	BC207B	11p	BF198	15p
BC148	7p	BC212L	10p	BF200	25p
BC149C	8p	BC213LB	10p	BF750	15p
BC149S	9p	BC308	10p	TIP32B	45p
BC171B	10p	BC338	10p	2N2906	16p
BC172'b B	10p	BC547	11p	2N2907	18p
		BD183	90p	2N3055	45p
		BF137	11p		

C280 POLYESTER CAPACITORS 250v

.01uF	4p	.068uF	5p	.33uF	8p
.015uF	4p	.1uF	5p	.47uF	8p
.022uF	4p	.1uF 400v	7p	.68uF	12p
.033uF	4p	.15uF	6p	.68uF 630v	10p
.047uF	4p	.22uF	6p	1.0uF	15p

DIODES

BZY88c 6v2	7p	BZY88c 22v	7p
BZY83c 6v2	7p	BZY79c 68v	7p
BZY88c 7v5	7p	IN914	3p
BZY88c 8v2	7p	IN4148	2p
BZX79c 9v1	7p	IN4150	3p
BZY88c 15v	7p	IN4004	5p
BZY88c 20v	7p	IN4005	6p
OA91	4p		

CAN CAPACITORS

1250/50v	50p	10,000/10v	60p
2500/35v	70p	15,000/10v	60p
15,000/16v	75p		

SUB-MIN PRESETS

Horizontal: 100Ω 220Ω 470Ω 1k, 1k5, 2k2, 4k7, 10k, 22k, 47k, 100k.
Vertical: 470Ω 2k2, 4k7.
All price: 5p

All prices include V.A.T. and post and packing. Send for free pamphlet on all our instrument cases, boxes and components. Discount on boxes and instrument cases only, as follows: Orders over £10 5%, over £20 10%, over £30 15%.

HARRISON BROS. P.O. Box. 55, Westcliff-on-Sea, Essex. SS0 7LQ. Telephone: Southend-on-Sea (0702) 32338.

MORE I.C.'s

AJ371-002	4p
930399-500	4p
XK345	4p
343-5DR	4p
949DC	4p
937DC	4p
TYA0171	4p
SN15844	4p
930DC	4p
MC862	4p
SN75110	46p
TAA661B	35½p
SN76666N	35½p
SN76660N	35½p
MC135YP	35½p
MC1315P	35½p

C90 Cassette Tape 62p

50 ohm BNC plug through connector or round or flanged chassis socket 50p TNC plug or N plug or through connector 70p

Mullard +12-0-12V 1A, 4A stabilized, regulated, power supply. £12.50

27V 5A Double section bobbin transformer £4.50

250 Ω 50 watt + Resistor 40p

UK — Postal Orders for same day service. Cheques require 8 days from a Monday banking to ensure clearance: export — banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear.

SEMICONDUCTORS full spec. by Mullard etc. Many others in stock

AC128/176	16p
ACY20	30p
ACY29	22p
AD161/2 match pr.	70p
AF116	21p
AF124/6/7	27p
AF139	23p
AF178/80	35p
AF181	33p
AF239	35p
ASY27/73	35p
AU110 98p AU113	£1.51
BC107/8/9 + A/B/C	7p
BC147/8/9 + A/B/C	5p
BC157/8/9 + A/B/C	5p
BC171B/173	8p
BC178A/B 179B	14p
BC182/184C/LC	5p
BC186 23p BC187	8p
BC204	12p
BC212/213L/214B	5p
BC238/338	5p
BC327/8 337/8	8p
BC547/8 + A/B/C	5p
BC556/7/7B/8/9	5p
BCX32/36	15p
BCY31	59p
BCY40	31p
BCY70/1/2	8p
BCZ11	32p
BD113	57p
BD115	35p
BD116(BRC116T)	54p
BD131/2	16p
BD133	35p
BD135/6/7/8	30p
BD139 17p BD142	35p
BD140	32½p
BD201/2/3/4	88p
BD232	52p
BD234	13p
BD233/5	45p
BD238 28p BDX77	97p
BD437 52p BD438	28p
BF/115/167/173	18p
BF178/9	23p
BF180/1/2/3/4/5	18p
BF194/5/6/7	5p
BF194A, 195C	5p
BF200	13p
BF258	17p
BF234	15p
BF262	33p
BF263	29p
BF336	31p
BF274	8p
BFS28 Dual Mosfet	£1.15
BFT61	40p
BFW10/11 F.E.T	46p
BFW30	£1.15
BFW57/58	21p
BFX12/29/30	23p
BFX84/88.89	20p
BFY50/51	13p
BFY90	50p
BR101	34p
BRY39/56	29p
BSV64	36p
BSV79/80 F.E.T.s	50p
BSV81 Mosfet	75p
BSX20/21	10p
BSY40	30p
BSY95A	14p
BU204 + Mount Kit	78p
BU208	£1.85
CV7042 (OC41/44 ASY63)	12p
GET111/E112	45p
OC45(ME2)	13p
ON222	23p
R2008B	92p
R2010B	79p
TIP30/48	33p
TIS43 (2N2646)	22p
μA7805 Reg.T03	55p
ZT1486	£1.15
ZTX300/341	9p
2N393 (MA393)	35p
2N456A	57p
2N706A	13p
2N918	12p
2N929	16p
2N987	45p
2N1484	£1.15
2N1507/2219	18p
2N2222A	8p
2N2401	35p
2N2412	27p
2N2483	28p
2N2904/5/6/7/7A	9p
2N3053	16p
2N3055 R.C.A.	42p
2N3133/4062	24p
2N3553	56p
2N4037	30p
2N5484 FET	37p
40250(2N3054)	35p

OTHER DIODES

1N916	4p
1N4009	9p
1N4148/1N914	1½p
BA145	15p
Centercel	29p
BZY61/BA148/OA81	12p
BB110 Varicap	24p
BB113 Triple Varicap	43p
BA182/BB103 Varicap	6p
OA5/7/10	17p
BZY88 up to 43 volt	5p
BZX61 11 volt	15p
AA133 10p AA119	7p
BZY96C 10V	34p
BZY95C 33V or 15V	34p

RS *Irravin* high temperature wire, 19/0.16, minus 55° to 105°C. 600V 3A, white, black or red. Quarter trade price at 22½p 10M coil.

PVC QUALITY TAPE

Lasso 10m x 15mm grey **38p**
33m x 33mm green **£1.13p**

Trimmer: Post stamp type 3-30pF	10p
10-80pF	10p
30-140pF	23p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	34p
1	140	OSH01-200	30p
5	100	Ex Equip	73p
0.6	110	EC433	20p
5	400	Texas	£1.10
2½	100	I.R.	48p
3¼	100	B40C 3200	58p

CATALOGUE

38, 11 x 8 ins illustrated sheets, listing approx. 5,250 items, photo printed on day requested, from constantly updated masters, to ensure latest stock position, 75p (refundable with orders) plus 27p s.a.e. or label.

TRANSFORMERS

Ferromag C core. Screens 95-105-115-125-200-220-240v input output 17v ½A x 2 + 24-0-24v 1.04A+20v 1mA. These current ratings can be safely exceeded by 50%. **£5.00**

Cassette Dynamic Microphone with switch and twin plug **£1.35**

Telephone Pickup, sucker with lead and 3.5 plug **62p**

GARRARD

GCS23T Crystal Stereo Cartridge **£1.24**
Mono (Stereo compatible) Ceramic or crystal **£1.14**

RECTIFIERS

	Amp	Volt	
M1	½	68	5p
1N4002	1	50/100	3p
1N4004/6/8	1	4/800	3½p
1N4007/BYX94	1	1250	4½p
BY103	1	1,500	21p
SR100	1.5	100	9p
SR400	1.5	400	10p
REC53A	1.5	1,250	16p
LT102	2	30	15p
BYX22-200	1½	300	25p
BYX38-300R	2.5	300	48p
BYX38-600	2.5	600	52p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-300R	3	300	35p
BYX49-600	3	600	42p
BYX49-900	3	900	47p
BYX49-1200	3	1,200	60p
BYX48-300R	6	300	47p
BYX48-600	6	600	60p
BYX48-900	6	900	70p
BYX48-1200R	6	1,200	92p
BYX72-150R	10	150	42p
BYX72-300R	10	300	52p
BYX72-500R	10	500	65p
BYX42-300	10	300	36p
1N5401	3	100	13p
1N5402	3	200	15p
MR856	3	600	24p
BYX42-900	10	900	92p
BYX42-1200	10	1,200	£1.07
BYX46-300R	15	300	£1.19
BYX46-400R	15	400	£1.75
BYX46-500R	15	500	£2.00
BYX46-600	15	600	£2.30
BYX20-200	25	200	72p
BYX52-300	40	300	£2.05
BYX52-1200	40	1,200	£2.90
RAS310AF	1.25	1,250	48p

OPTO ELECTRONICS

Diodes	
BPX40	57p
BPX42	92p
BPY10	92p
(VOLTIAC) BPY68	
BPY69	92p
BPY77	
Wire end neons	4p

Photo transistor	
BPX29	92p
OCP71	40p

L.E.D.'s
.2" Red Mullard CQY24 **8p**
TIL209 .25" red 9p or green **13p**

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp **£1.15**

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 19m/a segment, common anode **80p**
HP .43 in yellow **£1.50**
RS 0.6in. green **£1.77**
Minitron 0.3in 3015F filament **£1.25**

CQY11B L.E.D.
Infra red transmitter . . **£1.15**
H15B Photon coupled isolator I.R. diode & NPN Photo-Darlington amp **£1.05**
Data Sheet **10p**

THYRISTORS

Amp	Volt		
1	240	BTX18-200	35p
1	400	BTX18-300	41p
1	240	BTX30-200	35p
4	500	40506	58p
15	500	BT107	£1.00
6.5	500	BT109-500R/SCR957/BRC4444	71p
20	600	BTW92-600RM	£3.40
15	800	BTX95-800R Pulse Modulated	£8.75

	Plug	Chassis socket	Line socket
2.5	12p	10p	—
3.5	10p	6p	11½p
	plastic 11½p metal	switched	
¼	17p	20p	16p
Stereo	26½p	20p	28p
Speaker	7p	7p	—
		switched	
3DIN	11p	10p	14p
5DIN 180°	10p	10p	14p
5DIN 240°	13p	8p	16p
Phono	6p	6p	15p

Twin Socket 9p, Triple 20p, 4mm Plug or Socket 9p, TV coax plug 9p, Socket 8p, Line connector 9p, Surface outlet box 40p.

DIGITAL I.C.'s

7400	10p	7401/2	8p
7410			6p
7404/20/30/50			9p
7406			15p
7414			39p
7417/26/32			15p
7441	25p	7442	22p
7437/38	15p	7451/54	12p
7445	42p	7472/76	20p
7473	16p	7474	19p
7490/8280			25p
7482/83			45p
7486	14p	7493	18p
74107	16p	74118	75p
74122	25p	74123	35p
74132	44p	74141	42p
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RIPPLE	<5mV 2,2 Amp
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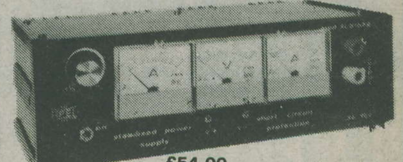

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OUTPUT VOLTAGE RANGE	± 1,7 ± 15 V dc
OUTPUT CURRENT RANGE MAX	3 Amp
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WEIGHT	4,140 Kg.

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CMOS OSCILLATORS

by
R. J. Caborn

Using CMOS logic gates as pulse generators.

CMOS logic circuits frequently require low frequency oscillators or pulse generators, these being used for such purposes as producing clock pulses or causing light-emitting diodes to attract attention by flashing on and off. It then becomes desirable to use CMOS logic gates themselves in the oscillator circuit.

The amplification required for oscillation may be provided by two CMOS inverters in tandem, as shown in Fig. 1(a). The output is in phase with the input, and if the output is coupled back to the input by way of a frequency controlling RC network, an oscillator will result. NAND gates with 2 inputs (as in the CD4011) and 2-inputs NOR gates (as in the CD4001) are usually easier to obtain than CMOS inverters, and they can be used as inverters by connecting their inputs together. Fig. 1(b) shows two NAND gates connected as inverters, whilst Fig. 1(c) shows two NOR gates similarly connected.

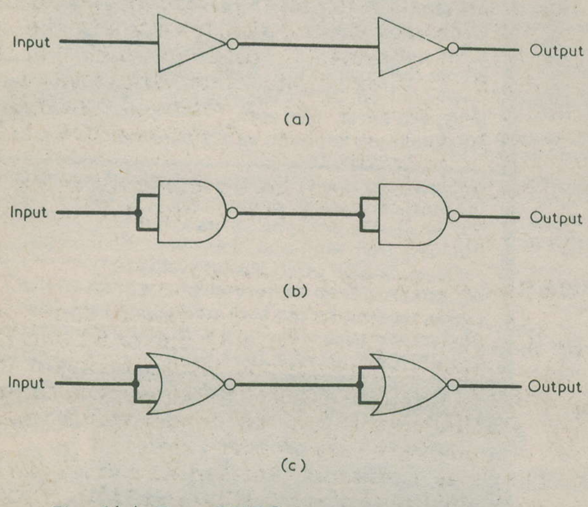


Fig. 1(a). Two CMOS inverters connected in tandem. The output is in phase with the input (b). NAND gates may be employed to act as inverters (c). The inverters may also consist of NOR gates

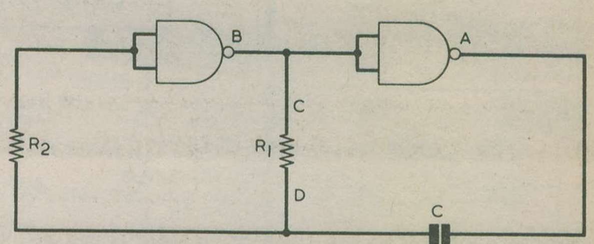


Fig. 2. Recommended CMOS oscillator circuit. NAND gates are shown here, but the circuit will function equally well with inverters or NOR gates

RC NETWORK

Several CMOS oscillator circuits with RC frequency control have appeared in this and other journals, but what is possibly the best for low frequency and audio frequency applications is that shown in Fig. 2. Before discussing how this circuit functions it is necessary to briefly consider two aspects of a CMOS inverter, or of a NAND gate or a NOR gate connected as an inverter.

Fig. 3 gives a transfer characteristic for a CMOS inverter at a supply voltage of 10 volts. The output voltage stays at 10 volts for an input voltage change of zero to about 2 volts, after which it starts to fall. At the other end of the curve, the output voltage stays at zero for an input voltage between about 8 and 10 volts. The curve of Fig. 3 is typical only, and the device will still be within specification if the output commences to fall at any input between 1 and 3 volts, or to rise above zero level at any input between 7 and 9 volts. This spread means that frequency calculations for an RC controlled CMOS oscillator can only be of an approximate nature.

The second aspect of a CMOS inverter which has to be considered is the presence of the "hidden" protection diodes at each gate input. The normal

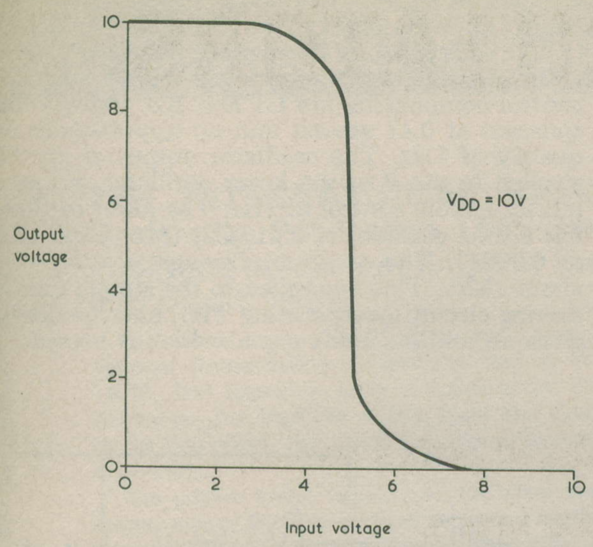


Fig. 3. Typical transfer characteristic for a CMOS inverter

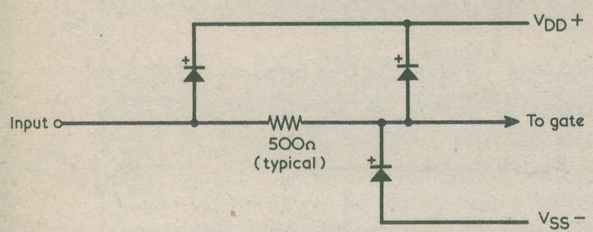


Fig. 4. CMOS logic gates have diode input protection circuits

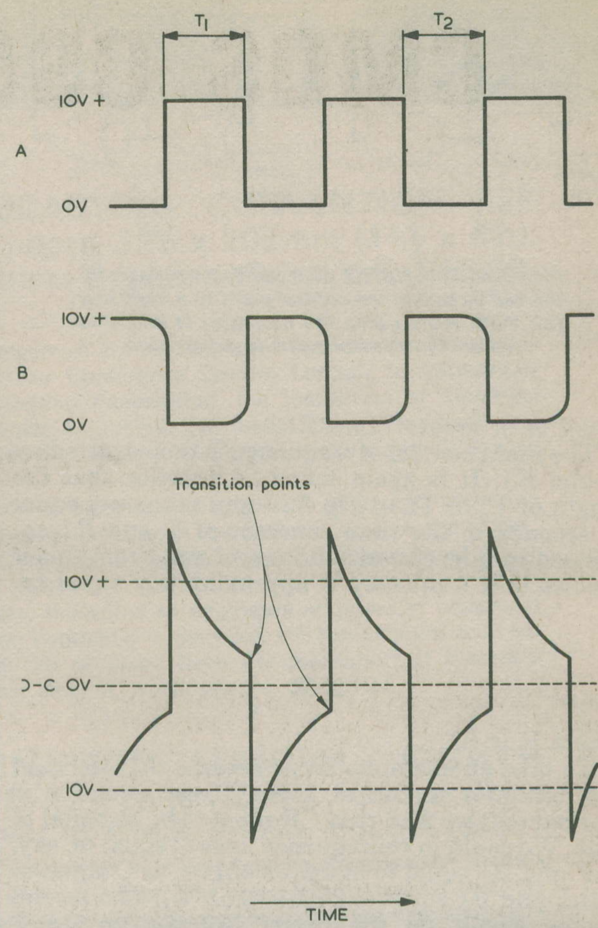


Fig. 5. Waveforms appearing in the oscillator circuit of Fig. 2. The bottom waveform shows the voltage at point D with respect to point C

gate input protection circuit is shown in Fig. 4, and the diodes conduct to protect the gate if the input is taken more than 0.6 volt positive of the positive rail, or more than 0.6 volt negative of the negative rail.

Representative curves for the oscillator of Fig. 2 are given in Fig. 5, the upper two curves showing the voltages at points A and B respectively. A 10 volt supply is assumed. The third curve shows the voltage at point D with respect to point C. If we commence our examination at an instant half-way along the T1 section of the curves, we have point A high and point B low. Capacitor C in Fig. 2 is discharging into R1, and the voltage at its left-hand terminal is applied to the input of the left-hand inverter via R2.

As the input of the left-hand inverter goes more and more negative it reaches the curved section of the inverter transfer characteristic, and the inverter output, at point B, commences to go positive. It continues to go positive until it arrives at the curved section of the transfer characteristic of the right-hand inverter, whereupon both inverters become capable of linear amplification. There follows a very rapid changeover, and it results in point A going low and point B going high.

The changeover starts at the "transition point" in the bottom waveform of Fig. 5, at which point the left-hand terminal of capacitor C is negative of its right-hand terminal. When point A goes low, the left-hand terminal of the capacitor is then taken *negative* of the negative supply rail by, typically, about half the supply voltage. At the start of the next half-cycle, therefore, the capacitor is discharging both through R1 *and* through R2 and the appropriate input protection diode (or diodes) of the left-hand inverter input. The discharge path through R2 ceases when the left-hand terminal of the capacitor is less than 0.6 volt negative of the negative supply rail.

The cycles then continue as illustrated in Fig. 5, each half-cycle being a mirror image of the half-cycle preceding it.

OSCILLATOR FREQUENCY

The oscillator frequency is obviously controlled by the values of the capacitor C, and of R1 and R2. Since transfer characteristic spread makes it impossible to calculate oscillator frequency accurately, simplifications can be made which make calculations very easy to carry out.

The range of suitable values in R1 and R2 can lie between the limits of some 10kΩ and 1MΩ. If R2 is given a value which is equal to or greater than R1 it is found in practice that it has only a small effect on oscillator frequency, and its presence can be ignored. So the final step in calculating component values is simply to remember that R2 must be

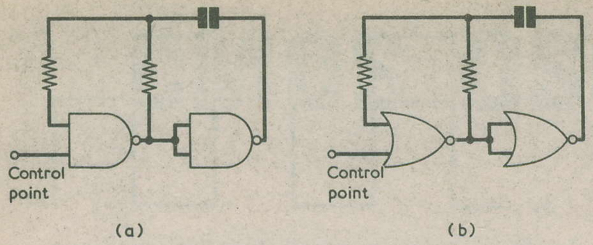


Fig. 6(a). This NAND gate oscillator may be inhibited by taking the control point to a logic low (b). With NOR gates the oscillator is inhibited when the control point is taken high

equal to or greater than R1.

The main control of frequency is then exerted by C and R1. It is again found in practice that the length of T1 or T2 in Fig. 5 is approximately equal in seconds to the time constant of C and R1 expressed in microfarads and megohms. From this it follows that frequency is approximately equal to

$$\frac{1}{2CR},$$

where R is R1.

To take an example, let us assume that we want the oscillator to run at 10Hz. If the equation is worked out, we find that CR must then be equal to 0.05. We could in consequence have C equal to, say, 1μF and R1 equal to 50kΩ (0.05MΩ), or C equal to 0.1μF and R1 equal to 500kΩ (0.5MΩ). The second choice would be the better because an 0.1μF capacitor is usually cheaper and less bulky than a 1μF capacitor. Since we are working approximately only, R1 could be 470kΩ. The remaining step is merely to make R2 of Fig. 2 470kΩ or, say, 1MΩ.

Where a frequency is required more precisely, the values calculated as just described make a useful starting-off point. The value of R1 can then be finally trimmed until the required oscillator frequency is given.

INHIBITING

If the oscillator inverters consist of NAND gates or NOR gates, the oscillator can be readily inhibited or enabled. In the circuit shown in Fig. 6(a), which employs NAND gates, one of the inputs of the left-hand gate is taken to a control point. The oscillator will only run if the control input is taken to a high logic level. The oscillator is inhibited if the control input is taken low.

The reverse occurs with the two NOR gates of Fig. 6(b). In this case the oscillator is enabled when the control input is low and is inhibited when the control input is high.

A simple 1-second bleeper circuit is given in Fig. 7. In this diagram the upper oscillator frequency control components are C1 and R2, giving a time constant of 0.47 second and an approximate frequency of 1Hz. The oscillator output at pin 4 is applied to pin 8 of the lower oscillator, giving an inhibit-enable control at 1Hz. The lower oscillator has a time constant of 0.01 (C2) times 0.047 (R4), or 0.00047. The oscillator frequency is therefore about 1kHz. This is applied to the simple speaker driving circuit incorporating TR1, and the bleeper gives an audible 1kHz signal which is present for

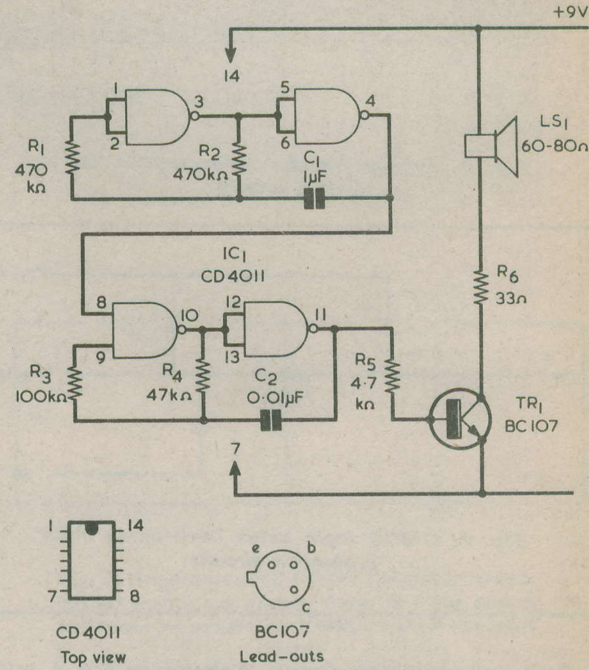


Fig. 7. A 1-second bleeper circuit incorporating a CD4011. All the resistors may be ¼ watt 5%. The function of R6 is merely to limit collector current in TR1

about 0.5 second and absent for about another 0.5 second in each cycle. If the bleeper is required to give pulses at almost exactly 1Hz, R2 may be replaced by a 390kΩ resistor in series with a 220kΩ pre-set potentiometer. The potentiometer is then set up as accurately as possible for 1 second operation. ■

RECENT PUBLICATIONS

7TH INTERNATIONAL BROADCASTING CONVENTION (IEE Conference Publication 166). 364 pages, 295 x 205mm (11½ x 8in). Published by the Institution of Electrical Engineers. Price, U.K. £15.00, overseas £18.50.

This book comprises 82 technical papers presented by leading engineers at the 7th International Broadcasting Convention held at Wembley Conference Centre, London, in September 1978. The sponsors were the Electronic Engineering Association, the Institution of Electrical Engineers, the Institute of Electrical and Electronics Engineers, the Institution of Electronic and Radio Engineers, the Royal Television Society and the Society of Motion Picture and Television Engineers.

The papers cover virtually all technical aspects of current and projected radio and television broadcasting, and the authors represent bodies based not only in the U.K. but also in the U.S.A., Canada, Japan, Australia, Federal Republic of Germany, Republic of Ireland, Republic of South Africa, Denmark, the Netherlands, Belgium and Italy.

Although this notice has been subject to delay, the value to engineers engaged in advanced transmission development work of the information contained in the book still remains vastly in excess of the charge made for it. The book may be obtained from the Institution of Electrical Engineers, Marketing Department, Station House, Hitchin, Hertfordshire, SG5 1RJ.

RADIO AMATEURS' EXAMINATION MANUAL, EIGHTH EDITION. By G. L. Benbow, G3HB. 120 pages, 248 x 184mm (9½ x 7in). Published by the Radio Society of Great Britain. Price £1.85.

The trend in technical examination these days is towards multiple-choice questions with which a correct answer has to be picked from a number of alternatives. This approach certainly makes the job of examination paper markers considerably easier but, since the person sitting the examination is presented with one answer among several which has to be correct, the examination can hardly be as searching as the older type in which the candidate faced a blank piece of paper. In the same way that Napoleon preferred officers who were lucky our institutes are apparently beginning to favour examinees who also possess that attribute.

At any event, the Radio Amateurs' Examination has now changed over to multiple-choice questions and this fact, combined with alterations in the R.A.E. syllabus, has caused the appearance of this new 1979 edition of "Radio Amateurs' Examination Manual". As with all R.S.G.B. publications which this reviewer has seen, presentation of text and diagrams is excellent. The book commences with the procedure of becoming a radio amateur transmitter and then deals with the technical information which the R.A.E. applicant will need to know. There are four appendices, of which the last gives two practice R.A.E. multiple-choice question papers with, on the final page of the book, correct answers.

Apart from its value to budding radio amateurs, most of the volume forms a useful textbook in its own right. If desired, "Radio Amateurs' Examination Handbook" may be obtained direct from the Radio Society of Great Britain, 35 Doughty Street, London WC1N 2AE, at £2.16 including post and packing.

"HOW IT WORKS" – TELEVISION. By David Carey. 52 pages, 170 x 115mm. (6¾ x 4½in). Published by Ladybird Books Ltd. Price 30p.

To attempt in some 6,000 words to explain the manner in which television works, and to include in those 6,000 words accurate descriptions of scanning, transmission and reception, audio detection, amplitude modulation, studio practice, O.B. practice and colour reproduction is a challenge to daunt any technical journalist. David Carey succeeds in meeting the challenge and, what is more, presents his text in a manner which can be understood by the children for whom Ladybird Books are, presumably, mainly produced. The colour illustrations by B. H. Robinson assist considerably.

What is primarily to be commended is the fact that the text does not gloss over or give misleading short-cuts with technicalities but presents these accurately. The book is curiously dated in several places, as in the references to "Light", "Home" and "Third" on page 35, and to 405 lines on page 32, but this does not detract overmuch from its value. The book will certainly be genuinely instructive for any youngster who wishes to find out how the television picture appears on his domestic screen.

NEWS . . . AND

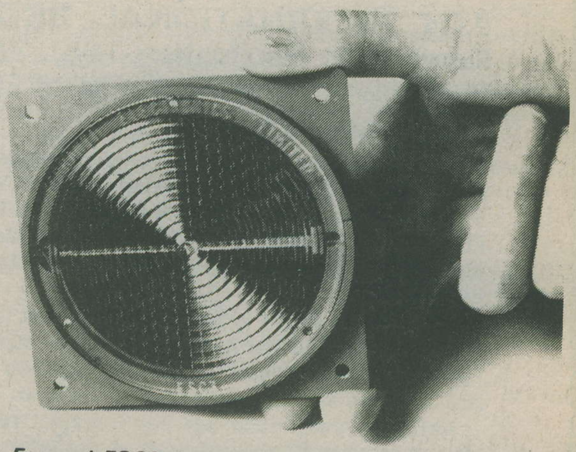
EDUCATIONAL SOLAR CELL FROM FERRANTI

Ferranti Electronics Limited have developed and produced a Silicon Solar Cell specifically for educational use.

The cell, designated the ESC3 series, is 3ins. in diameter and is capable of producing 0.9A at 0.5V under good sunlight conditions. Physical protection is provided by a tough moulded case and by a Fresnel lens which also acts as a light collector Power take off is from metal pins on the rear of the case. Accidental short circuiting of the output will not damage the cell, and any number of cells can be arranged in series/parallel combinations to provide increased output values.

In addition to providing an educational aid for schools, colleges and universities it can provide the DIY enthusiast with a power source for operating functional models and electro/mechanical devices.

Further information can be be obtained on application to: Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancs, OL9 8NP.



The Ferranti ESC3 Solar Cell which will produce 0.9A at 0.5V under good sunlight conditions. Ferranti Electronics Limited have developed the cell specifically for educational use, although there are obvious DIY applications

NEW INDUSTRY LINKED DEGREE COURSE

A new 4½ year degree course in Electronic/Electrical Engineering has been devised jointly by Bath University and GEC-Marconi Electronics Limited. The course covers a broad spectrum of electronic/electrical engineering and yet allows for specialised study to a greater than normal depth. It is intended for students of high calibre and will lead to a Master of Engineering degree (M.Eng).

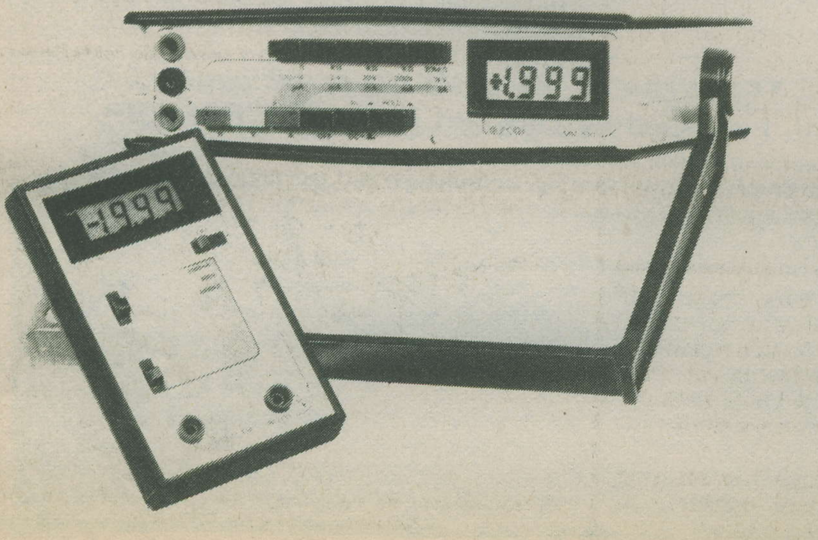
Bath University already has an excellent reputation for its electronic and electrical degree courses and always draws a very high level of candidates for them. The University has entered enthusiastically into the joint study which also has the support of the Engineering Industries Training Board in the form of a grant.

The course will start in September 1980. Applications to enter the course should be made to the School of Electrical Engineering, Bath University, Claverton Down, Bath, from where full details may be obtained.

TWO NEW DIGITAL MULTI-METERS FROM LASCAR

Lascar Electronics, the Essex based manufacturers of Digital Panel Meters And Counters have moved to larger premises in Basildon.

At the same time two new digital multi-meters have been introduced. Both have LCD read-outs for clarity and long battery life, and are claimed to be considerably lower cost than imported products of similar specification.



The LMM-100 is suitable for field or bench use, has 25 different ranges, a basic accuracy of 0.1% and is priced at £69.95 + VAT.

The LMM-200 is a compact hand-held instrument, with 15 different ranges, a basic accuracy of 0.5% and a 200 hour battery life. It is priced at £34.95 + VAT and should have wide appeal in many different applications.

Another ten instruments will be introduced over the next year. Eventually the range will include frequency counters, counter-timers, thermometers and other general purpose instruments. All will feature LCD read-outs for extended battery life and high portability.

Lascar Electronics are now at Unit 1, Thomasin Road, Burnt Mills Industrial Estate Basildon, Essex.

. . . COMMENT

NEW DC TURNTABLE FOR THE PROFESSIONAL USER

Lee Engineering Limited of Napier House, Bridge Street, Walton-on-Thames, Surrey KT12 1AP have introduced into the UK the QRK Electronics GALAXY, a new DC Turntable designed for the professional user. It has a D.C. Motor with an electronic speed control which provides for plus or minus 10% speed variation on both 33⅓ and 45 RPM. The turntable which is instant starting, provides for slip cueing without a loss in speed and it has back cueing with no drag.

Direct speed readout on LED's of the RPM is located on the front panel. Switching is digital with remote start/stop for operator convenience. Bob Sidwell, President of QRK of Fresno, California, says this is the first new turntable designed and manufactured for the professional user in the U.S. since the original outer rim drive table which QRK introduced in 1944.

The turntable costs approximately £350.00.

FIRST UK '3-CHANNEL' SURROUND-SOUND BROADCAST

The first experimental transmissions of an improved stereo-compatible system of 'surround-sound' broadcasting developed by IBA engineers have been made on the Independent Local Radio station 'Radio Victory' at Portsmouth.

On Sunday, September 23, 1979 a two-hour concert recorded by IBA and Radio Victory engineers at Chichester Cathedral last July was broadcast in surround-sound on Radio Victory's VHF/FM service on 95.0MHz.

The surround-sound system uses a 3-channel matrix transmission system that has been developed at the IBA engineering centre at Crawley Court, Winchester to improve stereo-compatibility beyond that found possible with '2-channel' and '2½-channel' systems.

These experiments are part of an IBA investigation into surround-sound techniques with particular reference to the 'ambisonics' techniques of the National Research Development Corporation.

Continuing IBA work has underlined the advantages of a full '3-channel' system using a new IBA matrix, particularly in respect of the excellent compatibility for listeners using conventional mono or stereo equipment. The penalties imposed by such a system may be a slight reduction of coverage area and non-compatibility with the earlier 'surround-sound' systems.

IBA engineers stress that these '3-channel' experiments are not yet at a stage where it is possible to recommend a 'surround-sound' standard for national or international use.

Readers will only be too well aware, from their own experience, how costs are rising in all directions which, of course, also applies to this magazine and we regret that, with this issue our cover price has had to be increased by 5p. We know that our high standards are greatly valued and we shall continue to maintain them.

We have in the pipeline many highly interesting and worthwhile projects which will continue to make this magazine a 'must' for so many.

LONG LIVE SHORT WAVE

Rather belatedly, we give news of a record, entitled as above, produced by Mitch Murray, one of this country's leading songwriters and record producers.

On side one, after some introductory music from "Toys for Big Boys", one of Mitch Murray's songs, there follows an introduction and information on frequencies, propagation and the Radio Spectrum. This is succeeded by indentification of Facsimile Telegraphy, RTTY, Slow Scan etc. Satellites, Decoding Single Side Band, Receivers, Aerials are among other topics dealt with. There is also a talk by Henry Hatch, of BBC World Radio Club fame, on the DX hobby.

Side two consists entirely of station identifications, more than thirty of them from Australia's "Waltzing Matilda" to Voice of America's "Yankee Doodle Dandy".

This unique LP is a first class introduction to the DX hobby and is a useful accessory for SWL enthusiasts. The record is priced at £3.50, inclusive of postage, and is obtainable from Trans-Island Productions Ltd., P.O. Box 24, Douglas, Isle of Man.

"Sir, according to my 'light charge' alarm unit, there's a brigade of horsemen coming up the valley."

SUGGESTED CIRCUIT

AMPLIFIER CLIPPING MONITOR

By G. A. French

Whilst solid-state a.f. amplifiers have many practical advantages when compared with valve amplifiers, they tend to suffer from one single disadvantage. This disadvantage arises when the amplifier goes into overload. If a valve amplifier overloads the resultant distortion increases gradually, whereas overload in a solid-state amplifier results in a very sharp rise in distortion which is, also, subjectively unpleasant. Solid-state a.f. amplifiers almost always employ a totem-pole output stage and the sudden increase in distortion arises when the positive and negative output voltage swings become too large to be handled by the output transistors. The result is that signal voltage peaks become flattened, and the effect is referred to as "clipping".

Due to the widely varying amplitude of most types of music it is possible for a solid-state amplifier to be set up such that the majority of the music signal is given virtually distortion-free reproduction with only occasional peaks being clipped. The clipping effect may even pass unnoticed by listeners with less musical ears although it can cause anguish to listeners with experience of good quality audio reproduction. In cases where amplifiers are operated at very high output levels, as occur in discos and musical festivals, occasional or even frequent clipping can occur and may not be audibly evident to the operator of the amplifier if he is close to one or more of the loudspeakers in the system. With domestic high fidelity systems, the operator will want to avoid clipping on high volume peaks but, if the clipping is only slight and occasional, may not realise that it is occurring.

The solution to all these problems is to add to the amplifier concerned a monitor which gives a visual indication when clipping occurs, or when the output signal voltage level is just below the level at which clipping will take place. This article describes a very simple clipping level monitor circuit which can be added to most conventional solid-state mains-powered amplifiers and which causes a light-emitting diode to be illuminated when the output signal level exceeds a predetermined value. It should be stressed that the circuit requires changes in components or component values to suit particular amplifiers and that it may require some experiment on the part of the constructor. The circuit should only be used by readers who are reasonably familiar with a.f. amplifier operation and who have the ability to make connections into an existing amplifier without causing any damage thereby.

BASIC CIRCUIT

The basic circuit of the clipping monitor appears in Fig. 1, and here it is assumed that the amplifier has positive and negative supply rails giving a voltage between 20 and 40 volts, that the supply is capable of providing the few extra milliamps required by the monitor circuit and that the amplifier clips when the output signal voltage approaches the negative rail by less than 1.2 volts. If the amplifier has a conventional totem-pole output circuit, the

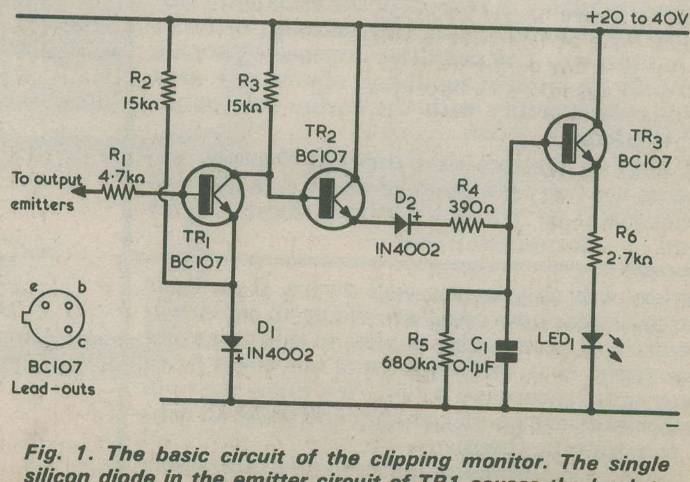


Fig. 1. The basic circuit of the clipping monitor. The single silicon diode in the emitter circuit of TR1 causes the l.e.d. to light up when the output emitters have a voltage which is less than 1.2 volts positive of the negative rail

output will be available at the junction of the two output transistors, frequently at the emitters of two emitter followers, and its voltage will be central between the two supply rails under quiescent conditions. The output then normally couples to the loudspeaker via a large-value electrolytic capacitor. In this article we shall, for convenience, refer to the output point as "the output emitters" although, in practice, the output may be at the junction of two collectors, or at the junction of an emitter and a collector. Where there are small series resistors to prevent thermal runaway, or a small series choke, the output point is considered to be on the speaker side of these components.

The amplifier output point couples to the base of TR1 via R1, which has a very high value compared with the loudspeaker impedance and should have no effect whatsoever on amplifier performance. At all signal output voltages which cause the left-hand end of R1 to be positive of the negative rail by greater than about 1.2 volts, TR1 is turned on and its collector voltage is only slightly positive of the negative supply rail. The 1.2 volt voltage delay is due to the forward voltage drop of 0.6 volt in silicon diode D1, and the similar forward voltage drop in the base-emitter junction of TR1.

If the output voltage takes the left-hand end of R1 to less than the voltage delay TR1 turns off. The base of emitter follower TR2 is very quickly taken to the positive supply rail by R3, causing C1 to charge via diode D2 and current limiting resistor R4. TR3 is another emitter follower and the positive voltage which now appears on its base causes its emitter to go positive and light up LED1. If TR1 now turns on again its collector at once goes to a low voltage above the negative rail, taking the base of TR2 with it. This does not cause any discharge in C1, however, because D2 now becomes reverse-biased, and no current can flow through it and the emitter-base junction of TR2 (which acts like a zener diode at its reverse breakdown voltage).

C1 now commences to discharge through R5 and the base of TR3, whereupon LED1 extinguishes more slowly than would be the case if C1 were not present. Without C1 in circuit the l.e.d. would give only a momentary flicker if TR1 were turned off by, say, a single short transient signal at clipping level. C1 ensures that the l.e.d. remains alight for a longer time so that a much more noticeable effect is given. The

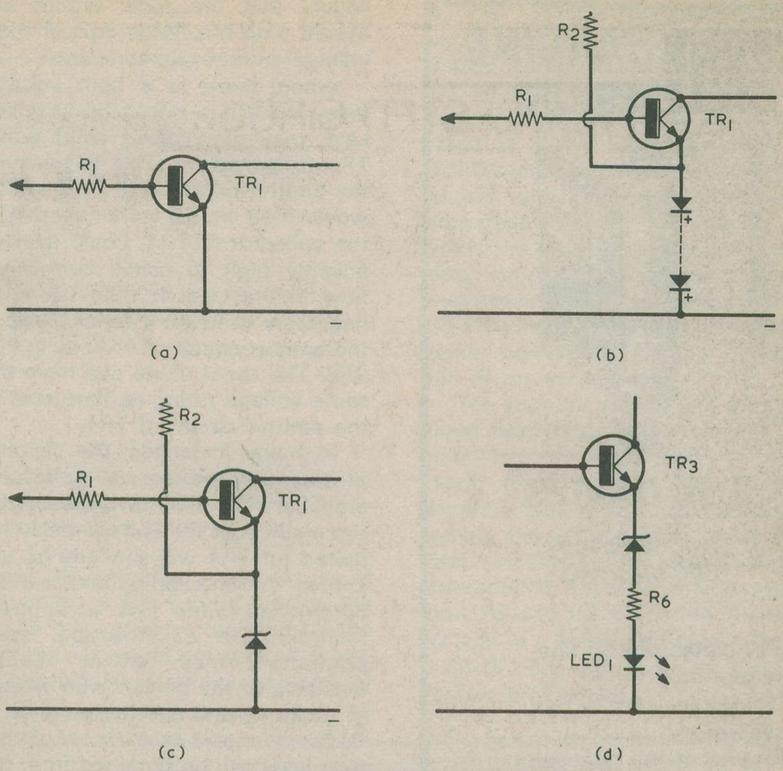


Fig. 2(a) If D1 and R2 are omitted, and the emitter of TR1 is connected direct to the negative rail, the voltage delay at TR1 base is 0.6 volt anly

(b). A higher voltage delay is given by connecting two or more silicon diodes in the emitter circuit

(c). In cases where a large number of silicon diodes would be required, a zener diode may be employed instead

(d). When there is a high voltage delay it may be necessary to add a zener diode in the emitter circuit of TR3

capacitor also provides a greater brightness level in the l.e.d. when TR1 is turned off by a series of negative half-cycle signal peaks, since the l.e.d. remains at least partly illuminated between the peaks. The time constant of the circuit, taking into account TR3 base current, is roughly 0.04 second, which is the length of a cycle at 25Hz.

All the resistors may be 5% or 10% types, and R2 to R5 inclusive should have a rating of ¼ watt. At supply voltages below 30, R1 may be ¼ watt and R6 ½ watt. Above 30 volts R1 should be ½ watt and R6 1 watt. Where only gain-selected BC107's are available, the three transistors can be BC107B or BC107C, although their gain figures are not in practice particularly critical. LED1 can be any l.e.d. of any desired colour. With a supply of 30 volts there is a 2mA flow in both R2 and R3 and about 10mA in R6 when the l.e.d. is fully alight.

VOLTAGE DELAYS

In Fig. 1 it was assumed that clipping occurred when the amplifier output negative peaks were less than about 1.2 volts positive of the negative rail. However, different amplifiers will have different clipping levels and the voltage delay provided in the emitter circuit of TR1 has to be set up to suit the particular ampifier with which the clipping monitor is to be used.

In Fig. 2(a) there is no voltage delay component in the emitter circuit, and R2 of Fig. 1 is not needed. The monitor will then cater for amplifiers which clip when negative voltage peaks are less than about 0.6 volt positive of the negative rail. Two or more silicon diodes, which may all be 1N4002 or similar, are used in Fig. 2(b). The voltage delay between the base of TR1 and the negative rail is then approximately equal to 0.6 volt multiplied by the number of diodes plus the 0.6 volt given by the base-emitter junction of TR1. Four diodes would, for instance, give 4 x 0.6 + 0.6, or 3 volts delay. For delay voltages above this level, it would be preferable to use a single zener diode of the appropriate voltage, as in Fig. 2(c). Diodes in the BZY88 series would be suitable. R2 should then be reduced to 7.5k Ω ¼ watt, to ensure that the zener diodes are biased onto the flatter part of their voltage-current characteristic.

When there is a high voltage delay there is a possibility that the l.e.d. may glow dimly even when TR1 is turned on. This is because the emitter potential of TR3, which would then be 1.8 volts negative of the collector of TR1, could be sufficiently high to cause current to flow in the l.e.d. It then becomes necessary to insert a zener diode in the emitter circuit of TR3, as in Fig. 2(d). The zener diode can have the same voltage rating as that used in the emitter circuit of TR1.

In many instances, the clipping output voltage for a particular amplifier may not be known, with the result that the voltage delay required for TR1 will similarly be unknown. Whilst clipping level can be determined with test equipment, including an oscilloscope, such equipment may not be readily available to the person who wishes to make up and use the monitor. A fairly reasonable assessment of clipping level can be obtained from the amplifier specifications remembering that, from Ohm's Law, voltage squared is equal to power in watts multiplied by resistance in ohms. To take an example, let us suppose that we have an amplifier which operates with a 30 volt supply and which is stated to have a maximum r.m.s. output power of 16 watts into 4 Ω. The product of 16 and 4 is 64, which is equal to the r.m.s. output voltage squared. The maximum r.m.s. output voltage for the amplifier is thus 8 volts. If we multiply this by 1.4, we find that the corresponding peak voltage is 11.2 volts. It is fairly safe to assume from this that the amplifier will start approaching overload when its peak output voltage significantly exceeds 11.2 volts. The next process is to measure the quiescent output voltage between the output emitters and the negative rail, and this could be, say, 14 volts. The voltage delay for the clipping monitor could then be set at 14 minus 11.2 (= 2.8) if it is to respond to negative peaks of 11.2 volt or more. In practice, the delay could be set at 2.4 volts by using three diodes in the circuit of Fig. 2(b), or at 1.8 volts by using two diodes. Subsequent checks, consisting of deliberately running the amplifier close to or into overload, will indicate whether the clipping monitor is capable of detecting occasional negative peak excursions which go up to distortion level.

This approach has to be of an approximate nature but should nevertheless enable the monitor to indicate output signal levels which approach or are at the clipping level. The example purposely employed "easy" figures to assist in demonstrating the procedure, but the work involved in calculating the peak output voltage is quite easy if a pocket calculator is employed.

Since the amplifier concerned will almost certainly be one of a pair in a stereo system, another monitor circuit will need to be fitted also in the second amplifier. This can have the same voltage delay as was considered desirable for the first amplifier.

SUPPLY VOLTAGES

The circuit of Fig. 1 is, as was stated, suitable for amplifiers having a positive and negative supply of 20 to 40 volts. The monitor is then connected as shown in Fig. 3(a).

More powerful amplifiers have positive and negative rails on either side of a central zero voltage rail. When the voltages are suitable the clipping monitor may be powered by the zero voltage rail and the

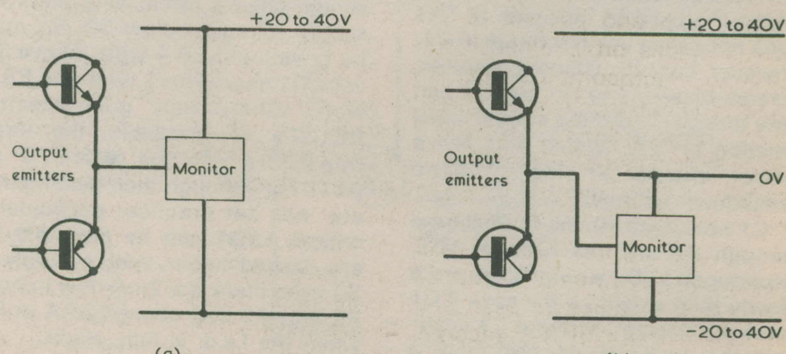


Fig. 3(a). With amplifiers having two supply rails the monitor is connected as shown here

(b). This method of connection may be employed when the amplifier has a central zero voltage rail

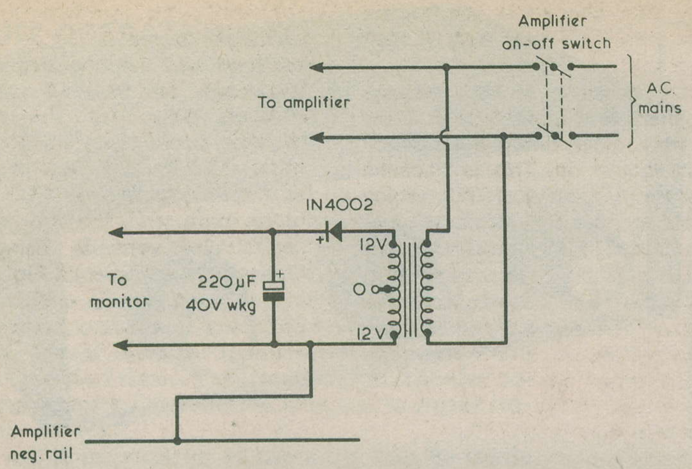


Fig. 4. The monitor can be powered by an inexpensive supply incorporating a low-cost mains transformer. The same supply can also be used for the second monitor in a stereo system

negative rail, as in Fig. 3(b). Amplifiers in this category have a relatively very wide output voltage swing, and with these R1 should be increased in value to 10k Ω 1 watt.

If the supply voltages available from the amplifier are in excess of 40 volts, or if it cannot provide the small extra current required by the monitor, it would not be unduly uneconomic to provide the monitor with its own power supply, as in Fig. 4. The mains transformer can be any small type offering a rectified output voltage in the range of 20 to 40 volts. A miniature transformer having a 12 - 0- 12 volt secondary rated at 50mA or more would be satisfactory, for instance, and this would provide a rectified and smoothed output of around 33 volts. The single power supply could also supply the second clipping monitor in a stereo system. Note that the negative rail of the supply is made common with the negative rail of the amplifier.

The monitor circuit will function quite well with much smaller a.f. amplifiers having supply voltages down to as low as 9 volts. The monitor circuit can be connected across the supply rails, as in Fig. 3(a), and some of the resistor values are reduced. For 9 to 20 volt operation, R2 and R3 should be changed to 8.2k Ω , R4 to 220 Ω and R6 to 1.8k Ω . The values of R1 and R5 remain unchanged. ■

THE OSCAR PHASE III

A Progress Report By Arthur C. Gee

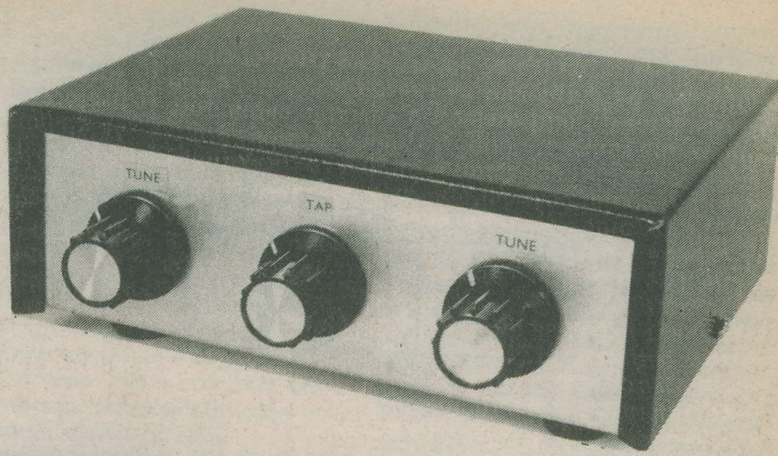
In March 1980, the latest of AMSAT's Orbiting Satellites Carrying Amateur Radio, will be launched from Kourou, French Guiana. AMSAT-III A, as it is called, will be a much more sophisticated than previous amateur radio satellites and will give its amateur radio users a new experience, because at the highest point of its orbit, it will be available to the entire hemisphere below it and users will have continuous access up to ten hours per orbit.

AMSAT Phase III is a high altitude, long life satellite, which will be launched as a secondary payload, aboard an Ariane mission. The European Space Agency will provide the launch opportunity from a site in Kourou, near the coast of French Guiana. It will be first put into an elliptical orbit with a projected inclination of 17 degrees, an apogee of 35.000 Km and perigee of 200 Km. After a few weeks in this orbit, when it has stabilised and the onboard microcomputer has determined that the satellite is in the proper orientation to the sun, to the earth and its proper position in its orbit, a one-shot onboard perigee kick motor will fire. This will lift the perigee to its projected 1500 km altitude and raise the inclination to 57 degrees. This orbit will have a period of approximately 660 minutes and a longtitude increment of about 165 degrees west per orbit. The kick motor is a solid propellant motor which will burn for 20 seconds. These parameters are the anticipated ones — the final ones will no doubt be slightly different from these.

This orbit will favour the Northern Hemisphere at first, as the apogee after the perigee kick motor firing will occur at about 26 degrees North latitude. Over the course of the first two years, the latitude of the apogee will drift gradually northward to its highest point: 57 degrees North latitude. From this time on the apogee will drift southward until after another year or so it will occur over the equator. From this point on, the Southern hemisphere will be favoured and the second of the AMSAT Phase III missions will have been launched, again initially favouring the northern hemisphere. Throughout its lifetime however, the AMSAT Phase III series satellites will be accessible throughout the world at some point during the day; those regions falling under the illumination at apogee will simply have greater access time.

AMSAT Phase III-A will carry a Mode B transponder. Its uplink will be in the 70 cm band and the downlink in the 2 metre band. The passband will accommodate SSB, CW, SSTV, RTTY and whatever digital modes are approved for use through the satellite. There will be several Special Service Channels that will deal exclusively with such matters as data exchange, education, scientific study, officially authorised traffic and general telemetry and codestore information, and an engineering beacon for more sophisticated management purposes will be at the very edges of the passband. To access the satellite, a user will need about 1000 watts e.r.p. on 70 cms — but high gain antennas to achieve this effective radiated power economically are feasible as near apogee (plus or minus 3 hours) AMSAT Phase III-A will move very slowly and through a comparatively small arc; tracking will be a fairly simple matter. ■

S.W. AERIAL TUNING UNIT



by

R. A. PENFOLD

Improves receiver performance over 1.6MHz to 30MHz

An aerial unit (or a.t.u.) is one of the simplest accessories for a short wave receiver and yet it can provide quite significant and worth-while improvements in performance. It has two beneficial effects, these being an increase in signal strength and an attenuation of spurious responses.

Since an a.t.u. is a passive device a claim that it increases signal strength may seem unlikely, since such a claim gives the impression that the unit provides active amplification. In practice it does not, and what it does do is to improve the coupling between the aerial and the receiver input which, in most receiver installations, is inefficient over at least some if not most of the frequencies covered. The a.t.u. simply ensures that as much of the aerial signal energy as possible is coupled into the receiver. Normally, it can provide an increase of two or three "S" units when an ordinary long wire antenna is employed with a receiver having the usual low impedance aerial input circuit.

The reduction in spurious responses applies mainly with superhet short wave receivers. The aerial tuning unit is made resonant at the frequency of the desired signal, thereby giving additional input tuned filtering and reducing the effect of image and similar responses.

COMPONENTS

Capacitors
VC1 365pF variable, Jackson type "O" (see text)
VC2 356 variable, Jackson type "O" (see text)

Inductor
L1 see text

Switches
S1 d.p.d.t. toggle
S2 1-pole 12-way rotary, with adjustable end stop

Sockets
SK1 insulated wander plug socket
SK2 insulated wander plug socket
SK3 insulated wander plug socket

Miscellaneous
Metal instrument case (see text)
3 control knobs
4 cabinet feet
Wire, nuts, bolts, etc.

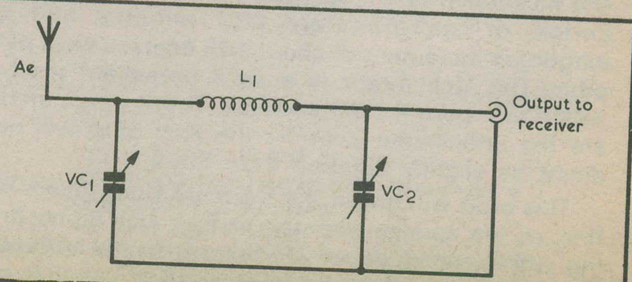


Fig. 1. The pi-network circuit employed in the aerial tuning unit

CIRCUIT OPERATION

The conventional arrangement for an a.t.u. is the well-known pi network circuit shown in Fig.1. This is a form of matching circuit which, if correctly set up, provides an input impedance which correctly matches the source impedance of the aerial (which, like any other signal source, must have a source impedance) and which also matches the input impedance of the receiver. The aerial impedance varies considerably at different frequencies and, if a wide range of frequencies is to be covered, it is impossible for a single aerial to have a source impedance equal to the input impedance of the receiver at all of these. Optimum signal transfer occurs when source impedance is equal to input impedance.

The input impedance of the a.t.u. can be made variable by adjusting VC1, and the output impedance may be altered by VC2. A further factor is that VC1 and VC2 in series provide a tuning capacitance which is connected across the coil. If, therefore, the two variable capacitors are adjusted such that the consequent tuned circuit is resonant at the desired frequency and also provides the required input and output impedances it follows that the tuning unit must provide maximum transfer of signal energy from the aerial to the input of the receiver.

The working circuit of the a.t.u. described here appears in Fig.2, and it differs mainly from that of Fig.1 by making the inductance variable by means of switch S2, which selects sections of the complete coil. A variable inductance is necessary if the unit is to carry out the threefold requirement of being resonant at the desired frequency and, at the same time, of presenting the correct input and output impedances.

A refinement is the inclusion of S1(a)(b), which can be switched so that the unit is bypassed. This feature can be very useful when setting up the a.t.u., as it provides an instant check on the effect of the unit.

The two variable capacitors are Jackson type "O" single gang air-spaced components having a maximum value of 365pF. It is not essential to use these particular capacitors and any other air-spaced variable capacitors having a maximum value in the range of 300pF to 500pF will be equally satisfactory. Solid dielectric variable capacitors should not be employed as these do not have the required performance at short wave frequencies.

CONSTRUCTION

The author's a.t.u. is housed in a metal instrument case having dimensions of 152 by 118 by 51mm. This is a case type BC1, available from Harrison Bros., P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ. Any other metal case of about the same dimensions, or slightly larger, should be equally satisfactory. The input and output sockets, an earth socket, and switch S1(a)(b) are mounted on the rear panel of the case, whilst the two variable capacitors and the coil tap switch S2 are fitted to the front panel. VC2 is to the left of the switch and VC1 is to its right. The spindles of all three components are at the same horizontal level and they are laid out in symmetrical manner as illustrated in the photograph of the front panel.

The Jackson 365pF variable capacitors have three mounting holes in the front plate which are tapped 4BA. Three corresponding 4BA clear holes

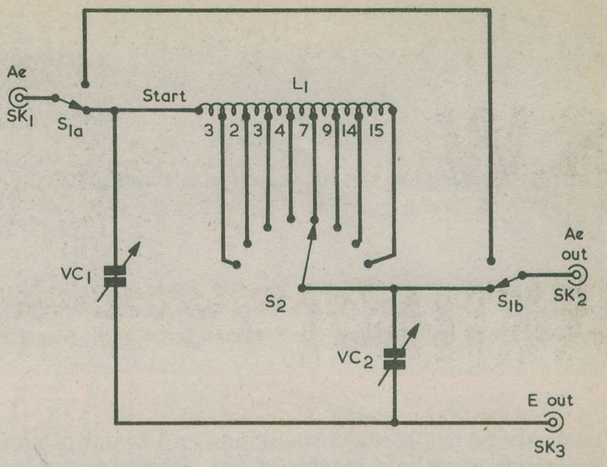


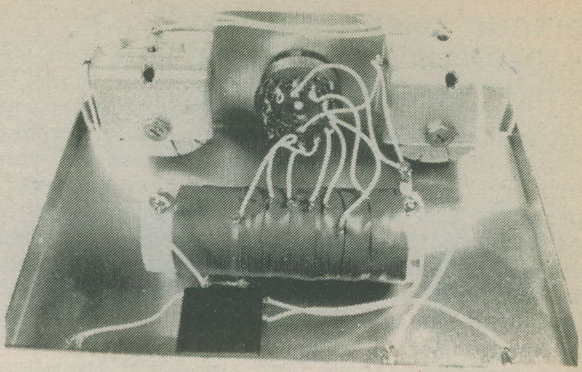
Fig. 2. The practical a.t.u. circuit requires variable inductance in addition to variable capacitance, and this is provided by tappings in the coil which are selected by S2. The numbers indicate the number of turns in each section of the coil

have to be drilled in the front panel for each capacitor and they may be marked out in the following manner. Take a piece of paper, cut out a hole of ¼in. diameter in its centre and pass the hole over the spindle of the capacitor. Mark on the paper, with a pencil, the positions of the three 4BA tapped holes. Then use the paper as a form of template to mark out the 4BA clear holes required in the front panel of the unit. Drill out the holes, together with the central hole for the capacitor spindle. The capacitor is then mounted by three short 4BA bolts, with spacing washers (which could be 2BA nuts) between the inside surface of the front panel and the front plate of the capacitor. Short bolts are essential because their ends must not protrude more than fractionally beyond the capacitor front plate as they could then damage the fixed or moving vanes.

The coil is home-constructed and, because of the large variables in the circuit, is not as critical in its construction as would be, say, the aerial input coil of a short wave receiver. The former used in the prototype is a plastic tube about 72mm. long and 25mm. in diameter. It was orginally part of a reel on which Multicore solder was supplied. Any reasonably strong tube made of plastic material

The three sockets and the bypass switch, S1(a)(b), are mounted on the rear panel of the case

The wiring between the coil taps and switch S2



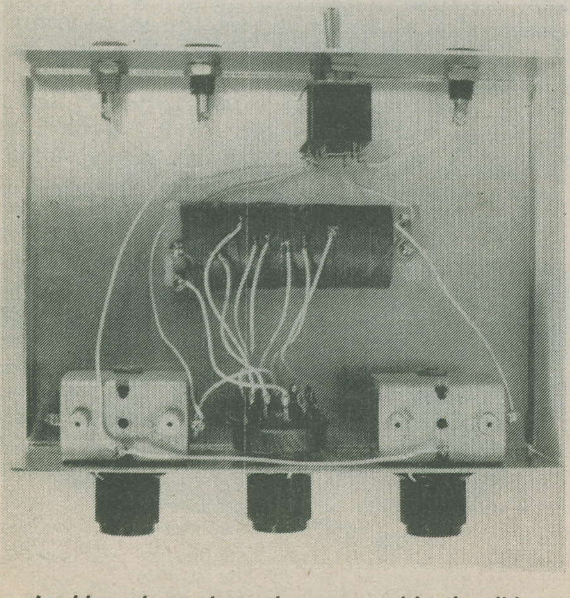
with about the same dimensions can be employed. An alternative is a length of 1in. diameter timber, such as a piece cut from a broom handle. Provided that it is dry this will have more than adequate insulation resistance for the present purpose.

A 6BA solder tag is mounted at each end of the former to provide anchoring points for the ends of the coil. If a plastic tube is employed, a 6BA clear mounting hole is drilled in it opposite each solder tag. With a wooden former, the mounting will be carried out with woodscrews. The coil is wound with enamelled copper wire of around 26 to 30 s.w.g., 28 s.w.g. wire being employed for the coil used in the prototype. A length of 5½ metres of the wire will be more than sufficient. The coil is wound in sections, the turn numbers being indicated in the circuit of Fig.2. Each section has a length of about 6 to 7mm., with the result that sections with a small number of turns have the wire fairly well spaced out whilst those with a large number of turns have the wire very nearly close-wound.

Strip the enamel from the winding wire at one end and solder this to one of the solder tags. Wind on the first section, which has 3 turns. The winding proper may start about 5mm. in from the solder tag, and a narrow band of p.v.c. insulation tape is then used to hold the section in place on the former. A small loop is made in the wire and the next section, with 2 turns, is wound on and secured in place with tape. A loop is again made in the wire. This procedure is continued with further sections of 3, 4, 7, 9, 14 and 15 turns, the free end at the last section being cut to length, stripped of enamel and soldered to the second solder tag. Note that it is important for all the turns on the coil to be wound in the same direction. Mark the former in any convenient way, say by a piece of coloured tape, so that the coil start end, with the 3 turns section, may be identified.

Next carefully scrape away the enamel from the wire loops between the sections and tin these with solder. The completed coil is then mounted in the case as shown in the photograph of the interior, with the coil start nearer VC1. It is this end of the coil which connects to the fixed vanes of VC1. The coil former is spaced off from the case surface by two spacing washers about 10mm. long.

Wiring is then carried out as illustrated in Fig.3. S2 is a single pole 12-way switch with adjustable end stop set for 8-way operation. Before connecting to its tags, check with a continuity tester or by visual inspection the eight outer tags which the switch brings into circuit. With some switches the relative positioning of these tags and the central tag may differ from that shown in Fig.3. The wiring should be kept reasonably short and direct, and care should be taken to avoid dry joints, particularly at the tapping points in the coil. The wire connecting together the moving vanes tags of VC1 and VC2 is not essential, since the bodies of these two capacitors are connected together via their mounting to the front panel, but it is in general good practice to fit the wire.



Looking down into the case with the lid removed. The general view is the same as that in the wiring diagram of Fig. 3

USING THE UNIT

A 2-way cable is used to connect SK2 and SK3 of the a.t.u. to the receiver aerial and earth terminals. It is not essential, or even desirable, to use a coaxial cable here, and ordinary unscreened wire is perfectly suitable. If the receiver earth terminal connects to an external earth this connection is retained.

The unit will match any long wire aerial of about 10 metres or more in length to a receiver having a normal input impedance in the range of 50 Ω to 600 Ω.

Setting up is considerably eased if the receiver has a tuning meter or an "S" meter. S2 is then tried at various settings, with VC1 and VC2 being adjusted at each setting in an attempt to peak the received signal as indicated by the meter. Switching the unit in and out by means of S1(a)(b)

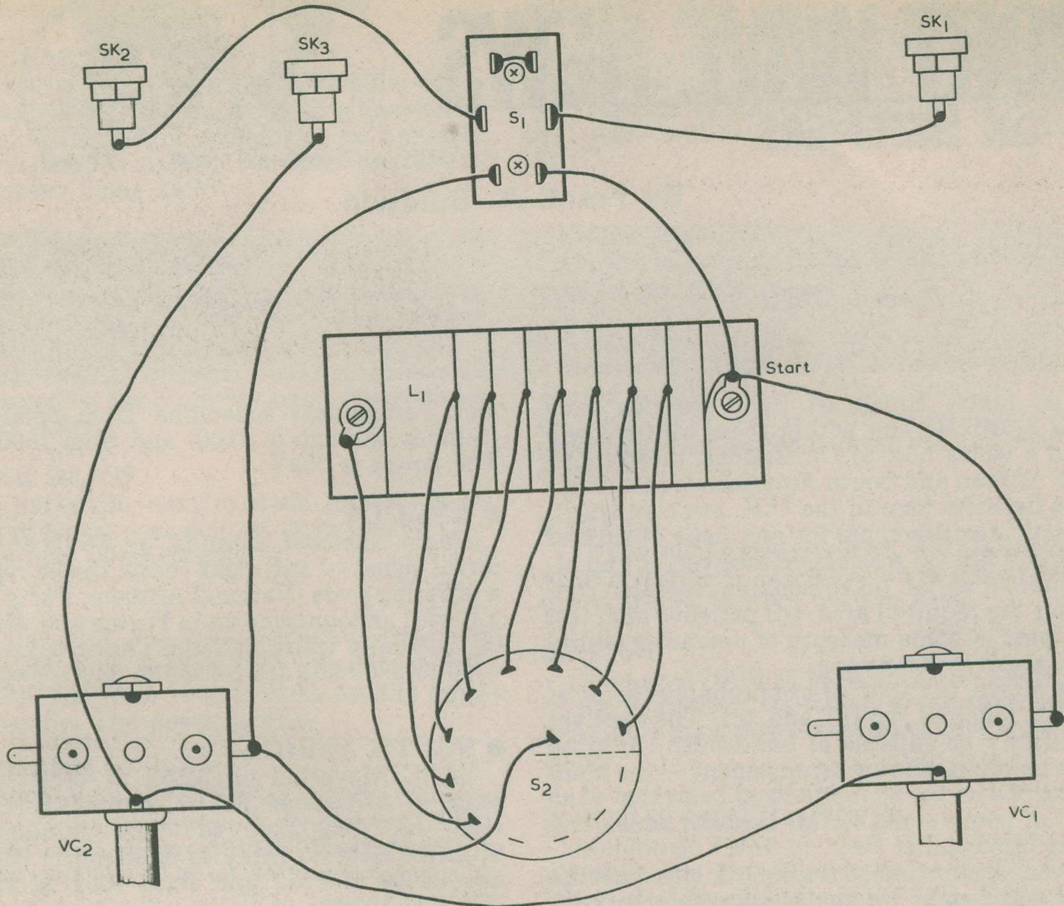
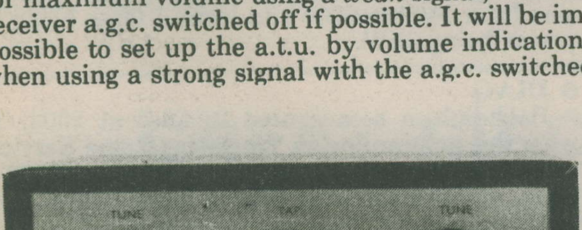


Fig. 3. Wiring up the aerial tuning unit. The wires should be kept reasonably short and direct

will show that if any improvement is introduced by the tuning unit. If the receiver does not have a signal strength meter the tuning unit can be set up for maximum volume using a *weak* signal, with the receiver a.g.c. switched off if possible. It will be impossible to set up the a.t.u. by volume indications when using a strong signal with the a.g.c. switched in, as the a.g.c. will mask any improvements in signal strength. The a.t.u. will not always provide an increase in signal strength since there may already be an adequate match between the aerial and the receiver on some short wave bands. In these cases, the controls can either be set up for maximum results, or the unit can be bypassed by means of S1(a)(b).

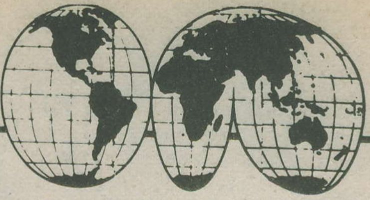
If extensive listening is to be carried out over a wide range of frequencies, it would be worth-while fitting logging scales around the knobs for S1(a)(b) and the two variable capacitors. The optimum settings for these controls for each band can be found initially and noted. Resetting the controls when changing bands will then be much simpler and quicker.

In general, the lower the reception frequency, the greater the number of coil turns which has to be switched into circuit by S2. It should be possible to use the aerial tuning unit successfully at any frequency within the short wave spectrum of about 1.6MHz to 30MHz. ■



Switch S2 is mounted at the centre of the front panel with VC1 to its right and VC2 to its left

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT — *Frequencies = kHz*

The 90 metre Broadcast Band extends from **3200** to **3400kHz** and within these confines will be found a whole host of Dx stations, mostly low-powered African and South American transmitters as far as listeners here in the U.K. are concerned.

The main requirements for any hope of success on this band are (a) a selective receiver, (b) an efficient outdoor aerial, (c) reasonable reception conditions for the required area, (d) patience and, last but not least — some measure of operating ability with the receiver concerned.

Of the above, (a) and (d) are probably the most important, followed by (b) and (c). The receiver should ideally be capable of bandwidth variation and/or a bandpass tuning arrangement — the main bar to progress on the 90 metre band being that of an 'overlay' of commercial QRM, beneath which one must 'dig' for results.

However, from time to time, if one has the patience and listens on the band regularly, conditions prevail such that some African and Latin American stations may be logged by almost anyone around at the appropriate time — but these ideal occasions are few and far between.

Just recently we have been 'observing' the band during what may be termed normal conditions and what follows are the results obtained.

● MOZAMBIQUE
Radio Mozambique, Maputo, on **3210** at 1832, light orchestral music, YL with a ballad in Portuguese. This is the 'A' programme in Portuguese, scheduled here from 0255 to 0530 and from 1630 to 2210 (except for an English programme from 1800 to 1815). The power is 100kW.

● LIBERIA
Monrovia on a measured **3227** at 1958, OM with a talk in vernacular. This is the Home Service, scheduled from 0600 to 0800 and from 1805 to 2220, the power being 10kW.

● MALAGASY
Tananarive on a measured **3287.5** at 2006, OM and YL with a duet in vernacular mixed with heterodyne QRM. The schedule is from 0300 to 0600 and from 1300 to 2100 and is the Home Service in French and Malgache. The power is 100kW.

● NIGERIA
Lagos on a measured **3326.5** at 2000, YL with identification and a newscast in English. New frequency, schedule unknown at present — testing?

● BURUNDI
Bujumbura on **3300** at 0410, OM with (news?) in vernacular. This is the Home Service 1 in French and Vernaculars scheduled from 0330 to 0600 (Sunday through to 2100) and from 1500 to 2100. The power is 25kW.

● ANGOLA
Radio Nacional, Luanda, on **3375** at 0400, interval signal — and eight chime theme repeated in a differing scale, National Anthem, Party Anthem, YL with announcements in Portuguese when opening the daily transmissions. The schedule is from 0400 to 0800 and from 1530 to 2400. The power is 10kW.

● SOUTH AFRICA
SABC Meyerton on **3250** at 1953, local folk songs in Afrikaans. The schedule (All Night Service) is from 2200 to 0300 (Sunday 0400), Springbok Radio (May to September) 0300 (Sunday 0400) to 0552 and from 1662 to 2200. The power is 100kW.

● MALAWI
Blantyre on **3380** at 2004, OM with announcements in vernacular followed by a church service. The schedule is from 0245 to 0520 (April to October until 1110) and from 1745 to 2210 (April to October from 1300). The power is 100kW.

● ZIMBABWE-RHODESIA
RBC Salisbury on a measured **3396** at 2008, YL's in operatic chorus. This is the General Service scheduled from 0355 to 0530 and from 1530 to 2200. The power is 20kW.

● CONGO
RTVC Brazzaville on a measured **3264** at 1838, YL with announcements in French followed by a musical interlude. This is a new frequency, probably a move from **3232** where the schedule was from 0400 to 0700 and from 1700 to 2300, the power being 4kW.

● IRAQ
Baghdad on a measured **3242.5** at 2003, YL with the programme in Kurdish (Home Service), scheduled from 0258 to 0855 and from 1230 to 2200. In Turkmen from 0900 to 1225. The power is 50kW.

● ECUADOR
Radio Iris, Esmeraldas, on **3380** at 0338, local-style pops, YL song in Spanish. The schedule is from 1100 to 0300 (closing time is variable) and the power is 10kW.

Radio Zaracay, Santo Domingo, on **3390** at 0350, OM with a song in Spanish, local-style dance music. The schedule is from 1000 to 0500 (closing time is variable) and the power is 10kW.

● **GUATEMALA**
La Voz de Nahuala, Nahuala, on **3360** at 0334, local music similar to Samba but with a loud drum beat predominating, OM announcer in Spanish. The schedule is from 1100 to 1300 and from 2230 to 0430, the power being 1kW.

● **VENEZUELA**
Radio Universidad, Merida, on **3395** at 0355, OM with a love song followed by announcements in Spanish. The schedule of this one is from 1000 to 0400 and the power is 1kW.

All of the foregoing however does not include all that was logged on the 90 metre band — see under **Now Hear This.**

60 METRE BAND
As this particular article would appear to be aimed at the Dxer — as distinct from the SWL — we migrate now to this band.

● **CONGO**
Pointe Noire on a measured **4843** at 1944, OM with a harangue in French. The schedule is from 0400 to 1200 and from 1500 to 2100, usually relaying Brazzaville. The power is 4kW.

● **CAMEROON**
Radio Bertoua on **4750** at 0430, National Anthem and announcements in French by OM on opening the daily transmissions. The schedule is from 0430 to 0730, 1630 to 2200 and there is an English programme from 1830 to 1845. The power is 20kW.

Radio Garoua on **5000** (yes, the frequency is correct) at 1938, local-style music, OM with announcements in French, all mixed with MSF. Also logged on the listed **5010** at 0439, OM with religious chants. They would appear to be using both channels but not simultaneously.

● **NIGERIA**
Lagos on **4990** at 0436, YL with the programme review in English. This is the National Service which is in English and vernaculars, scheduled from 0430 to 1000 and from 1700 to 2305. The power is 20kW.

● **COLOMBIA**
Emisora Nuevo Mundo, Bogata, on **4755** at 0410, local-style dance music, OM with vocal in Spanish. This transmitter is on the air around the clock, the power being 1kW.

● **HONDURAS**
La Voz Evangelica, Tegucigalpa, on **4820** at 0418, OM and YL in English, YL with hymns. The schedule of this one is from 1030 to 0500 with programmes in English from 1500 to 1600, 0300 and 0400 and from 0415 to 0430. The power is 5kW.

OTHER BANDS
On the remaining bands some items of interest were logged, such as —

● **LEBANON**
Beirut on **21610** at 1932, Arabic music in the Arabic programme for Africa, scheduled from 1900 to 2000. For those interested, the English programme for Africa is from 1830 to 1900 on this channel.

● **LIBYA**
Tripoli on **15100** at 1949, OM in Arabic, local songs and music. The schedule on this channel, entirely Arabic, is from 0800 to 2200.

●**EGYPT**
Cairo on **17690** at 1430, OM with identification in the opening of the Hindi programme for South and South East Asia, scheduled here from 1530 to 1630.

● **EQUATORIAL GUINEA**
Malabo on **6250** at 1948, OM and YL with announcements and news items in Spanish. This is the Home Service scheduled from 0500 to 2300. There is an English programme listed from 2030 to 2100, the evening Spanish transmission being from 1900 to 2030 and from 2100 to 2300. The power is 10kW.

● **CHINA**
CPBS Peking on **7335** at 2000, YL with identification and opening announcements, 'East is Red', in the opening of the Domestic Service 1 Programme scheduled on this channel from 2000 to 2300. Also logged in parallel on **7504.**

NOW HEAR THIS
FR3 Cayenne, French Guyana, on **3385** at 0340, light orchestral music, OM announcements in French, YL song in French. The schedule is from 0900 to 1200 and from 2100 to 0200 but on Saturday (when logged) closing time is variable. The power is 4kW.

DIGITAL TANTALISER

By I. M. Attrill

Match your timing skill against this ingenious electronic game

This amusing electronic game is a development of a circuit which was published some years ago in *Radio & Electronics Constructor* ("The 'Tantaliser' — An Electronic Game", by G. A. French, October 1975 issue). In the earlier circuit an l.e.d. flashed on and off continually, and it was required that a push-button be pressed during the periods when the l.e.d. was extinguished. This allowed a capacitor to aquire a small charge. If the button was pressed when the l.e.d. was alight the capacitor discharged at a much higher rate. The voltage across the capacitor was monitored by a voltmeter and the purpose of the game was to achieve as high a voltage as was possible in a given period of time, or to take the voltmeter indication up to full-scale deflection.

DIGITAL CIRCUIT

The present circuit employs a basically similar approach for the charge and discharge of the capacitor. The l.e.d. indicator flashes on and off at a fairly slow rate of around 0.6Hz. There is a push-button on the front panel of the unit and it is again intended that this be pressed when the l.e.d. is extinguished. Where the design now differs from the previous one is that there is a digital readout instead of the simple voltmeter arrangement used in the previous design. A 2-digit counter commences to count at the start of the game and ceases only when the voltage across the capacitor has reached a pre-determined level. As a result, a skilful player will be able to stop the digital count at a low number, whereas a less skilful player may only be able to do so after a higher count has been displayed. Of course, the aim is to abtain the lowest possible final score on the counter.

It is not possible to cheat by merely holding the push-button depressed continuously as the capacitor discharge rate is higher than the charge rate. Thus it is important to avoid having the button pressed when the l.e.d. is alight, as any charge previously acquired by the capacitor will be more rapidly lost again.

The game can be made slightly more difficult by switching the l.e.d. to a second, faster, flashing rate, once the player has become competent at the game with the lower flashing rate selected.

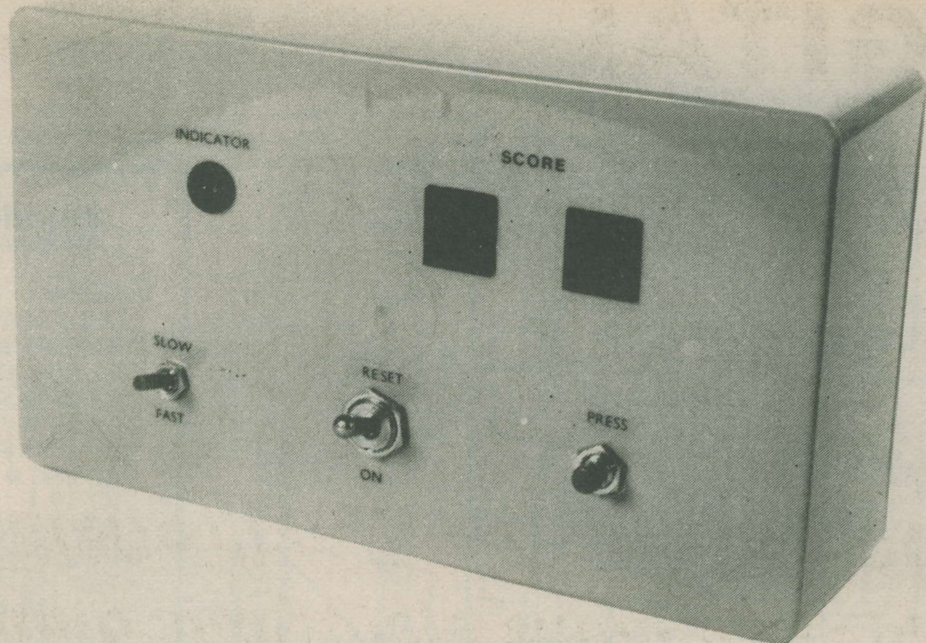
This game obviously tests the reactions of the player, since in order to do well it is necessary to activate the push-button very quickly after the l.e.d. indicator has switched off. However, a good sense of timing is also needed, because it is not possible to succeed at the game by waiting for the indicator light to switch on again before releasing the push-button. However fast one's reactions may be, this would inevitably leave a short period with the l.e.d. on and the button depressed, leading to very slow progress for the reason stated earlier. It is necessary for the player to anticipate the switching on of the l.e.d. indicator, so that he or she can release the push-button momentarily before the l.e.d. turns on. This gives a steady progress towards completion of the game without any "back tracking", and therefore gives a good low score.

This game is also a good test of concentration because, during the half minute or so that the game usually lasts, it is necessary to concentrate carefully and continuously on the game. A slight loss of concentration almost invariably leads to the push-button being depressed at the wrong time and ground being lost in consequence.

GENERAL ARRANGEMENT

The general arrangement of the unit is shown in the block diagram of Fig.1. The l.e.d. indicator is driven by a low frequency oscillator which produces a square wave having a 1:1 mark-space ratio, and the l.e.d. lights up when the oscillator output is low. As well as lighting the l.e.d. the oscillator output is taken via a time constant circuit and the push-button to the storage capacitor. When the push-button is pressed in the required manner, the voltage across the capacitor increases.

At the start of the game the clock oscillator feeding the 2-digit counter commences operation,



The front panel of the digital "Tantaliser". This offers a challenge to test skill in timing and visual reaction

and the count starts from zero. Clock frequency is approximately 2Hz. The voltage across the storage capacitor is applied to a voltage detector and, when it reaches the required level, the voltage detector inhibits the counter. The "frozen" count which is then displayed is the player's score.

FULL CIRCUIT

The full circuit of the "Tantaliser" game appears in Fig.2. The oscillator driving the l.e.d. is a 555 multivibrator, and the l.e.d. and series resistor R4 are connected between its output and the positive rail so that the l.e.d. is turned on when the output is low. Timing components R2, R3 and C2 give a flashing rate of approximately one flash every 1.7 seconds, and R3 is made large in relation to R2 so that a mark-space ratio of virtually 1:1 is obtained. When S1 is closed, R1 is shunted across R3, reducing the timing resistance and nearly doubling the oscillator frequency.

C3 is the storage capacitor and, when the 555 output is high, it charges via R5 when push-button S2 is pressed. D2 becomes forward biased if S2 is pressed when the 555 output is low, causing R6 to be effectively in parallel with R5. In consequence, the discharge rate is much greater than the charge rate.

The voltage detector uses operational amplifier

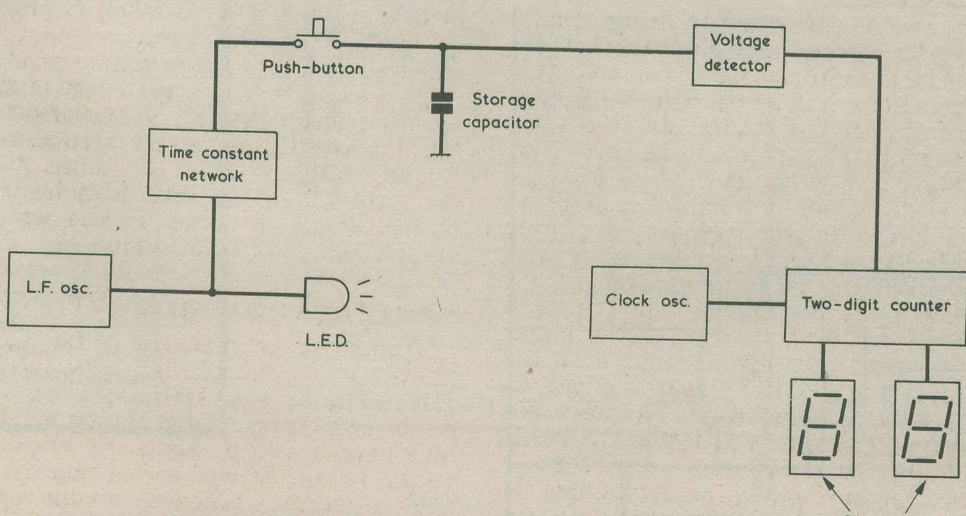


Fig.1. Basic line-up of the "Tantaliser" game. The low frequency oscillator produces a square wave which lights the l.e.d. when the output voltage is low. The purpose of the game is to manipulate the push-button such that the storage capacitor becomes charged sufficiently to trigger the voltage detector. The latter then stops the two-digit counter

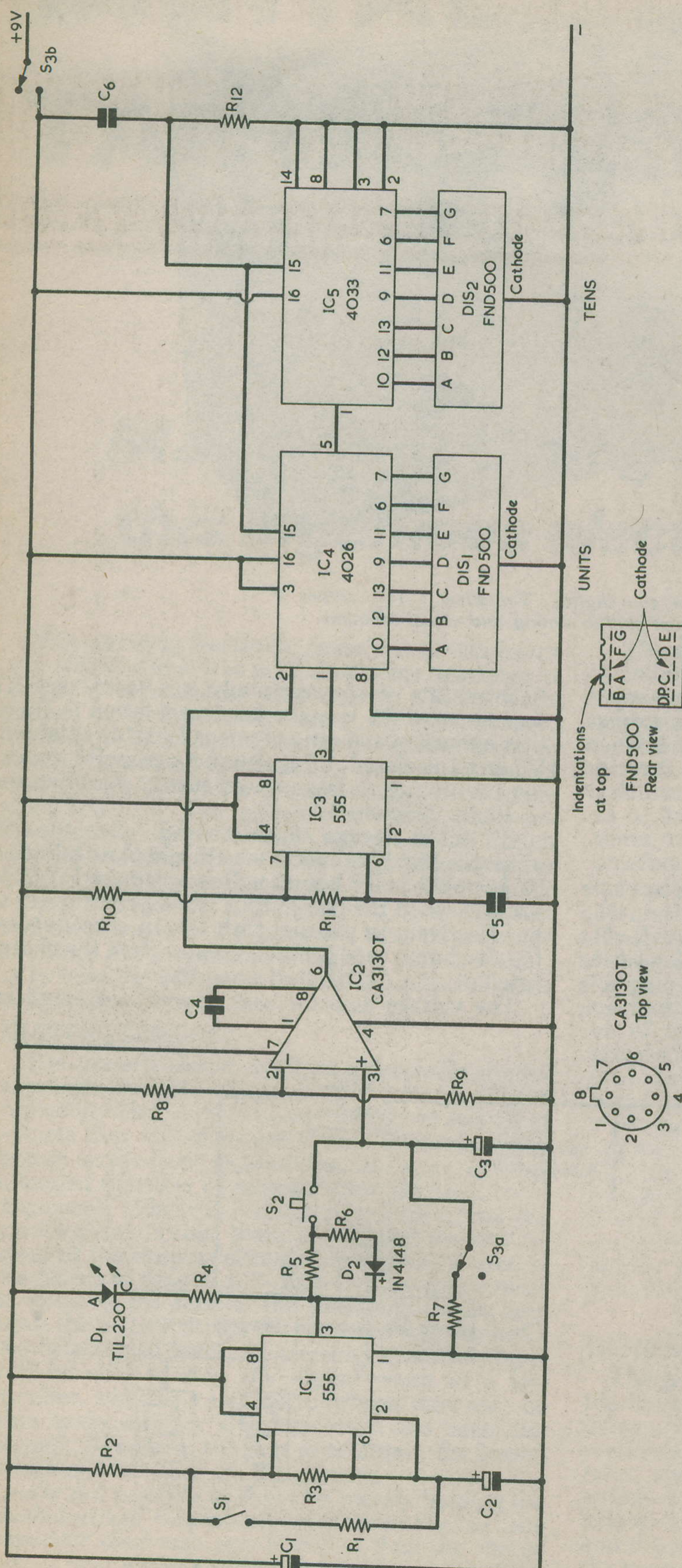


Fig.2. The full circuit of the unit. C3 is the storage capacitor and the short-circuit across it, via R7, is removed when switch S3 is set to the "On" position to start the game. C6 and R12 ensure that IC4 and IC5 are reset to zero and the count then commences

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 560k Ω
R2 2.7k Ω
R3 470k Ω
R4 1k Ω
R5 560k Ω
R6 56k Ω
R7 10 Ω
R8 4.7k Ω
R9 4.7k Ω
R10 1M Ω
R11 1M Ω
R12 100k Ω

Capacitors
C1 100μF electrolytic, 10V. Wk
C2 2.2μF electrolytic, 63V. Wk
C3 10μF electrolytic, 10V. Wkg
C4 22pF ceramic plate
C5 0.22μF polycarbonate or typ
C280
C6 0.1μF type C280

Semiconductors
IC1 555
2 CA3130T
IC3 555
IC4 4026
IC5 4033
D1 l.e.d. type TIL220 or similar
D2 1N4148

Displays
DISI FND500 (see text)
DIS2 FND500 (see text)

Switches
S1 s.p.s.t. toggle
S2 push-button, press to make
S3 d.p.d.t. toggle

Miscellaneous
Plastic case (see text)
Veroboard, 0.1in. matrix
2-off 16-way i.c. holders
9-volt battery type PP7 or PP9
Battery connectors
Panel-mounting bush (for D1)
Nuts, bolts, wire, etc.

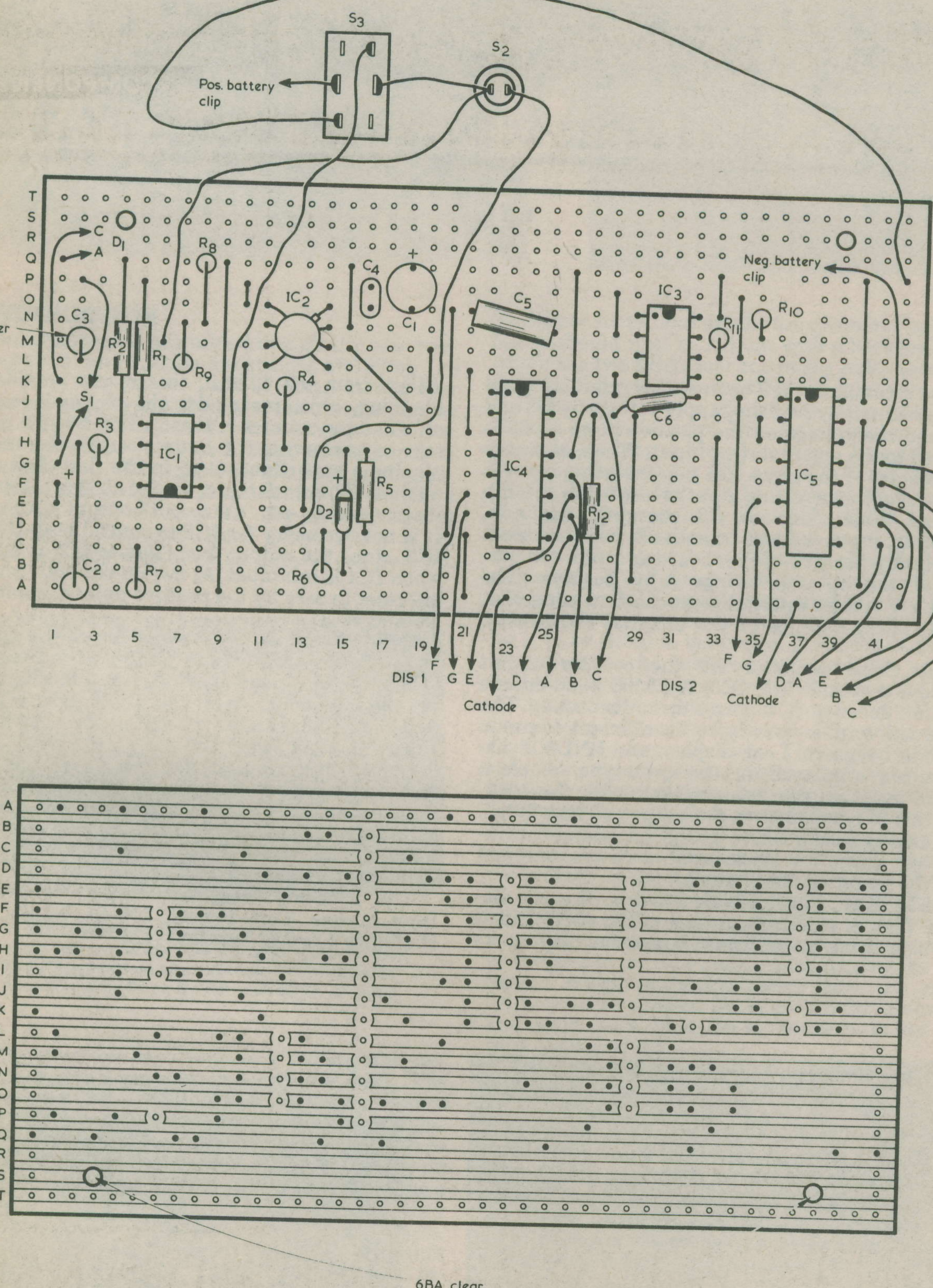
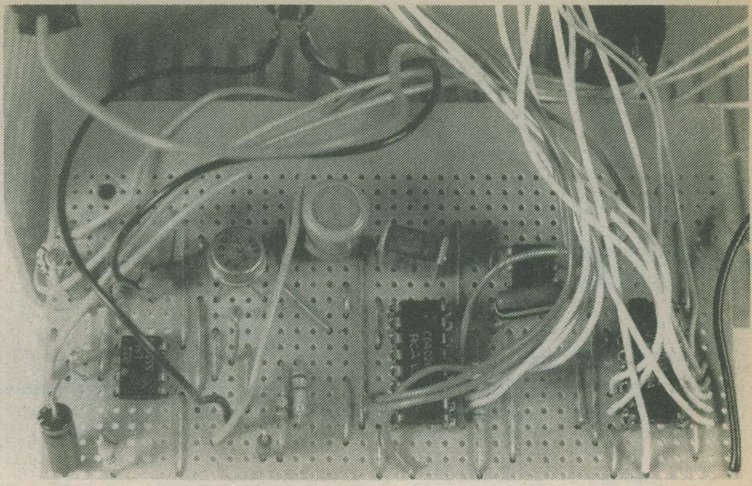


Fig.3. The wiring and layout of components on the Veroboard panel. IC4 and IC5 are fitted in i.c. holders and should be the last components to be fitted to the board



The unit employs five integrated circuits and these, with most of the discrete components are assembled on a Veroboard panel

IC2 as a comparator. The inverting input is biased to approximately half the supply voltage by R8 and R9, and the voltage on the positive plate of C3 is applied to the non-inverting input. When, as occurs at the start of the game, the non-inverting input is negative of the inverting input so also is the op-amp output. When, due to C3 charging, the non-inverting input voltage rises and becomes even marginally positive of the inverting input, the output of the op-amp swings fully positive. The CA3130T has no internal compensation capacitor, necessitating the use of the external component, C4.

The clock oscillator for the counter circuit employs a second 555, IC3. A CM0S 4026 decade counter/decoder, IC4, drives the units display. The 4026 will couple directly to an efficient common cathode 7-segment l.e.d. display, and FND500 displays are employed in the prototype. A clock enable input on pin 2 is available with the 4026, and this is connected to the output of IC2. When IC2 output goes positive at the successful conclusion of a game the clock input of IC4 is inhibited and the count is then halted.

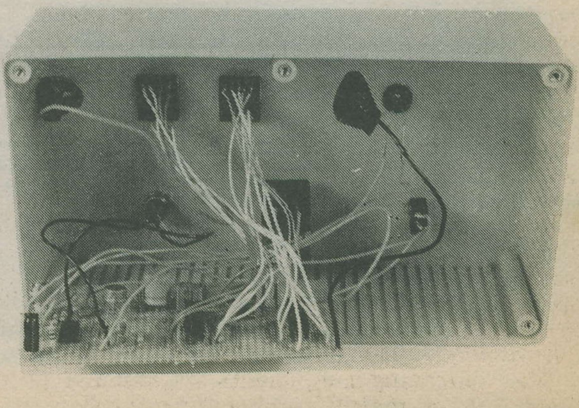
A CM0S 4033 device is used to drive the tens display. This is basically similar to the 4026, and it can also drive an efficient 7-segment display. It differs from the 4026 in that it can provide zero blanking, which means that the display is switched off when the counter is at zero. This has the advantage of conserving the battery supply by not displaying a superfluous zero in the first digit of the readout. The clock signal for the 4033 is taken from the divided-by-ten "carry out" output of the 4026. It is not necessary for IC2 to control both IC4 and IC5, since the output from IC4 to IC5 is stopped when IC4 is inhibited. At switch-on, both counters are reset to zero by the positive pulse generated by C6 and R12.

On-off switching is provided by S3(b), and C1 gives all the supply decoupling that is necessary. When the unit is switched off, S3(a) discharges C3 via the low value current limiting resistor R7, so that the circuit is ready to commence a fresh game when it is next switched on.

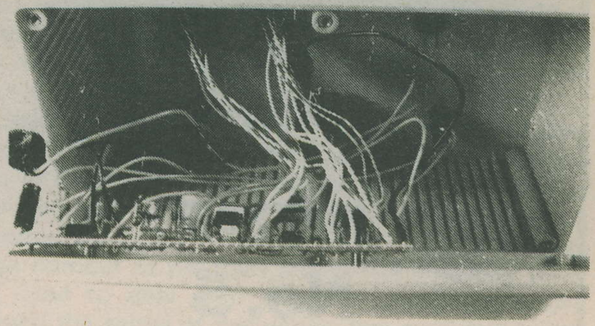
Current consumption depends to a large extent on the number of display segments which happen to be turned on, and the current drain is normally within the range of 40 to 80mA. A fairly large 9 volt battery such as a PP7 or PP9 is needed for economical running.

The FND500 7-segment display is available from Messrs. Tom Powell, 306 St. Paul's Road, Highbury Corner, London, N.1.

The Veroboard panel is wired up to the components on the front panel before it is finally mounted to the rear panel of the case

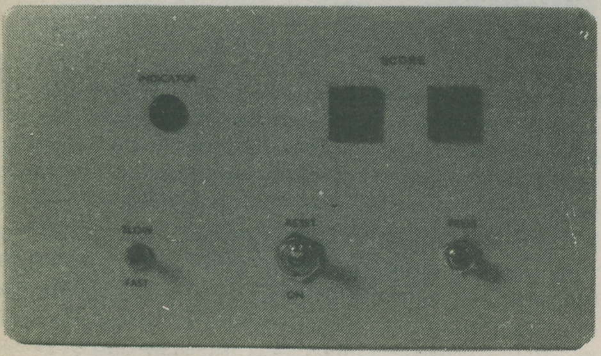


Here, the Veroboard panel is secured in place. After the battery has been fitted, the rear panel is mounted in position on the case



CONSTRUCTION

The prototype is assembled in a plastic case having approximate outside dimensions of 190 by 110 by 60mm. Any plastic case of about this size or larger should be capable of accommodating the parts. The lid of the case becomes a removable rear panel and the Veroboard component panel is mounted on it. The displays, the l.e.d. indicator, and the three switches are mounted on the front panel, as can be seen in the accompanying photographs. The exact front panel layout is not critical and any sensible arrangement can be used.



In the prototype the flashing l.e.d. is situated upper left on the front panel. To its right are the two 7-segment displays. Below, S3 is mounted centrally with S1 to its left and S2 to its right

The two displays each require a rectangular cut-out measuring 15mm. wide by 16mm, high. The cut-outs can be made by first drilling a central hole about 13mm. in diameter and then filing this out to the correct size and shape with a miniature flat file. Alternatively a fretsaw or coping saw could be used. The displays can be glued in place using a good quality adhesive such as an epoxy type or they can be made a tight push fit into the cut-outs. The decimal points of the displays are not used in the present application but they will assist in indicating which way up the displays should be mounted. Also, the indentations in the displays should be at the top. The specified FND500 displays have built-in display filters, incidentally.

The remaining components are assembled on a piece of 0.1in. matrix Veroboard having 42 holes by 20 copper strips, and details are given in Fig.3. The board should first be cut out with a hacksaw, after which the two 6BA clear mounting holes should be drilled. The layout requires a relatively large number of breaks in the copper strips and these should be made next. The link wires and components are then soldered in place. It is advisable to use i.c. holders for IC4 and IC5, since these are CMOS devices which can be damaged by high static voltages. The two i.c's should be fitted to these holders when all other wiring has been completed, and until that time should be left in their protective packaging. Care must also be taken with IC2, which has a MOS input stage, and this i.c. should also be left in its protective packaging until it is time for it to be fitted to the board. It should be the last component to be soldered into position, and the soldering iron must have a reliably earthed bit.

The completed component panel is wired up to the components on the front panel by means of thin flexible p.v.c. covered wires. The wiring is finally completed by connecting the two battery clips and the lead which connects between S2 and S3. The component board is then mounted on the rear panel of the case on the extreme left hand side, as viewed from the rear. This leaves a suitable space for the battery on the right, and the latter may be held in place by a simple home-made clamp. Spacing washers about 6mm. long should be fitted over the two 6BA mounting screws which secure the component board to the rear panel, these spacing the component board underside away from the panel. Without these washers the board would be strained and could crack when the mounting nuts and bolts were tightened up.

After giving the unit a thorough check for wiring errors a battery may be connected, and it is then ready for use.

It should be noted that if a player is very slow at completing the game the counter will cycle through a complete count and commence from zero once again. The actual score is then equal to the number displayed plus 100. Alternatively, the game can simply be considered as lost if the player fails to complete it before the count goes back to zero. ■

A few copies of the October 1975 issue containing the original 'Tantaliser' article by G. A. French, are still available price 65p, inclusive of postage (a free piece of veroboard is also contained in the issue).

DATABUS really explains microprocessors

series No. 5

By Ian Sinclair

Addressing Memory

In this fifth article in our 12-part series on microprocessors we examine the various methods employed for addressing memory.

You remember that, in part 4, we went over the ways in which the normal 1,2,3 count of the program register could be interrupted by jumps or by calling data out of memory? In this part we're going to look at these processes in more detail, because the way we can use a microprocessor very much depends on what methods we can use for memory addressing. Because memory addressing methods are important, what appears to be a bewildering variety of methods has been devised, and at first sight they all look pretty much alike.

IMMEDIATE ADDRESSING

Taking the simplest type of memory addressing first, immediate addressing means that the address of the data is the next address in the program. Immediate data is part of the program, so that when a program instruction is "immediate", then the next program byte is the data. For example, the instruction called "load immediate" will be followed in the program by a byte which is the number to be loaded into the accumulator. More of this follows in part 6; for the moment we can forget the immediate instructions, because they have no effect on the smooth flow of the program.

Two important types of memory addressing are DIRECT absolute addressing and IMPLIED addressing. There's also a method called INDIRECT addressing which is rather less common and which we'll leave out of this section. Because there are different methods of carrying out these address instructions, however, it often looks as if there are more types of addressing than really exist — some differences are so slight that they hardly merit separate descriptions. The addressing problem, remember, is that any address consists of two bytes, but the accumulator can hold only one byte at a time. Direct memory addressing looks straightforward. A typical direct memory addressing instruction would have a 1 byte instruction code followed by the two bytes which give the memory address. Some CPU's require the address bytes to be loaded in with the high order (the first byte of the number) first, others, notably the 6502 as used in KIM-1, require the reverse order. Whatever method of load-

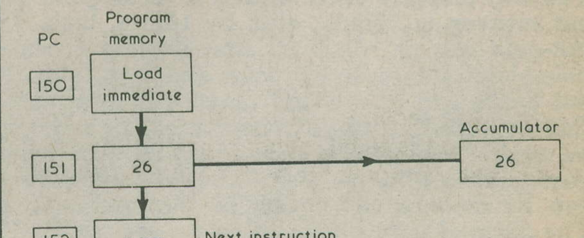


Fig. 1. A "load immediate" instruction in the program memory causes the next byte in the program memory to be loaded into the accumulator. Decimal numbers are shown for simplicity

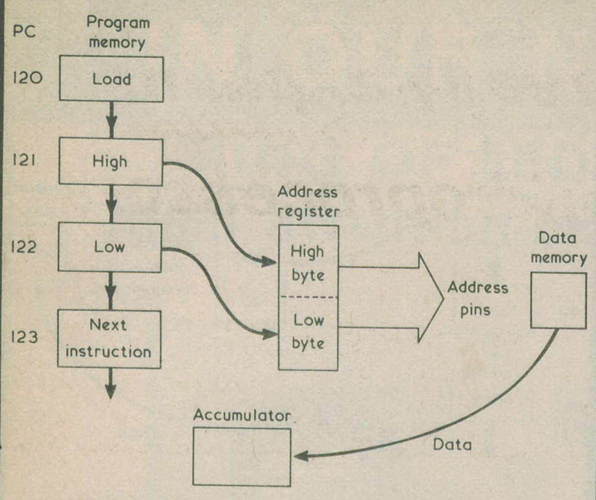


Fig. 2. Direct addressing. The instruction code is followed by two bytes which are assembled into a 16-bit number in an address register. This is then gated to the address pins, causing data to be released from the memory with that address. The data on the data lines is gated into the accumulator, completing the instruction

ing is used in the program, the two byte number is the address of the memory which has to be read or loaded by the instruction. The word "direct" is a good reminder of what is done — the address of the memory is the byte pair directly following the instruction byte.

Implied addressing is rather more cunning. The memory address is loaded into the data counter, and the read or write instruction simply specifies the data counter — so switching the address lines to the data counter. If more than one register can be used for this purpose, the instruction byte will specify which register is used to store the address. The advantage of this method is that the address does not have to be specified right away — it can be loaded into the data counter (or whatever register is used) later, after all the rest of the program has been completed. The address can also be a number which is calculated during the program and loaded into the data counter.

Indirect addressing, incidentally, is a roundabout business in which two bytes of program contain an address which is loaded into the data counter. This address in memory contains one byte of another address, with the next byte in the address which is one greater (for example, addressing No. 59 for the first byte, with the second in 60). This second address is where the data is to be found. It has its advantages but not many programmers make much use of indirect addressing, and not all CPUs permit indirect addressing.

ADDRESS LINES

Not all CPUs allow direct addressing as we've described it either. Some instructions use only one byte, so that a full two byte address cannot be specified; a few CPUs have less than the normal sixteen address lines. When fewer than sixteen address lines are used, the CPU is said to have paged memory access — for example if only ten lines were used the "memory page" would have $2^{10} = 1024$ addresses. The rest of the normal 65536 addresses are obtained by using other signals (such as bits from the program counter) as the "page numbers".

Single byte memory instructions also restrict the range of addresses to a page of $2^8 = 256$ words. This would be unsafisfactory for some types of instruction, but acceptable for others, such as jump, because not many programs need to jump over a large number of program steps. The methods that are used to deal with paged memory are a bit beyond the scope of this series, however. What we want to look at for the moment are some of the methods of memory access, direct or implied, which are commonly used.

One very common method is what is called program-relative displacement; it is a two-byte instruction in which the first byte is the instruction code and the second is a pure number. The instruction is the byte which sets up the CPU ready for the number that follows. The number is a number of ***program steps*** added to the number that is already stored in the program counter. This number is called the ***displacement.*** Suppose, for example, that we are at program step number 21 (decimal), and the jump instruction byte is followed by 56 (decimal). The effect is then to add 56 to 21 giving 77 (decimal), so that the next program step we want is 77 (decimal). The number 77 (in binary, of course) would then be transferred to the data counter (or address register) so as to fetch the byte which is stored at that address. We've used the decimal numbers here rather than binary because they're easier to follow, but the numbers which are handled by the program are, of course, binary numbers. This is a procedure for a jump, but we can also use this type of add-to-program-count method to find an address in memory to deposit or recover a byte of data.

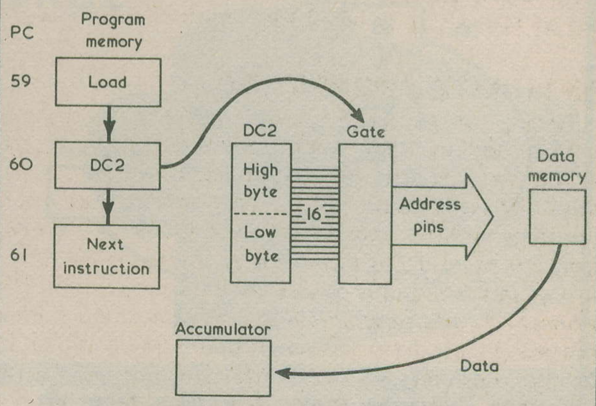


Fig. 3. Implied addressing. A two-byte address is stored in a data counter, DC2 in this example. The instruction to load, implied, followed by the code address of the data counter causes the number stored in DC2 to be gated to the address pins so that it fetches data from that memory address into the accumulator

NEGATIVE NUMBER

Do I hear an objection? It looks rather as if we could only add a number on, going to an address number higher than the one the program has reached. Don't you believe it — we can add a ***negative*** number, so that the program goes ***back*** a number of places equal to the number byte following the instruction. Now there's another objection — nobody has ever told you how a binary number can be labelled as + or −. Not now, folks, but definitely later.

The advantage of program-relative displacement (splendid phrase, isn't it?) is that it doesn't depend on any particular address being available. Let me explain that. Suppose we have a program starting at address 1, and at address 15 (decimal) there is a displacement of 10 (decimal), sending the counter to 25 (decimal). If now we need this row of memory addresses for some other program, we don't need to alter our program in any way — it can be fed in at any other address, and when the jump part of the program occurs, it's still a jump of ten places. If by contrast, the instruction had been one which forced the CPU to move to step number 25, that instruction would need to be changed if we moved the program to another patch of memory.

There's a disadvantage, though. For a reason that should become clearer later on when we discuss signed binary numbers, we can only displace the program counter by +127 or −128 places. For a lot of work, this isn't a serious restriction; and if we really need to get hold of an address more than these numbers away from the program count then there are other ways.

The type of program displacement we've just described is called direct program-relative displacement — because the number of steps to be added to the program counter comes directly after the jump instruction. There's another type of program-relative displacement called ***indexed*** which involves a rather more roundabout method. When we use this sort of jump, the first byte, as usual, sets up the CPU ready for the next byte. The next byte once again is the number of steps to be displaced, but this displacement is not added to the number in the program counter. The program counter is held waiting, while this number is added to a number in the data counter and the total of these two is the address which is used in the instruction.

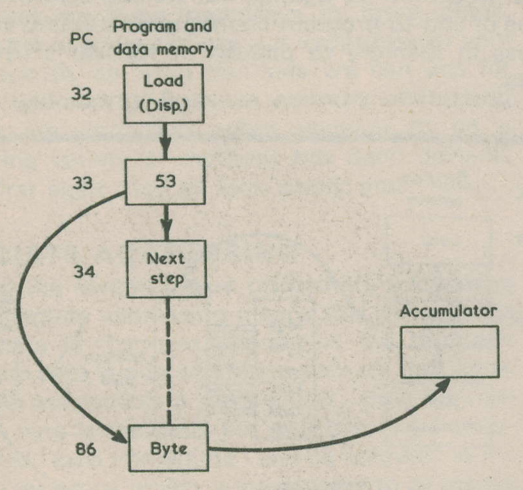


Fig. 4. Program-relative addressing. When the program-relative load instruction is used, the next byte in memory is added to the number which is in the program counter register, and the sum is used as a memory address. The address number must be fairly close (128 steps or less) to the step in program where this instruction is used

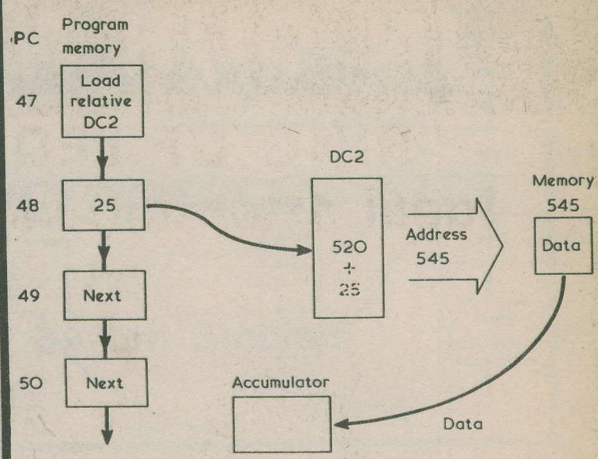


Fig. 5. Indexed addressing. The indexed-load instruction causes the next number byte in the program to be added to a two-byte number (the base number) which has been stored in a data counter. The sum of these numbers is used as an address to fetch data from memory. Any part of the memory can be addressed in this way. Decimal numbers are used in the illustration

INDEXED DISPLACEMENT

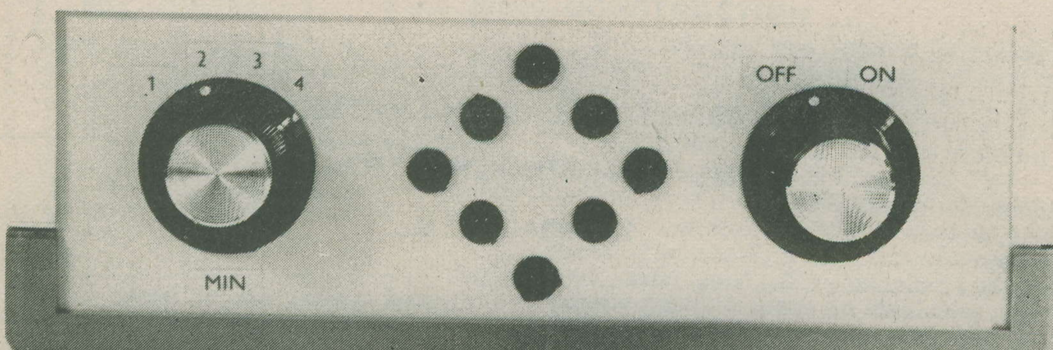
Now that may look a rather elaborate way of adding a displacement, but it has its advantages. For example, while you're writing a program you may very well not know how many places you want to jump until the program is finished. Using indexed displacement, you can leave the decision until later, then enter the number into the data counter which is specified after the jump instruction. The step forward from this is true indexed addressing. In this memory addressing system, an address number stored in memory is added to the number in the data counter, or in some other register. The advantage of this system is that a much wider range of memory addresses can be accessed; in some types of CPU, for example, this is the only way of getting from one page of memory to the next.

All microprocessor CPUs can use this program-relative displacement systems, and some have interesting variations. One such variation is indexed displacement with increment. In this scheme, the jump instruction specifies a memory address in

(Continued on Page 234)

IN OUR NEXT ISSUE

"RING OF LEDs" PRINT TIMER
Ideal attention-catching presentation



UNIQUE DISPLAY indicates 8 segments of timing period

15 METRE DELTA BEAM

A "DX-grabbing" antenna which requires little outside space. Costs only a few pounds, this driven delta will work real DX and is equivalent to a 3-element Yagi in performance.
The antenna is very simple to construct and can be air-borne in a couple of hours. The results should satisfy the most critical DX chaser.

IN YOUR WORKSHOP

SHORT WAVE NEWS

NEWS & COMMENT

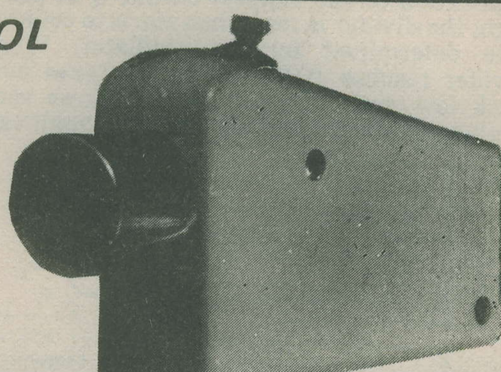
ELECTRONICS DATA
Controlled Voltage Gain

USING CMOS 555's

The CMOS 555 has now become available on the home constructor market. Known more properly as the ICM7555, it is a fully pin-compatible with the well-established bipolar 555 i.c., but draws a much lower supply current. It is suitable for supply voltages from 2 to 18, and its output can drive both t.t.l. and CMOS devices. The trigger and threshold pins have much higher input impedances than do the corresponding pins in the 555.

ULTRASONIC REMOTE CONTROL

- ★ **Sequential on-off switching**
- ★ **Exceptionally low receiver consumption**
- ★ **Portable hand-held transmitter**



RADIO & ELECTRONICS CONSTRUCTOR

LONG TIME LOW C

By E. A. Parr

50 MINUTE PARKING METER REMINDER USING THE FERRANTI ZN1034 TIMER.

For timing periods of up to a few minutes, the ubiquitous 555 timer i.c. reigns supreme. Unfortunately, the period is given by the formula:

$$T = 1.1RC,$$

which means that for periods above about 5 minutes the timing resistance goes into hundreds of kilohms, giving problems with leakage, and the capacitance goes into thousands of microfarads, resulting in problems with leakage, poor tolerance and cost.

FERRANTI ZN1034

The Ferranti ZN 1034 was designed to overcome these problems in a rather novel way. Its main internal connections are shown in Fig. 1. Basically, it consists of an oscillator and a 12 stage divider. The oscillator runs at a frequency determined by a timing resistor and capacitor. The 12 stage divider divides the oscillator frequency by 4096. When the chip is triggered (by a negative pulse on pin 1 or by application of the supply) output Q at pin 3 goes high; the divider is reset then starts to count up at a rate determined by the oscillator. When the divider reaches 4096 the control takes output Q back low again. This approach allows very long timing periods to be given for quite small values of R and C. With pins 12 and 11 linked, the period is given by:

$$T = 2700RC.$$

With 500k Ω between pins 11 and 12 the period is:

$$T = 7500RC.$$

Another useful feature of the chip is the inclusion of a 5 volt shunt regulator on pin 5. This allows the timer to be run on a wide range of supply voltages from 5 volt d.c. up to (with suitable external components) 440 volts a.c.

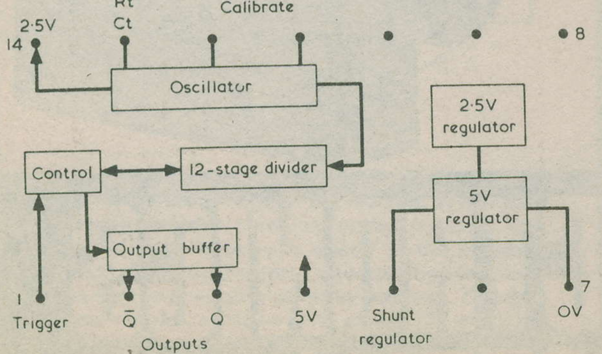


Fig. 1. The main internal functions of the ZN1034

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
- R1 100kΩ
- R2 470Ω
- R3 470Ω
- VR1 47kΩ pre-set potentiometer, 0.1 watt, horizontal

Capacitors
- C1 10μF electrolytic, 10 V. Wkg.
- C2 0.1μF ceramic disc or type C280
- C3 10μF electrolytic, 10 V. Wkg.
- C4 0.1μF ceramic disc or type C280

Semiconductors
- IC1 ZN1034 in 14 pin d.i.l.
- TR1 BC107

Switch
- S1 see text

Battery
- B1 9 volt battery type PP3

Buzzer
- Audible alarm — see text

Miscellaneous
- Veroboard, 0.1 in. matrix
- Case — see text.

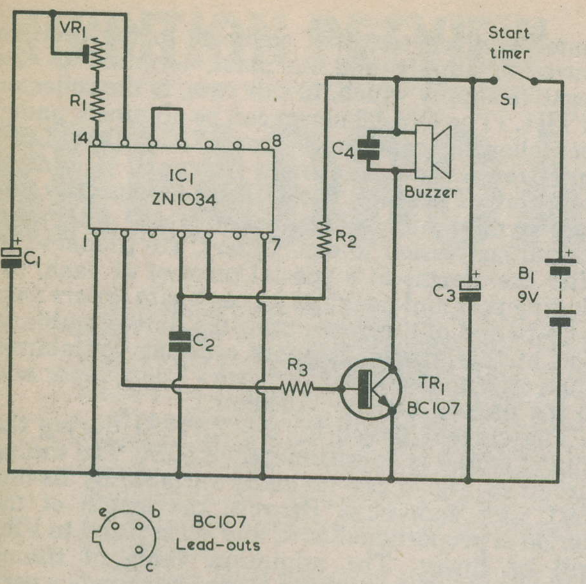


Fig. 2. The circuit of the parking meter reminder timer. This causes the buzzer to sound after 50 minutes

PARKING METER REMINDER

The author has used the ZN1034 in a number of applications, the most interesting of which is a parking meter reminder. This was designed to sound a miniature buzzer at the end of a 50 minute period, and the unit had to be small enough to fit in a pocket and run off a 9 volt battery. The circuit is shown in Fig. 2. The same circuit can also be employed to function as a 1 hour timer.

IC1 is the ZN1034, and R1 and C1 are timing components with fine adjustment being given by VR1. The circuit is powered by a 9 volt battery type PP3, and the internal shunt regulator on pin 5 is used to provide the 5 volt supply on pin 4. Resistor R2 is the dropper resistor and C2 a decoupling capacitor.

The output is taken from the not-Q output, which is low during the timing period and high when the timing is complete. The output turns TR1 on at the end of the timed period, sounding the audible alarm.

The timer is operated with pin 1 connected to the zero volt rail, and this initiates the timer when the supply is turned on. Switch S1 thus starts the timer. C3 decouples the battery and was found necessary because of the extra current drawn by the audible alarm.

CONSTRUCTION

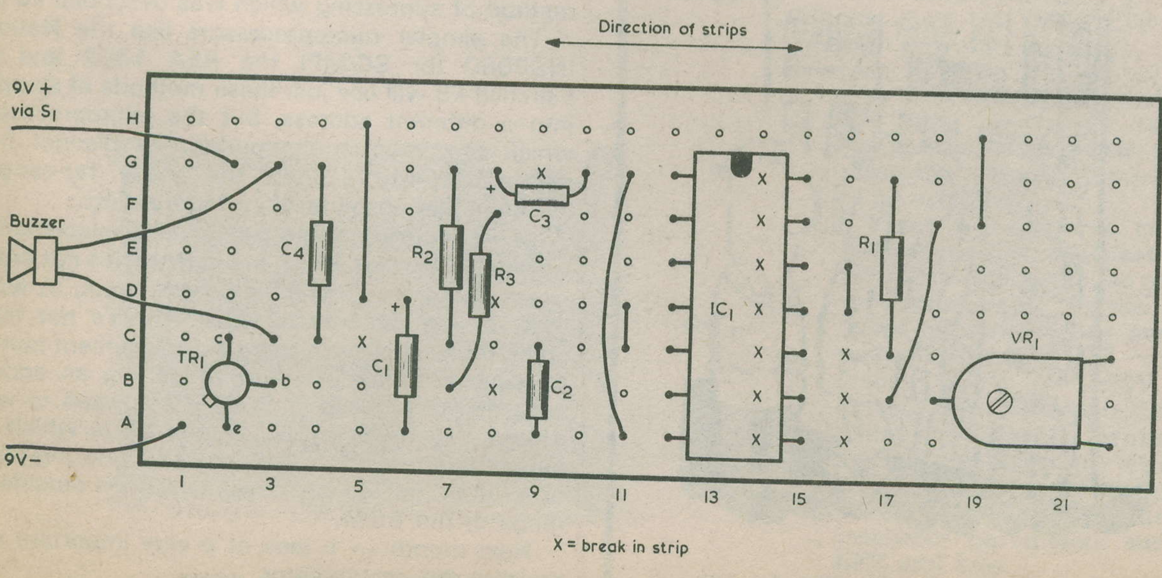
The prototype was designed for pocket use, hence size was a problem. (The large values of capacitance necessary with a 555 would have needed large pockets!) The circuit was built on a small piece of 0.1 in. Veroboard with the layout shown in Fig. 3. This should be self-explanatory.

The case for the prototype caused some searching, until a domestic calculator died in a rather terminal manner. With the keyboard sawn off and the end made good with modeller's plasticard and plastic putty, it made an ideal case complete with battery compartment and connector! As an added bonus, the switch S1 was provided by the jack socket on the calculator side. Removal of the jack plug starts the timer, and the alarm is silenced by re-inserting the plug. This gives greater protection against inadvertent operation than a normal on-off switch, which could easily be knocked in a pocket.

When the circuit is first built, C1 should be 0.1μF. This will give a timing period of the order of 40 seconds, allowing correct operation to be checked and the circuit de-bugged.

CALIBRATION

With all the timing components at their nominal value, the calculated timing range is 45 to 67.5 minutes. In practice, tolerances in value, particularly with C1, may cause the desired timing period (50 minutes or 1 hour) to be outside the range of VR1. This discrepancy can be taken up by employing a different value for R1, as determined in the calibration process.



X = break in strip

Fig. 3. The component side of the Veroboard assembly employed in the prototype

The calibration is a simple, but somewhat lengthy, procedure. With C1 at its correct nominal value of 10μF, turn VR1 to its minimum resistance position and start the timer. Note the time which elapses before the buzzer sounds. The setting for VR1 (and the possible altered value in R1) can then be calculated.

Let us suppose the timer sounds after 45 minutes and we are aiming for a 50 minute period. 45 minutes corresponds to 100kΩ, and therefore 50 minutes corresponds, in kilohms, to 100 multiplied by 50 and divided by 45, or 111kΩ. The total value of R1 and VR1 is thus 111kΩ, and VR1 is then adjusted to insert 11kΩ. If we were aiming at a period of 60 minutes, the total value required in R1 and VR1 would be 100 multiplied by 60 and divided by 45, or 133kΩ. VR1 would then be adjusted for 33kΩ.

AUDIBLE ALARM

The audible alarm employed in the prototype was a miniature Solid State Electronic Buzzer type DM-03. This has approximate dimensions of 33 by 16 by 17 mm., draws a maximum current of 17mA at 9 volts and produces a rich clear sound when actuated. Its red terminal connects to the positive source of supply and its black terminal to the negative supply which, in this case, is the collector of TR1. (The DM-03 alarm can be obtained, under the following conditions, from Field Tech Ltd., Spitfire Road, Heathrow Airport, London, Hounslow, TW6 3AF. Field Tech Ltd. normally impose a minimum order charge of £10 but, as a special concession to our readers, are prepared to offer the alarms at a special price of £1 each, including post and packing, for *cash with orders only* for a period of 3 months from the date of publication of this article. Readers ordering the alarms must refer to *Radio & Electronics Constructor* and to the present article. — Editor.)

The current drawn by the ZN1034 during the timing period is approximately 8.5mA. The timing circuit of Fig. 2 can be made variable by having VR1 user accessible. Because the length of the period is proportional to R, any scale fitted to VR1 will be linear. The minimum value of timing resistance is 4kΩ, and the author has made a very useful timer covering 7 to 105 minutes by making C1 33μF, R1 4.7kΩ and by using a 100kΩ multi-turn potentiometer in the VR1 position.

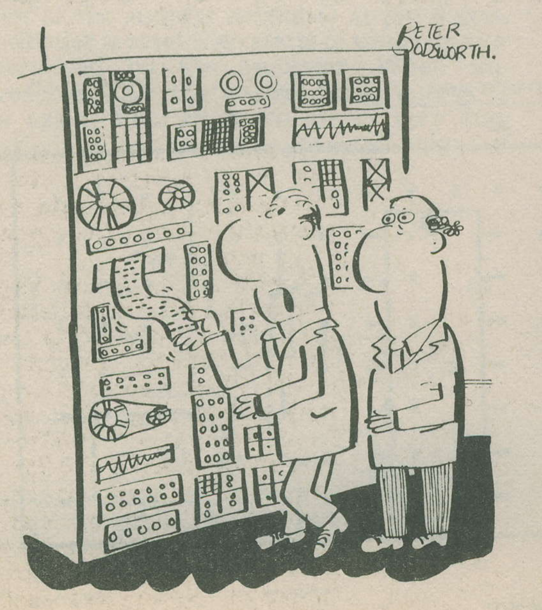
■

Databus Series No. 5

ADDRESSING MEMORY

(Continued from page 230)

which the displacement is stored, but *also* increments the address number so that each repeated jump goes to a different memory address. This is a very smart method of making sure that different numbers are fed in each time there is a jump. The fancy name for this type of system is auto-incremented indexed program relative displacement. If no displacement is added, and no increment, then this "indexed" system is just the implied method of addressing which was described earlier.



"It wants to know when Pay-day is".

The simpler microprocessors like the National INS8060 (or SC/MP) the REA 1802 and the Fairchild F8 will use just these methods of stepping into a different address, but the microprocessors which are used in computing, as distinct from machine control, need the more far-ranging methods like absolute direct addressing.

Convenient as program-relative displacement is for small programs which are in RAM, it's not entirely satisfactory for machine-control work, in which most of the memory is ROM. There's not much point, for example, in adding a displacement number to a program number, and so getting an address which is an address in ROM if you need to write data out to RAM. In the simpler CPUs which use only program relative displacement, indexing has to be used to provide addresses which are outside the range of the ROM.

Next month — a look at a very important data register, the accumulator.

(To be continued)

EXHIBITION PREVIEW

BREADBOARD '79

Following upon the great success of last year's **Breadboard 78,** which attracted more than 10,000 visitors, the organisers, **Trident International Exhibitions Ltd.,** have booked the Royal Horticultural Halls at Elverton Street, Westminster from Tuesday 4th December to Saturday 8th December for an even bigger exhibition — **Breadboard 79.**

Breadboard 79 will contain more than 90 exhibition stands accommodating UK, and overseas, manufacturers and suppliers of components, tools and test equipment. The stands will feature microcomputer systems, analysers, logic test accessories, hi-fi kits, modulators etc., as well as a varied range of construction kits and TV games.

There will also be a number of competitions and demonstrations in which visitors can participate.

We give brief details of some of the items to be exhibited which will be of special interest to our readers.

Ambit International will include among the many items on their stand the DFM3 shown in the photograph. The DFM3 was introduced in response to many requests for received frequency displays for portable operation.

The DFM3 incorporates a 5 digit LCD, giving direct frequency display on the following ranges:

VHF	with 10kHz resolution up to 200MHz typ (limited by prescalar — theoretical maximum is 399.99MHz).
Direct	reading the above range without IF offset.
LW/MW	with 100Hz resolution for the Marine DF channels.
LW/SW	with 1KHz resolution for up to 39.999 MHz.

The IF offsets include all standards around 450-470kHz for AM, plus 2MHz and 10.7MHz for shortwave in addition to the 450-470kHz ranges. VHF offsets are based around 10.7MHz.

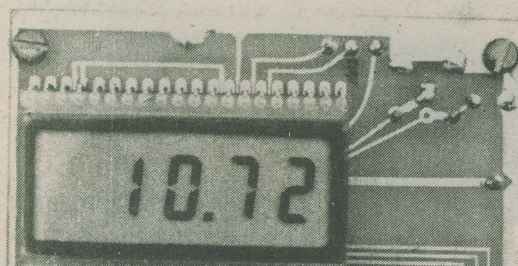
The unit is supplied for panel mounting as a double deck system, with the rear section being devoted to input shaping and prescalar operations. The front section carrying the main IC and display can be used independently in the AM mode only, providing facilities for portable DF receivers where the total current drain of 4mA is essential.

The display is static, thus creating no strobing interference, and enabling the last digit stage to be incorporated in a simple frequency stabilizer sensor system.

Made in England by Ambit International

Price ready made module £44.90 + VAT.

* * * *



Ambit continue receiver frequency display line with the DFM3

A brief mention of just two of the new additions to the **Stevenson Electronic Components** range of components to be exhibited.

First a range of rugged general purpose multimeters of very high quality yet as always very reasonably priced. The model illustrated has over 20 ranges including DC voltage from 100mV to 1000V and current from 50μA to 0.25A. All ranges are well protected against voltage or current overload. An interesting feature is its ability to read directly transistor parameters such as hFE and Iceo.

The meter comes complete with probes, batteries, and a comprehensive manual, and is priced at £12.95 (inc VAT).

A second new line represents an article which in these days of digital electronics is increasingly difficult to find, but for which in many applications there is no substitute. A range of 2" moving coil panel meters with an attractive modern appearance and a tough acrylic face. The window is slightly raised so that the meter may be mounted behind a rectangular cutout in the panel. Alternatively bolts are provided at the rear for front mounting.

There is a wide choice of ranges including a VU meter and an illumination kit is available which is easily installed. Price is £4.75 for the meter and 50p for the illumination kit.

The HT-320 multimeter from Stevenson Electronic Components

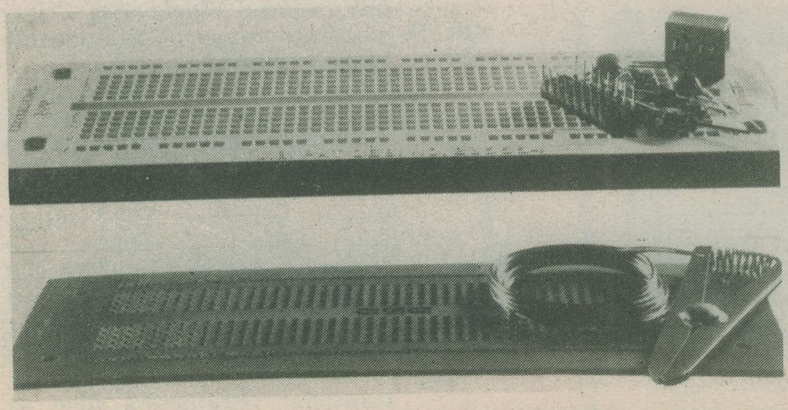
★ ★ ★ ★ ★ ★ ★ ★

At Breadboard 1979, **Continental Specialties Corporation (U.K.) Ltd.** is featuring its extensive range of prototyping boards and accessories for circuit designers, as well as several new ranges of low-cost digital troubleshooting and test aids for the development, production or service environment.

Among the new products on show is the CSC Experimentor family of modular solderless bradboards, designed to provide a quick, simple method of realising electronic circuits. The Experimentor breadboards can be used in conjunction with the unique 'Scratchboard' worksheet concept to provide rapid documentation of circuit designs, and Experimentor 'Matchboard' pre-drilled, pre-etched printed-circuit boards are available if a permanent circuit is required.

New low-cost test intruments on show include the MAX-100 frequency counter and associated prescaler; the miniature MAX-550 frequency counter, which operates at up to 550MHz; the Model 2001 sweepable function generator, which can produce sine, square or triangle waves at up to 100kHz.

CSC is also showing a range of circuit-powered digital troubleshooting equipment, including logic probes, digital pulsers, logic monitors and logic test kits.

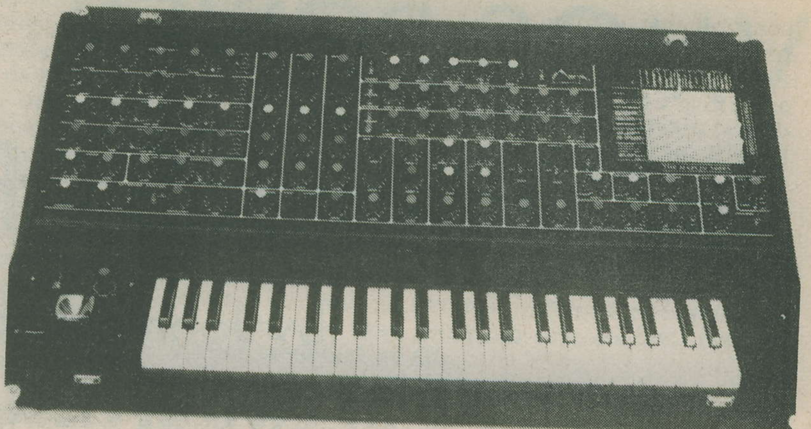


The continental Specialties Corporation Experimentor system of solderless bradboard and, underneath, the matchboard pre-drilled

EXHIBITORS

Ace Mailtronix Ltd.
Acorn Microcomputers Ltd.
Alcon Instruments Limited
Ambit International
Amtron UK Limited
Aura Sounds
Bernard Babani (Publishing) Ltd.
Bi-Pak Semiconductors
Boss Industrial Mouldings Limited
T. J. Brine Associates
The British Amateur Electronics Club
Carston Electronics Ltd.
Charcroft Electronics Ltd.
Chordgate Limited
Chromasonic Electronics
Chromatronics
Clef Products
Commodore Systems Division
The Component Centre
Compshop Ltd.
Continental Specialties Corporation
Crael UK Ltd.
Crimson Elektrik
Crofton Electronics Limited
De Boer Elektronika
Electronic Organ Constructors Society
Electronics Today International
Electroni-Kit Ltd.
Electrovalue Ltd.
Everyday Electronics
Expo (Drills) Limited
Falcon Acoustics Ltd
GMT Electronics
Hart Electronics
Havant Instruments Ltd.
Henry's Radio
Lektrokit Limited
Light Soldering Developments Limited
LINDY-Klaus Lindenberg KG
Lotus Sound
Manx Electronics
M.C. Márketing
Magnum Audio Ltd.
Maplin Electronic Supplies Ltd.
A. Marshall (London) Ltd.
Medelec Ltd.
Microdigital Ltd.

One of Maplins range of synthesisers



Exhibitors (continued)

- N.I.C. Models
- The Newbear Computing Store
- OK Machine & Tool (UK) Ltd.
- P.I.L. Ltd.
- T. Powell
- Powertran Electronics
- Practical Computing
- Practical Electronics
- Sentinel Supply
- **Stevenson Electronics Components**
- Strutt Electrical & Mechanical Engineering Ltd.
- Transam Components Ltd.
- TUAC Ltd
- Two Plus One Components Ltd.
- Vero Electronics Ltd.
- Watford Electronics
- West Hyde Developments Ltd.

One of the major exhibitors at Breadboard will be **Maplin Electronic Supplies.** This company is looking forward to being able to attend this exhibition as it provides such a golden opportunity to greet all their customers and exchange views. This years change of venue to the Agricultural Halls will be a great asset as they offer a lot more room for the public to browse and play with or buy any of the many items on show. Maplin will have a full arena of exhibits.

Their range of project kits will be on display with special attention being given to the organ and synthesizer (see photo) for which professional musicians will be in attendance giving continuous demonstrations with Mr. John Parker on the organ and Mr. Mike Beecher putting the new 5600 synthesizer through its paces.

In addition many of the lines shown in this company's large catalogue will be on sale along with their range of leaflets.

★ ★ ★ ★ ★ ★ ★ ★

Due to the success of last year's show, **BI-PAK Semiconductors** are very pleased to be taking part in the second London Breadboard Exhibition. The name BI-PAK is now well known, not only to enthusiasts, but right across the electronics industry having been in the forefront of the distribution market for some fourteen years.

Over those years their growth has been considerable and yet they still manage to keep in touch with customers' requirements for quality components at competitive prices and maintain a same day service.

They will again be demonstrating and exhibiting their full range of Bi-Kits and high quality audio modules, including some new additions. Also there will be a large selection of semiconductors and components on sale.

★ ★ ★ ★ ★ ★ ★ ★

Bernard Babani (Publishing) Ltd will be displaying their entire range of publications.

The series of titles is one of the largest available and covers practically every aspect of radio and electronics with subjects to interest all enthusiasts from the complete beginner to the highly experienced. All their books offer extremely good value, being inexpensive paperbacks ranging in price from 25p to £2.75.

Their new 1980 eight page descriptive catalogue covering all their books will be available FREE to all visitors to their Stand.

★ ★ ★ ★ ★ ★ ★ ★

The British Amateur Electronics Club (B.A.E.C.) is the only national amateur electronics club in this country, and its importance is widely recognised in the world of amateur electronics, including exhibitors at Breadboard '79.

Members keep in touch and help each other through the quarterly B.A.E.C. Newsletters and several exhibitors will be offering special concessions to B.A.E.C. members. The B.A.E.C. Stand will be the place to go for friendly discussions on amateur electronics and a chance to play with elec-

VMOS POWER DEVICES—Part 1

By John Baker

The first of two articles describing applications for the new VMOS power transistors

VMOS power field-effect transistors are not a new development but they have only been in existence for a few years and it is only recently that they have become available to the amateur experimenter. Previous f.e.t. types have been mainly suitable for low power applications, such as high impedance buffer amplifiers, low noise pre-amplifiers and similar functions. Devices such as the 2N3819, 2N3820, etc., have maximum dissipation figures of a few hundred milliwatts, and at first sight could conceivably be considered suitable for medium power applications, such as in the output stages of portable radios. In practice, however, they are unsuitable for such applications since their drain-to-source resistance when made fully conductive is unlikely to be less than about 100Ω and could be as much as several times this figure. An f.e.t. audio output stage, employing devices of this type, would obviously give very poor efficiency even when driving a high impedance loudspeaker.

VMOS devices, or "vertical" f.e.t.'s as they are sometimes called, have the structure shown in the representitive cross-sectional diagram of Fig. 1. The current flows vertically between the drain and the source, rather than horizontally as is the case with an ordinary JUGFET or MOSFET. It is the unusual VMOS structure which enables VMOS devices to handle high powers and currents.

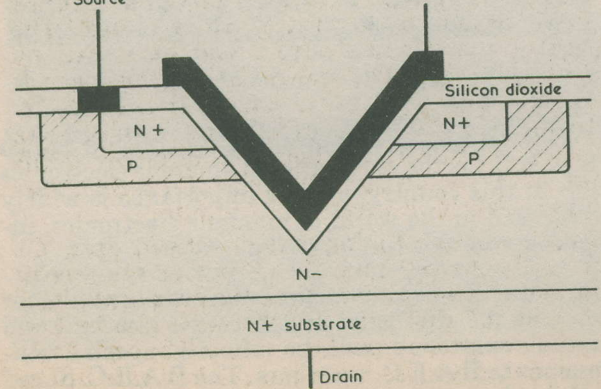


Fig. 1. A cross-section illustrating the internal

AVAILABLE TYPES

At the time of writing, three medium power VMOS devices are readily available to the amateur user, these being the VN46AF, VN66AF and VN88AF, all of which are manufactured by the Siliconix Corporation. They may be obtained from Maplin Electronic Supplies. The main difference between these three devices are their maximum drain-to-source voltage ratings, which are 40 volts, 60 volts and 80 volts respectively. They are all in a TO-220 encapsulation, have a maximum drain-to-source current rating of 2 amps and a maximum power dissipation of 12.5 watts.

These VMOS devices are enhancement f.e.t.'s rather than the depletion types which are more often encountered. A depletion f.e.t. is normally in the on state, and its gate must be reversed biased with respect to its source in order to turn off the device or bias it for linear operation. An enhancement mode f.e.t. is much more like an ordinary bipolar transistor in that it is normally turned off, and its gate must be forward biased with respect to its source if it is to be turned on. For a drain-to-source current of 1mA, the VMOS devices require a forward bias of between 1.8 and 2 volts. Like ordinary f.e.t.'s, these transistors are voltage rather than current operated, and they have very high input impedances. The drain-to-source saturation voltage with a gate bias of 10 volts and a drain current of 1 amp is 3 volts maximum (4 volts maximum for the VN88AF).

ADVANTAGES

VMOS f.e.t.'s have several advantages over bipolar power transistors, the most obvious being their very high input impedance. This makes it possible for the device to provide an output current of an amp or more whilst being driven from a high impedance circuit, since no significant input current is drawn by a VMOS transistor. In consequence, a single VMOS device can often be employed where two or three bipolar transistors connected in a Darlington configuration would be needed. This fact can offset one disadvantage of VMOS transistors, which is their slightly higher cost (at the time of writing) when compared with most bipolar power devices.

Another advantage with VMOS transistors is the fact that they do not have the minority carrier storage time effect associated with bipolar transistors, since they are majority carrier devices. In practice this means that they have a very fast switching speed, the actual figures for the devices mentioned here being 2 nanoseconds typical and 5 nanoseconds maximum. Typical FT is 600MHz.

A third advantage of VMOS transistors is that they do not suffer from thermal runaway and secondary breakdown. Bipolar transistors are subject to thermal runaway because they have a positive temperature coefficient; as they increase in temperature they conduct more heavily, thereby producing increased power dissipation and further temperature rise. Unless appropriate steps are taken, this regenerative process can easily continue until the transistor is destroyed. Secondary breakdown can be regarded as a form of localised thermal runaway within a transistor, and it limits the maximum voltage-current combination that can be safely handled. VMOS devices have a negative temperature coefficient, so that increased temperature causes a reduced current flow. Thus, a sort of negative feedback action prevents thermal runaway and secondary breakdown.

There are disadvantages to VMOS transistors which are, once more, applicable at the time of writing. The main disadvantage is that the saturation voltage is higher than that of a bipolar transistor, whereupon they become slightly less efficient in some applications. Another disadvantage is that, in the power range being considered here, only n-channel devices are available at present. It is probable that future developments will overcome these problems.

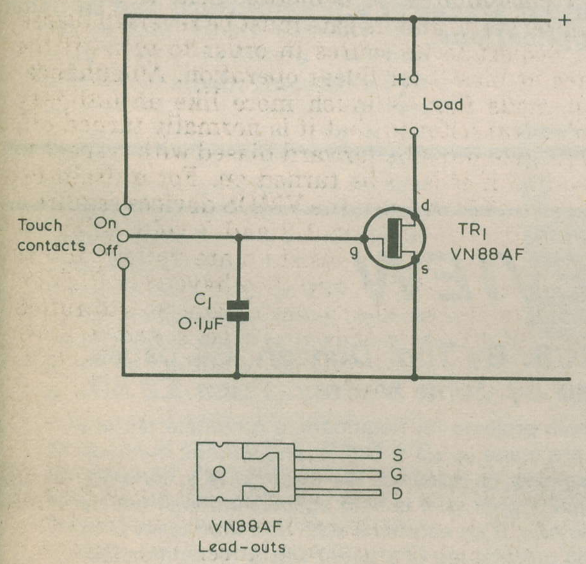


Fig. 2. A very simple touch switch incorporating a VMOS transistor. If leakage resistances are kept very high the circuit remains almost indefinitely in the on or the off state

TOUCH SWITCH

The remainder of this present article will be devoted to two circuits incorporating a VMOS transistor, and the first of these is shown in Fig. 2. The diagram shows a very simple touch switch which demonstrates the main properties of a VMOS device.

It is assumed that, when power is first applied to the circuit, C1 is in a discharged state. TR1 is, as a result, turned off. Only leakage current will flow in the load and at most this should be only 10μA. The leakage currents in several prototype circuits were all much less than 1μA; too low, in fact, for the author to detect at all.

The switch can be set to the on state by touching the upper set of contacts. C1 then charges up to the supply rail voltage through the skin resistance of the operator, biasing TR1 into the on state. The circuit will remain in this state until C1 gradually discharges into TR1 gate and through its own leakage resistance, or until the operator touches the lower set of contacts to provide a discharge path through his skin resistance. The input resistance of TR1 and the leakage resistance of C1 will both be extremely high, and it is found in practice that the circuit seems to stay in the on state indefinitely.

The touch contacts do not need to be particularly efficient in terms of low contact resistance with the skin of the finger which touches them, as a high resistance here will merely increase the time taken for the circuit to switch from one state to the other, rather than preventing the circuit from working at all. On the other hand it is important to ensure that there is a very high resistance between the contacts since even a minute leakage current would be sufficient to prevent the circuit from functioning correctly. For the same reason there must be very high resistance in the wiring to the transistor gate lead-out, and the capacitor must be a good quality plastic foil component.

The touch switch circuit works well with loads drawing current up to about 100mA. At these currents there is no significant voltage drop across TR1 when it is turned on.

CMOS TIMER

An obvious field of application for VMOS devices is as an output switching device driven by CMOS logic. An example is given in the CMOS timer of Fig. 3. Here, two gates of a CMOS 4001 quad 2-input NOR i.c. are connected to act as a monostable multivibrator which produces a timed positive output when switch S1 is closed. The length of the positive output can be varied by means of VR1. The range of timing periods available will vary to a small extent due to tolerances in the value of C2 and variations in transfer characteristic between different NOR gates, but it should be of the order of less than 1 second to slightly in excess of 1 minute.

At the end of a timing period, with S1 open, C1 will be discharged and the output at the second gate, at pin 4, will be low. Both the inputs, at pins 1 and 2, of the first gate will therefore also be low, and the first gate output, at pin 3, will be high. If S1 is momentarily closed, pin 1 of the first gate will be taken high causing pin 3 to go low. Since C2 is discharged, pins 5 and 6 of the second gate will also be taken low, and its output will go high, maintaining

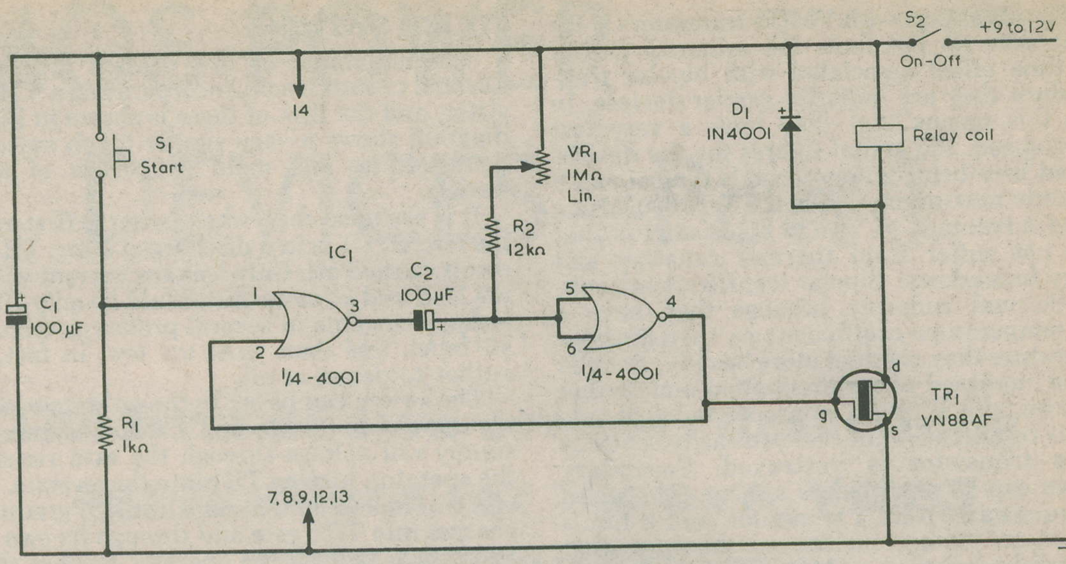


Fig. 3. A timing circuit in which the output of a CMOS gate couples directly to the gate of the VMOS transistor. The loading placed on the CMOS output is negligibly low

the low output at pin 3 of the first gate. The high output of the second gate turns on TR1 and causes the relay, whose coil is in its drain circuit, to energise.

C2 commences to charge via R2 and VR1. When its right hand plate is sufficiently positive the output of the second gate starts to go negative, taking pin 2 of the first gate negative also. The overall gain in the two gates results in a fairly rapid transition to the original state in which the output at pin 3 of the first gate is high and pin 4 of the second gate is low. The timing period is then over, with TR1 turned off and the relay de-energised.

The low current output of a CMOS gate is not sufficient to energise a relay directly, and a VMOS transistor is an ideal device for converting a CMOS output voltage to a high load current. Indeed, a CMOS output could actually drive more than a hundred VMOS transistors.

As with the touch switch of Fig. 2, the VMOS transistor of Fig. 3 can readily provide output load currents up to 100mA. This enables relays with quite low coil resistances to be used.

NEXT MONTH

In next month's concluding article, we shall discuss the use of VMOS devices in the output stages of a.f. amplifiers and in other applications.

(To be concluded)

BOOK REVIEW

ADVENTURES WITH ELECTRONICS. By Tom Duncan. 64 pages, 245 x 190mm ($9\frac{3}{4}$ x $7\frac{1}{2}$in). Published by John Murray. Price £2.50.

This hard cover book presents simple constructional projects for beginners, a particular feature being that no soldering is required. The assemblies are made up on S-DeC's, and various methods are employed for making connections which would normally be soldered. For instance, if a transistor lead-out is to be extended a piece of 22 s.w.g. tinned copper wire is held against the lead-out by passing 1mm bore rubber or plastic sleeving over the two. If an earphone with stranded leads is to be connected to the S-DeC, the neat trick of opening out one leg of a paper clip is recommended. The opened-out part of the clip is passed into the S-DeC hole and the stranded lead is held in the remaining section.

After an introductory passage the book proceeds to a few simple circuits and then describes fifteen projects. These include a rain detector, a burglar alarm, an electronic metronome and an f.e.t. radio. The book carries on to two short sections covering the working of radio and the testing of transistors, and concludes with a list of the parts required for the projects. The components may be purchased individually or as a complete kit for the book.

"Adventures With Electronics" is printed in red and black, and has an imaginative approach which will particularly appeal to the younger reader.

Radio Topics

By Recorder

Now that everybody is going mad about microprocessors, it becomes desirable for all of us to get at least a smattering of knowledge about some of the things which go on in the realm of what the media keep referring to, annoyingly, as the "silicone chip". The extra "e" added to the correct word "silicon" conjures up horrible visions of chunks of unhealthy looking potato fried up in silicone grease.

One of the mildly eccentric points about microcomputer i.c.'s is the numbering of inputs and outputs. Instead of numbering these in the order 1, 2, 3, 4, 5 and so on, the first input is numbered zero, giving the series 0, 1, 2, 3, 4, etc.

2 TO THE NOUGHT

Perhaps this makes sense when we consider binary numbers. We may in reading about microprocessors encounter the number 1111111, which consists of seven binary digits. This is obviously 1 less than 10000000 which, when we count the number of digits (8) we may erroneously assume to be 2 to the power of 8, or 256. The number 1111111 must therefore be 1 less, or 255.

But we would be wrong because 10000000 is not 2 to the power of 8, but is 2 to the power of 7, which is equal in decimal to 128. Why is this? It is because the least significant digit in the number, the one at the extreme right, does not represent 2 to the power of 1, it represents 2 to the power of zero.

Let's try it with smaller binary numbers. 100 in binary is 4 in decimal, and is obviously equal to 2 squared or 2 to the power of 2. If we count the number of digits, from right to left, we do not use the series 1, 2, 3 but, instead, the series 0, 1, 2 to arrive at the correct power of 2. With the binary number 1000, the digits, counting from right to left, number 0, 1, 2, 3. So 1000 is 2 to the power of 3, or 2 cubed, or 8 in decimal.

The same state of affairs exists in decimal. 100 in decimal is 10 to the power of 2, as can be determined by counting the digits from right to left, using the sequence 0, 1, 2.

NUMBER DOODLES

Whilst on the subject of numbers, some mild and harmless amusement can be obtained from doodling with pocket calculators. As an example, key in any number from 1 to 9 inclusive, and then multiply this by 3. Multiply again by 7, then by 11, then by 13 and then finally by 37. After this, press the "equals" button.

The numbers 11 and 101 multiplied together in any order produce palindromic number (numbers which read the same in both directions) until you take the number of multiplications too high. For instance, try keying in 11 times 11 times 101 times 101 equals. The result will stand another multiplication by 11 before the number becomes too large.

I can't guarantee that all calculators will give the desired answer to the next little doodle, but it's worth trying. Key in 9.876543 and then divide it by 8. The result, with simpler calculators, should be 1.2345678.

Most people know the result of keying in 7734 and then turning the calculator upside-down. Another number which can be treated in the same manner is 58008.

POWER SUPPLIES

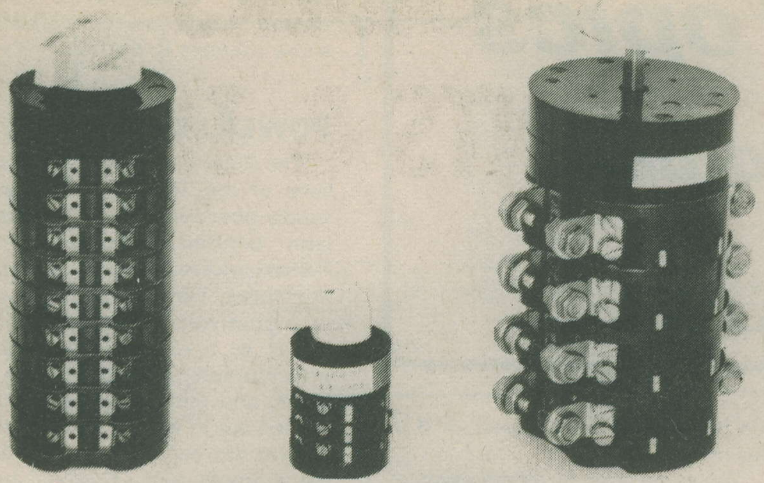
The illustration shows the smart lines of the TPS 21 bench power supply now available from Gresham Lion Limited, Gresham House, Twickenham Road, Feltham, Middlesex, TW13 6HA.

Output voltage on all types is adjusted by a high-accuracy 10-turn potentiometer mounted on the front panel, and this allows setting to be carried out to within 5mV. Similarly, current trip adjustment is made using a single turn "Cermet" potentiometer. In the range, the TPS 20 power supply offers a single variable voltage from 0 to 30 volts with current limiting up to 1 amp and a separate 5 volt 1 amp output. The TPS 21 gives two 0-30 volt outputs up to 1 amp, together with a 5 volt 3 amp output. Variations on the TPS 21 are the TPS 21D, which has l.e.d. digital displays instead of meters, and the TPS 23A with variable current limiting up to 2 amps. The two remaining power supplies in the range are the TPS 25 with a single 0-40 volt output and variable current limiting up to 1 amp, and the TPS 28 which offers a single variable 0-60 volt output at 2 amps maximum, or tracked 0-30 volt positive and negative outputs, again up to 2 amps maximum.

Bench power supply type TPS 21. This is one of a new range of precision power supplies manufactured by Gresham Lion Limited

CAM SWITCHES

The cylindrical components with terminals in the second photograph are husky rotary cam switches marketed by J & N Wade (Switches) Limited. Meeting most European specifications, these switches feature a positioning cell which determines the switching angle (30, 45, 60 or 90 degrees) and also sets the start and stop positions of the switching function. Either one or two double-make,



Cam switches of 16 and 25 amp rating available from J & N Wade (Switches) Limited. These versatile and rugged units can be adapted to control a wide range of high current switching circuits

double-break contacts are available, and the switch design enables the user to employ up to 72 contacts by using, for example, a three-column unit having a single operating handle.

The switches are available for mains, on-off, changeover, step control, starter, motor reversing, voltmeter, ammeter, wattmeter and group control applications. Spring return functions are available on many of the switches and a range of series-parallel units is also available.

The switches are described as 16 amp (type K) and 25 amp (type A) units. Voltage ratings are up to 660 volts, and thermal current ratings range from 16 to 200 amps, or 2,000 amps with contacts in parallel. Further details may be obtained from J & N Wade (Switches) Limited, Limberline Road, Hilsea Industrial Estate, Portsmouth, PO3 5JQ.

IMMERSION SWITCH

I have just received a sample of the new Immersion Heater Time Switch manufactured by Smiths Industries Limited, and a very neat little item it is, too. Intended for operation from 220 to 250 volt 50Hz mains supplies, it is capable of switching on an off resistive loads up to a maximum of 16 amps. In its nominal application as an immersion heater time switch it can offer savings in electricity since it automatically provides just the right amount of water heating in each day. There is no need to rely on memory. The switch can, of course, be used for switching resistive loads other than immersion heaters.

The switch measures $2\frac{3}{4}$in. square by $2\frac{1}{4}$in. deep, and can be fitted directly into any flush conduit fixing or surface mounted switch box. It is supplied complete with mounting screws and bracket and can be purchased from electrical retailers.

The timing mechanism incorporates a plastic ring, calibrated in hours from 1 to 24, which is driven by the internal synchronous clock so that it rotates once every 24 hours. Near the periphery of the ring are two concentric circles of holes, these being spaced out at quarter hour intervals. A metal peg is inserted at the appropriate hole in the inner circle to give switch-on, and a second peg is fitted to another hole in the outer circle to provide the switch-off function. Four additional pegs are provided, enabling the controlled item to be switched on and off two or even three times a day. A lever at the front of the switch can be manually actuated to switch the load on or off (apart from a period up to ten minutes after a timing operation, during which the lever action is inhibited) and the timer will then automatically take over the subsequent switching off or on at the appropriate time. Indeed, the timer can have only one peg inserted, whereupon it simply switches on or off at a predetermined time.

EARTH STATION

Now fully operational at Madley, Herefordshire, is the £6M Madley I satellite communication ground station commissioned by the Post Office. The inauguration took place in April and the prime contractor was Marconi Communications Systems Limited.

Initially Madley I is being used with the Indian Ocean Intelsat IVA satellite and provides a large capacity for telephone, telex and television traffic. The station has facilities for further expansion and it is foreseen that it will be used with the next generation of international telecommunication satellites, Intelsat V, whereupon the system channel capacity will be doubled. In terms of quantity of equipment Madley I, with its 32 metre antenna, is one of the largest satellite earth stations operating in the Intelsat system. In all, 55 chains of receiving equipment, 14 chains of transmitting equipment and 10 high power amplifiers give Madley I the capability to communicate with about 40 countries simultaneously, and Marconi Communication Systems is already manufacturing equipment to extend this capacity.

As prime contractor, Marconi Communications Systems is co-ordinating the efforts of an international team of sub-contractors including Mitsubishi Electric Corporation, Japan, for the antenna sub-system and Comtech, in the U.S.A. for the low noise amplifiers.

The complete Madley I station is built up in modular fashion from a number of individual sub-systems. The largest of these is the steerable 32 metre parabolic antenna which is mounted on a building housing the steering and control equipment. Also in this building are the high power transmitter amplifiers with their associated control logic, and low noise cryogenically cooled broadband receivers.

In the Post Office central building is installed the Marconi Ground Communication Equipment. This consists of s.h.f. branching, s.h.f./i.f. downconverters, demodulators, modulators and base-band equipment. Also in the building is the cross-site make-up amplifier operating at the s.h.f. receiver frequency, fixed station test facilities and all associated control and monitoring equipment. (S.H.F., incidentally, stand for Super High Frequencies of 3,000 to 30,000MHz.)

Peripheral systems, such as public address, air conditioning, fire detection and weather recording facilities have all been supplied.

It should be mentioned that Marconi has a long record of achievement in the technology and construction of communication earth terminals. For the Post Office the company designed and equipped the Intelsat A stations at Goonhilly 2 and 3, and in September of 1978 handed over Goonhilly 4. Marconi Communication Systems remain the only British Company to have supplied complete communication satellite earth stations.

In your workshop

READERS' HINTS & TIPS

Smithy discusses hints sent in by readers

"Knock Knock!"

Smithy sighed wearily.

"Who's there?"

"Two people: Killer and Mugger."

"Killer who and Mugger who?"

Dick grinned expansively.

"Killer Hertz and Mugger Hertz!"

Smithy grunted irritably. It had been a tiresome day. On the "For Repair" rack were no fewer than four colour television receivers which had been collecting dust over the last week awaiting replacement parts from their manufacturers' service departments. Accompanying them were two black and white television receivers which were similarly awaiting replacement parts from the manufacturers' service departments. Also on the rack was a multi-knobbed silvery music centre for which a replacement part had actually arrived from the manufacturer's service department that very morning, the only snag being that it was for the wrong model.

Smithy drew some comfort from the fact that he and Dick had at least cleared the rest of the stock on the "For Repair" rack. The last item had been an inexpensive cassette recorder with an intermittent fault on "Playback". They had struggled for a fruitless and frustrating two hours of the afternoon in their search for the source of the intermittent, tapping components and flexing the printed board without a single sign of success. It was eventually Dick who noticed that the intermittent fault became evident only when the "Playback" button on the "Record-Playback" switch was pressed in at a certain angle. This finally led to the discovery of a cold joint at one of the switch tags. After the wasted two hours, the intermittent fault was cured in less than ten seconds by a touch of the soldering iron and the expenditure of three millimetres of resin cored solder.

READERS' HINTS

"Come on Smithy, cheer up." called out Dick from his side of the Workshop.

Smithy looked over at his assistant and then glanced at his watch.

"You must admit," he stated, "that it hasn't been one of our better days. Oh well, there's no use moping about it, I suppose. You can press on home early if you like, as there won't be anything else to do today."

But Dick seemed reluctant to depart.

"D'you remember," he asked casually, "when we were doing that cassette recorder, you asked me to have a look in your bench drawer for an insulated rod which you could use to poke at the components?"

A pained expression passed over the Serviceman's face.

"I don't think 'poke' is quite the right word to use. I employ that little rod to gently tap the components."

"You were poking them all right near the end, when you were getting all het up about that intermittent," retorted Dick. "Anyway, while I was looking in your drawer I noticed that you had quite a large sheaf of letters in there, all clipped together with a whacking great paper clip. I was wondering ..."

His voice trailed away expectantly.

"Sheaf of letters?" repeated Smithy frowning. Suddenly his expression changed and his eyes lit up. "Why, of course! Those are the letters with hints sent in by readers, and they've been gradually accumulating over the months. There should be quite a pile there by now."

He opened the drawer and took out the letters.

"Yes," he went on cheerfully. "We've got quite a selection here. Certainly enough for us to have a good readers' hints session. Shall we do just that?"

"Yes please!"

"Right. Well, you come over here and I'll have a go at them."

As Dick carried his stool across the Workshop and set it up alongside Smithy's, the Serviceman looked through the letters. He extracted one from the sheaf.

"Here's a good one for starters," he announced. "And it's from a reader who uses a home-constructed short-wave preselector with plug-in coils. The ones he uses are the Denco miniature types which plug into a B9A valveholder. As you will very probably know, these coils are supplied in aluminium cans which can be used as screens for the coils, and in his preselector he first fits the coil he wants to use and then screws the screen over it." (Fig. 1.)

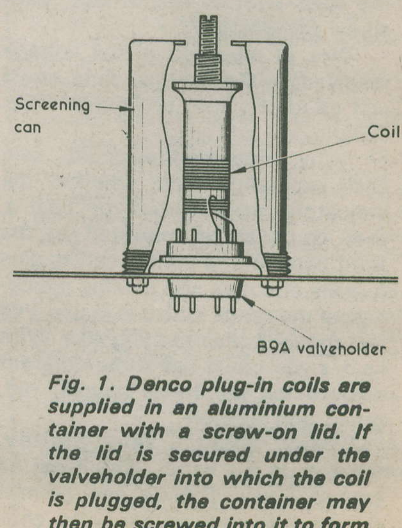


Fig. 1. Denco plug-in coils are supplied in an aluminium container with a screw-on lid. If the lid is secured under the valveholder into which the coil is plugged, the container may then be screwed into it to form a screening can

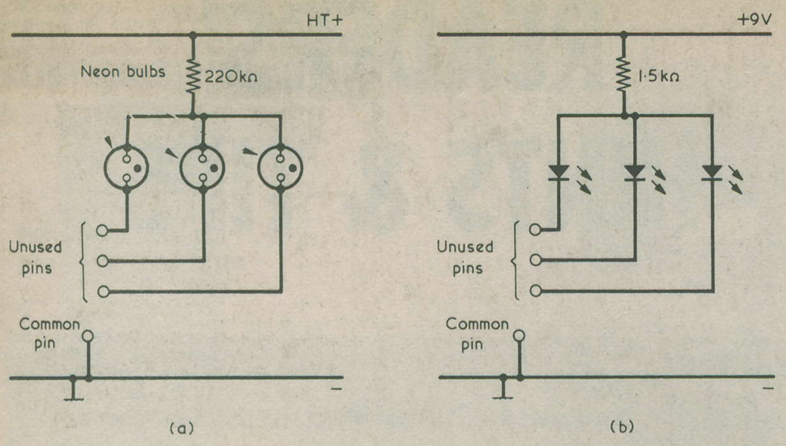


Fig. 2(a). The three neon bulbs are wired to the B9A valveholder so that each lights up when one of three separate coils is plugged in. The series resistor has a value suitable for h.t. voltage of around 150 to 200 volts

Fig. 2(b). With semiconductor equipment having a low supply voltage, light emitting diodes may be employed instead of neon bulbs

"Yes?"

"The snag is that he doesn't always know which coil happens to be plugged in without having to uncrew the can again! And so he uses an electrical method of indicating which coil is in use. There are three coil ranges and he has modified the coils by adding to each a bridge wire which connects between a common pin at chassis potential and a disused pin. The disused pin is different with each coil. The result is that whichever coil is inserted completes a circuit between chassis and a neon indicator coupled to the h.t. positive rail. I should add that his preselector is a valve job with a high voltage h.t. supply." (Fig. 2(a).)

"Does that mean you can't use the idea with a low voltage transistor preselector?"

"Not at all. With a low voltage preselector the bridged pins could just as readily turn on l.e.d.'s." (Fig. 2(b).)

"Why, of course they could," said Dick excitedly. "And, whether the indicators were neons or l.e.d.'s, they could all be mounted on the front panel of the preselector to give a really effective and striking indication of the range which is in use. I've just thought of something else. With l.e.d.'s you could use three different colours for the three ranges; red, green and yellow!"

"Okay, okay," said Smithy, holding up his hand. "Don't get all carried away. There's one point I should make to anyone who considers adding the bridging wire to the Denco coil pins."

"What's that?"

"The pins are mounted in polystyrene, which melts very readily with heat, and so the soldering iron should be applied and withdrawn very quickly. A good plan is to first plug the coil into an odd B9A valveholder, fit the bridging wire to the pins and then solder it quickly. After that, give the coil a good few minutes to allow the polystyrene to reset hard again before removing it from the valveholder." (Fig. 3.)

ETCHANT TRAYS

"That bridging wire idea is a good hint to begin with," said Dick enthusiastically. "What's the next one, Smithy?"

"It's a method for making up trays for etching printed circuit boards," replied Smithy slowly, as he read a new letter. "There are two diagrams attached to the letter, so you'd better have a look at these."

He removed a sheet of paper from the letter and passed it over to his assistant. (Figs. 4(a) and (b).)

"What's the advantage of these trays?"

"The main advantage is that they cost nothing at all," stated Smithy. "As you know, it's often recommended that a photodeveloping tray be used for printed circuit etching, but trays of that nature are not so easy to come by nowadays, and they can also be quite pricey, too. What this letter suggests is that suitable etchant trays can be made up with the plastic available from discarded washing-up liquid bottles, plastic milk bottles or similar circular containers. First of all the neck and base of the bottle are cut off, after which a cut is made down the resultant cylinder, giving a rectangle of plastic sheet. If necessary, this can be cut down again to give a final rectangle of the desired size. Next, you draw lines on the rectangle as shown in the first diagram, and then fold or crease along the lines. Follow this by folding the sheet to the shape illustrated in the second diagram and, using an office paper stapler, staple together the multiple layers of plastic material at the corners. The staples must be high enough up the walls of the tray which has now been formed to be above the surface of the etchant."

"What size of tray can you make up with this idea?"

Smithy studied the letter.

"The average washing-up liquid bottle will make a tray measuring about six by six inches with three-quarter inch walls," he stated.

"Furthermore, a series of smaller trays could be made, to fit one inside the next. As a result, an appropriately sized tray can be selected for whatever board is to be etched, with a consequent saving on etchant. Finally, trays made up in this way are neat and durable, and will survive the etching of many a printed circuit board."

He turned to a further letter.

"Snap!"

"What did you say?"

"I said snap!" chuckled Smithy. "Believe it or not, but the very next letter I've picked up describes another home-made plastic bath for etching printed circuits. Let me read from the letter. 'The bath which I now use, and have used very successfully for two years, is made from one of those boxy-shaped plastic bottles in which supermarkets commonly sell half-gallons of lemon squash. The plastic from which these are made is translucent and reasonably tough but is quite

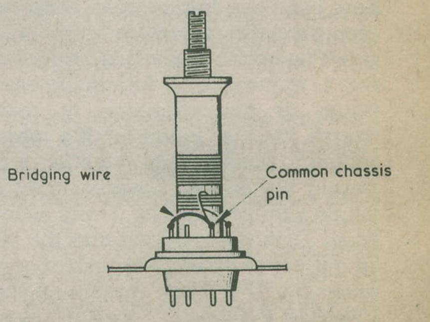
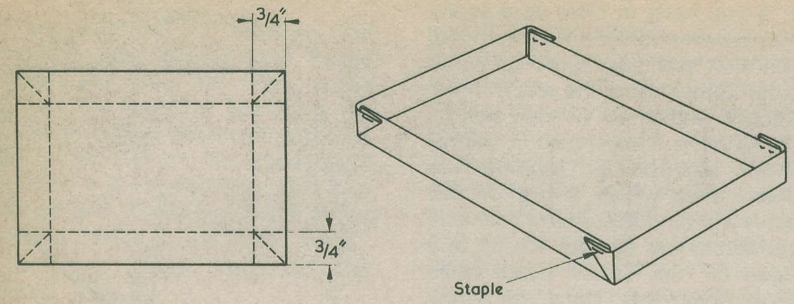


Fig. 3. The bridging wire is soldered to the appropriate coil pins in the manner shown here



(a) (b)

Fig. 4(a). A rectangle of plastic cut from a plastic container is marked up as illustrated
(b). The plastic is then folded up to form a tray, the corners being secured by staples

easy to cut with a sharp knife.' "

"I think I know the sort of bottle that's being referred to," said Dick, frowning, "but I'm not entirely certain."

"The reader has drawn a sketch of the bottle after it has been converted to a bath."

Smithy handed Dick a sketch which had been attached to the letter. (Fig. 5.)

"Oh, I know the type of bottle that's meant now," said Dick. "Go on, Smithy."

"Okeydoke," replied Smithy equably. "The bottle is used laying on its side, and a rectangular aperture measuring, say four by five inches is cut centrally in the upper face. This hole is significantly smaller than the maximum which could be cut out, so that there is an overhang all round the inner surface, giving the advantage that accidental spillage of the contents is very unlikely. This home-made bath still has the screw cap on it, which makes it very easy to empty and wash out when it becomes dirty. Another point is that the handle, which is also left on, provides a convenient place to attach a cord which can be looped over a simple crank on the spindle of a slow-speed electric motor. This allows the contents of the bath to be gently agitated whilst etching is in progress."

"Blimey," said Dick appreciably, "that's a cunning approach. There's one thing, though. Won't the overhanging edges make it difficult to remove the printed board after etching?"

"Our correspondent has covered that point too," grinned Smithy. "All that has to be done is to thread a piece of plastic covered wire about a foot long through a suitable hole in the board before it's put in the bath. The board may them be removed by this wire."

He paused for a moment.

"I think it's worth giving a word of warning here," he continued. "Ferric chloride etching solution is a pretty active chemical and like all active chemicals it should be handled with care.

"Dissolving ferric chloride crystals can sometimes cause the creation of heat, and so the process of dissolving should not be carried out in a plastic tray or bath, although it is of course in order to store a cool and fully prepared ferric chloride solution in a suitable plastic container."

"That seems sensible enough," commented Dick. "Is that the finish of that letter?"

"No," stated Smithy, "there's a second hint in it. This also has to do with printed circuits and it deals with a good and cheap etch resist. The letter says that the cheapest and best etch resist the writer has yet come across is a preparation sold as engineer's marking out liquid. This is a spirit based lacquer which is usually blue in colour, and it is widely used in metal working to provide a coloured background on

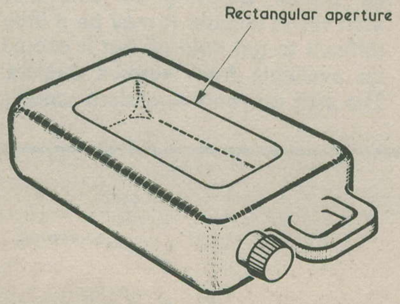


Fig. 5. A home-made bath for printed circuit etching is made from a supermarket lemon squash container

which scribed lines stand out clearly. It should not be confused with 'marking blue', a non-drying paint sold in toothpaste type tubes which is used for quite different purposes. The correct marking out liquid can be put on the cleaned copper surface of the board with a paint brush or a pen to form the tracks, or it can be applied all over and then scratched away, when dry, at the places where it is not wanted. The lacquer dries in a few moments and etching may then be carried out straightaway. After etching is complete, the lacquer can be removed with a paper towel wetted with methylated spirit."

"That sounds like just the thing for printed circuit buffs," commented Dick. "How d'you get hold of this marking out liquid?"

"That's not quite so easy," said Smithy, as he continued to read the letter. "It seems that the liquid is sold in large bottles only, which are much too big to provide the small quantities required for amateur printed circuit work. On the other hand, the liquid should be available in any good engineer's tool shop, and it may well be possible to obtain an odd ounce or two in an old ink bottle from a small local engineering company. Even this small quantitity would be adequate for dozens of printed boards."

"Does the marking out liquid have a trade name?"

"Let me see now," said Smithy, as he continued to look through the letter. "Ah yes, here we are. A very widely used brand of the liquid is sold under the name 'Spectra Color', and this should help you to identify it if you should go around hunting for it."

"'Spectra Color', eh?" repeated Dick. "I must remember that for any future printed circuit jobs I start off on. Any more hints, Smithy?"

AWKWARD SCREWS

Smithy picked up another letter.

"Here's a neat little one," he chuckled. "It's a solution to the perennial problem of getting screws started in awkward places."

He pointed to a sketch in the letter. (Fig. 6).

"If you have to offer up a screw in an awkward place," he continued, "you first put two turns of cored solder tightly round the screw in the direction indicated in the sketch. The screw is then placed in the required position by holding the solder, after which a tug on the solder will tend to turn the screw in. If possible, you can put the tip of a finger on the screw head while you're doing this. Once the screw has started the screwdriver takes over."

"Hey, that's crafty!"

"It *is* neat, isn't it?" agreed Smithy. "Now let's see what I've got next."

Smithy picked up several letters and looked through them carefully. After a little thought, he arranged them in a new order.

"Come on, Smithy, I'm getting all impatient!"

"Sorry to hold you up. The reason I'm sorting these letters out is that they come from one reader who has sent in a number of hints. However, these break down largely into three main ideas. Right, I'll get started on the first. This is an idea for replacing drive belts in reel-to-reel tape recorders and cine projectors. Our correspondent states that having paid prices from £2.50 to nearly £6 for replacement belts and, in some cases, not being able to obtain belts at all for some imported jobs, he got so fed up that he decided to see if he could make up his own belts. And here is one of the belts he actually made himself."

Smithy took out a belt from the letter envelope and handed it to Dick. (Fig. 7).

Dick picked it up and stretched it experimentally.

"It seems to have quite a bit of elasticity in it," he remarked. "The two ends are tied together with cotton thread. Here, hang on a minute this isn't a solid material — it's got a hole down the middle."

"That's right," confirmed Smithy. "It's plastic sleeving and it's known as 'Symel' Sleeving. As with that etch resist lacquer it may be a little difficult to get hold of, but it should be available from surplus dealers. The size our correspondent uses is

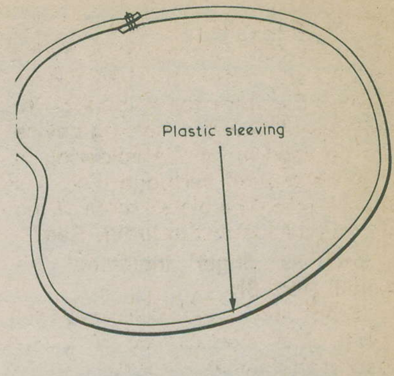


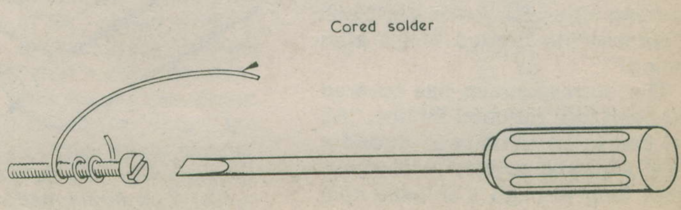
Fig. 7. A driving belt made up from tough plastic sleeving. The belt will be found a suitable replacement in many reel-to-reel tape recorders

$1\frac{1}{2}$ mil bore with $\frac{1}{2}$ mil wall thickness. A length of 25 yards can be obtained for quite a moderate sum and this can be cut up and made into a considerable number of belts. The sleeving is cut to the length required for the replacement belt and the two ends are tied together with several turns of thin strong thread. The sleeving will run over the smallest pulley likely to be encountered, and it has even been used successfully in replacements for square section drive belts. A further advantage occurs with tape recorders which have to be partially stripped down to fit a replacement belt. All that is required with the 'Symel' sleeving is to thread it through and get someone to hold it in position while you tie the ends together."

"That's certainly an idea I've never heard of before," commented Dick. "What's the next hint?"

"It's a holding device for soldering small components," said Smithy. "All it consists of basically is a crocodile clip soldered on to the end of a piece of fairly heavy copper wire about 6 to 10 inches long. If desired, the teeth of the clip can be filed down so that they don't mark the item to be held. The free end of the copper wire is secured in a vice or movable clamp, and the wire can be bent into any position. The item

Fig. 6. An idea for starting screws in awkward places. Pulling the solder turns the screw through several revolutions, after which the screwdriver may be brought into use



to be soldered is held in the crocodile clip, leaving both hands completely free to hold wires against the item for soldering. An example of how the holding device can be used is for the soldering of wires to a gram cartridge plug in a pick-up arm. There's a sketch of the holding device in the letter. See?"

Smithy's finger indicated the sketch. (Fig. 8).

"Stap me," said Dick eagerly. "That's just the sort of thing we need in this place. I'll make up one of these holding gadgets first thing tomorrow."

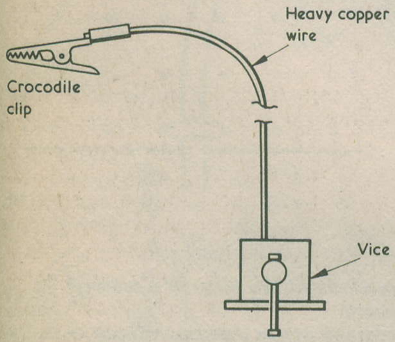


Fig. 8. A "third hand" for holding components during soldering. The copper wire can be bent to place the crocodile clip in any desired position

"It will certainly be jolly useful," agreed Smithy. "Now here's the third hint and it is concerned with mains units for transistor radios. Instead of making up a mains supply you simply obtain one of the pocket calculator mains adaptors which are on offer very cheaply these days. The letter writer states that he bought one rated at 7.5 volts d.c. at 50mA for less than a pound. These adaptors are intended for charging the batteries of pocket calculators, and they include a mains transformer and a rectifier. Now, there is of course no guarantee that a calculator adaptor will be suitable for a particular radio and so there's some risk that you may not be able to use the adaptor for this purpose after you've bought it. So far as hum is concerned, the electrolytics across the radio supply rails should provide sufficient smoothing in most cases. The calculator adaptors usually have the d.c. output carried by a 2-core wire terminated in a jack plug. The radio can then be fitted with a suitable jack socket which isolates the internal battery when the plug is inserted. It is essential that you check the output polarity of the calculator adaptor by means of a meter before wiring up the jack socket." (Fig. 9).

"That sounds to me," said Dick slowly, "as though the idea should only be used by people who understand the technicalities involved."

"That's right," agreed Smithy. "But against this has to be balanced the fact that these calculator mains adaptors can be picked up at giveaway prices. Now let's have a look at the next hint. Which, incidentally, brings us to the end of our present batch."

LEAD ANCHORING

Smithy took up the final letter in the sheaf on his bench and read it carefully.

"Ah", he remarked, "what we have here is an idea for anchoring leads which connect to Veroboard assemblies. Now, external connections to Veroboards are usually made with flexible insulated wires and these can pass through the appropriate holes in the boards and be soldered to the copper underneath. Alternatively, Veropins can be

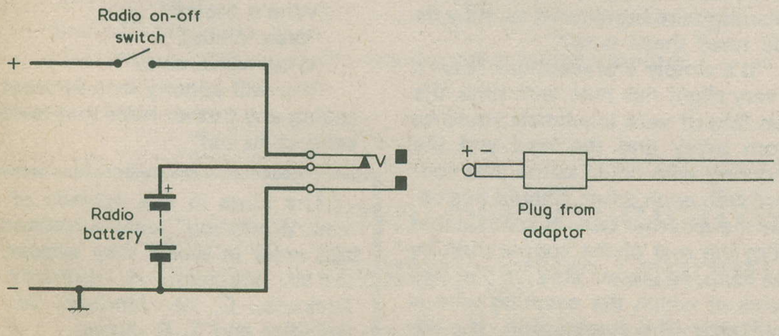


Fig. 9. Using a low-cost pocket calculator mains adaptor to power a small radio. It is necessary to find the polarity and voltage available at the adaptor output plug before using it with the receiver. Not all calculator adaptors may be suitable for this application

soldered to the board and the external leads soldered to these. Both of these methods are perfectly acceptable, but Veropins are to be preferred if the leads connecting to the board will be subjected to any physical movement, as would occur if they were leads going to a battery connector. Even with a Veropin there is still a weak point, this appearing where the wire leaves the rigid solder joint at the pin itself."

"That's true," agreed Dick. "I've bumped into several cases where wires have fractured at their Veropin solder joints."

"The answer to the problem," said Smithy, reading through the letter, "is to physically anchor the wires at the edge of the Veroboard. What is required for each lead are two adjacent holes in a single copper strip near the edge of the Veroboard, assuming that the Veroboard circuit layout allows this. Cuts are made in the strip on either side of the two adjacent holes. Next, a piece of single core insulated connecting wire has its ends bared for about half an inch at one end and about an inch and a half at the other end. Like this."

Smithy passed over a sheet attached to the letter. (Fig. 10 (a).)

"I'm with you so far. Go on, Smithy!"

"Then," said Smithy, "you pass the half inch bared end through one of the Veroboard holes and solder it to the copper."

"Right!"

"Next," resumed Smithy, "you pass the lead to be secured under the wire." (Fig. 10(b).)

"Check!"

"Finally," stated Smithy, "you pull the one and a half inch wire end fairly tight with a pair of pliers and quickly solder it at the second hole in the copper." (Fig. 10(c).)

"Right!"

"And that's it," said Smithy. "Cut off the excess wire on the copper side of the Veroboard and the lead is then held securely at the edge of the board. Easy, isn't it?" (Fig. 10(d).)

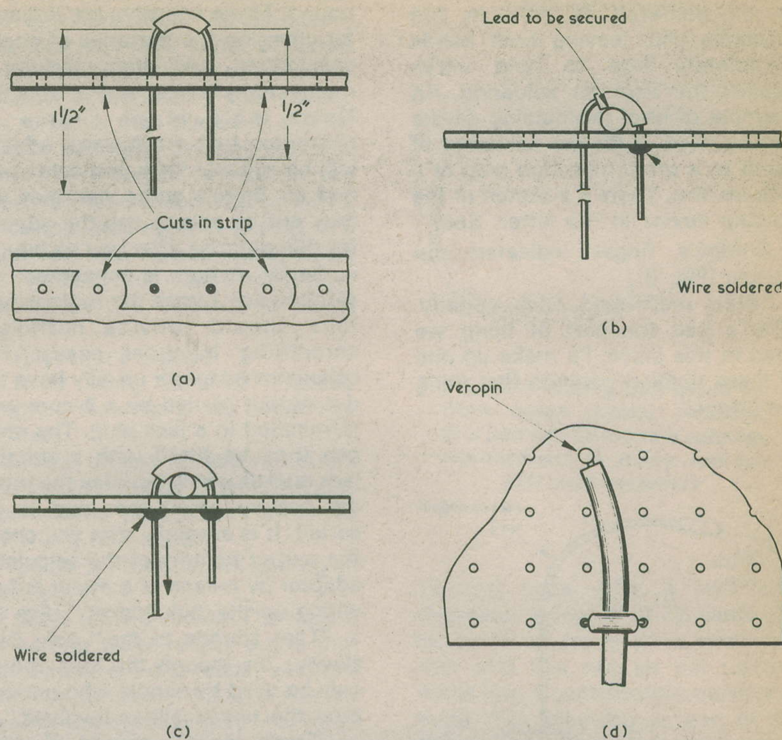


Fig. 10 (a). First step in anchoring a lead at the edge of a piece of Veroboard
(b). The short end of the wire is soldered at the Veroboard hole through which it passes
(c). The long end is pulled tight with a pair of pliers, and it is also soldered to the Veroboard copper strip
(d). Top view illustrating how the lead is secured in position near the edge of the Veroboard. There is now no risk of the lead breaking at the point where it leaves the solder joint at the Veropin

"I'll say," agreed Dick warmly. "Just a minute, though."

"What's wrong?"

"At the start you said that the copper strip is cut at the two holes on either side of the two which the securing wire is soldered to. Why do you need these cuts?"

"It's simply a precaution. There's a very slight risk that, with time, the two lots of wire insulation could be worn away and the lead and the securing wire could come into contact with each other. Should this occur the external wire is still isolated from the rest of the copper strip by the cuts on either side of the two holes at which the securing wire is soldered. The precaution is, admittedly, in the ultra-cautious category if no other connections are made to the strip concerned, but it is worth carrying out, nevertheless."

Smithy picked up the letters, tidied them up and clipped them together again.

"Well," said Dick, "this has been a really good hint session."

"It certainly has," agreed Smithy. "It's always of interest and value to know what other people are thinking about, and the ideas they use to make life easier. Knock knock!"

Dick looked startled.

"Who's there?"

"Wee Willie!"

"Wee willie who?"

"We will eagerly look forward to seeing any further hints that readers send in to us!" ■

The hints in this episode of "In Your Workshop" were submitted, in the order in which they appear, by D. W. Mepham, H. Kennedy, F. Dickens, C. M. Lindars, W. H. Spindler and T. F. Jones.

As Smithy states, further hints for this feature are welcomed. Payment is made for those that are published.

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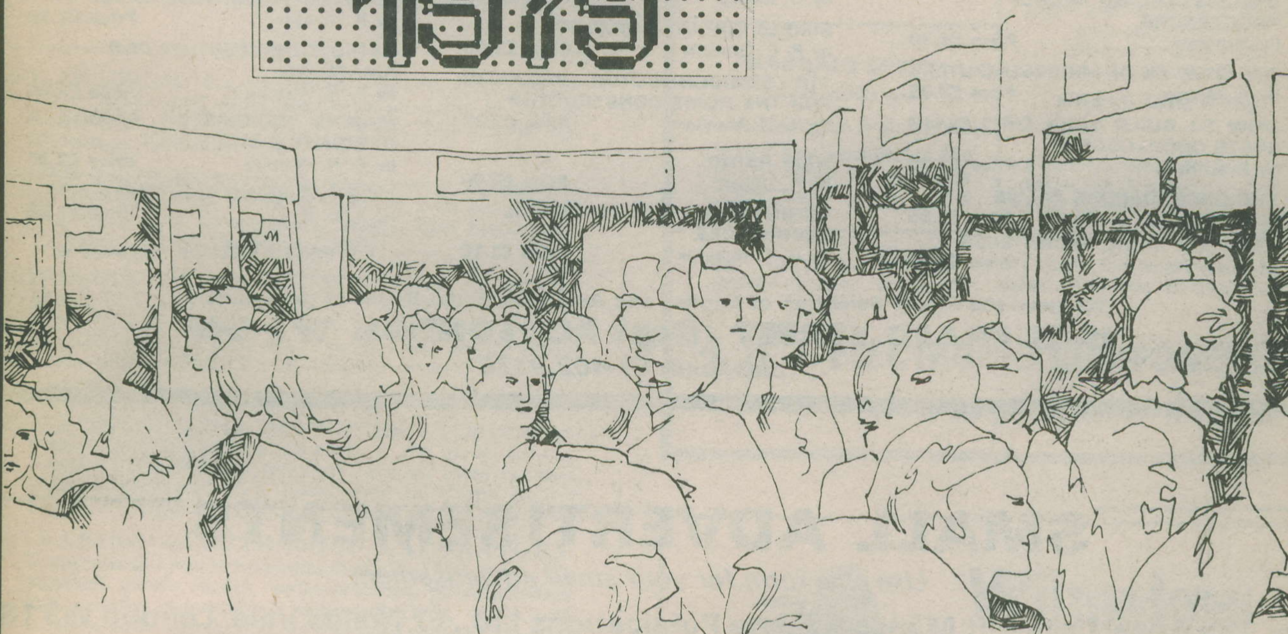

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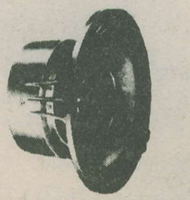

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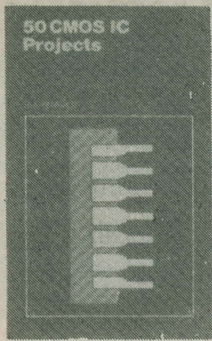

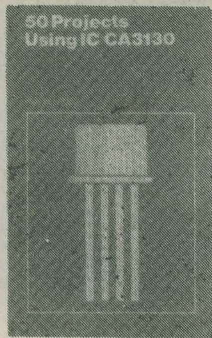

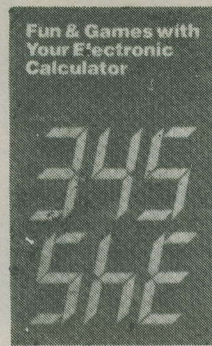

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(Continued from page 253)

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