

JULY  
1978

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JULY 1978 · VOLUME 54 · NUMBER 3

**BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR**

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**News and Views**

- 20 **EDITORIAL**—Standards
- 21 **NEWS . . . NEWS . . . NEWS**
- 24 **SPECIAL PRODUCT REPORT**—SES Electronic Ignition Kit
- 27 **PW READER'S PCB SERVICE**—Prices and details of the PCBs available
- 28 **STRAY SIGNALS**.....*Point Contact*
- 38 **SHOW ROUND-UP**—IEA/Electrex; Wireless Show; Energy Show
- 43 **PRACTICAL WIRELESS**—Preview of our next issue
- 52 **NEW BOOKS**—Comments on the latest books in the electronics field
- 53 **HOTLINES**—Recent developments in electronics.....*Ginsberg*
- 54 **PRODUCTION LINES**—Information on the latest products.....*Alan Martin*
- 60 **KINDLY NOTE**—"Bovington" Tank Game, June 1978
- 65 **ON THE AIR**—Amateur Bands .....*Eric Dowdeswell G4AR*  
     SW Broadcast Bands.....*Charles Molloy G8BUS*  
     MW Broadcast Bands.....*Charles Molloy G8BUS*  
     VHF Bands.....*Ron Ham BRS15744*  
     VHF Personality—John Branegan.....*Ron Ham BRS15744*

**For our Constructors**

- 22 **PHASE-LOCKED CALIBRATOR**.....*C. H. Luck*  
 An off-air frequency standard receiver
- 32 **PW "PURBECK" OSCILLOSCOPE—4**.....*Ian Hickman*  
 The Y-amplifier
- 44 **PW "AVON" 2m TRANSMITTER—1**.....*B. L. Phillips G8FWM*  
 Beginning the circuit description and constructional details
- 52 **FOLLOW-UP TO THE MORSE TUTOR**  
 Extra information on our project of August, 1977
- 55 **IDEAS DEPARTMENT**  
 Stereo headphone blender. Electronic switch
- 56 **DIGITAL LOCK**.....*P. J. Wheeler*  
 A multi-combination, multi-purpose lock
- 59 **FOLLOW-UP TO THE "JUBILEE" ORGAN**  
 Extra information on this popular project
- 61 **μDECNOLOGY Project No. 4**.....*David Gibson*  
 Fuzz box

**General Interest**

- 25 **THE START OF EMPIRE BROADCASTING**.....*Ron Ham*  
 How our overseas broadcasting system started
- 29 **INTRODUCTION TO LOGIC—1**.....*S. A. Money*  
 What can electronic logic do for us? Gates
- 41 **IC OF THE MONTH**.....*Brian Dance M.Sc.*  
 The ESM532 audio amplifier
- 50 **MAKING IT WORK**.....*Ian Hickman*  
 A step-by-step approach to fault finding

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**RECEIVER UNIT** small personnel type made for use by Army covers 500Kc to 18Mc/s by means of a 4 way plug in coil unit, uses 5 min valves inc BFO in superhet circ reqs 67.5v HT & 1.5 L.T. as o/p for 4K phones supplied tested with circ £13. HT batteries if req £1.30 ea or 2 or more £1 ea.

**AERIAL DRIVE UNIT** suitable 2mt beam & up, 24v DC motors max speed 6 RPM supplied with remote 360° Ind again 24v DC & connections, ex aircraft radio compass two items £13.

**HANDSETS** rubber covered m.c. type nom 100 ohm with press to talk swt suit 19 or 62 sets store soiled elec okay £2.50.

**VALVE TESTER ADAPTOR** type MX849 for use with American I-177 valve tester extends range, in case with data £5.40.

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**TRANSISTOR VHF** pwr type 2N3375 stud mt 7.5w at 100Mc/s 3w at 400Mc/s new £1.80 ea.

**BATTERIES** sealed lead acid type 6v rechargeable 1.8 A/Hr size 2 1/2 x 2 x 2" new £5.40.

**RECEIVER UNIT** single channel crystal controlled for use in range 225 to 400Mc/s double superhet 21 min valves 230v 50c/s 1/P 19" rack mt with circ £30.

**FREQ METERS** type BC221 125Kc to 20Mc/s req 135v HT & 6.3v with handbook & charts few only £27.

**DIODES** power types 100 PIV 10 amps 4 for £1.60. 1000 PIV 10 amps 4 for £2.50 both new full spec. C.R.T.s

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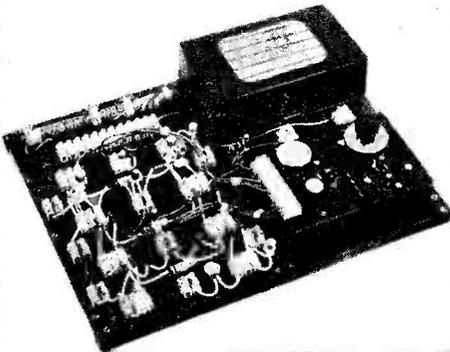
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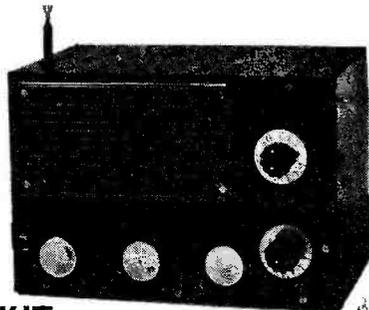
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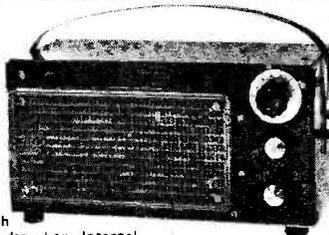
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MultiBand A.M. Receiver. M. W. L. W. Trawler Band and Three Short Wave Bands. Seven Transistors and Four Diodes. Push Pull Output stage. 5" x 3" Loudspeaker. Internal Ferrite Rod Aerial. Kit includes all parts to build it up including Carrying Strap, Rubber Feet and ready-drilled Panels. Comprehensive Instruction Manual for stage by stage construction. Uses P.P.9 Nine Volt Battery.

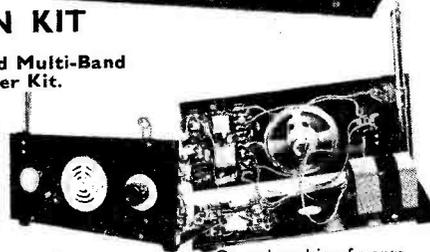


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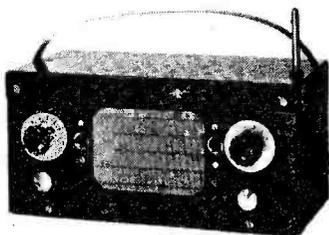
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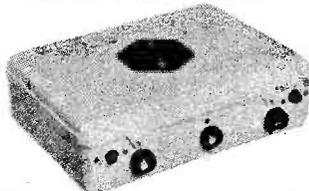
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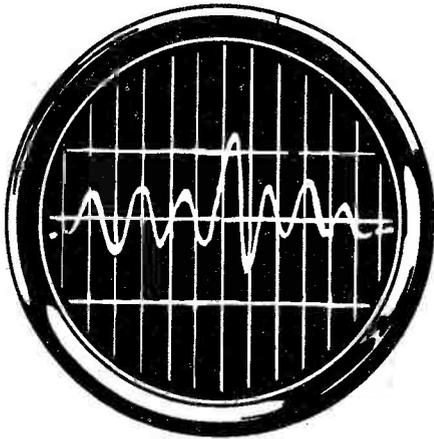
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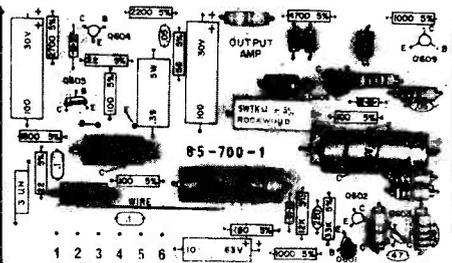
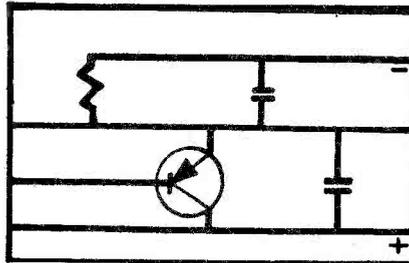
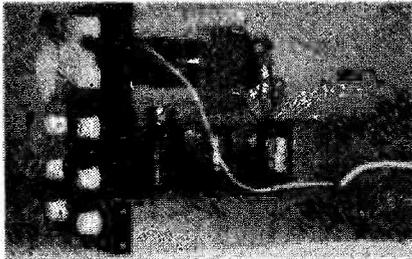
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# 15—240 Watts!

## HY5 Preamplifier

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

**FEATURES:** Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

**APPLICATIONS:** Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

**SPECIFICATIONS:**

**INPUTS:** Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; Input impedance 4-7k $\Omega$  at 1kHz.

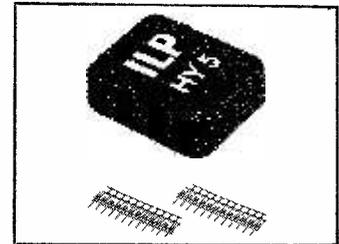
**OUTPUTS:** Tape 100mV; Main output 500mV R.M.S.

**ACTIVE TONE CONTROLS:** Treble  $\pm$  12dB at 10kHz; Bass  $\pm$  at 100Hz.

**DISTORTION:** 0.1% at 1kHz. Signal/Noise Ratio 68dB.

**OVERLOAD:** 38dB on Magnetic Pick-up. **SUPPLY VOLTAGE**  $\pm$  16-50V.

**Price** £5-22 + 65p **VAT P&P free.**



## HY30 15 Watts into 8 $\Omega$

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

**FEATURES:** Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

**APPLICATIONS:** Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

**SPECIFICATIONS:**

**OUTPUT POWER** 15W R.M.S. into 8 $\Omega$ ; **DISTORTION** 0.1% at 1.5W.

**INPUT SENSITIVITY** 500mV. **FREQUENCY RESPONSE** 10Hz-16kHz—3dB.

**SUPPLY VOLTAGE**  $\pm$  18V.

**Price** £3-22 + 65p **VAT P&P free.**



## HY50 25 Watts into 8 $\Omega$

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an Integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust high fidelity modules in the World.

**FEATURES:** Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

**APPLICATIONS:** Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

**SPECIFICATIONS:** **INPUT SENSITIVITY** 500mV

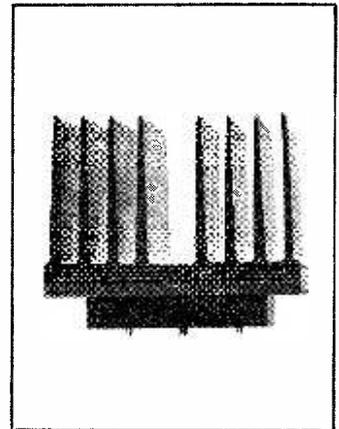
**OUTPUT POWER** 25W RMS into 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.04% at 25W

at 1kHz

**SIGNAL/NOISE RATIO** 75dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB.

**SUPPLY VOLTAGE**  $\pm$  25V **SIZE** 105 50 25mm

**Price** £6-22 + 85p **VAT P&P free**



## HY120 60 Watts into 8 $\Omega$

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

**FEATURES:** Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

**APPLICATIONS:** Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

**SPECIFICATIONS:**

**INPUT SENSITIVITY** 500mV.

**OUTPUT POWER** 60W RMS into 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.04% at 60W

at 1kHz

**SIGNAL/NOISE RATIO** 90dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB **SUPPLY VOLTAGE**

$\pm$  25V

**SIZE** 114 50 85mm

**Price** £15-84 + £1-27 **VAT P&P free.**

## HY200 120 Watts into 8 $\Omega$

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

**FEATURES:** Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

**APPLICATIONS:** Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

**SPECIFICATIONS:**

**INPUT SENSITIVITY** 500mV

**OUTPUT POWER** 120W RMS into 8 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.05% at 100W

at 1kHz.

**SIGNAL/NOISE RATIO** 96dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB **SUPPLY VOLTAGE**

$\pm$  45V

**SIZE** 114 50 85mm

**Price** £23-32 + £1-87 **VAT P&P free.**

## HY400 240 Watts into 4 $\Omega$

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

**FEATURES:** Thermal shutdown—Very low distortion—Load line protection—No external components.

**APPLICATIONS:** Public address—Disco—Power slave—Industrial

**SPECIFICATIONS:**

**OUTPUT POWER** 240W RMS into 4 $\Omega$  **LOAD IMPEDANCE** 4-16 $\Omega$  **DISTORTION** 0.1% at 240W

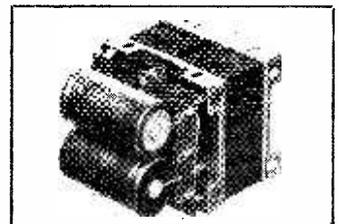
at 1kHz

**SIGNAL NOISE RATIO** 94dB **FREQUENCY RESPONSE** 10Hz-45kHz—3dB **SUPPLY VOLTAGE**

$\pm$  45V

**INPUT SENSITIVITY** 500mV **SIZE** 114 100 85mm

**Price** £32-17 + £2-57 **VAT P&P free.**



## POWER SUPPLIES

PSU36 suitable for two HY30's £5-22 plus 65p **VAT.** P/P free.

PSU50 suitable for two HY50's £6-82 plus 85p **VAT.** P/P free.

PSU70 suitable for two HY120's £13-75 plus £1-10 **VAT.** P/P free.

PSU90 suitable for one HY200 £12-65 plus £1-01 **VAT.** P/P free.

PSU180 £23-10 + £1-85 **VAT.**

BT £0-48 + £0-06 **VAT.**

TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

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CANTERBURY, KENT, CT4 7AD.**

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# GREENWELD

443 Millbrook Road Southampton  
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All prices quoted include VAT. Add 25p UK/BFPO postage. Most orders despatched on day of receipt. SAE with enquiries please. **MINIMUM ORDER VALUE £1.** Official orders accepted

from schools, etc. (Minimum invoice charge £5). Export/Wholesale enquiries welcome. Wholesale list now available for bona-fide traders. Surplus components always wanted.

## BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

- ★ **SAVE ON TIME**—No delays in waiting for parts to come or shops to open!
- ★ **SAVE ON MONEY**—Bulk buying means lowest prices—just compare with others!
- ★ **HAVE THE RIGHT PART**—No guesswork or substitution necessary!

ALL PACKS CONTAIN FULL SPEC, BRAND NEW MARKED DEVICES—SENT BY RETURN OF POST. VAT INCLUSIVE PRICES.

**K001** 50V ceramic plate capacitors, 5%. 10 of each value 22pF to 1000pF. Total 210, £3.35

**K002** Extended range, 22pF to 0.1µF. 330 values £4.90

**K003** Polyester capacitors, 10 each of these values: 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47µF. 110 altogether for £4.75

**K004** Mylar capacitors, min 100V type. 10 each all values from 1000pF to 10,000pF. Total 130 for £3.75

**K005** Polystyrene capacitors, 10 each value from 10pF to 10,000pF. E12 series 5% 160V. Total 370 for £12.30

**K006** Tantalum bead capacitors. 10 each of the following: 0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1, 2.2, 3.3, 4.7, 6.8, all 35V; 10/25, 15/16, 22/16, 33/10, 47/8, 100/3. Total 170 units for £14.20

**K007** Electrolytic capacitors 25V working, small physical size. 10 each of these popular values: 1, 2.2, 4.7, 10, 22, 47, 100µF. Total 70 for £3.50

**K008** Extended range, as above, also including 220, 470 and 1000µF. Total 100 for £5.90

**K021** Miniature carbon film 5% resistors, CR25 or similar. 10 of each value from 10R to 1M, E12 series. Total 610 resistors, £5.90

**K022** Extended range, total 850 resistors from 1R to 10M £8.30

**K041** Zener diodes, 400mW 5% BZY88, etc. 10 of each value from 27V to 36V, E24 series. Total 280 for £15.30

**K042** As above but 5 of each value £8.70

### EDGE CONNECTORS

Special purchase of these 0.1" pitch double-sided gold-plated connectors enables us to offer them at less than one-third their original list price! 18 way 41p; 21 way 47p; 32 way 72p; 40 way 90p.

### SOLAR CELLS

As used on space labs, etc., these tiny cells give 50µA @ 0.5V in sunlight. Ideal for powering small C-MOS projects, etc. Can be banked together for greater power output. Size 19 x 6.5mm. 3 for £1; 10 for £3; 25 for £7; 100 for £25.

### POWER PACK

Wood grained metal case 90 x 80 x 75mm containing mains transformer giving 6V @ 200mA, 2 co-ax. sockets, PC board with 13 fuseholder R's C's, etc. Only 75p.

### S-DECS & T-DECS

S-DEC Breadboard £3.25  
T-DEC Breadboard £4.20

### SIRENS

Work off 4 x HP7 batteries, emit very loud noise. Overall size 110 x 75 x 60mm. Use as Burglar Alarm in car, house, workshop, etc. ONLY £1.95.

### PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, D.A.L.O etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. £3.95

SEND 45p FOR OUR 1977/8 CATALOGUE. CONTAINS 50p DISCOUNT VOUCHERS. AMENDMENT SHEET No. 2 GIVES DETAILS OF OVER 100 ITEMS SLASHED 50%!!! (Send SAE if you've already got cat.)

Our latest Bargain Sheet is FREE, send SAE for your copy.

### DARLINGTON COMP PAIR

BD695A and BD696A—45V 8A 70W plastic power!! gain 750 @ 4A. PNP-NPN pair £1.50.

### VEROCASES

Plastic top and bottom ally panels front and back		
1237	154 x 85 x 40	£2.53
1238	154 x 85 x 60	£2.79
1239	154 x 85 x 80	£3.32
3007	180 x 120 x 40	£3.30
3008	180 x 120 x 65	£3.50
3009	180 x 120 x 90	£3.74
1410	205 x 140 x 40	£3.51
1411	205 x 140 x 75	£4.05
1412	205 x 140 x 110	£5.12

**VERO PLASTIC BOXES**  
Professional quality two tone grey polystyrene with threaded inserts for mounting PC boards

2518	120 x 65 x 40	£2.17
2520	150 x 80 x 50	£2.45
2522	188 x 110 x 60	£3.23

**SLOPING FRONT BOXES**

1798	171 x 121 x 75/37.5	£4.19
2528	220 x 174 x 100/53	£6.90

Potting box. 71 x 49 x 24mm black or white 40p  
Hand controller box 94 x 61 x 23mm White 64p

We keep a very large range of VERO products, including their recently introduced G range of cases and Series II boxes. SAE for their catalogue.

### VEROBOARD

Our packs of vero offcuts are one of our biggest sellers—and no wonder, they are amazing value!! Each pack contains 7 or 8 pieces to make up a total area of 100 sq. ins. All packs are the same price. £1.30 each and are available as follows:

Pack A all 0.1" pitch  
Pack B all 0.15" pitch  
Pack C mixed 0.1 & 0.15"  
Pack D all 0.1" plain

Also available by weight 1lb £3.95 10lbs £32.50

Regular size vero  
17 x 33 x 0.1" £2.00, 10 strips £15  
17 x 32 x 0.15" £1.76; 0.1" plain £1.63

DIP Breadboard size 6, 15 x 4.5", can accommodate 20 x 14 pin ICs £2.35

VQ Board, size 148 x 75mm 0.1" pitch. Copper strips in rows of 4 to facilitate construction with IC's. Layout sheet provided 85p

### VERO PINS AND TOOL

Spot face cutter for 0.1 or 0.15 pitch 75p  
0.1" pins single sided 30p/100  
0.1" pins double sided 35p/100  
0.15" pins single sided 30p/100  
0.15" pins double sheets 35p/100

### LOW COST PLASTIC BOXES

Made of high impact ABS. The lids are retained by 4 screws into brass inserts. Interior of box has PCB guide slots (except V219)

V210	80 x 62 x 40mm black	58p
V213	100 x 75 x 40mm black	72p
V215	120 x 100 x 45mm black	86p
V219	120 x 100 x 45mm white	86p

### CALCULATOR CHIP

Type C500 by GI. 4 function + constant. 9 digit. Multiplexed output for simple keyboard interfacing 24 pin DIL. With comprehensive data + socket £1.50.

**RESISTOR OFFER.** Miniature 1W 5% carbon film, but the leads, although full length have been preformed for vertical mounting. Now in the following values only: 68R, 150R, 330R, 390R, 470R, 1k, 1k2, 2k7, 3k9, 5k6, 15k, 22k, 27k, 33k, 68k 100k, 470k, 820k, 1M—15 values altogether. 100 off each value, total 1900 resistors for £6. Or 1000 off each value, total 1900 resistors for £45 (this works out at 0.2368p per resistor!!)

### SPECIAL TRANSISTOR OFFERS

BC108-9	BCY70-71-72 at very low prices.	
PN108 (BCY08)	18 for £1	
PN70 (BCY70)	14 for £1	
PN72 (BCY72)	15 for £1	
PN109 (BCY09)	16 for £1	
PN71 (BCY71)	14 for £1	

Complementary Power Pair. BD525 & BD526. Motorola plastic power, 60V 2A devices, normally 94p pair. Special offer price 50p pair.

Small signal PNP transistors, like 2N3702 (Marked MSPS1218) 20 for £1.

TANT BEAD CAPS—4.7µF 50V, normally 14p each. Our special offer price 12 for £1.

# The Antenna that Hertz missed out on!

We suppose it was quite an achievement to predict radio-wave transmission and then devise a shock-excited VHF dipole in those far off days, but what a time the Grand Old Man could have had on the range 5-30 MHz. if only he'd had a Joystick VFA (Variable Frequency Antenna) to play with. And what's more, whilst his original experiment was transmission across a room, with the Joystick many delighted users have found an indoor installation (it's only 7' 6" long) has got them better DX (receiving and transmitting) than experienced on previous antennae.

In use by Amateur Transmitting and SWL Stations world-wide and in government communication.

## SYSTEM "A" £36.00

250 w. p.e.p. OR for the SWL.

## SYSTEM "J" £42.60

500 w. p.e.p. (improved 'Q' on receive).

## PARTRIDGE SUPER PACKAGES

### COMPLETE RADIO STATIONS FOR ANY LOCATION

All Packages feature the World Record Joystick Aerial (System 'A'), with 8ft. feeder, all necessary cables, matching communication headphones. Deliv. Securior our risk. **ASSEMBLED IN SECONDS! BIG CASH SAVINGS!**

### PACKAGE No. 1 £210.55

As above with R.300 RX. SAVE £17.28!

### PACKAGE No. 2 £195.00

Is offered with the FRG7 RX. SAVE £12.21!

### PACKAGE No. 3 £177.00

Here is a lower-price, high-quality package featuring the LOWE SRX30., with all the Partridge extras. SAVE £12.21!

### RECEIVERS ONLY, inclusive delivery, etc.

R.300 £184.50 FRG7 £162.00 SRX30 £146.25

All prices are correct at time of going to press and include VAT at 12½% and carriage.



Just telephone your card number  
Phone 0843 62535 (ext. 5)  
(or 62839 after office hours)



or write for details, send 9p stamp



5, Partridge House, Prospect Road, Broadstairs, CT10-1LD. (Callers by appointment).

## MAINS TRANSFORMERS

All these have 230/240v 50Hz Primary

VOLTAGE	CURRENT	REF.	PRICE
1v	2 amp	TM 1	£1.94
2-4v	5 amp	TM 2	£1.62
4v	2 amp	TM 32	£2.70
6v	2 amp	TM 3	85
6-5v	2 amp	TM 37	85
6-5v	200 ma	TM 21	£1.62
6-5v-0-6-5v	100mA	TM 21	£1.62
6-5v-0-5-5v	750mA	TM 22	£2.16
6-3v-0-6-3v	100mA	TM 33	£1.62
6-3v	2 amp	TM 4	£1.89
8-5v	1 amp	TM 12	£1.62
8-5v + 8-5v sep winding	1 amp	TM 12	£1.62
9v	1 amp	TM 5	£1.62
9v	1 amp 'c' core	TM 6	£1.90
9v	3 amp	TM 35	£2.86
9v	5 amp	TM 38	£3.24
10v	25 amp	TM 15	£4.86
10v-0-10v	12 amp	TM 15	£4.86
12v-0-12v	4 amp	TM 27	£4.32
12v	1 amp	TM 9	£1.05
13v	2 amp	TM 7	£2.16
12v	2 amp	TM 10	£1.89
12v-0-12v	50mA	TM 19	£1.62
12v-0-12v	1 amp	TM 41	£3.24
15v tapped 9v	2 amp	TM 11	£2.70
15v	7 amp	TM 27	£4.32
15v-0-15v	3 amp	TM 27	£4.32
15v-0-15v	5 amp	TM 35	£2.86
17v	1 amp	TM 12	£1.62
18v	2 amp	TM 13	£1.90
20v	5 amp	TM 14	£1.62
20v	5 amp	TM 27	£4.32
20v	12 amp	TM 15	£4.86
20v-0-20v	8 amp	TM 15	£4.86
13v	100mA	TM 21	£1.62
24v	1 amp	TM 16	£2.12
24v	2 amp	TM 17	£2.70
24v + 2v 7 amp	2 amp	TM 39	£2.97
24v	4 amp	TM 40	£3.78
25v	1 amp	TM 42	£4.05
26v	2 amp	TM 39	£2.98
30v tapped 24, 20, 15 & 12	3 amp	TM 27	£4.32
30v	8 amp	TM 15	£4.86
30v	37 amp	TM 34	£31.86
37v	5 amp	TM 15	£4.86
40v tapped at 30v, 20v & 10v	6 amp	TM 22	£2.86
50v-2 amp with 6-3v shrouded	8 amp	TM 29	£11.65
50v	5 amp	TM 24	£7.02
75v-3 amp with 6-3v shrouded	4 amp	TM 24	£7.02
75v	4 amp	TM 24	£7.02
80v tapped 60v & 75v	1 amp	TM 25	£7.02
100v-0-100v	3 amp	TM 25	£7.02
130v tapped 120v	3 amp	TM 28	£3.78
200v	3 amp	TM 25	£7.02
250v-0-250v with 6-3v 2A	50mA	TM 36	£3.78
250v	100mA	TM 36	£3.78
500v	50mA	TM 36	£3.78
250v	60mA	TM 26	£2.70
1Kv	100mA	TM 44 P.O.A.	
2Kv	100mA	TM 44 P.O.A.	
5Kv	5mA	TM 30	£7.02
8-5Kv	10mA	TM 31	£10.26

Quality prices available. Please, unless you are calling, add 25% to your order to cover the cost of carriage. Also if you want to collect, telephone the day before.

**Quick Cuppa.** Mini immersion heater, ideal for taking on holiday, for making a "quick cuppa" tea, or for heating by the bedside for baby's feed etc. 250w heater @ 230 volts or approximately 90 watts @ 110 volts. Price £2.95.

**Neon Screwdrivers.** Two useful models— $\frac{1}{2}$ " price 79p and  $\frac{3}{4}$ " price 85p.

**240° 1mA Moving Coil Panel Meter.** A large instrument, size approximately  $4\frac{1}{2}$ " square at the front and  $4\frac{1}{2}$ " deep. Intended for panel mounting, its scale is calibrated 0-7 and it was intended to be used as rev. counter. £14 each.

**Pressure Switch.** Adjustable through a range of pressures from where it can be operated by sucking or blowing to approx. 50 psi-10 amp changeover microswitch, metal body with threaded inlet. Price £2.90.

**Push-Push Switch.** Fixed through panel this is a ratchet action, double pole changeover switch, the contacts we understand are hard gold plated. Spindle is  $\frac{1}{8}$ " diameter so that a standard radio knob can be fitted. Price 30p + 3p. Good quantity available at usual discounts.

**C.R.T. Display Unit.** We feel this would be easy to convert to an oscilloscope, it has all the necessary ingredients. It is in a case size  $15" \times 10" \times 11"$  approx. with a carrying handle and a front protection flap. Plenty of controls and its mains operated through step down transformer. Size of the tube is 3". Price £16.75.

**VU Meter** Edgewise mounting, through hole size  $1\frac{1}{2}" \times \frac{1}{2}"$  approx: these are 100 micro amp fsd and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price £1.85.

**Cassette Mechanism.** Jap. made to rigid specification. These will fit many music centres and cassette players. Chassis size approx.  $4\frac{1}{2}"$  wide by  $5\frac{1}{2}"$  deep, 6v motor and tape position counter at the rear. The six levers for "play", "fast forward", "rewind", "stop", "record and eject" are all at the front, as is the auto mechanism to stop the motor when tape end is reached. These are new and unused and have record playback and erase heads. Limited quantity. Price £15.50.

**Shortened 3kw Tangential Heater.** This is in fact near enough the same size as the normal 2kw tangential. Motor runs a bit faster to compensate for the increased heating and the fan impellers are metal to save any possibility of extra heat distorting them. The heater element is taped so that 1, 2 or 3kw's of heating can be used or of course this will blow cold. Price £8.95, post £1.50p + 12p.

**Omron 410 Relay.** Built like a contactor, this has a clear plastic cover over the working parts but the terminals are all brought out of the front so that connection may be made without removing the cover also the relay may be fitted into position and the wires brought to it afterwards, generously rated at 10 amps the contacts are really more like 15 amps, they are changeover and there are 4 sets of them. A really robust relay which looks as though it will give a lifetime of service. Size  $3\frac{1}{2}" \times 3" \times 3\frac{1}{2}"$  high. Price £4.50.

**8 Track Cartridge Players.** In car units with amplifiers but this amplifier may need attention, mechanism guaranteed O.K. £9.00 + 19p.

**Low rpm Crouzet Meters.** Two more types have just come in; these are 2 rpm and 15 rpm, both 115v motors but as these consume only two to three watts it is a simple matter to divide the mains voltage using a mains working condenser, resistor auto transformer or of course use them in pairs. Price £2.25, £2.00 + 16p each.

**12 volt Miniature Relay.** Gold plated contacts with plastic dust covers 4 sets of changeover contacts, 90p, bases 45p.

## MULLARD UNILEX

A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in the stereo-assembly modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.



## SPIT MOTOR WITH CARTER G/BOX

Probably one of the best spit motors made. Originally intended to be used in very high priced cookers, however this can be put to plenty of other uses, for instance your garden barbecue or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. £4.32.

## PP3/PP9 REPLACEMENT MAINS UNIT

Japanese made in plastic container with leads size  $2" \times \frac{1}{2}" \times \frac{1}{2}"$ , this is ideal to power a calculator or radio, it has a full wave rectified and smoothed output of 9 volts suitable for a loading of up to 100mA. £2.53.



## SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £1.94—crystal earphone 55p including VAT and postage.



## RADIO STETHOSCOPE

Easiest way to fault find, traces signal from aerial to speaker when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube, twin stetho-set. £3.95.



## BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components, and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1" long—the diodes have approx.  $\frac{1}{2}$ " leads.

List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which were made to receive these units). The price of this four unit parcel is £1 including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

## INFRA RED BINOCULARS

Made for military purposes during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (5KV approx.) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra red cell, technical data on which is available. The binoculars are unused, believed to be in good order. Sold without guarantee. Price £17.50 per set. Post & VAT £2.50.



## SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. £9.95.

## MINI-MULTI TESTER

Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000 opv—mirrored scale.

11 instant ranges measure:—  
DC volts 10, 50, 250, 1000  
AC volts 10, 50, 250, 1000  
DC amps 0-1 mA and 0-100 mA  
Continuity and resistance 0-150K ohms.

Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only £5.50p + 50p post and insurance.

FREE Amps ranges kit enable you to read AC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly, but if you already own a mini tester and would like one send £1.50p.

**Terms: Prices include Post & VAT. But orders under £6.00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.**

**J. BULL (ELECTRICAL) LTD**  
(Dept. P. W.), 103 TAMWORTH RD.,  
CROYDON CR8 1SG

## IT'S FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains sell out before our advertisement can appear—It's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lists.

**Mains Transformer.** Small 2 secondaries, 115 volts at 10 mA and 6-3 volt @  $\frac{1}{2}$ A, a useful transformer for many instruments. £2.70.

**25 Watt Audio Systems in Cabinets.** Comprising 8" woofer and 3" tweeter with crossover and terminal connection panel, mounted in simulated teak finish cabinet with fabric front. These are extremely good quality units comparable with those selling at twice the price. Cabinet size approx. 20" high 10 $\frac{1}{2}$ " wide and 8 $\frac{1}{2}$ " deep, heavy cabinet made of thick blackboard. Price £25.00 the pair, we're worth your coming in to collect them but if you cannot collect them, then still worth adding £5.00 the pair for carriage.

**Another Special Item,** for callers this month is a pen recorder. Mains operated this is bigish instrument which probably cost originally several hundreds of pounds. We are having a reverse auction on this. The starting price is £50 but the price will come down £5.00 per week until it is sold.

**Opto Electronics.** Two special bargains in this field, the OPCP 70, price 75p and the ORP 12, price 85p.

**Titl Switch 15 amp.** Meant to switch off heater should be knocked over, this pendulum operated switch is on only when it is in the upright position. It could be incorporated in burglar alarm, car alarms etc. Contacts look quite able to cope with 15 amp loads at mains voltage. Price 50p + 4p.

**Neon Indicator Lamp.** Two features about this particular one are—it has screw down terminal connectors for wiring and is fixed by a single threaded screw. The lens is clear so you could colour to suit your needs. Price 35p.

**Indicator Lamp Holders.** For low voltage lamps (Liliput) type, we have these in five different colours—red, yellow, blue, green and white. Price 35p.

**Twin Padded Flex.** 5 amp ideal for some electric irons and appliances which require very flexible lead, 10 metre lengths. Price £1.

**Heating Pads.** These measure 11" long x 8 $\frac{1}{2}$ " wide and are flat. Look rather like pieces of thick blotting paper. Wire ended 250 watt of joined in series they would be approximately 60 watt each. Dozens of uses. Price 80p or two for £1.50.

**Rod Thermostat.** For high temperatures up to 550°F. This is adjustable either at the head or remotely by a length of flexible drive. Price £2.95.

**Interval Timer.** As used in schools and similar establishments to trigger off the bell which sounds the end of lessons, lunch breaks etc. This is another one off item we feel for callers only. It is in polished hardwood case, glass fronted, comprises 2 hour carry over, a large brass disc and other smaller discs on which the time is set out in relatively small intervals and a pair of contacts to switch a bell or something similar at precise times during the week. Price £55.00.

**Two More Mullard Modules.** Pre amp module ref. 1181/1183, stereo 1 month. It is on a printed circuit board with wire connections. Supplied complete with connection diagram. Price 99p.

**Mullard IF Module Type 1181.** In a metal case  $2\frac{1}{2}"$  long x  $1\frac{1}{2}"$  wide x  $\frac{3}{8}"$  thick. Can be mounted on a printed circuit board connection to wire lead outs. Price £1.25.

**Silicon Diodes.** Two special bargains this month. 400 volt 1 amp, for £1.25, 50 volt 1 amp, 200 volt 1 amp. Large quantity available at very much discounted prices.

**Flex Cable Bargains.** Core size 5mm 2 white pvc outer, pvc covered cores. Coloured coded with the usual blue, brown and green/yellow. Price 100 metre coil for £10.25.

**Electrical Installation Work.** We have good stocks of all the mains items required for ring mains and light installations, for example we have 2.5mm twin and earth pvc covered at £12.50 + £1.00. Carriage £2.00 + 16p. We hope to make a complete list of the installation items we have in time for our next newsletter but if there is anything you are wanting by all means give us a ring.

**Plastic Case Sections.** Small very tough plastic cases at very reasonable prices, always repeatable. The case is 2-11/16" long, Section A is  $1\frac{1}{2}"$  deep and section B  $1\frac{1}{2}"$  deep, use 2A's or 2B's or an 8 to get different depths or 1 $\frac{1}{2}"$ , 1 $\frac{1}{4}"$  or 2"—note these are external dimensions, the wall thickness of the case of 15" thick. Price, section A 25p, B 30p.

**Computer Capacitors.** Made by famous American companies for working under very exacting conditions. These are large condenser units in Alicantin form with a mounting. Ideal if you want to make a large storage bank 15,500 uf 10 volts working, 15 volts surge, 10 for £8.

**Alarm Bells.** Holiday time can often be a holiday for house breakers; why not fit a really loud alarm as good a method as any is to use trigger mats under carpets, at windows and doors. Connect them all in series through a latching circuit to sound off a really loud bell or hooter, prices of these various parts are as follows:

**Loud Ringing Bell,** industrial type with 6" gong, 24v, DC operated. Price £7.50.

**Switch Trigger Mat,** size 24" x 18" for going under carpet etc. Price £2.50.

**24v Relay** with latching contacts. Price 95p.

**Secret Switch** with key. Price 85p.

**24v 1 amp DC Power Supply** Price £5.50.

**Circuit Diagram.** No charge, just request.

**Mouth Operated Switch.** Probably not made with this in mind, more likely made for use on machines to control water level etc. This is a sensitive low pressure device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity—blow gently into it and No. 1 switch operates, blow a little stronger and No. 2 operates, blow harder still and No. 3 operates. This switch is airtight so weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approximately  $\frac{3}{8}"$  dia. x  $\frac{1}{2}"$  thick—the air entry is a pipe approximately  $\frac{3}{16}"$  diameter—electrical contacts we estimate a 10 m/c p.c. a 250 volt connection by push on tags. Order ref. PS. Price £1.95. Large quantity available.

**Powerful Induction Motor.** 1 $\frac{1}{2}"$  stack, double ended, would drive a small lathe, drill or grinder or would power a blowing or extracting fan. Fit suitable pulleys and it would drive a pebble polisher or similar, being double ended it will drive in either direction. Can also be fixed from either end, fixing bolts are fitted and these are  $\frac{1}{8}"$  apart. Spindles  $\frac{1}{8}"$  diameter, extend  $\frac{1}{2}"$  beyond each end plate. A motor like this would cost at least £3 from makes but we have a large quantity to offer at £2.50. Order Ref. MM.10.

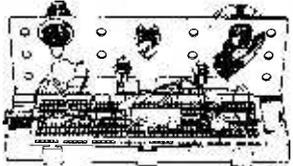
**Can any reader help!** We urgently need some reasonably priced decoders to go with the F.M. tuner we have. If you can help us to find a supply we will be very much obliged and will try to do you a good turn some day—thank you.

### MINI CONSOLES

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

MC 161 x 96 x 58mm £2.12 (1-9) (Includes VAT)  
MC 215 x 130 x 75mm £2.94 (1-9) (Includes VAT)  
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Stop wasting time soldering  
**The NEW MW BREADBOARD accepts**  
Transistors, LED's, Diodes, Resistors, Capacitors and all DIL packages with 6 to 40 pins



Includes slot-in Component Support Bracket and has 470 individual sockets, plus Vcc and Ground Bus Strips  
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### SC BOXES

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

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SC 161 x 96 x 59mm £1.81 (1-9) (Includes VAT)  
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50 for only £5 — 100 for only £9  
Mixed bags, all sizes, various colours



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

### TYPE MP NEON INDICATOR

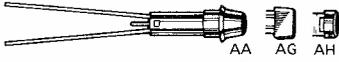
Supplied with resistor for 240 Volts operation  
150mm leads, held in 6.4mm hole by nut



Red, Amber, Clear, Opal 20p each

### TYPE A NEON INDICATORS

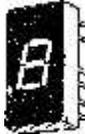
Supplied with resistor for 240 Volts operation  
Held in 8mm hole by plastic bezel  
150mm wire leads



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

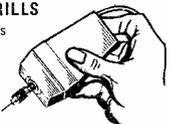
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Accessory tools... 5 Burrs, 1mm, 2mm, 1/8th Drills, 3/32" Collet Price £1.75 (Includes VAT & P.P.)



### RC BOXES ABS and DIECAST

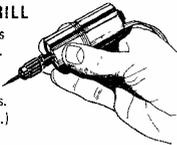
1.5mm pcb slots and close fitting flanged lids. ABS in orange, blue, black or grey colours. Diecast in natural or grey hammertone colour. Lid held by screws running into integral brass bushes.

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

Polystyrene version  
in grey only, no slots, no integral brass bushes  
RC(P) 112 x 81 x 31mm 61p  
All prices are 1-9 off, include VAT, but please add 25p per £1 order value for Post & Packing

### 12 VOLTS MINI HAND DRILL

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



Quantity quotations on request

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

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

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<h3>TTL</h3> <table border="0"> <tr><td>7400</td><td>— 0-13</td><td>7447</td><td>— 0-80</td></tr> <tr><td>7401</td><td>— 0-13</td><td>7451</td><td>— 0-16</td></tr> <tr><td>7402</td><td>— 0-16</td><td>7470</td><td>— 0-30</td></tr> <tr><td>7403</td><td>— 0-16</td><td>7472</td><td>— 0-28</td></tr> <tr><td>7404</td><td>— 0-19</td><td>7473</td><td>— 0-30</td></tr> <tr><td>7406</td><td>— 0-36</td><td>7474</td><td>— 0-30</td></tr> <tr><td>7407</td><td>— 0-36</td><td>7475</td><td>— 0-40</td></tr> <tr><td>7408</td><td>— 0-19</td><td>7476</td><td>— 0-35</td></tr> <tr><td>7410</td><td>— 0-14</td><td>7486</td><td>— 0-35</td></tr> <tr><td>7413</td><td>— 0-36</td><td>7479</td><td>— 0-85</td></tr> <tr><td>7414</td><td>— 0-74</td><td>7493</td><td>— 0-35</td></tr> <tr><td>7416</td><td>— 0-36</td><td>7496</td><td>— 0-82</td></tr> <tr><td>7420</td><td>— 0-16</td><td>74107</td><td>— 0-32</td></tr> <tr><td>7442</td><td>— 0-35</td><td>74141</td><td>— 0-70</td></tr> </table>	7400	— 0-13	7447	— 0-80	7401	— 0-13	7451	— 0-16	7402	— 0-16	7470	— 0-30	7403	— 0-16	7472	— 0-28	7404	— 0-19	7473	— 0-30	7406	— 0-36	7474	— 0-30	7407	— 0-36	7475	— 0-40	7408	— 0-19	7476	— 0-35	7410	— 0-14	7486	— 0-35	7413	— 0-36	7479	— 0-85	7414	— 0-74	7493	— 0-35	7416	— 0-36	7496	— 0-82	7420	— 0-16	74107	— 0-32	7442	— 0-35	74141	— 0-70	<h3>CMOS</h3> <table border="0"> <tr><td>4001</td><td>— 0-17</td><td>4047</td><td>— 0-95</td></tr> <tr><td>4002</td><td>— 0-17</td><td>4049</td><td>— 0-48</td></tr> <tr><td>4011</td><td>— 0-19</td><td>4050</td><td>— 0-53</td></tr> <tr><td>4013</td><td>— 0-45</td><td>4070</td><td>— 0-53</td></tr> <tr><td>4014</td><td>— 0-85</td><td>4502</td><td>— 0-95</td></tr> <tr><td>4015</td><td>— 0-85</td><td>4508</td><td>— 2-90</td></tr> <tr><td>4016</td><td>— 0-52</td><td>4510</td><td>— 1-51</td></tr> <tr><td>4017</td><td>— 0-85</td><td>4511</td><td>— 1-75</td></tr> <tr><td>4018</td><td>— 0-85</td><td>4514</td><td>— 2-98</td></tr> <tr><td>4023</td><td>— 0-19</td><td>4516</td><td>— 1-90</td></tr> <tr><td>4027</td><td>— 0-52</td><td>4518</td><td>— 1-20</td></tr> <tr><td>4028</td><td>— 0-97</td><td>4528</td><td>— 1-20</td></tr> <tr><td>4042</td><td>— 0-85</td><td>4536</td><td>— 5-00</td></tr> <tr><td>4046</td><td>— 1-40</td><td></td><td></td></tr> </table>	4001	— 0-17	4047	— 0-95	4002	— 0-17	4049	— 0-48	4011	— 0-19	4050	— 0-53	4013	— 0-45	4070	— 0-53	4014	— 0-85	4502	— 0-95	4015	— 0-85	4508	— 2-90	4016	— 0-52	4510	— 1-51	4017	— 0-85	4511	— 1-75	4018	— 0-85	4514	— 2-98	4023	— 0-19	4516	— 1-90	4027	— 0-52	4518	— 1-20	4028	— 0-97	4528	— 1-20	4042	— 0-85	4536	— 5-00	4046	— 1-40			<h3>MAINS TRANSFORMERS</h3> <p>P &amp; P 60p each</p> <table border="0"> <tr><td>6-0-6</td><td>100mA</td><td>£1-10</td></tr> <tr><td>9-0-9</td><td>75mA</td><td>£1-10</td></tr> <tr><td>12-0-12</td><td>50mA</td><td>£1-15</td></tr> <tr><td>12-0-12</td><td>100mA</td><td>£1-40</td></tr> <tr><td>9-0-9</td><td>1 Amp Sh.</td><td>£2-44</td></tr> <tr><td>12-0-12</td><td>1 Amp ..</td><td>£3-12</td></tr> <tr><td>15-0-15</td><td>1 Amp ..</td><td>£3-60</td></tr> <tr><td>30-0-30</td><td>1 Amp ..</td><td>£4-24</td></tr> <tr><td>20-0-20</td><td>2 Amp Unsh.</td><td>£5-75</td></tr> <tr><td>30-0-30</td><td>2 Amp Unsh.</td><td>£7-00</td></tr> </table> <p>Stereo amp module 6 + 6 watts £7-99 o.p. imp. 8Ω. 34v. d.c. F.M. Tuner module. 9v dc. £7-99</p>	6-0-6	100mA	£1-10	9-0-9	75mA	£1-10	12-0-12	50mA	£1-15	12-0-12	100mA	£1-40	9-0-9	1 Amp Sh.	£2-44	12-0-12	1 Amp ..	£3-12	15-0-15	1 Amp ..	£3-60	30-0-30	1 Amp ..	£4-24	20-0-20	2 Amp Unsh.	£5-75	30-0-30	2 Amp Unsh.	£7-00	<h3>MISCELLANEOUS</h3> <table border="0"> <tr><td>U<sub>2</sub> size N CAD BAT.</td><td>£1-95</td></tr> <tr><td>(p &amp; p 30p)</td><td></td></tr> <tr><td>8 pin 741</td><td>0-18</td></tr> <tr><td>Scope Probe, BNC plug</td><td>£14-99</td></tr> <tr><td>BNC Socket</td><td>0-90</td></tr> <tr><td>Signal Injector</td><td>£5-20</td></tr> <tr><td>Multimeter 1,000 OPV. 11 ranges (p &amp; p 50p)</td><td>£6-25</td></tr> <tr><td>Telephone pick-up coil</td><td>0-92</td></tr> <tr><td>3" 8Ω Spkr. (20p p &amp; p)</td><td>0-99</td></tr> <tr><td>4" 8Ω Spkr (30p p &amp; p)</td><td>£1-44</td></tr> <tr><td>0-1mA panel meter</td><td>£4-20</td></tr> <tr><td>240v AC/9v 120mA</td><td>£3-78</td></tr> </table> <p>Regulated supply in plastic case</p>	U <sub>2</sub> size N CAD BAT.	£1-95	(p & p 30p)		8 pin 741	0-18	Scope Probe, BNC plug	£14-99	BNC Socket	0-90	Signal Injector	£5-20	Multimeter 1,000 OPV. 11 ranges (p & p 50p)	£6-25	Telephone pick-up coil	0-92	3" 8Ω Spkr. (20p p & p)	0-99	4" 8Ω Spkr (30p p & p)	£1-44	0-1mA panel meter	£4-20	240v AC/9v 120mA	£3-78
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2N706A	0.24	2N3866	1.05
2N708	0.30	2N4033	0.60
2N718	0.41	2N4123	1.94
2N914	0.32	2N4125	0.20
2N916	0.96	2N4400	0.15
2N918	0.38	2N4401	0.18
2N929	0.24	2N4402	0.21
2N930	0.24	2N4403	0.23
2N930A	0.25	2N4441	1.06
2N1132	0.85	2N4442	1.30
2N1613	1.27	2N4443	1.43
2N1711	0.32	2N4444	1.88
2N1890	0.77	2N4870	0.78
2N1893	0.30	2N4871	0.74
2N2102	0.93	2N4918	0.67
2N2218	0.29	2N4919	0.70
2N2218A	0.32	2N4920	0.74
2N2219	0.30	2N4921	0.63
2N2219A	0.31	2N4922	0.67
2N2221	0.23	2N4923	0.70
2N2221A	0.26	2N5060	0.42
2N2222	0.18	2N5061	0.43
2N2222A	0.21	2N5062	0.49
2N2369	0.21	2N5063	0.52
2N2369A	0.23	2N5064	0.55
2N2646	0.56	2N5088	0.21
2N2904	0.30	2N5108	4.03
2N2904A	0.31	2N5190	0.69
2N2905	0.38	2N5191	0.74
2N2905A	0.32	2N5192	0.80
2N2906	0.23	2N5193	0.75
2N2906A	0.23	2N5194	0.80
2N2907	0.23	2N5195	0.85
2N2907A	0.23	2N5400	0.27
2N3053	0.35	2N5401	0.28
2N3054A	0.84	2N5415	0.81
2N3055	0.89	2N5416	1.11
2N3055H	1.08	2N6027	0.62
2N3439	1.09	2N6028	0.79
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# Standards

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## BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

FROM time to time, *Practical Wireless* receives letters decrying the fact that we continue to publish circuit diagrams in which symbols other than those laid down in BS:3939 are used. We are by no means the only "offender", and in fact a letter published in the latest issue of *Electronic Technology*, the journal of the Society of Radio and Electronic Technicians, slates the whole of the UK technical press, with the exception of the text-book publishers.

The writer of that letter, a lecturer in Radio and TV studies at a south coast technical college, complains that his students have to learn not only the BS:3939 symbols for their examinations, but also a variety of other symbols in order to understand circuits published in technical journals. He sees this as a waste of time, and exhorts those responsible to get into line.

While I am, in general, in favour of standardisation, it is as well to realise that we live in a real world. Even if all UK technical journals and magazines used BS:3939 symbols exclusively from now on, there is a wealth of material, both existing and still coming in from abroad, which uses other symbols. If we are not to dismiss that material completely, we must accept that there is this variety and learn to interpret the various forms encountered.

It is, in any case, arguable whether some of the BS:3939 symbols are the best. Taking the humble resistor as an example, while the rectangular box may be simple for a computer or other mechanical draughting machine to draw, the zigzag is much easier to draw freehand with a little practice. Since many draughtsmen now use rub-down transfers to produce finished drawings, it makes little difference to them anyway, so why not make life a little easier for the student and development engineer trying to produce a neat sketch, by sticking with the zigzag? Again, with logic symbols, it has always struck me that the familiar shapes of MIL-STD-806B make a diagram much easier to understand than do the featureless outlines of their BS:3939 counterparts.

It has been said that the prime reason for the adoption of some of the BS:3939 symbols was that they were easier for machines to draw. Since the vast majority of circuit diagrams must surely still be produced by human means, the justification for those symbols is therefore highly questionable. It makes one wonder whether, at some time in the future, the standard which will replace BS:3939 will consist merely of rectangular boxes containing numbers from 1 to  $n$ , each indicating a different type of circuit element!

Geoffrey C. Arnold

## PLEASE NOTE—CORRESPONDENCE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

## Aid for R & D

The Dept. of Industry has set up an Electrical Technology Requirements Board (ETRB) to fund research and development in the electrical engineering industry. The Board will be composed of eminent British engineers and chaired by Mr. T. W. B. Sallitt, Director, Hawker Siddeley Group Ltd.

The Board will cover such products as motors and generators, transformers, switchgear, cables and accessories, domestic appliances, and miscellaneous electrical equipment including lamps and batteries.

Major objectives of The Board will be to identify those areas which will most benefit from additional research and development, so as to promote technological innovation and to increase the application of known technology.

The Board welcomes applications from private companies as well as research organisations, for financial support on research and development projects, usually on a co-operative basis, in any of the fields mentioned above.

Enquiries should be addressed to: *Dr. L. Goldstone, Executive Officer/Secretary ETRB, Abell House, John Islip Street, London SW1. Tel: 01-211 3450.*

## Look in

Five new promotional films, to be shown by Independent Television programme companies, have been made by the IBA to promote 'better viewing'.

The five films are:

- (1) The importance of the receiving aerial (30 seconds).
- (2) The importance of correct receiver adjustment (60 seconds).
- (3) The expanding coverage of the IBA transmitter networks (60 seconds).
- (4) New technical developments in television broadcasting (60 seconds).
- (5) Controlling the day-to-day quality of ITV broadcasts (30 seconds).

Film (2) on receiver adjustment is to be backed by a special leaflet which dealers and rental companies will be encouraged to distribute to viewers.

The films include shots of many IBA engineering installations and

developments, including the unique Emley Moor concrete aerial tower, low-power solid-state transmitters for local relay stations, the special SABRE adaptive receiving aerial that brings ITV colour to the Channel Islands, DICE—the IBA's pioneering digital standards converter used for inter-continental relays, optional subtitling for the deaf which may become possible by using ORACLE teletext techniques, etc.

## New source

Amtest Radio and Electronic Equipment, is a new company set up to specialise in equipment and aerials for s.w. listeners.

They hope in the near future to provide a similar service for long, medium and v.h.f. listeners with the emphasis on DXing.

The company will answer any enquiry, provided it is accompanied by a SAE.

*Amtest Radio and Electronic Equipment, 55 Vauxhall Hill, Worcester WR3 8PA. Tel: 0905 22704.*

## The Wireless?

A foreign spy, an astronaut in deep space, a man in the street... what have they in common? A radio receiver!

The cost and sophistication varies enormously over the range of available equipment, from a few pounds for the portable 'transistor' to thousands for radar and satellite communications. No matter what the application the advances since the days of the cat's whisker crystal detector have been considerable and it is proposed to survey the subject at a conference on 'Radio Receivers and Associated Systems' organised by the I.E.R.E. to be held at the University of Southampton from 11-14 July, 1978.

Thirty-seven papers will be delivered formally and a further twenty will be presented in poster-booth sessions. An exhibition of relevant equipment is to be organised by the Electrical Research Association. Further details from:

*Conference Secretariat, I.E.R.E., 99 Gower Street, London WC1E 6AZ. Tel: 01-388 3071.*

## Mobile Rally

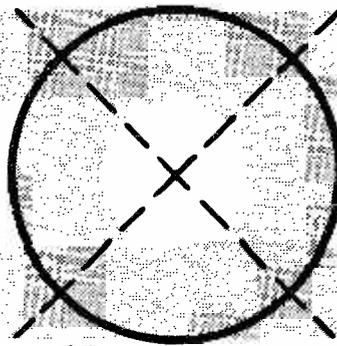
The Nunsfield House Community Association Amateur Radio Group are holding a mobile radio rally on Sunday 11 June 1978 at Elvaston Castle Country Park, which is located 5 miles south-east of Derby on the B5010.

Talk-in stations will be available from 10.00am; G3EEO/P on 160m, G3ZBI/P on 2m f.m. ch. S22, and on 70cm G8KGC/P on f.m. chs. SU8 and SU20. All the usual rally attractions will be present; over 40 trade stands housed in two marquees, bring and buy sale, RSGB bookstall, childrens rides and entertainments, sideshows and a full catering service at competitive prices. The I.B.A. will also be present demonstrating their ORACLE teletext service. The rally will be open from 11.00am and should provide an ideal day out for all the family. Further details are available from: *Ian Cage G4CTZ, 25 Petersham Drive, Alvaston, Derby DE2 0JU.*

## Summer School

The Dept. of Electrical Engineering Science at the University of Essex will be holding its annual electronics summer school for teachers during the week 10-14th July, 1978. This year, as well as running two established courses in linear and digital circuit design, a third course in Electronics Systems is being introduced. The object of the course being to cover some of the more difficult material of the AEB Electronics Systems syllabus as well as discussing the teaching aspects of the 'A' level.

The linear design course is concerned with the use of transistors and operational amplifiers in analogue applications; particular emphasis being placed upon design related to basic circuits in a hi-fi amplifier. The digital design course concentrates on the use of the transistor as a switch and develops design using integrated logic circuits. A programme of laboratory work is included on each course. Teachers who require further information contact: *R. J. Mack, Dept. of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester. Tel: 0206 44144 Ext. 2408/2299.*



200000

# phase-locked calibrator

CH.LUCK

The purpose of this project is to provide an accurate calibration source for digital frequency meters. The 200kHz Long Wave BBC signal is the standard frequency employed, and by regeneration is formed into a 4 volt peak to peak square wave output. It is emphasised that the calibrator requires moderate signal strength for reliable operation, but should function in most areas of the British Isles.

## Circuit Description

The aerial coil is tuned by a trimmer in addition to a fixed capacitor. The signal is fed direct to the gate of Tr1, an f.e.t., which is used purely as a high impedance buffer and works in the source follower mode. This feeds its output through C2 to the base of Tr2 which forms a direct coupled amplifier with Tr3. Tr4 is another buffer used to feed the digital frequency meter without influencing circuit performance.

Regeneration is effected principally by capacitive coupling between the can of Tr3 and the aerial circuit. The overall gain of Tr2-Tr3 is sufficient to clip what would otherwise be a sine wave into a sloping square wave at the collector of Tr3. Transistors 2-4 are not run at the full 9 volt supply but are fed via a decoupled resistor, R7, at about 4.5 volts. This, in conjunction with aerial damping resistor R1, serves to restrict the degree of feedback. This technique was adopted when trying to lock on to a French transmission at 180kHz, a rather weaker signal than the 200kHz transmission.

## Phase Locking

The circuit as a whole constitutes a free-running multivibrator which happens to use a tuned aerial as part of its feedback loop. Now, as with any multivibrator, it can be triggered by a suitably strong impulse, and the closer the triggering frequency is to that of the multivibrator, the more readily will phase locking occur. By adjusting the aerial close to 200kHz we allow the received signal to trigger the circuit.

However, we have a problem with triggering in that the received signal strength will vary by vast amounts, depending mainly on the distance from the transmitter. One way to overcome this problem is to devise a multivibrator with minimal feedback level, thereby reducing the trigger level required: hence the technique described here.

## Construction

The m.w. winding supplied with the ferrite rod is discarded. Only leads 3 and 5 on the l.w. winding are used; lead 4 may be cut short, the ends carefully cleaned, and the two wires resoldered. If "P" clips are not available for mounting the rod it can be glued with Araldite direct to the top of the board.

The board is drilled to take four 4 BA mounting bolts, two of which secure the "P" clips, and also, as appropriate, for the type of trimmer used. These bolts may also be used to mount the unit in a suitable case if desired.

The components are back-wired on 0.15in matrix plain Veroboard and the layout shown should be adhered to, as spurious feedback plays such an important role.

The leads of R8 are formed into loops close to the resistor body before they pass through the board; these loops form the earth and output terminals. A PP3 type connector is fitted enabling either a PP3 or PP6 to be used.

## ★ components

### Resistors

All 1/4W 5% carbon

R1 470kΩ

R3 47kΩ

R5 3.3kΩ

R7 1.8kΩ

R2 4.7kΩ

R4 47kΩ

R6 1kΩ

R8 1kΩ

### Capacitors

C1 200pF silvered mica

C2 1nF ceramic

C3 22nF ceramic

C4 10μF electrolytic 6V

TC1 40pF compression trimmer

### Semiconductors

Tr1 2N3819

Tr2, 3, and 4 BC109

### Miscellaneous

L1 Denco 5FR m.w./l.w. with ferrite rod, or similar, "P" clips, 4BA bolts—4 off, plain Veroboard 64mm × 95mm 0.15in. matrix, suitable case (optional), PP3 connector

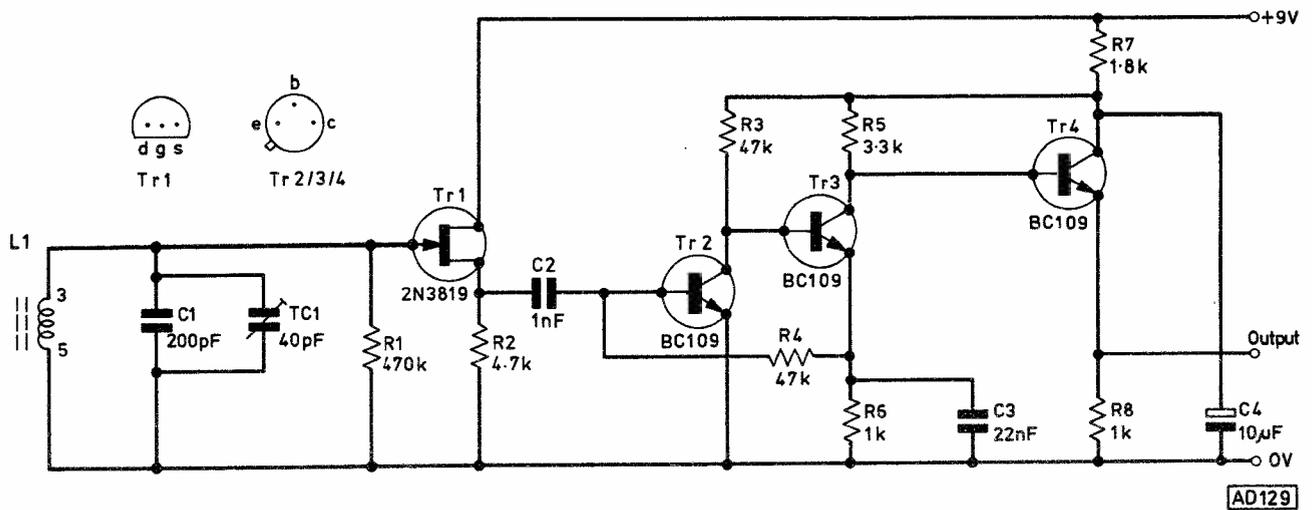
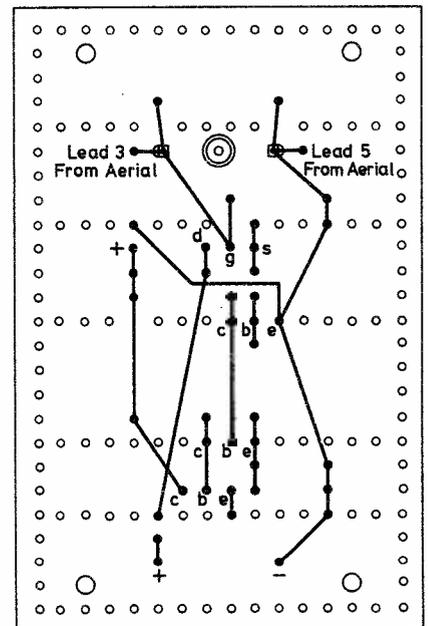
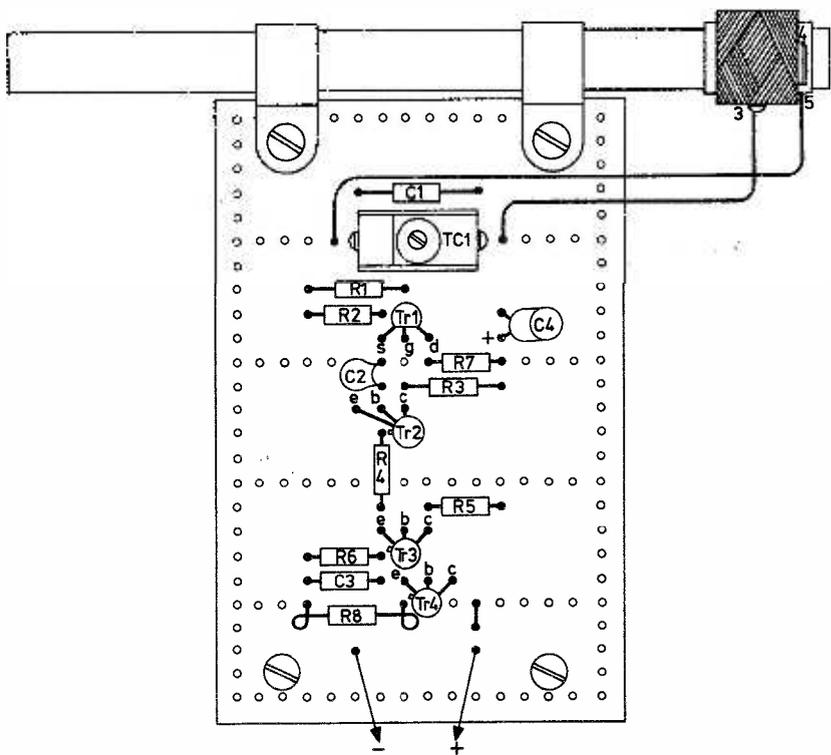


Fig. 1: (above) The complete circuit diagram of the Phase-Locked Calibrator

Fig. 2: (below) Component layout and wiring of the perforated board



## Alignment

The equipment required for setting up is no more than a Long Wave receiver and an insulated trimming tool (a plastic knitting needle filed to shape will serve). Proceed as follows.

1. Screw down TC1, then unscrew  $\frac{1}{2}$  to  $\frac{3}{4}$  of a turn.
2. Connect the frequency meter earth to the 0V side of R8 and the probe to the output loop. Ensure that the unshielded section of the probe runs directly away from the aerial.
3. Connect a battery to the calibrator and then tune in 200kHz on the receiver which is placed nearby with both aligned for best reception.
4. Adjust the coil former on the ferrite rod until a heterodyne whistle is heard from the receiver; continue until the note is fairly low.
5. Using the trimming tool adjust TC1 until the beat disappears altogether. At this point the calibrator is phase locked to 200kHz.

6. Switch on the frequency meter, and after a suitable warming-up period make any adjustment necessary.

The coil former may be fixed in place with a few drops of candle wax melted with a soldering iron.

## Final Notes

Remember that any digital frequency meter will have a last digit error of plus or minus one, so don't expect the readout to be rock steady. Static or man-made interference, including radiations from the meter itself, if too close, can cause a momentary spurious reading. The circuit, which consumes about 4mA, is quite tolerant of falling battery voltage.

The prototype was used some 90 miles from the transmitter at which range locking occurs without difficulty, but at appreciably greater ranges it could be more of a problem.

Receiver with Screened-grid H.F. Amplification" covering 20-48 metres. The circuit consisted of a screened grid h.f. stage followed by a leaky grid detector with reaction and two l.f. stages; the price, £25, exclusive of royalty, valves and batteries.

## Receiver Designs

Somewhat different to the Short-Wave 2 described by H. B. Dent, *Wireless World* (4.11.32) covering from 15 to 80 metres with 5 plug-in coils. The blueprint was obtainable from *WW* for 1s.6d, post free, the receiver was available for inspection at their Editorial Offices in Fleet Street and the approximate cost of the parts, excluding valves, was £4.12s.0d.

For some years, up until the end of 1924, *Wireless World* was the official organ of the Radio Society of Great Britain, and in July 1925 the first issue of the *T and R Bulletin*, forerunner of today's *Radio Communication*, was published at the instigation of Henry Bevan Swift, G2TI, and Gerald Marcuse.

In later years the Marcuse family moved to the picturesque seaside village of Bosham, Sussex, where today, outside the church stands a teak seat on which is a bronze plaque inscribed:—"In Memory of Gerald Marcuse, G2NM, Pioneer of Empire Broadcasting, President RSGB 1929-30", accompanied by the badges of both the RSGB and RAOTA. This memorial seat was handed over to the Chairman of Bosham Parish Council (Mr Frank Parham) by representatives of the Radio Amateur Old Timers' Association at a short ceremony outside the church on July 21st, 1962. In the same year RAOTA also arranged for a commemoration plaque to be installed at Gerry's former home in Caterham which reads:—"From this house Gerald Marcuse, G2NM, inaugurated Empire Broadcasting in September 1927".

# G2NM

'TIDEWATERS' BOSHAM  
SUSSEX ENGLAND



Special event station operated by members of Chichester and District Amateur Radio Club in memory of the late Gerry Marcuse G2NM. The two pictures show Gerry with some of the equipment he used at the time of Empire Broadcasting from Caterham, Surrey in 1927.

TO RADIO	DATE	GMT	MHZ	RST

The QSL card of special event station G2NM, operating from Bosham, West Sussex, on 24/25th June, 1978

To commemorate the 50 years of Empire Broadcasting, the Chichester and District Amateur Radio Club are operating a station from Bosham on June 24th and 25th, and have a special QSL card to mark the occasion. Although they will be active on 2m, G8NMF, they intend to concentrate their efforts on the DX bands, as Gerry did. Owing to the limited space available, people wishing to visit the station must first contact Terry Allen, G4ETU, QTHR, to make arrangements.

*Practical Wireless*, July 1978

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May 78	DX'ers Audio Filter	D001	2·35+15	<input type="checkbox"/>
June 78	Bovington Tank Game	R006	3·80+20	<input type="checkbox"/>
June 78	Audio Distortion Meter (set)	R007/8/9/10	6·75+25	<input type="checkbox"/>
June 78	Darkroom Timer	R011	1·55+15	<input type="checkbox"/>
July 78	Avon Transmitter	R015/16/19/20	5·10+40	<input type="checkbox"/>
July 78	Digital Lock	D002	1·25+15	<input type="checkbox"/>
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# Introduction to

S.A. MONEY

# LOGIC ~ 1

During the past few years something of a revolution has taken place in the field of amateur electronics. The valves and transistors of the past have been overtaken by a wide range of integrated circuits (i.c.s) or "chips" as they are often called. These new devices make possible amateur electronic projects which, only a few years ago, would have been just science fiction dreams. The integrated circuits available range from simple two- or three-stage audio amplifiers up to microprocessors with some 20,000 or more transistors packed on to a tiny chip of silicon.

Some integrated circuits, such as those for audio, radio or television applications, are linear types and they work in much the same way as their discrete component counterparts. It will be noticed however, that the great majority of i.c.s advertised have type numbers in the 74 and 4000 series. These are logic devices originally developed for use in digital computers and industrial control systems.

## What can Logic do for us?

So all of these digital logic chips are available but how can they be used in amateur projects? Let us consider radio communication. Amateur radio operators and keen short wave listeners often need to measure frequencies accurately. The old methods of using heterodyne wavemeters, calibration charts or even crystal markers work quite well but they are rather inconvenient. Modern communications receivers often indicate the frequency, to perhaps the nearest 100 hertz, as a number on a digital display. This facility is achieved by using logic circuits.

Basically all we need do to measure frequency is to count the number of cycles of the signal that occur in an accurate time period. If the time period is a millisecond then the answer will be the frequency in kilohertz. Logic devices are very good at counting things and measuring time periods.

To measure time we simply count down from an accurate crystal-controlled oscillator. The count can be arranged to provide the answer in hours, minutes and seconds. In fact this is precisely how a digital watch or clock works.

Many amateur radio stations use the radioteletype (RTTY) mode of communication where signals from a typewriter-style keyboard are converted into coded patterns of pulses and then transmitted. At the receiving end, the pulse patterns are decoded and the message is printed out as text on a sheet of paper. Because printers are rather expensive some stations display the messages as text on a modified television receiver. Extensive use is made of digital logic for coding, decoding and displaying the RTTY messages. Morse code, still used by many radio amateurs, can be dealt with in the same way. Messages, typed on a

keyboard, are converted by logic to perfect Morse code and at the receiver the signals are decoded and displayed as text on a TV screen.

Logic is very good at sequential control tasks such as running a model railway, controlling a machine, or even switching the lights on a Christmas tree. There are many ways we can use this capability for amateur projects.

Recently logic has crept into television in the form of TV games and Ceefax/Oracle decoders. There are some TV sets which can display the time or channel number on the screen by using logic. In other cases, digital techniques may be used for tuning and for remote control. Even those touch switches on the front of some sets use digital logic.

Some large scale integrated (l.s.i.) digital circuits have been specially developed for use in electronic organs, digital multimeters, digital clocks and calculators. By far the most complex of the logic devices are microprocessors which, unlike the more specialised circuits, can easily be programmed to perform an almost infinite variety of tasks perhaps only limited by the imagination of the user.

People sometimes regard digital circuits as rather mysterious. It is true that when we enter the digital world we shall meet some new concepts; new devices, new circuit symbols and a whole new vocabulary of technical terms. In fact, however, digital systems are not too difficult to understand, and in this series we shall explore the way in which they work and some of the ways in which they can be used.

## Digital Signals

First, let us take a look at the signals involved in a digital logic system. Readers will already have met analogue signals, such as those in an audio amplifier, where the level of the voltage or current in the circuit varies in proportion to the signal level. Thus the amplitude can vary continuously over the whole range of signal levels, to give a virtually infinite number of discrete voltage or current levels.

In contrast to the analogue case the signals in a digital logic system can have only two possible levels. One of these is called the "zero" or 0 level, and this corresponds to the signal being turned off. The second level is called the "one" or 1 level and is equivalent to the signal being turned on.

Sometimes in the literature and in data sheets for logic circuits, other names may be used to describe these two signal levels. As an example the 0 level may be referred to as the "low" or "false" level, but it will still have the same value as the 0 level. Alternative names for the 1 level are "high" and "true" respectively. In this series we shall use the 0 and 1 terminology since it seems to be the most popular.

When both A AND B inputs are set at 1 both of the diodes will cut off and no current will flow in R. Now the output level will rise to +5V to give a 1 output state. Thus the diode circuit produces the same logical results as the electrical lamp and switch circuit.

If we needed to have more input signals these could be provided by merely adding more diodes. With more inputs the 1 at the output should only occur when all of the input lines are at the 1 level.

## Truth Table

A convenient way of setting down the various logic conditions in a gate circuit is by means of a Truth Table. In this table all of the possible combinations of input states are listed, together with their corresponding output states.

For a two-input AND gate such as that shown in Fig. 2 the truth table would be as shown in Table 1. In the case of an AND gate which has three inputs the truth table will have eight possible states as shown in Table 2.

TABLE 1

Input		Output
A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

TABLE 2

Input			Output
A	B	C	Y
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	1

Try working out the truth table for a four-input AND gate and you should end up with 16 combinations but the output will be at 1 only when all of the inputs are at 1.

## Integrated Gate Circuits

In an actual TTL 2-input AND gate the circuit is roughly as shown in Fig. 3 and is much more complex than our simple diode gate.

The gate action proper occurs in transistor Tr1 which has two emitters. This stage acts in much the same way as the diode gate so that the transistor

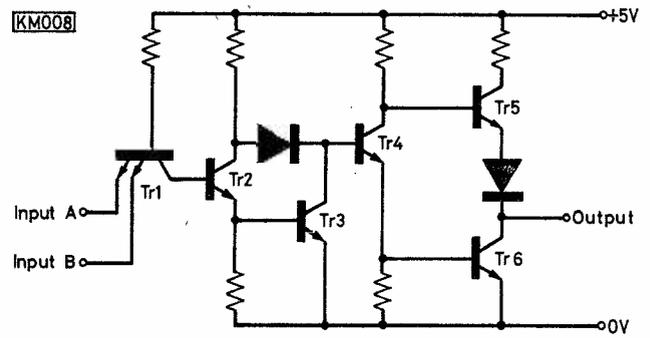


Fig. 3: A typical TTL AND gate

stops conducting if both emitter inputs are at 1. Transistors Tr5 and Tr6 form a "totem pole" output stage which gives a low output impedance and fast switching. For a 1 output Tr5 is "on" and Tr6 is "off" and vice versa for the 0 state. Thus the output is clamped to either 0V or +5V through one or other of the output transistors. The other transistors in the circuit provide the required drive signals for the output stage.

In the 4000-series CMOS circuit a 2-input AND gate would be made up roughly as shown in Fig. 4. In this circuit the series n-channel transistors provide the AND gate action operating in much the same way as the series switches in our electrical circuit. The p-channel f.e.t.s Tr1 and Tr2 are used to pull the point X up to the supply rail if either of the inputs is at 0. When both inputs are at 1 Tr3 and Tr4 will both conduct to bring point X down to 0V. The output stage in this case is a push-pull complementary pair. If X is at 0, Tr6 will be "off" and Tr5 will be "on" so the output terminal will be clamped to the positive supply rail to give a 1 output. If X is at 1 the output level will be clamped to 0 via Tr6. In some cases there may be several other stages to provide full drive for the output stage but the operation is much the same.

For more inputs a TTL gate would have more emitters on Tr1, whilst a CMOS gate will have more transistors in series.

## Symbol for an AND Gate

Obviously we cannot draw out the complete circuit for every gate so a special symbol is used to indicate an AND gate. This is shown in Fig. 5(a) for a 3-input gate. Where there are a lot of inputs the gate symbol may be modified as in Fig. 5(b) for drawing convenience.

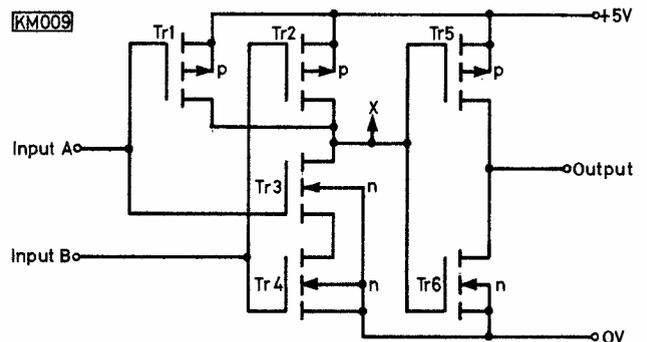
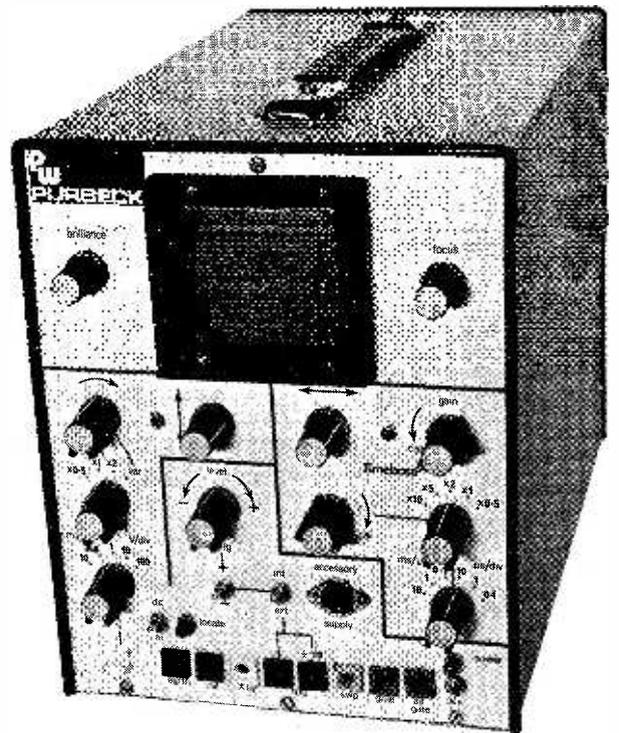


Fig. 4: A typical CMOS AND gate

continued on page 60



**Part 4**

# OSCILLOSCOPE

IAN HICKMAN

This month's instalment deals with the construction of Board 3, the Y amplifier. This board uses a ground plane, in view of the high gain and wide bandwidth. With a ground plane, a low impedance earth return is available everywhere, ensuring that decoupling capacitors are fully effective.

As double sided boards were ruled out on the grounds of excessive cost, the component interconnections use conventional wiring. It may well be possible to produce a successful single sided printed wiring layout, but the author lost a considerable amount of time trying to do just this and therefore returned to the ground plane construction used in a previous oscilloscope design. Figs. 3 and 5 show the component layout and wiring, which should be followed closely to avoid instability. Note that i.c. sockets must not be used.

Up to this point, the components mentioned have all been fairly conventional, apart from the special mains transformer and the tube itself, of course. On this board we encounter some more out of the way components, but their use is more than justified by the performance which is obtained.

Take the dual junction gate f.e.t. type E421 (Siliconix) used in the input stage for example. The low temperature coefficient of input offset results in no drift of the trace level from switch on, even on the most sensitive setting of about 2.5 mV per division.

This dual f.e.t. acts as a source follower, providing the necessary high input impedance for use with the

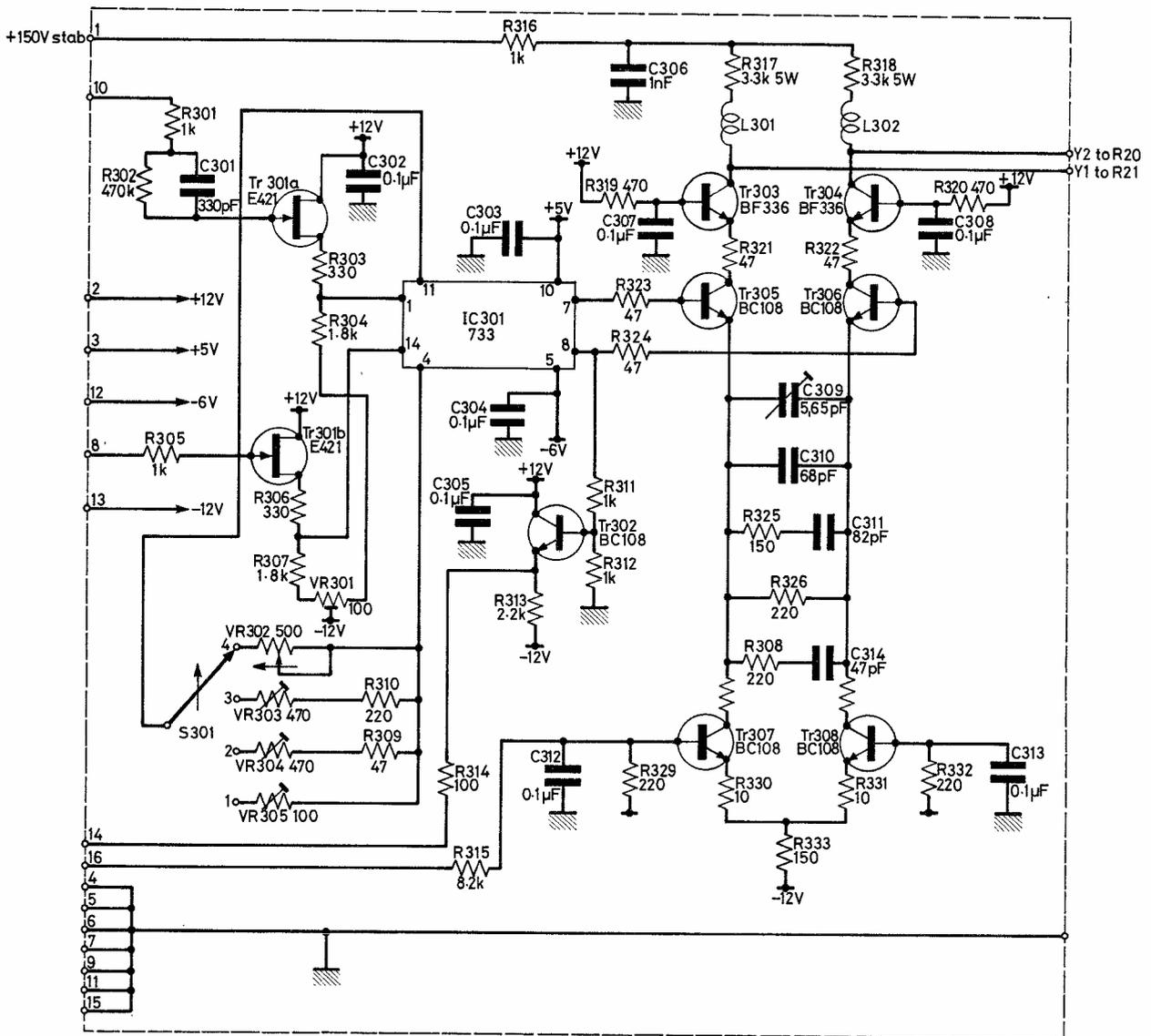
frequency compensated input attenuator S3 and a low output impedance to drive the 733 video amplifier IC301. Network R301, R302 and C301 protects Tr301a from excessive input voltages without causing deterioration of high frequency response. R303, R304 and R306, R307 provide d.c. level shifting of Tr301's outputs to bring them within the input range of IC301. They result in a small degree of attenuation of the input signal at d.c. and are therefore not bypassed, to keep the a.c. and d.c. gains equal.

The purpose and adjustment of VR301 is covered in the last article, and at this stage it should simply be set to mid-travel.

The 733 video amplifier IC301 forms the main gain block, and its gain is switched by S301 to provide an overall sensitivity for the complete instrument of 5, 10 and 20 mV/division. A fourth position of S301 brings VR302 into circuit, providing a continuously variable gain facility and incidentally providing a maximum sensitivity of approximately 2.5 mV per division.

The bandwidth of the 733 varies with gain, but even at maximum gain it is 40 MHz, so that in practice the bandwidth of the complete instrument is determined entirely by the Y deflection amplifier Tr303 to 308.

Note that owing to its common mode rejection (typically 60 dB even at 5 MHz) the output of IC301 is balanced, even though an unbalanced input is applied at pin 1.



**Fig. 1: The circuit diagram of the Y amplifier, clearly showing how the essential bandwidth is achieved; gain block IC301 couples to the Y deflection amplifier, and the R326 by-passing C/R network maintains upper frequency response. Note that R329 and R332 are connected to the -6V supply and that the unmarked resistors in the collector circuits of Tr307 and Tr308 are both 47Ω (R327, 328)**

Tr302 is the trigger pick off amplifier. This is by no means a trivial function, as the action of an oscilloscope's trigger slicer circuit can easily reflect back a small disturbance into the Y amplifier. This results in slight notches in each cycle of the displayed waveform, which move up and down as the Trigger Level control is varied. Here, R311, R312 attenuate the signal by a factor of 2 and emitter follower Tr302 acts as a buffer.

An emitter follower provides only limited reverse isolation at high frequencies, but disturbances emanating from the trigger circuit, before they can reach the Y deflection amplifier input, are also attenuated by the ratio of R311 to the output impedance of IC301. This ratio is very much greater than 2:1, as IC301's output stages are emitter followers.

Further buffering is provided by another emitter follower and 2:1 attenuator on Board 4, described next month. R314, like the 47Ω resistors in the Y

deflection amplifier, is an anti-parasitic stopper resistance.

The bandwidth of an oscilloscope is usually limited by the Y deflection amplifier. Certain steps can be taken to maximise the bandwidth and a fairly obvious one is to use symmetrical deflection, i.e. to drive the deflection plates in antiphase. For if only one of the two plates were driven, twice the voltage swing would be required, so needing twice as high a collector supply voltage.

For a given deflection transistor dissipation, we would then have to halve the standing current through the output transistor. Twice the voltage at half the current means four times the collector load resistance and this would result in a quarter of the bandwidth!

The Y output transistors Tr303 and Tr304 are used in the grounded base mode. The low input impedance at their emitters results in virtually no signal voltage

swing at the collectors of Tr305 and Tr306. There is therefore no Miller multiplication of their internal collector/base capacitance, minimising capacitive loading on IC301's outputs.

The collector/base capacitance of a BF336 is approximately 3.5 pF and this, together with the Y plate capacitance of the 3BP1 c.r.t. and wiring strays, results in a total capacitive loading at the output of Tr303 (and Tr304) of around 10 pF. A peak to peak voltage swing of around 90V is required to provide a reasonable degree of overscan and choosing a conservative value of dissipation for Tr303 and 304 leads us to a standing current for each of just over 15 mA, with 3.3kΩ collector loads. Allowing a minimum Vce of 10V to maintain a good high frequency response leaves us with an h.t. requirement of 120V—the excess 30V is dropped by R316.

## ★ components

Resistors		
<i>1/4W 5% carbon film</i>		
10Ω	2	R330, 331
47Ω	7	R309, 321, 322, 323, 324, 327, 328
100Ω	1	R314
150Ω	2	R325, 333
220Ω	5	R308, 310, 326, 329, 332
330Ω	2	R303, 306
470Ω	2	R319, 320
1kΩ	4	R301, 305, 311, 312
1.8kΩ	2	R304, 307
2.2kΩ	1	R313
8.2kΩ	1	R315
470kΩ	1	R302
<i>5W w.w.</i>		
1kΩ	1	R316
3.3kΩ	2	R317, 318
Potentiometers		
<i>Miniature vert. skeleton preset</i>		
100Ω	2	VR301, 305
470Ω	2	VR303, 304
<i>1/4 inch diameter spindle</i>		
500Ω	1	VR302
Inductors		
See text L301, 302		
Capacitors		
<i>Ceramic</i>		
47pF	1	C314
68pF	1	C310
82pF	1	C311
330pF	1	C301
<i>Disc ceramic</i>		
1nF	1	C306
0.1μF	8	C302, 303, 304, 305, 307, 308, 312, 313
<i>Trimmer</i>		
5-65pF	1	C309
Semiconductors		
<i>Transistors</i>		
BC108	5	Tr302, 305, 306, 307, 308
BF336	2	Tr303, 304
E421	1	Tr301 (Siliconix)
<i>Integrated circuits</i>		
LM733	1	IC301
Switches		
1p.4w rotary	1	S301
Miscellaneous		
Printed circuit board (1) (Watford Electronics)		
Printed circuit board test pins and matching sockets (3)		

Now 3.3kΩ and 10pF gives a time constant of  $3.3 \times 10^{-8}$  sec corresponding to a -3dB point of 5MHz and this is in fact the measured -3dB frequency of the oscilloscope for full screen Y deflection. With suitable inductive peaking in the collector circuits, this could be extended by about 20 per cent to 6MHz or a shade more if overshoot were accepted on fast edges. This bandwidth would be independent of the amplitude of the Y deflection. However, in this design a different approach has been adopted. The voltage gain of the Y deflection amplifier from the bases of Tr305, 306 to the collectors of Tr303, 304 is the ratio of the collector to collector load resistance ( $3.3k\Omega + 3.3k\Omega$ ) to the emitter to emitter resistance (R326, 220Ω).

A gain of 30 for a cascade stage is quite modest, considerably more gain could be obtained by using a lower value for R326.

Advantage has been taken of this extra available gain by partially bypassing R326 at high frequencies with capacitors C309, 310, 311 and 314. This provides increased output current swing at Tr303, Tr304 collectors at high frequencies to charge the capacitance of the Y plates, so maintaining the frequency response level.

This substantially reduces the rise time when displaying pulses or square waves, but there is a limit.

After all, the available current through Tr303 and Tr304 together is set by the tail resistor R333. All the input signal can do is alter its distribution between them.

If due to the large size and fast risetime of an input square-wave, the current needed to charge the deflection plate capacitance quickly enough exceeds the tail current, then we cannot faithfully display the waveform.

The "in" phrase for this is to say that the output voltage of the Y deflection amplifier is "slew-rate-limited". If either the amplitude of the input were

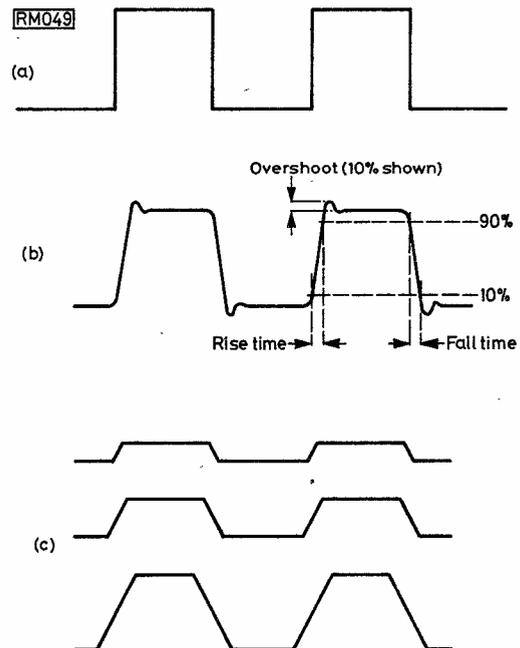
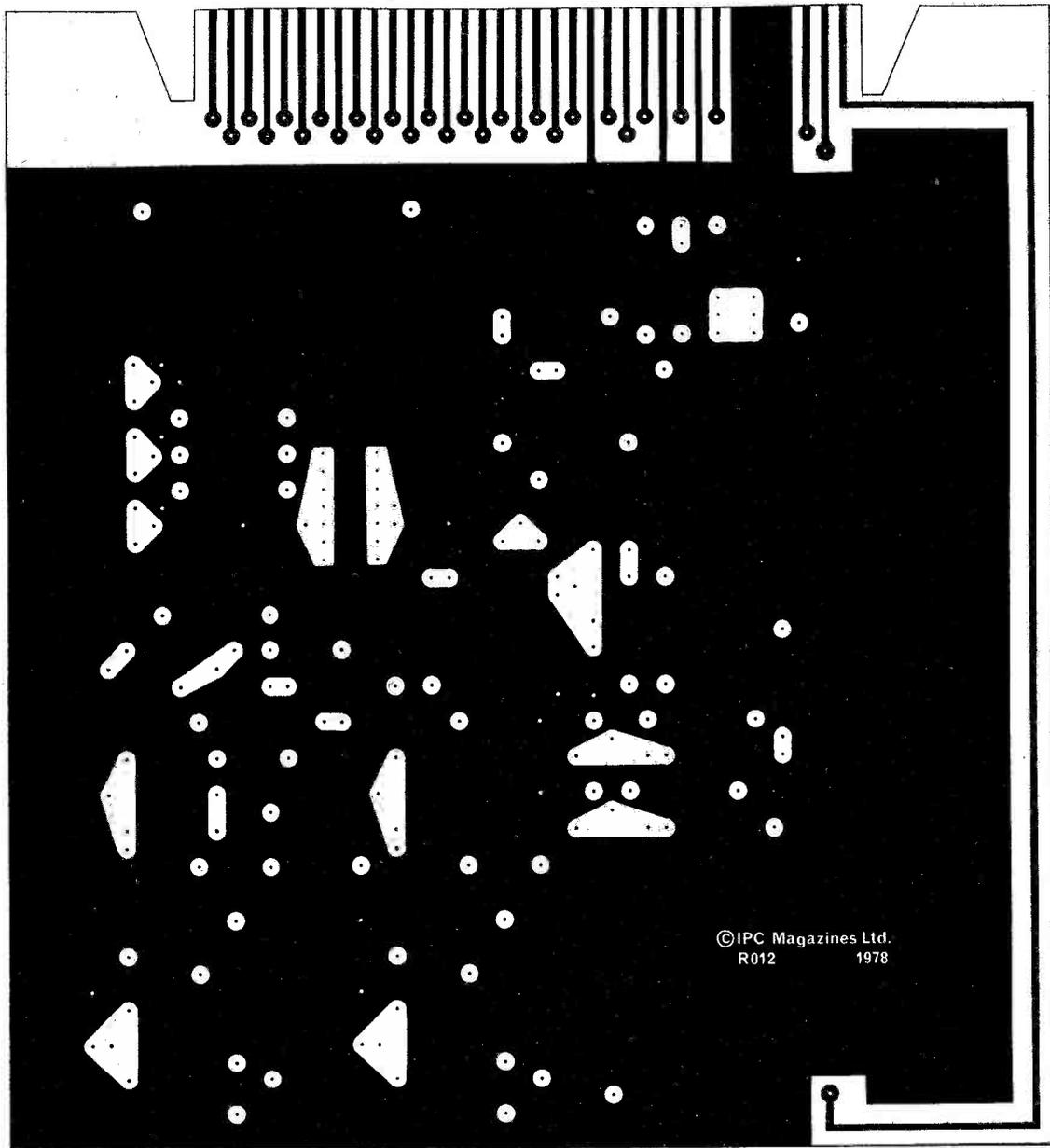


Fig. 2: An ideal square wave is shown in (a) with typical degradations which occur in practice shown in (b). At (c) are the output waveforms from a slew-rate-limited amplifier for three increasing values of input



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Fig. 4: The copper ground plain pattern of the Y amplifier board

smaller, the higher their frequency.

In other words, the amplitude/frequency characteristic of the amplifier matches the requirements for displaying square waves and pulses. For a vertical deflection of 1 division, the rise time of the oscilloscope is 20 ns, so the display of a 5MHz square wave looks commendably square, whilst even a 10 MHz square wave looks as if it is obviously meant to be

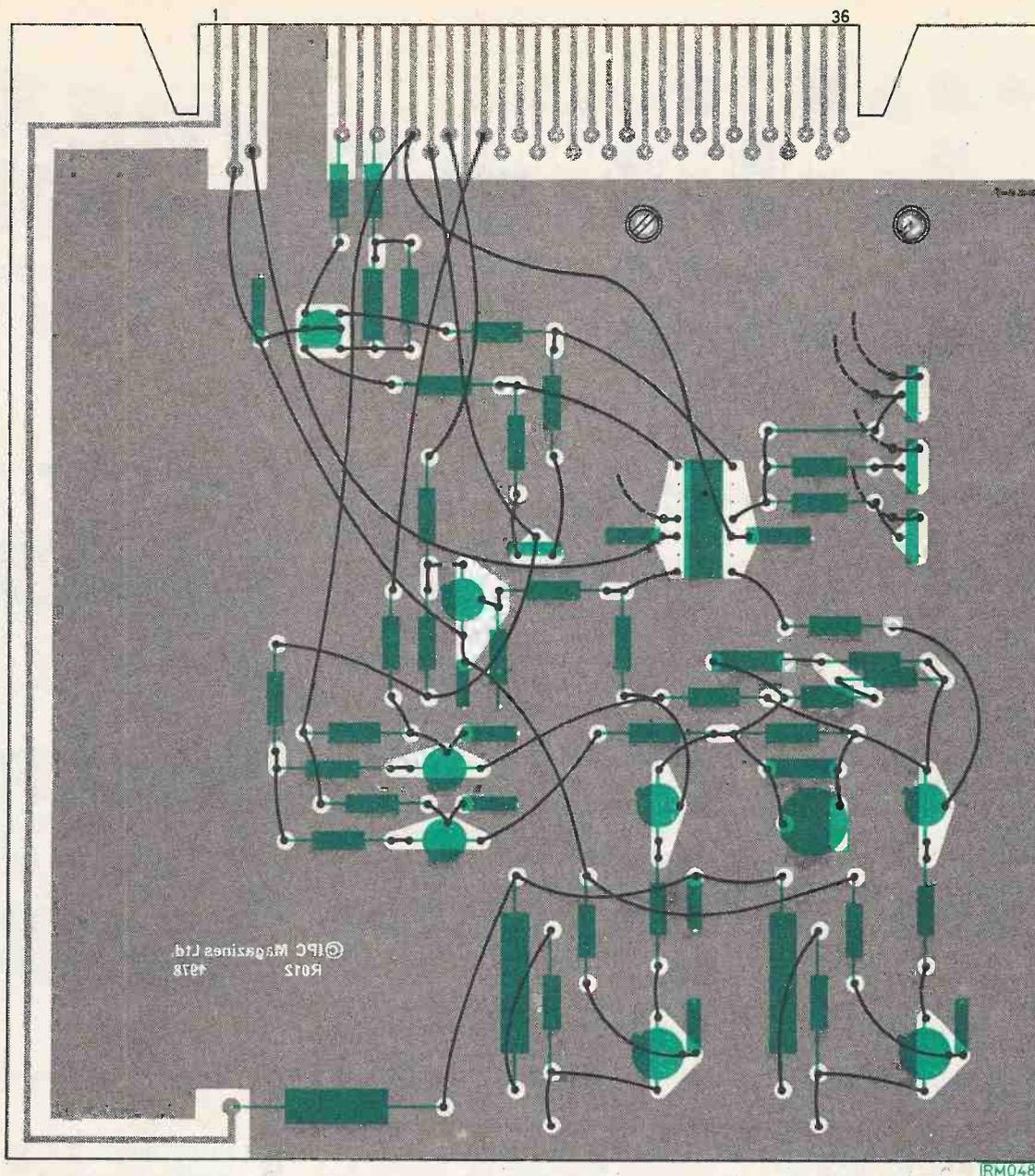
**WARNING**

Extra care must be taken when working on any part of this instrument while power is switched on. 1100 volts can kill. When delving into the insides of the scope for any reason with power on keep one hand in your pocket

square! L301, 302 provide a modest degree of peaking, as do L1 and L2, but are not in any way critical. L301, 302 are 35 turns of 38 s.w.g. wire on 100k $\Omega$  carbon composition resistors. L1, 2 (see Part 3) are similarly constructed with 15 turns of 38 s.w.g. wire. R308 and R325 shape the peaking provided by C311, 314 to give a flat frequency response and minimise overshoot and ringing on fast edges.

The emitter current of Tr305, 306 is provided by a long tailed pair TR307, 308. These provide a convenient means of injecting the Y shift voltage via R315. If the Y shift were injected ahead of IC301, the position of the trace would change when the Y gain selected by S301 was changed.

The author has not seen six transistors used in this configuration before: readers might like to think up a name for it—a long-tailed cas-cascode perhaps.



**Fig. 5: Back wiring of the board, in relation to the components. This layout of the wiring should be followed to avoid any possibility of instability occurring**

When Board 3 has been assembled, check each power supply pin to 0V with an ohmmeter to make sure none is short circuit and centre all pre-set pots and C309. Then plug it into the main frame, disconnect the Y plates from the temporary 47k $\Omega$  and 100k $\Omega$  resistor chain across the +150V STAB supply (see last month) and connect them via R21, L1 and R20, L2 sockets to pins Y1 and Y2 of the board.

Don't forget the ground link at the rear of the board either. You can also put up a crude timebase of sorts by disconnecting one of the X plates from the 47k $\Omega$  and 100k $\Omega$  resistors and reconnecting it via a 47k $\Omega$  resistor. A 0.1 $\mu$ F capacitor from the Y plate to pin 2 of Board 1 will give a small 50Hz sinusoidal X deflection. So, plug in briefly and check that all

stabilised supply voltages are normal, indicating no short circuits anywhere.

It should be possible to centre the trace vertically with the Y shift control. If not, adjust VR301 as necessary. With a suitable range selected at S3, feed in a sine wave from an audio oscillator. When its frequency is carefully adjusted to exactly 50Hz, 100Hz, 150Hz, etc, a stationary pattern known as a Lissajous figure should be obtained. At 50Hz, this will vary from a line to an ellipse and more complicated figures will be obtained at higher frequencies.

This simple test will enable you to check that the Y amplifier is basically operational and to test that the Y shift works, also that the gain can be varied in steps by S301 and in position 1, by VR302.

Next month we will look at the construction of Board 4, which carries the timebase circuits.

therefore not multiplied by the audio frequency gain of the circuit and the quiescent output voltage is very close to the ground potential; the steady quiescent current passing through the loudspeaker can therefore be kept very small.

The bandwidth (or rather the high frequency response) of the circuit is controlled by the value of C3, the compensation capacitor. The bandwidth is approximately equal to  $2.7 \times 10^{-4} R2/R5C3$ ; thus with the values shown, the response extends to about 160kHz, but can be reduced by increasing C3.

The capacitors C6 and C7 are required for good high frequency decoupling to ensure stability; they should be soldered close to the ESM 532. Although these capacitors are connected in parallel with very much larger capacitors in the power supply, the latter capacitors are electrolytics with a fairly large effective series inductance and may be some distance from the device. C6 and C7 have a far smaller series inductance than electrolytics.

## Power Supply

A simple power supply for feeding the circuit of Fig. 2 is shown in Fig. 3. D1 to D4 may be four separate diodes (e.g. 1N4002) or a single bridge rectifier containing four diodes (e.g. type REC 63 from Doram). Full wave rectification occurs in this circuit, the output voltage being nearly  $1\frac{1}{2}$  times the transformer secondary voltage.

The use of the light emitting diode and its series resistor R1 to indicate when the power supply is switched on is, of course, optional.

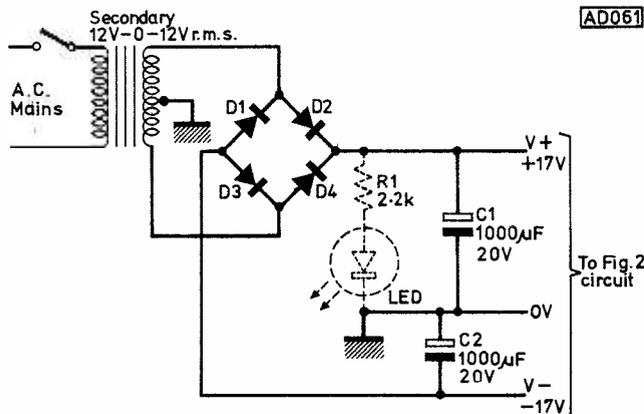


Fig. 3. A power supply circuit suitable for driving the Fig. 2 circuit

## Single Supply

The circuit of Fig. 4 has a similar performance to that of Fig. 2, but a single power supply is used. A positive bias must be applied to the non-inverting input in this circuit otherwise the output would be at a low voltage and would not be able to swing lower in voltage to amplify negative going peaks. The positive bias brings the output potential to a positive quiescent value and therefore a large electrolytic capacitor C4 must be included in series with the loudspeaker to prevent a constant quiescent current from flowing through the loudspeaker.

The gain of the circuit is approximately equal to  $R7/R5 + 1$  or about 28 (29db) with the circuit values shown. The bandwidth is about 12Hz to 140kHz with the value of C5 shown. At high values of gain a capacitor in series with a resistor should be connected from the junction of R7 and R5 to ground, the

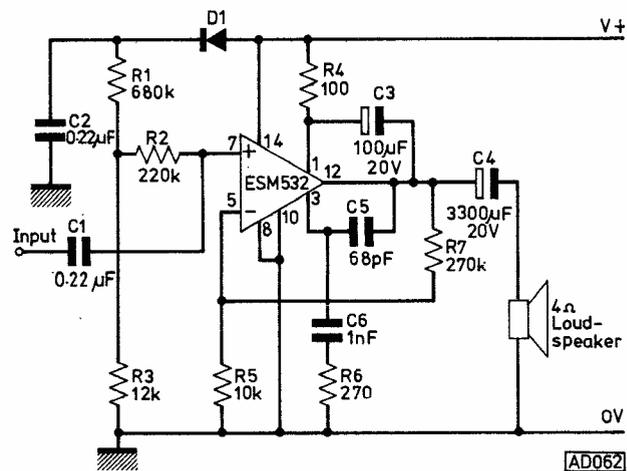


Fig. 4. A 20W amplifier using a single power supply

product of the values of this capacitor and resistor being appreciably less than the product of the value of C4 and the loudspeaker impedance.

## Comparison

In general readers will find the circuit of Fig. 2 more convenient than that of Fig. 4, since no large output capacitor is needed in series with the loudspeaker. Thus the high switch-on transient currents are eliminated together with the switch-on 'plop' noise and one obtains optimum response at low frequencies. On the other hand, the power supply used with the Fig. 2 circuit does require a tapped secondary winding on the mains transformer.

Heat sinks suitable for use with the ESM 532 are available from Staver Thermal Products Ltd., Heron Trading Estate, Bruce Grove, Wickford, Essex SS11 8BS under the type numbers V3-3-2020 and V3-5-2020, the latter having the lower thermal resistance of  $4.5^\circ\text{C/W}$ . When the ESM 532 has been connected on its circuit board, silicone grease should be placed on it and the heat sink bolted to the board so that it is held in good contact with the ESM 532. Readers can make their own heat sinks using a sheet of metal of area not less than about 70 sq. cm. and bending it as required, leaving the part in contact with the device quite flat.

## Other devices

One may well ask how the ESM 532 compares with other 20W devices? It has the same maximum current rating as the SGS-ATES TDA2020, but has a somewhat lower voltage rating than the latter. At present the ESM 532 appears to be somewhat cheaper than the TDA2020 and has the advantage that its typical quiescent current is only 25mA at 28V. The TDA2020 has the lower thermal resistance of  $3^\circ\text{C/W}$  (junction to case). The other characteristics of the two devices are quite similar, but the connections are different.

A lower voltage version of the ESM 532 is produced with a maximum rating of 30V under the type number ESM 432. The ESM 532N is similar to the ESM 532, but has a bracket for the connection of a heat sink.

## Availability

The ESM 532 is available from Phoenix Electronics Ltd., 46 Osborne Road, Southsea, Hants at £2.95 including VAT and packing and postage.

# ON' metre n. Transmitter

BRIAN L. PHILLIPS G8FWM



Readers who intend to operate the Avon Transmitter should be in possession of the appropriate licence issued by the Home Office to those who have passed the City and Guilds Radio Amateurs' Examination. Details may be obtained from: The Home Office, Radio Regulatory Department, Amateur Licensing Section, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

fully and when the board is dry, each island and connection examined to make sure no copper bridges exist between them. One should also ensure adequate clearances.

Place the board in a suitable plastic or earthenware container and pour on just sufficient ferric chloride solution as is necessary to cover it. The solution can be purchased ready-mixed from most radio component stores, or can be made up by a chemist. It is however a corrosive, albeit a mild one, so handle carefully and wash off any of the solution that comes into contact with the skin *immediately*.

Initially, leave the board submerged for about twenty minutes, agitating occasionally. You will see the chemical action taking place quite clearly and when all the unwanted copper has been eroded, take out the p.c.b., wash in clean water and then dry.

Using a wet abrasive pad—such as a Brillo pad—the paint is now removed and a final wash and dry will leave the copper gleaming. After a final check of the work, drill the mounting holes for fixing to the metal chassis.

Each board in the transmitter is etched in this way and provided the simple instructions are followed you should easily be able to provide good examples.

Using a soft, lead pencil, draw out the islands on the board, and then draw around these and the interconnections of the earth plane edge. The small islands and fine connections are then filled in by means of an etch-resist pen or fine paint brush, using quick drying paint, such as car touch-up paint, thinned down if necessary. The larger areas are then put in care-

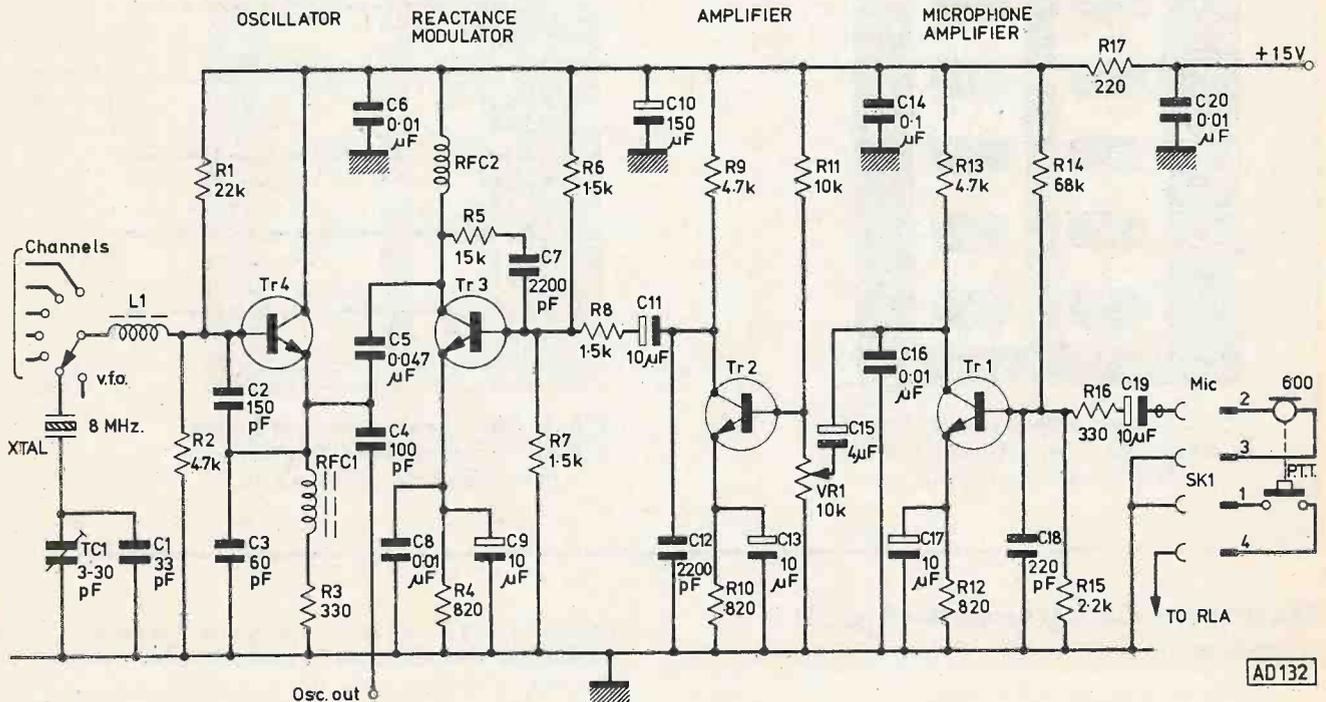
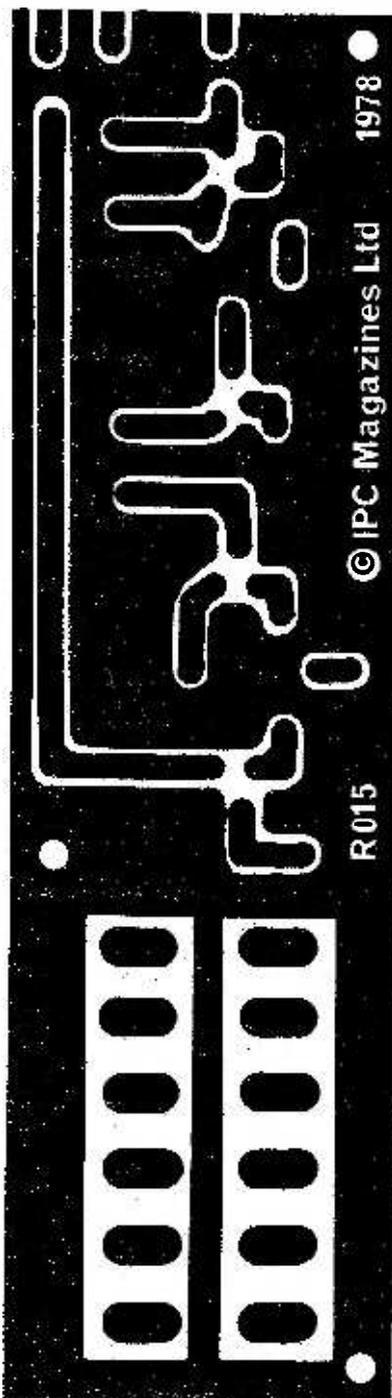
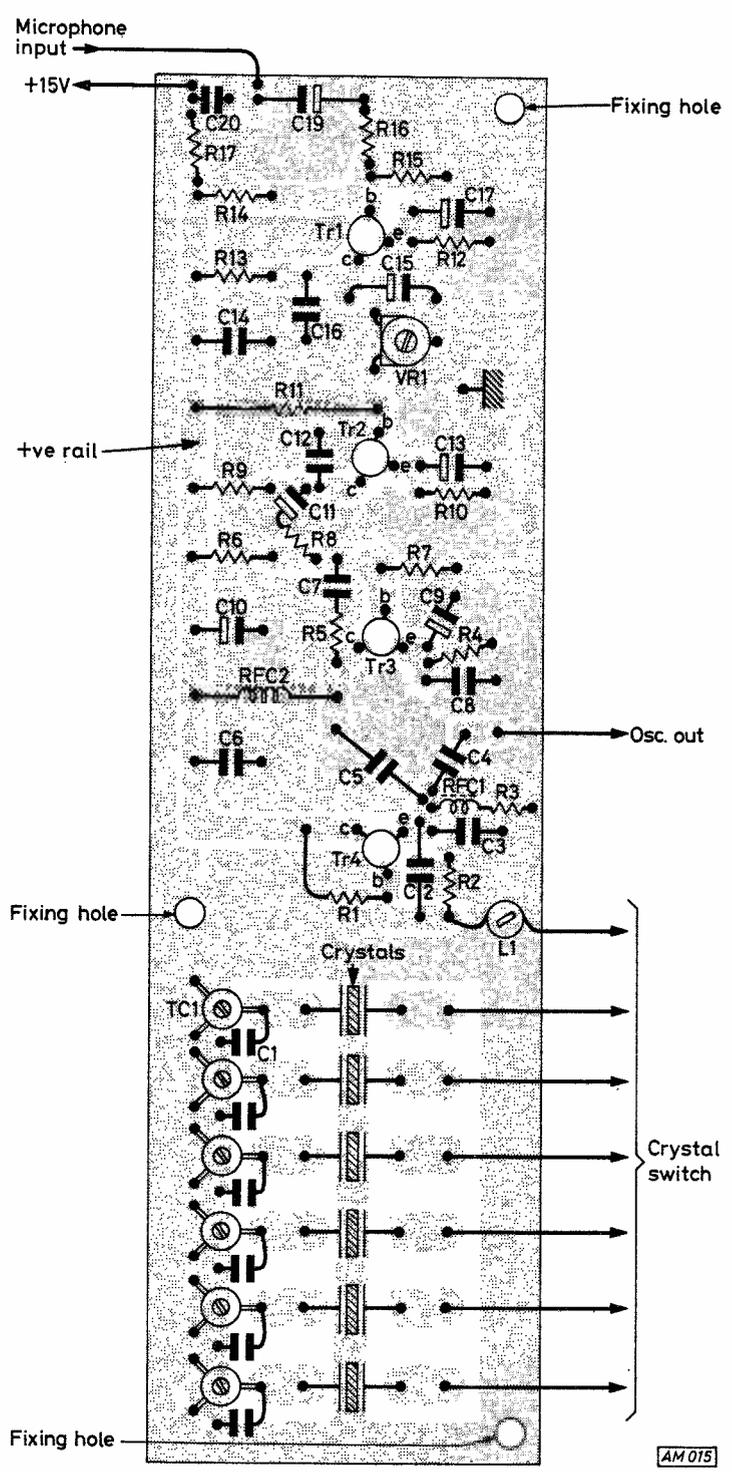


Fig. 1: Circuit diagram for the Crystal Oscillator and Audio Stages—Board 1



**Fig. 2: Copper side layout of Board 1.** Available from Reader's PCB Service (see page 27)

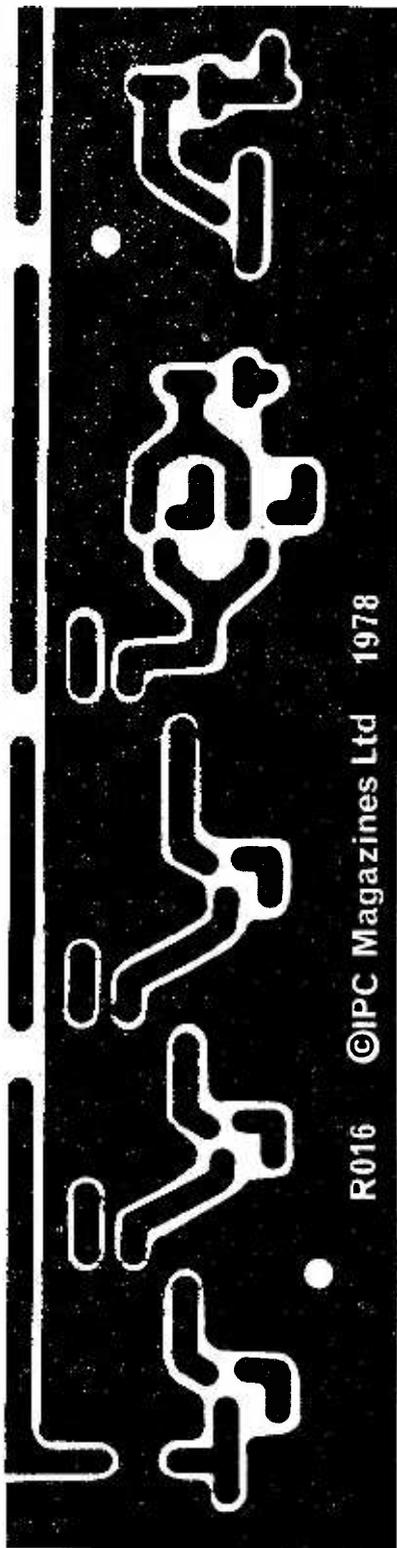


**Fig. 3: Component layout of Board 1.** Note components soldered direct to copper side of the p.c.b.

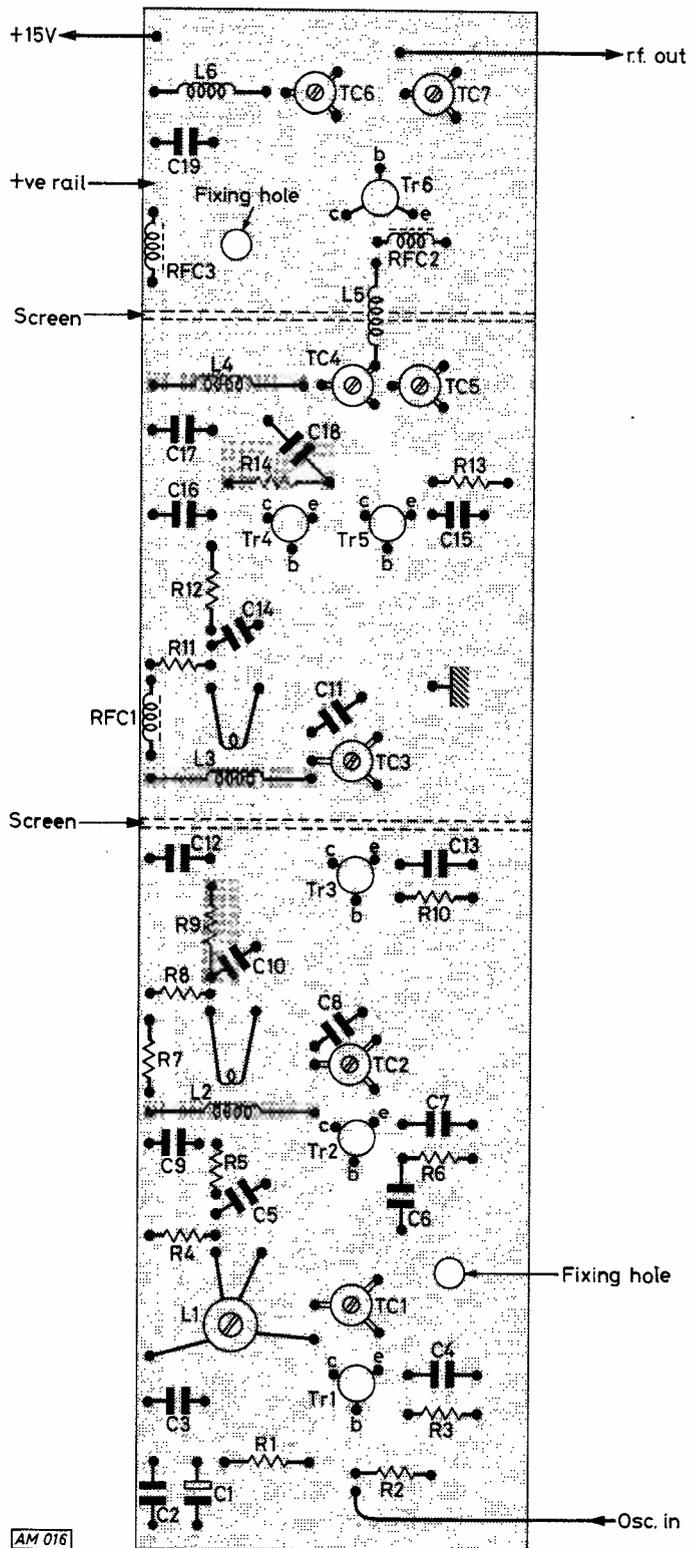
### Mounting Components (Fig. 3)

There is no hard-and-fast rule about fixing the components to the board, but the Author favours soldering the resistors first, followed by the capacitors, the coils and finally the transistors. Keep lead lengths

short—typically 6-12mm for transistors—and solder neatly, holding the iron in place just long enough for the solder to flow to the joint. An iron of 15W rating with a bit size of 3mm or so is to be preferred for work of this nature.



**Fig. 5: Copper side layout of Board 2. Available from Reader's PCB Service (see page 27)**



**Fig. 6: Component layout of Board 2. Note components soldered direct to copper side of p.c.b.**



price, but it is worth getting one with a sensitivity of at least 10,000 ohms per volt. Very good value for money is the U4324, advertised in this magazine at £14.50 upwards, but adequate multimeters can be found at a few pounds less than this. They usually use 3V internal batteries for the ohms range and are not likely to damage any common diodes or transistors on any of the ohms ranges.

## Stage by Stage

Next, set all preset pots to mid travel, put a short circuit across R4 and disconnect: Tr1 collector, Tr2 base and collector, Tr3 collector, Tr4 base and emitter and the point P. Switch S2 to OFF. These moves have isolated the current limit circuit (Tr1, etc.) and divided the rest of the circuit up into sections so we can bring it into operation in stages. With experience you will get into the habit of *building* a circuit in stages and testing it again and again as each stage is added. Now switch on and check that there is approximately 18V across C1 and 36V across C2. (All voltages measured with the negative lead of the voltmeter on the negative lead of C5).

If only one of the voltages is correct, most likely the wiring or B1 is faulty. Before replacing the latter, remember it may have been damaged by a short-circuited C1 or C2, so check these as well. If neither voltage is there, the trouble may be the wiring, the fuse or T1. From now on, I won't keep saying "the wiring" every time when pointing out possible faults, but remember that if you are using good quality components from a reliable supplier, the wiring is always the most likely cause of trouble. If you are using salvaged components or gems from the junk box—well, good luck! Apart from costing you a lot of time, dud components can cost you money by burning out other good components.

## Safety

So now you've checked your "raw supplies" are present and correct, reconnect point P and check that there is approximately 26V across C3 and 16V across D1. **ALWAYS PULL OUT THE MAINS PLUG AND DISCHARGE C1 AND C2 THROUGH A 470Ω RESISTOR BEFORE WORKING ON THE UNIT.** Faults should be fairly obvious, e.g. 30V or so across D1—it's open circuit; just under 1V—it's in back to front! Having checked that the voltages are now right, measure the voltage across the track of VR3 and set it to 12.7V by adjusting VR2. Check that the voltage at the slider of VR3 can be adjusted from 0 to 12.7V. Reconnect the base of Tr2 and temporarily link its collector to point "c"—i.e. top end of R5. We have thus connected Tr2 as a straightforward emitter follower and adjusting VR3 should swing the voltage at Tr2 emitter from 0 to 12V. If it doesn't, it can only be wiring or components and our bit-by-bit approach has only added R9, Tr2 and R7 since the last stage.

## Progressing

So assuming you've surmounted that hurdle, remove the temporary connection from Tr2 collector and connect the collector to R6 as in Fig. 1. Also reconnect Tr3 collector to R10. You should now be able to vary Tr2 emitter voltage from 0 to 12V with

VR3 as before. Tr2 and Tr3 are now acting as a "complementary compound emitter follower". Sounds technical doesn't it? All it means is that Tr3 does most of the work, with Tr2 turning on just enough to provide sufficient base current to Tr3 to cause it to turn on and pull Tr2 emitter up to about 0.6V below the voltage at the slider of VR3. So Tr3 is supplying most of the current drawn by the load, which in this case consists just of R7 and your voltmeter.

If for any reason you aren't getting this negative feedback from Tr3 via R10—C4 short circuit or Tr3 open circuit for example—Tr2 emitter voltage might not quite make 12V because now all the load current will have to pass through R6. To make quite sure, temporarily put 2.7kΩ in parallel with R7—you should still be able to make 12V at Tr2 emitter.

Assuming all is well, reconnect Tr4 base and emitter. Now we have two d.c.-coupled complementary stages of amplification (Tr2 and Tr3) driving an emitter follower which provides 100 per cent negative feedback to the emitter of Tr2, and again we should be able to adjust the output from 0 to 12V with VR3. At this stage, we have only added a single component, Tr4, so if something is wrong now the answer is pretty obvious.

## Load Testing

Set the voltage at Tr2 emitter to 12V and connect a 100Ω resistor (at least 1½W rating) in parallel with the voltmeter. The output voltage as measured by the voltmeter should not change by more than the thickness of the pointer. With S1 open, remove the short from across R4 and reconnect Tr1 collector. Check that VR3 can set Tr2 emitter volts to 12V as before. Now on connecting 100Ω in parallel with the meter the output voltage should fall (set VR1 so that it falls to around 5V) but should return to 12V on closing S1. If this is not the case, one of the components in the current limit circuit, R3, S1, R4, VR1 or Tr1, is faulty. For example, output stuck at 0V—Tr1 collector-emitter short circuit. Now close S2 and check that 0 to 12V is available at the output terminals. We have now checked that everything is functional and it only remains to calibrate the unit as in the original article.

The principles of systematically getting a circuit going stage by stage are well illustrated by the above. If you are new to electronics or sometimes have problems getting a circuit to work, it would be well worth while studying the circuit of the original article in conjunction with the systematic approach described above, even if you have no intention of making up a Handy-Mini Power Supply. You will then grasp the principles and be able to apply them to repairing a transistor radio or getting a hi-fi amplifier to work, etc. Although the example given is a simple one, the principles are quite general and the more complex the circuit, the more important it is to divide it up and get it going stage by stage.

## Purbeck Oscilloscope

This approach is followed in the *PW* Purbeck now being published, and should allow any *PW* reader with an elementary knowledge of how transistors work and a little constructional experience to build a high-performance oscilloscope for a fraction of the cost of a comparable commercial instrument. ●

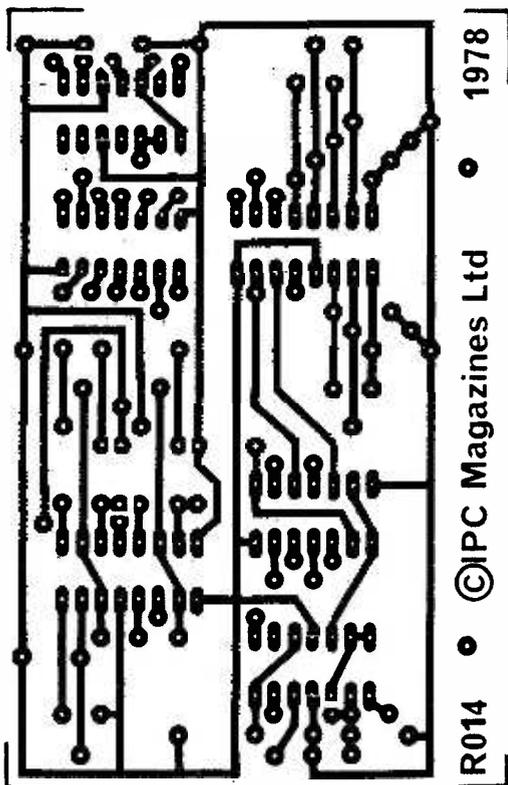
# Follow-up to morse tutor

A...B...C....

Although we try to take every reasonable precaution to ensure accuracy of presentation and technical efficiency in our constructional projects, it sometimes happens that circuit references turn out to be incorrect or the occasional instance of a reversed diode or capacitor causes universal consternation. When this happens, the editorial department attempts to publish a correction as soon as possible.

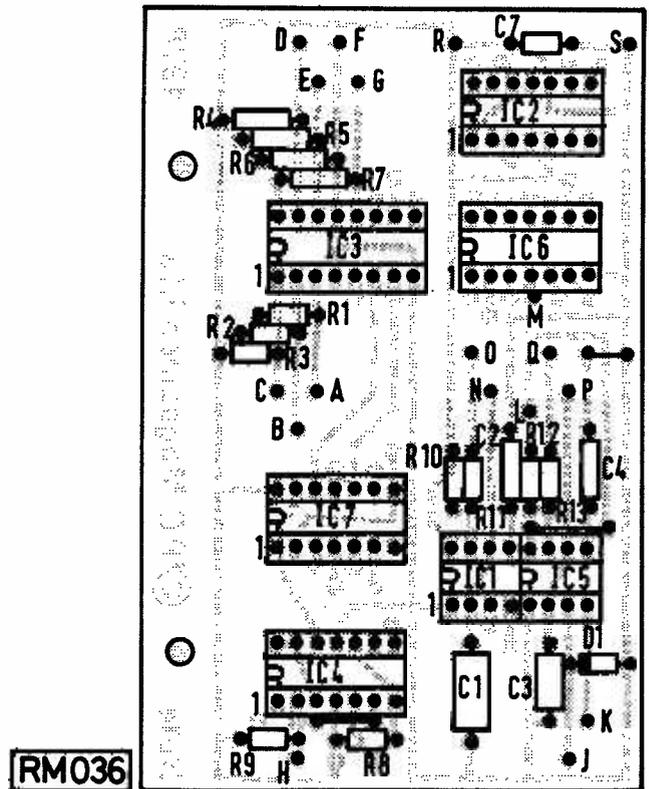
In the case of the Morse Tutor, of our August 1977 issue, the details have only just emerged of a divergence between the theoretical and practical instructions. The details are as follows:

The circuit diagram on p. 264 is correct except for the omission of the input B connection to IC2. This should be shown as pin 1. In the "Pin Connections" table on p. 266, "R" and "S" are reversed, i.e. "S" is the 0V terminal.



Copper track layout of the p.c.b.

1978  
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R014



Component layout of the Morse Tutor

The facts concerning the layout on Veroboard are not so simple. It appears that the component overlay relating to a p.c.b. layout was somehow confused with a Veroboard layout, resulting in the essential interconnections being lost. This refers to board A only, and the two remaining boards are correct. How the error arose is not clear, but was probably due to the major changes occurring at the time in the editorial team, with a retiring member handing over the half-formed details to his replacement, the fault probably appearing at the original artwork stage.

Whatever the facts, we have now prepared an accurate p.c.b. layout, complete with component overlay, to assist those who attempted this project. The new p.c.b. and the original code cards are available from Reader's PCB Service.

## NEW BOOKS

### THE SECRET WAR

by Brian Johnson

Published by the British Broadcasting Corporation,  
35 Marylebone High Street, London W1M 4AA  
352 pages, 243 × 170mm. Price £6.50

Those who have been fascinated by the recent BBC Television Series *The Secret War* will be enthralled by this book, which is based upon it, with some additional material. The earliest developments in radar and other radionavigational systems by both the combatants are described in some detail, with a wealth of photographs and drawings. In all, there are over 350 illustrations in the book, many of them previously unpublished.

GCA

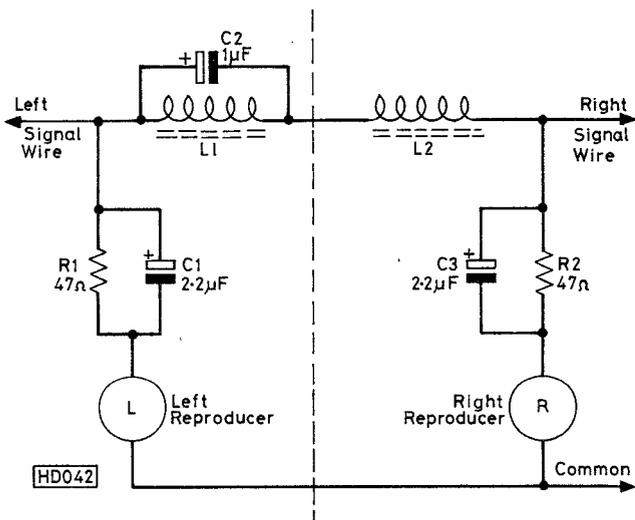
# Ideas DEPARTMENT

Some original circuit ideas provided by our readers. These designs have not been proved by us, and we cannot therefore guarantee their effectiveness. They should at least provide a basis for experimentation.

Why not send us your idea? If it is published, you will receive payment according to its merits. Articles submitted should follow the usual style of PW in circuit diagrams and the use of abbreviations. Diagrams should be clearly drawn on separate sheets, not included in the text.

Each idea should be accompanied by a declaration that it is the original work of the person submitting it, and that it has not been accepted for publication elsewhere.

## Stereo Headphone blender



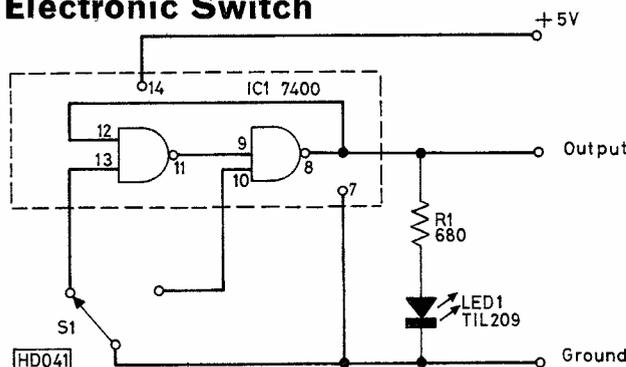
This circuit was developed to improve the stereo effect experienced when listening with stereo headphones. When listening with loudspeakers the stereo effect is produced by the interaction between the two speakers. With headphones, however, there is no such interaction and to obtain a realistic stereo image some form of blend circuit is needed.

The network of capacitors and inductors alters the amount of blend with frequency, the amount increasing at those frequencies which provide the main directional information.

The phones used for the prototype were of an inexpensive type which could be taken apart easily and the components were mounted inside the headphone bodies. The 10mH chokes used were Repanco type CH4 and the capacitors were of the tantalum variety. An extra wire was threaded through the headband to connect the right- and left-hand parts of the circuit. The original signal wires to the headsets need to be disconnected and the blend circuit inserted. R1, C1, C2 and L1 are mounted inside the left headphone and R2, C3 and L2 inside the right-hand one. The circuit can be used with all stereo headphones of 4 to 8Ω nominal impedance.

R. N. Soar,  
Mexborough, S. Yorks.

## Electronic Switch



When testing JK flip-flops it is unsatisfactory to use an ordinary switch connected to the clock input. This electronic switch uses a 7400 i.c. in an 'anti-bounce' circuit, with an l.e.d. to indicate a high or low output.

Connect a +5V supply to pin 14 and 0V (Ground) to pin 7. A 6V battery could be used. The unit is a bistable which does not change state when the switch is momentarily open circuit. The circuit can be constructed simply using Veroboard.

A. P. Cooper,  
Wimborne St. Giles, Dorset.



# Digital Lock

P. J. WHEELER

## Introduction

This is a design for an electronic lock which can replace the standard mechanical lock in many applications. It is impossible to "pick" as with a mechanical lock, and can have over 250,000 million different combinations, which will take all but the luckiest thief many hours to work through!

The lock can be used to disable a burglar alarm, taking the place of a mechanical key switch. Operation of the lock consists of depressing five keys on a keyboard in the correct sequence, the first key resetting the lock, and the other four keys providing the code.

The circuit can easily be extended with the addition of another i.c. and a few diodes to accept a nine digit code, which provides for extra security, although for most applications it is very tedious keying nine digits once the novelty has worn off, let alone trying to remember them! The operating code is programmed into the lock by the wiring between the keyboard and the p.c.b. and can easily be changed in the future.

The lock uses CMOS logic integrated circuits which have the advantage of negligible power consumption, thus continuous battery operation is quite feasible.

On the prototype, the quiescent current was about  $1\mu\text{A}$ , giving a battery life of well over 6 months. The output can be used to switch almost any solenoid, via a separate relay, if necessary, or can be used to disable a burglar alarm direct.

## Operation

The operation of the lock is dependent on a decoded decimal counter type CD4017. From the truth table for this device given in Fig. 1, it can be seen that for each clock pulse, the counter switches to another output in sequence. The circuit for the lock is shown in Fig. 2.

Each time a key is depressed, one of the diodes D1-D5 conducts and C1 charges through R2. When the voltage on C1 reaches the threshold voltage of IC1d, the output will go low, charging C2 through R3 thus producing a pulse of about 50ms duration at the output of IC1c. C1 and R2 delay the production of the pulse to eliminate any effects due to contact bounce in the keyboard switches.

The first key to be depressed can be any one of the keys connected to the "reset keys" input. Irrespective of the position of the counter, none of the keys will be gated to R4, therefore it will be at logic 0. The pulse

produced by depressing the key is therefore gated through IC1b to the reset input of IC3, which resets the counter. After a short delay due to R5 and C3, this pulse clocks the counter to output 1, enabling IC2c, which is an analogue switch. This sounds rather complex, but can be considered as an electronic relay.

When the control terminal is low, there is a very high resistance between the input and output (about  $10^{10}\Omega$ ), and is effectively an open switch. However, when the control terminal is high, the resistance between the input and output is about  $300\Omega$ , which is virtually a closed switch. Thus any voltage on pin 8 of IC2 will appear across R4 when the counter is at position 1. This effectively connects the first key of the code to R4, and if this key is depressed, pin 6 of IC1 will be at logic 1, and the pulse will be inhibited from the reset input of the counter by the action of the NOR gate IC1b. The clock pulse will still reach the counter and advance it to output 2. This enables the second key, and the process is repeated.

If the wrong key is depressed at any time, R4 will be at logic 0 and the counter will reset to its initial condition as described above. As the correct keys are

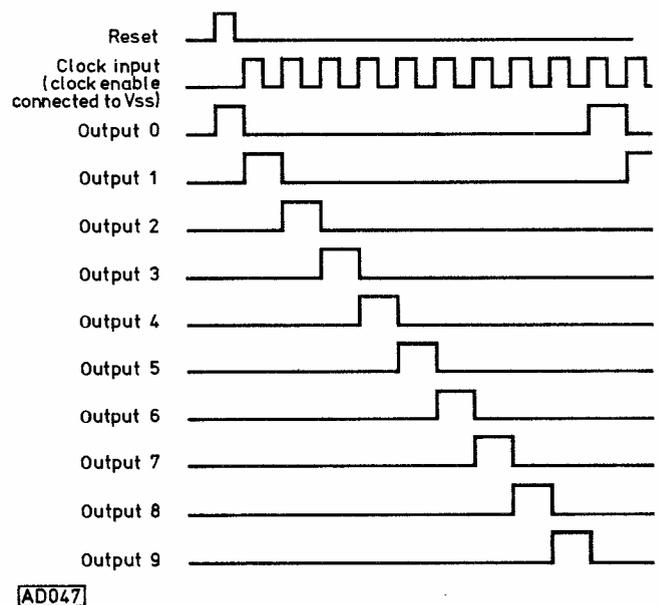


Fig. 1: Truth table for the CD4017 counter

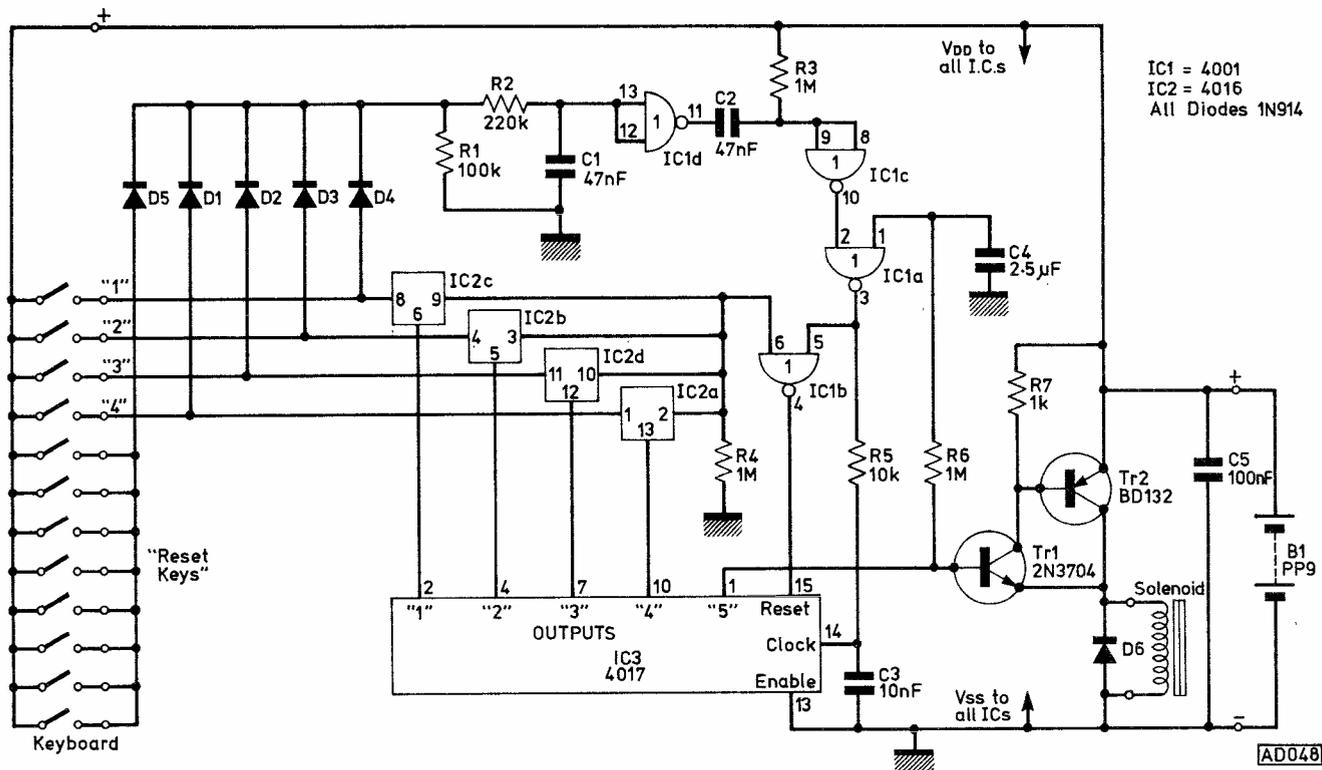


Fig. 2: Circuit diagram for the complete digital lock

depressed, the counter will increment to output 5, which will switch on the complementary output pair, Tr1 and Tr2. This energises the load, D6 providing protection against back e.m.f. from inductive loads. C4 also charges through R6, and after about  $2\frac{1}{2}$  seconds, the counter is reset to its initial condition via gate IC1a. C5 provides suppression of spikes that can appear on the supply line and interfere with the logic activity.

### Component Selection

Probably the most difficult item to obtain will be the calculator keyboard. This consists of 19 switches mounted on a p.c.b., which should be waterproof types, for use outdoors. These are dome type switches, operated by a thin piece of domed metal collapsing and making contact when pressure is applied.

This type of keyboard really needs a mounting frame and buttons, which are not readily available, however, the following method makes a presentable unit from this keyboard.

A small piece of white Fablon may be stuck over the entire front face of the unit, and Letraset numbers (or letters if you are hopeless at remembering numbers—the code can easily consist of an easily memorised word) put over the top of each dome.

The entire keyboard is then covered with a sheet of transparent self-adhesive plastic to protect the Letraset from rubbing off while in use. The keys can still be operated through the layers of plastic, and this makes the keyboard reasonably immune to cups of coffee being spilt over it!

Many types of calculator keyboard have the keys wired in a matrix arrangement, as opposed to one common rail and a lead to each switch. If this is the case, it will be necessary to remove the interconnecting tracks from the board, and rewire the unit.

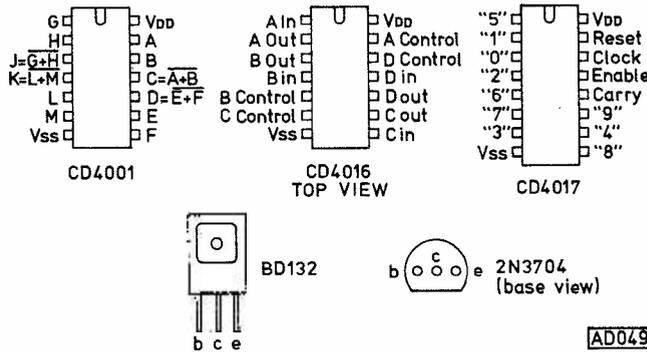
If a keyboard is available, with more than 12 keys, the remainder can be wired to the "reset keys" input on the p.c.b., thus effectively increasing the number of combinations available. Indeed as few as five keys could be used, with only one key connected to the "reset keys" input, the number of different combinations going down to a mere 3,125.

Solenoid selection can also be a problem. The lock will operate on any supply voltage between 4 and 15 volts, and the solenoid should be chosen to suit this.

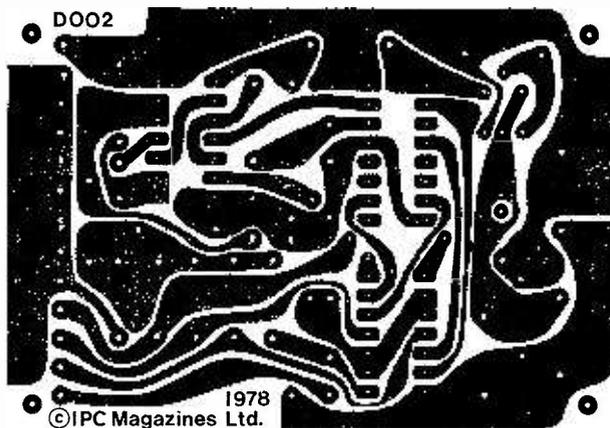
The other components are non-critical: almost any silicon diodes can be used, and most silicon transistors will suffice for the output stage, although the current rating of Tr2 should be well in excess of the load current of the solenoid.

### Construction

Most of the components are mounted on a p.c.b., the track and component layout being shown in Figs. 3 and 4 respectively. There are four links needed on the board, and these should be inserted first, followed



Connections to the integrated circuits and transistors



**Fig. 3 (above): PCB viewed from the copper side.** This board is available from the PW Reader's PCB Service

**Fig. 4 (above right): Component layout of the digital lock**

by the other components, leaving the integrated circuits until last, as they are easily damaged by static. The use of sockets is advised unless you have a properly earthed soldering iron. Tr2 is mounted with its metal face in contact with the board, with a short 6BA nut and bolt securing the transistor to the board. It is a good idea to connect fairly long wires from the keyboard to the p.c.b. as the code, and consequently the wiring, may need to be changed in the future. The load should not be connected yet, but if a spare l.e.d. is available, this can be connected across the load pins on the board with a 1kΩ series resistor for testing purposes.

## ★ components

### Resistors

- R1 100kΩ
- R2 220kΩ
- R3 1MΩ
- R4 1MΩ
- R5 10kΩ
- R6 1MΩ
- R7 1kΩ
- All ½W 5%

### Capacitors

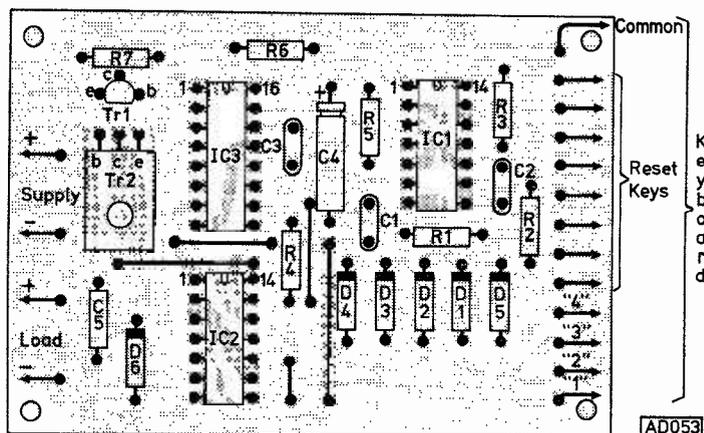
- C1 47nF Ceramic
- C2 47nF Ceramic
- C3 10nF Ceramic
- C4 2.5μF Electrolytic (16V)
- C5 100nF Ceramic

### Semiconductors

- D1-D6 1N914, 1N4148
- Tr1 2N3704
- Tr2 BD132
- IC1 CD4001AE or MC14001CP
- IC2 CD4016AE or MC14016CP
- IC3 CD4017AE or MC14017CP

### Other Components

- 2 off 14 pin DIL sockets
- 1 off 16 pin DIL socket
- Keyboard (see text)
- Solenoid (see text)
- PP9 Battery and Connector
- Printed Circuit Board



## Testing

If the lock does not work, connect a voltmeter between pin 10 and IC1 and earth. Each time a key is pressed, the voltmeter should give a short positive "kick" and then return to zero. This should be checked for all the keys, and they must work every time if the lock is to be reliable.

If that does not identify the problem, connect a voltmeter across R4. The meter should read almost supply volts while the correct keys are pressed. When the lock is working, connect the supply direct to the board, and the load across the output. After further checking, the digital lock can be installed.

## Possible Modifications

If a nine digit code is required, an extra CD4016 can be wired to switch 4 more keys to R4, controlled from outputs 5-8 of IC3. The output stage is taken from output 9 of IC3. Remember to include a diode from each extra key to R1, so that these keys produce a clocking pulse to operate the circuit.

If the lock is to be used with a burglar alarm, a relay can be used to disable the alarm, and the output stage can be made to stay on until another key is pressed by removing R6 and replacing C4 with a link.

However, the current drawn when the relay is on for long periods will probably be too high for economical battery operation, therefore the lock could draw its supply from a mains operated power supply, or from the burglar alarm itself.

If the load is to be switched on for other periods the values of R6 and C4 can be altered, the time the load is on being approximately given by  $T = R6 \times C4$ . R6 can be increased up to about 10MΩ, but if an electrolytic capacitor is used for C4, R6 should not be increased above 4.7MΩ, due to leakage current in the capacitor causing large timing errors. Care should be taken to prevent voltage spikes greater than 15V reaching the CMOS, since they can cause irreparable damage.

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PRACTICAL WIRELESS  
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## Notes on the Jubilee Organ project

Although the Jubilee Organ has undoubtedly emerged as very popular, in the time which has elapsed since its final part was published in our January 1978 issue, certain points have arisen which could cause some confusion. In order to dispose of these details, the following notes are provided as a complete list of published corrections, along with suggested modifications.

### General Constructional Corrections:

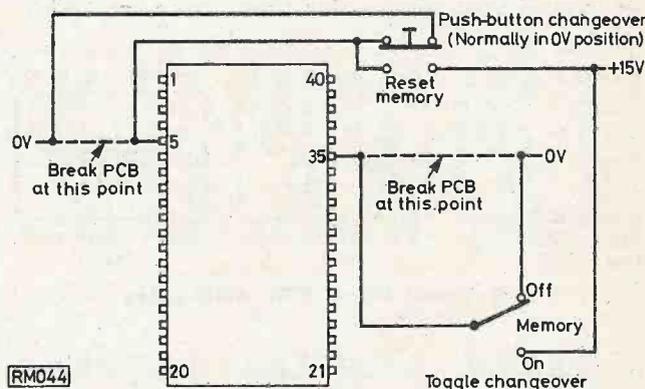
- (1) September 1977, p 353. Transistor BFY71 should read BCY71.
- (2) November 1977, p 509. The circuit diagram of the accompaniment section shows the base of Tr5 connected to the 12V positive rail. This connection should be broken, leaving the base of Tr5 connected to the free end of R44 (1M $\Omega$ ) only. The p.c.b. provided via Reader's PCB Services is correct.  
The end of R45, shown connected to the 12V positive rail, should be connected to the junction of R40 and C17. Again, the recommended p.c.b. is correct.
- (3) The collated components list, September 1977 p 353, contains the information "3-off 33nF". This should read "3-off 3.3nF Polystyrene".

### Operational and Setting-Up Instructions:

November 1977, p 506—in describing the interim keying tests, a mistake was made in the text. When the flying lead is connected to the +12V point (positive end of C8) the note is inhibited. It is when the lead is removed from this point that the note will sound, and it is under this condition that VR5 should be adjusted. Re-applying the 12V will terminate the tone according to the sustain setting of VR6. When S2 is open the tone burst will occur when the flying lead is removed from the 12V point. The same reversed logic would apply to testing the repeat percussion effect.

Our "Postscript" in the final part of the article (January 1978) gave details of a modification to enable major chords to be memorised, thereby intro-

ducing a continuous "vamp" facility. The fact that no drawings accompanied the text seems to have caused considerable confusion, so in order to illuminate the situation, the relevant diagram, showing the necessary switching, is now provided for reference.



Circuit diagram of the Major Chords Memory modification

As published originally, the text could be misleading, and should have said that to enable the memory, pin 35 of IC13 should be connected to +15V, while pin 5 should normally be at 0V, but momentarily connected to +15V via the push-button changeover when the memory is to be reset. This will cancel any previously selected chord.

### Suggested Modifications

Manfred Pfeifer of Bristol suggests in a letter to the author the following swell pedal modification:

"The volume is controlled by a foot operated pedal, linked via a l.d.r. To maintain a suitable range, the l.d.r. (ORP12) is connected in series with a 16 $\mu$ F capacitor, and then wired in parallel with R92. A small bell transformer supplies 5V a.c. to provide a light source for the l.d.r."

Another constructor, Lorin Knight, of Letchworth, suggests some further improvements. He has included three extra stops (one for future use), with one used for continuous rhythm as already described, and one used as an additional percussion stop for the melody. C12 is shunted with a 47k $\Omega$  preset and an extra 4.7 $\mu$ F. The preset is adjusted so that the amplitude only drops 6-10dB after the percussive attack, giving rise to a gradually "flattening" envelope shape, similar to that of a piano.

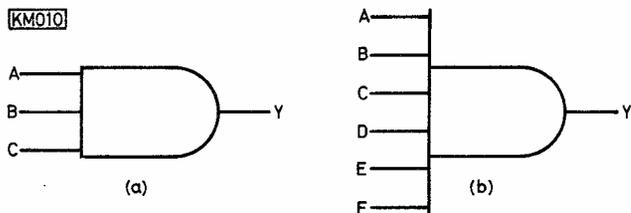


Fig. 5: AND gate symbols

### Practical Gate Devices

Let's now take a look at some of the actual AND gates available in integrated circuits.

In 74-series TTL the most commonly met AND gate is likely to be the 7408, which contains four separate 2-input AND gates in one package. Other types are the 7411 which has three 3-input AND gates, and the 7421 which is a dual 4-input AND gate. The function and pin connections for these types are shown in Fig. 6.

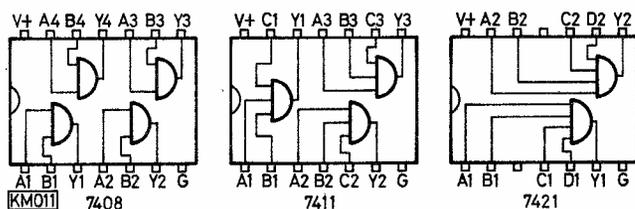


Fig. 6: Some actual TTL AND gates

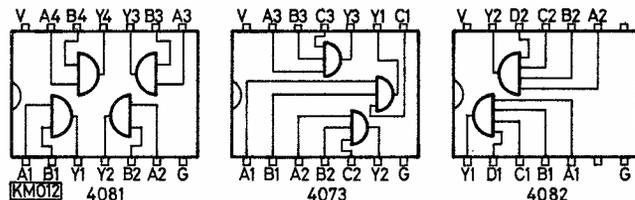


Fig. 7: Some actual CMOS AND gates

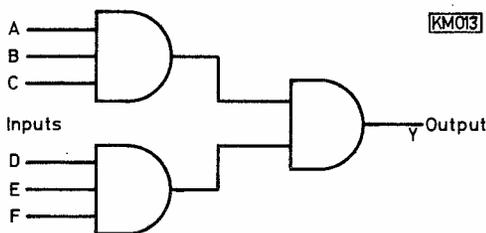


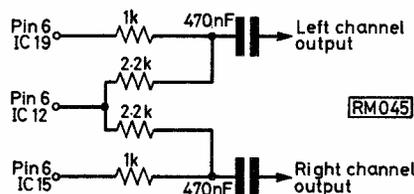
Fig. 8: Cascading AND gates to provide more inputs

The 4081 in the CMOS series provides the same logic functions as a 7408 but the pin layout is different. Other gates in the CMOS series are the 4073 triple 3-input AND gates and the 4082 which contains two 4-input AND gates. Fig. 7 shows the pin connections and functions of these CMOS devices.

If we wanted a 6-input AND gate this could be made up by using two 3-input gates feeding into a 2-input gate to form a cascaded tree of gates as shown in Fig. 8. This principle could be extended to give any number of inputs if desired.

Next month we shall look at some of the other types of gate circuit used in logic systems.

He also suggests modification of the DIN output socket, to introduce stereo effect. This gives drums to the left, melody centre, and accompaniment to the right.



Circuit diagram for Stereo Effect modification

Several readers have requested detailed cutting and drilling instructions for alternative keyboard versions. It was felt that in cases where the calculator keyboard was not opted for, general details for other types would necessitate a proliferation of differing instructions. Aside from this confusion, the conventional keyboard, for which we had approximate constructional details, appeared to be in limited supply (very limited supply as it eventually proved), and so we decided to confine our constructional notes to the details for the calculator version in general, and the initial measurements for the front and back panels. This was considered enough to cover the bare essentials, and the majority of constructors seem to have come to terms with this problem.

## KINDLY NOTE!

Bovington Tank Battle Game, June, page 38

The coil winding details for this project were inadvertently omitted from the components list. L1 80 turns 40 s.w.g. enam. copper wire on 6mm dia. former with dust core. L2 3 turns 22 s.w.g. tinned copper wire 6mm dia. x 8mm long air-spaced, tapped 3/4 turn from top.

Tr1 should be a BC108.

C24 should be connected to the tap on L2, not as shown in the circuit diagram (the printed circuit board is correct).

A small section of track is missing from the p.c.b. copper track pattern shown in the article. To overcome this a thin wire link should be used to connect together the pads for the +ve ends of C12 and C13. Solder this link onto the copper track side.

D3 to D12 are type IN4148.

R32 is selected according to type of indicator used. (Shown in Fig. 7.)

# μ-DeCnology

DAVID GIBSON

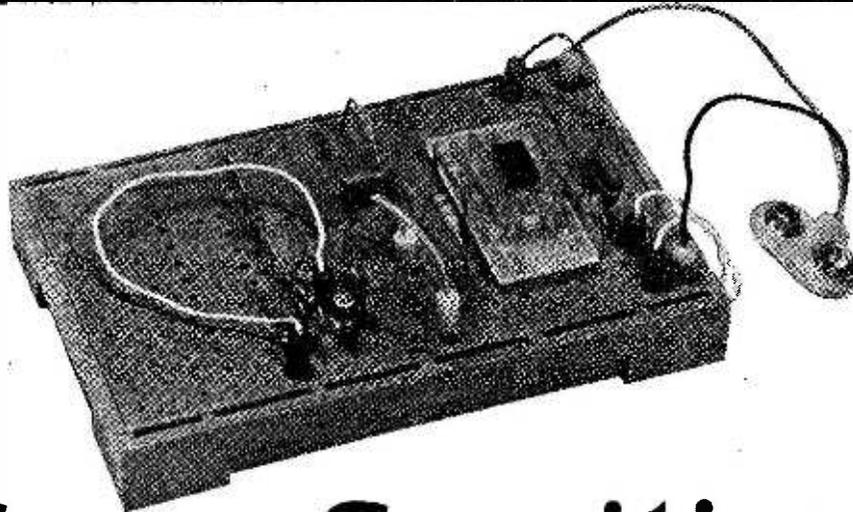
4



THIS MONTH



## 'Super Sensitive Fuzz'



In recent years "fuzz boxes" have been rife on the pop scene particularly with regard to guitars. The idea seems to be that one uses a fuzz box to make a guitar not sound like a guitar!

This month's μDeCnology circuit shows a very simple circuit for obtaining a fuzz effect. It is very sensitive and can be used to fuzz sound direct from a microphone or even a record player.

The commonest approach to fuzzing involves taking a luckless sine wave, chopping the tops or peaks off (known by the purists as "squaring"), and then amplifying the resultant noise with an ordinary audio amplifier.

We are cheating a little with our circuit by simply using the very high gain of the 741 op. amp. with no

negative feedback. To increase the sensitivity still further, an extra stage of preamplification has been added by using a BC107 transistor. This preamp stage is also very simple, being reduced to a bare minimum of components.

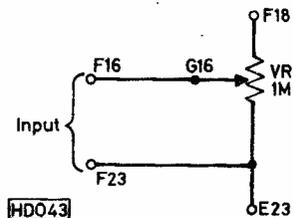
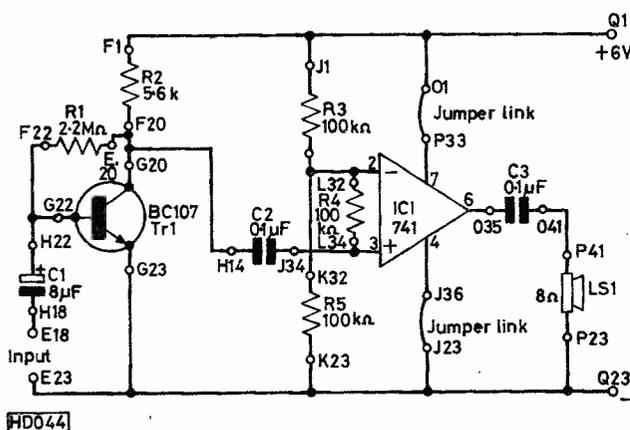


Fig 2: Connections and hole numbers for the inclusion of a suitable volume control



HDO44

Fig 1: Main circuit diagram including preamplifier

When you have "plugged" the components into your μDeC by their own leads (see Fig. 1) you should connect 6V to holes Q1(+) Q23(-). The input is connected to holes F22 and E23. On test it was found that almost any microphone would work well and give a horrendously fuzzed voice output. Those tried included a cheap crystal insert, a commercial crystal microphone, a magnetic type (some 300Ω impedance), and a small loudspeaker. Even small earpieces were tried and found to work.

Six volts proved ample for good sensitivity. Increasing this to 12V made the circuit super sensitive and if this is done there is a good chance of positive feedback which will make the circuit oscillate. In a permanent form, one could transfer the components from μDeC to Blob Board and then put the Blob Board in a metal case thus screening the circuitry from both the output loudspeaker and the microphone. This should prevent instability and make a useful fuzz box which could be used in many applications. For example, as a party game or at a disco, records could be announced with fuzz in followed by the record. Alternatively, the participants might be

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2N929 0-37	2N3417 0-25	2N4082 0-20	2N5045 0-37	AF106 0-60	BC182L 0-15	AY-3-8500	CA3062 3.75	LM341P248 80	LM923 0-50	LM78L05CZ	SN76018KE
2N930 0-37	2N3439 0-85	2N4121 0-27	2N5048 0-44	AF109 0-82	BC183A 0-12	6-50	CA3064 1-10	LM348N 0-95	LM1303N 1-15	LM78L12CZ	SN76023N1-50
2N1131 0-32	2N3441 0-92	2N4122 0-27	2N5093 0-44	AF114 0-70	BC183LA 0-15	CA3000 3-30	CA3065 1-10	LM358N 0-60	LM1304N 1-52	LM78L15CZ	SN76033N2 1-30
2N1303 0-80	2N3442 1-45	2N4123 0-19	2N5094 0-44	AF115 0-70	AC184 0-12	CA3001 4-25	CA3068 3-80	LM360N 3-00	LM1305N 1-52	0-30	SN76023ND 1-30
2N1305 0-80	2N3565 0-25	2N4124 0-19	2N5401 0-44	AF118 0-70	BC184L 0-15	CA3002 3-30	CA3070 1-90	LM370N 3-30	LM1307N 1-22	0-30	SN76033N2 1-30
2N1501 0-35	2N3566 0-25	2N4125 0-19	2N5416 1-65	AF124 0-70	BC205 0-17	CA3005 2-50	CA3071 1-90	LM371H 2-35	LM1310N 2-10	0-30	SN76110N1 30
2N1613 0-30	2N3567 0-25	2N4126 0-19	2N5447 0-16	AF139 0-75	BC212A 0-15	CA3006 4-60	CA3072 1-90	LM350K 6-45	LM1351N 1-30	0-30	SN76115N1 85
2N1637 0-72	2N3639 0-38	2N4235 1-35	2N5448 0-16	AF201 1-30	BC212L 0-18	CA3007 4-15	CA3075 1-70	LM373N 3-35	LM1458N 0-45	0-30	SN76116N1 80
2N1890 0-30	2N3639 0-38	2N4236 1-65	2N5449 0-20	AF201 1-30	BC213B 0-15	CA3008 2-50	CA3076 2-12	LM374N 3-35	LM1498N 1-97	0-30	SN76131N1 30
2N1893 0-30	2N3644 0-40	2N4237 1-65	2N5457 0-35	AF239 0-70	BC213LA 0-17	CA3012 1-65	CA3080 1-85	LM377N 2-80	LM1820N 1-16	0-30	SN76226N1 66
2N1991 1-10	2N3662 0-25	2N4240 1-70	2N5458 0-35	AF240 1-25	BC214 0-17	CA3013 1-85	CA3080A 2-10	LM378N 2-40	LM1820N 1-16	0-30	SN76227N1 30
2N2193 0-40	2N3663 0-29	2N4250 0-26	2N5555 0-65	AF279 0-88	BC214L 0-18	CA3014 2-20	CA3086 0-50	LM379S 4-25	LM1820N 1-16	0-30	SN76228N1 55
2N2194 0-42	2N3702 0-14	2N4266 0-32	2N6109 0-55	AF290 0-95	BC237B 0-15	CA3018 0-75	CA3088 1-87	LM380N 0-96	LM1828N 1-90	0-30	SN76228N1 55
2N2217 0-55	2N3703 0-14	2N4284 0-38	2N6122 0-44	ASV28 1-30	BC238B 0-13	CA3018A 1-10	CA3089 2-90	LM380N 0-96	LM1830N 1-90	0-30	SN76531N1 82
2N2219 0-35	2N3704 0-14	2N4286 0-32	2N6123 0-48	ASV55 0-79	BC239C 0-17	CA3020 2-20	CA3090 4-40	LM380N141 08	LM1830N 1-90	0-30	SN76532N1 55
2N2219 0-38	2N3705 0-14	2N4287 0-22	2N6124 0-45	BC107 0-16	BC256A 0-29	CA3020A 2-50	CA3130 1-96	LM381AN 2-70	LM1841N 1-90	0-30	SN76533N1 30
2N2221 0-25	2N3706 0-14	2N4288 0-22	2N6125 0-47	BC108 0-16	BC257A 0-18	CA3021 2-40	CA3140 1-04	LM381N 1-69	LM1845N 1-50	0-30	SN76544N1 60
2N2222 0-25	2N3707 0-14	2N4292 0-27	2N6288 0-50	BC109 0-16	BC258B 0-24	CA3022 2-20	LOBST1 2-25	LM382N 1-32	LM1848N 1-98	0-30	SN76545N1 80
2N2270 0-49	2N3708 0-12	2N4302 0-31	2S702 3-30	BC112 0-22	BC259B 0-19	CA3023 2-20	LM114H 2-75	LM386N 0-85	LM1850N 1-90	0-30	SN76546N1 58
2N2368 0-27	2N3709 0-12	2N4303 0-33	2S703 3-95	BC114 0-22	BC261A 0-25	CA3026 0-80	LM301AH 0-50	LM387N 1-10	LM1859N 4-90	0-30	SN76550-2
2N2369 0-27	2N3711 0-12	2N4341 0-60	40232 0-60	BC115 0-22	BC262B 0-26	CA3028A 0-90	LM304 2-60	LM388N 1-00	LM1859N 4-90	0-30	SN76550-2
2N2483 0-30	2N3711 0-12	2N4342 0-60	40311 0-55	BC116 0-22	BC263B 0-26	CA3029 0-75	LM307N 0-50	LM388N 1-00	LM1859N 4-90	0-30	SN76552-2
2N2613 0-90	2N3712 1-39	2N4401 0-20	40316 0-95	BC118 0-22	BC264B 0-65	CA3029 0-75	LM307N 0-50	LM389N 1-00	LM1859N 4-90	0-30	SN76552-2
2N2646 0-80	2N3714 1-55	2N4402 0-20	40363 1-45	BC135 0-22	BC307B 0-16	CA3029A 0-90	LM308H 1-20	LM3555CH 0-38	LM1859N 4-90	0-30	SN76570N1 80
2N2848 1-10	2N3716 1-70	2N4422 0-83	40389 0-70	BC136 0-22	BC308B 0-16	CA3033 1-50	LM308N 0-45	LM5655CN 1-39	LM3301N 0-60	0-30	SN76620AN 0-99
2N2904 0-31	2N3794 0-21	2N4870L 0-58	40408 0-82	BC137 0-22	BC309C 0-16	CA3030A 2-20	LM309K C1 95	LM731B 2-99	LM3302N 0-58	0-30	SN76620AN 0-99
2N2905 0-31	2N3819 0-36	2N4871L 0-51	40440 0-70	BC138 0-44	BC327 0-22	CA3033 3-70	LM317K 3-35	LM7374N 2-99	LM3401N 3-55	0-30	SN76650N1-20
2N2906 0-25	2N3820 0-39	2N4871L 0-51	40512 1-70	BC140 0-30	BC328B 0-26	CA3034 3-75	LM319N 2-15	LM702C 0-81	LM3900N 0-68	0-30	SN76660N 66
2N2907 0-25	2N3821 0-95	2N4999 1-55	40594 0-87	BC141 0-32	BC337 0-20	CA3035 1-95	LM320T5 2-15	LM703LN 1-15	LM3905N 1-15	0-30	SN76660N 93
2N2923 0-17	2N3827 0-27	2N4901 1-65	40595 0-98	BC142 0-32	BC414 0-17	CA3036 1-21	LM320T122-15	LM703 0-70	LM3909N 0-78	0-30	SN76660N 93
2N2924 0-17	2N3854A 0-30	2N4902 2-20	40673 0-80	BC147 0-13	BC415 0-16	CA3038 2-90	LM320T152-15	LM709-8 0-50	LM3911N 1-10	0-30	SN76660N 93
2N2925 0-19	2N3855 0-30	2N4904 1-85	AC126 0-48	BC148 0-15	BC416 0-17	CA3038A 4-10	LM320T242-15	LM709-14 0-49	LM4250CN	0-30	SN76660N 93
2N3011 0-37	2N3856A 0-19	2N4905 2-40	AC127 0-48	BC149 0-15	BC417 0-13	CA3039 0-77	LM320MP5	LM710 0-67	LM4250CN	0-30	SN76660N 93
2N3020 0-75	2N3857 0-20	2N4905 2-40	AC128 0-48	BC150 0-30	BC418 0-13	CA3040 3-75	LM320MP12	LM710-14 0-64	LM4250CN	0-30	SN76660N 93
2N3063 0-25	2N3859A 0-22	2N4920 0-83	AC151 0-43	BC154 0-30	BC419 0-13	CA3041 1-65	LM320MP12	LM711CN 0-72	LM4250CN	0-30	SN76660N 93
2N3054 0-72	2N3860 0-18	2N5086 0-30	AC152 0-54	BC157A 0-15	BC459B 0-14	CA3042 1-65	LM320MP15	LM723C 0-75	LM4250CN	0-30	SN76660N 93
2N3055 0-75	2N3866 1-98	2N5087 0-30	AC153 0-59	BC158B 0-15	BC558 0-13	CA3043 2-20	LM320MP15	LM723C-14 0-85	LM4250CN	0-30	SN76660N 93
2N3108 0-75	2N3901 0-30	2N5088 0-30	AC153K 0-59	BC159B 0-17	BC559 0-15	CA3045 1-58	LM320MP24	LM726 0-45	LM4250CN	0-30	SN76660N 93
2N3133 0-50	2N3904 0-18	2N5089 0-30	AC176 0-54	BC160 0-38	BC559A 2-40	CA3046 0-77	LM320MP24	LM726 5-80	LM4250CN	0-30	SN76660N 93
2N3242 0-68	2N3905 0-18	2N5129 0-82	AC176K 0-90	BC167B 0-13	BC596 0-27	CA3047 2-20	LM329K 1-15	LM741C 0-70	LM4250CN	0-30	SN76660N 93
2N3250 0-50	2N3906 0-18	2N5130 0-22	AC187 0-59	BC168B 0-13	BC597 0-21	CA3047A 3-70	LM329K 6-95	LM741C-8 0-30	LM4250CN	0-30	SN76660N 93
2N3301 0-45	2N3962 0-85	2N5131 0-22	AC187K 0-65	BC169 0-13	BC597 0-21	CA3048 2-45	LM339N 0-60	LM741C740 30	LM4250CN	0-30	SN76660N 93
2N3302 0-39	2N4031 0-55	2N5137 0-22	AC188 0-54	BC170B 0-19	BC597 0-21	CA3049 1-96	LM340T5 0-88	LM747CN 0-99	LM4250CN	0-30	SN76660N 93
2N3392 0-17	2N4032 0-65	2N5143 0-22	AC188K 0-65	BC171B 0-17	BC597 0-21	CA3050 2-88	LM340T120-88	LM748-8 0-50	LM4250CN	0-30	SN76660N 93
2N3394 0-17	2N4033 0-65	2N5180 0-58	AC177 1-00	BC172C 0-15	BD121 2-20	CA3051 1-83	LM340T150 88	LM748-14 0-50	LM4250CN	0-30	SN76660N 93
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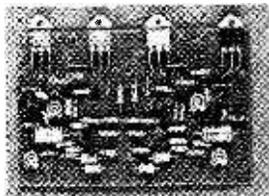
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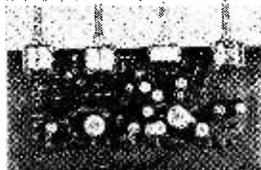
- ★ Class AB Operation
- ★ 16 Transistor Circuit
- ★ Unstabilised supply required
- ★ Tip 34A + Tip 33A Output
- ★ Supply Voltage 50V DC nominal
- ★ 30 Hz—18KHz @ -1dB
- ★ Output 8 ohm
- ★ Input 50 Kohm



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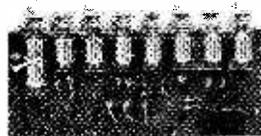


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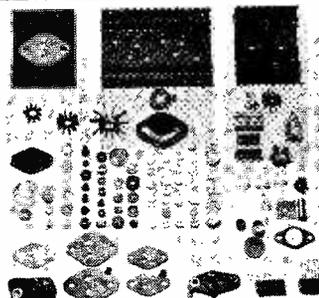
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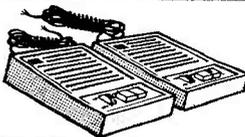
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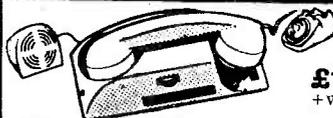
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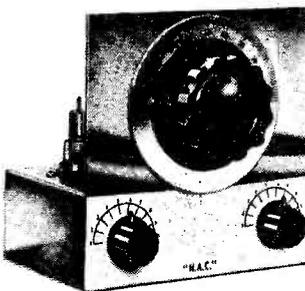
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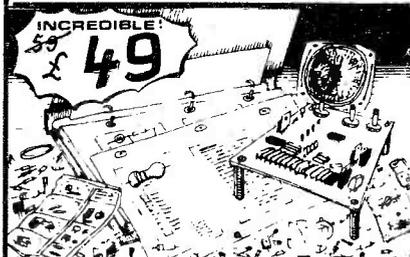
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TIL117	MINITRON 5015F	DPDT Biased	115
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		4 pole 2-way	24
		<b>PUSH BUTTON</b>	
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		Latching	
		SPST on/off	60
		SPDT C/over	65
		DPDT 6 Tag	85
		<b>MINIATURE</b>	
		Non Locking	15
		Push to make	25
		Push Break	25
		<b>ROCKER: (Black)</b>	
		on/off 10A 250V 23	
		<b>ROCKER: (white)</b>	
		5A 250V SP change-over centre off	30
		<b>ROCKER: (Illuminated, red)</b>	
		Chrome Bezel 5A 250V SP	52
		<b>ROTARY: "Make-A-Switch"</b>	
		Make your own multiway Switch. Adjustable Stop Shuffling Assembly. Accommodates up to 6 Wafers	69
		Mains Switch DPST to fit	34
		Break Before Make Wafers, 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way	47
		Spacer and Screen	5
		<b>ROTARY: (Adjustable Stop)</b>	
		1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way	41
		<b>ROTARY: Mains 250V AC, 4 Amp</b>	45
		<b>PW PROJECTS</b>	
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# INDEX TO ADVERTISERS

A.D.E. Security ... .. 75	G.C.H.O. ... .. 84	Radio Book Services ... .. 82
A. H. Supplies ... .. 2	G.T. Information Service ... .. 8	Radio Components Specialists ... cover III
Alben Engineering ... .. 2	Greenwell Electronics ... .. 83	Radio Exchange Ltd. ... .. 3
Amateur Radio ... .. 78	H.A.C. Short-Wave Supplies ... .. 85	Ramar Constructor Services ... .. 83
Ambic International ... .. 12	Harversons... .. 4	Reed Hampton ... .. 78
Bamber B. ... .. 12	H.M. Electronics ... .. 83	R.S.C. (Hi-Fi) ... .. 76
Barrie Electronics ... .. 73	Heathkit ... .. 63	R.S.G.B. ... .. 88
B. B. Supplies ... .. 84	Home Radio ... .. 73	R.S.T. Valve Mail Order Co. ... .. 79
Bentley Acoustic Corpn. ... .. 74	I.L.P. Electronics Ltd. ... .. 7, 13	Radio & T.V. Components Ltd. ... .. 64
Bib Hi-Fi Limited ... .. 80	Intertext ICS ... .. 15	Saga Ltd. ... .. 85
Bi-Pak Ltd. ... .. 18, 19	Jones Supplies ... .. 10	Salop Electronics ... .. 83
Birkett, J. ... .. 4	K. & A. Distributors ... .. 82	Sandwell Plant Ltd. ... .. 84
British National Radio & Electronics School ... .. 5, 16	Kramer & Co. ... .. 80	Science of Cambridge ... .. 68
J. Bull (Electrical) Ltd. ... .. 9	Lambda ... .. 83	Scientific Wire Co. The ... .. 83
Cambridge Kits ... .. 83	Lynx Electronics ... .. 15	Selray Book Co. ... .. 14
Caranna C. ... .. 83	Mail Sales ... .. 88	Seltronics ... .. 82
Chromasonics ... .. 6	Mainline ... .. 11	Sentinel Supplies ... .. 14
Chromatronics ... .. 81	Manor Supplies ... .. 75	Sonic (Hi-Fi) ... .. 85
Colomor ... .. 15	Maplin Electronic Supplies ... cover IV	Sonic Sound Audio ... .. 2
Continental Specialists ... .. 67	Marco Trading ... .. 63	Southern Valve Co. ... .. 76
Copper Supplies ... .. 84	Marshall A. (London) Ltd. ... .. 77	S.T.E. Ltd. ... .. 82
Cox Radio (Sussex) Ltd. ... .. 82	Minikits Electronics ... .. 83	Stirling Sound ... .. 73
Crescent Radio ... .. 12	Monolith ... .. 76	Swanley Electronics ... .. 4
C. R. Supply Co. ... .. 82	Moulded Electronics ... .. 78	T.D. Components ... .. 82
C. T. Electronics ... .. 17	Nicholls E. R. ... .. 74	Technomatic Ltd. ... .. 16
C.W.A.S. ... .. 83	O.K. Machine & Tool (U.K.) Ltd. ... .. 75	Teleradio ... .. 88
Doram Electronics ... .. 75	Partridge Electronics Ltd. ... .. 8	Tempus ... .. 6
Eldun Electronics ... .. 83	P.B. Electronics ... .. 76	The Trading Post ... .. 77
Electronic Design Associates ... .. 14	Powell T. ... .. cover II	T.K. Electronics ... .. 82
Electronic Supplies ... .. 74	Precision Petite ... .. 77	Trampus ... .. 80
Electrovalue ... .. 16	Progressive Radio ... .. 80	Van Karen Publishing ... .. 82
Fidelity Fastenings ... .. 10		Watford Electronics ... .. 86, 87
Flairline Supplies ... .. 74		West London Direct Supplies ... .. 85
		Williams, Michael ... .. 10
		Williamson Amplification ... .. 83
		Wilmslow Audio ... .. 6
		Z & I Aero Services ... .. 88

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## BAKER SPEAKERS "BIG SOUND"

Robustly constructed to stand up to long periods of electronic power. As used by leading groups.

Useful response 30-13,000 cps. Bass resonance 55 cps.

### GROUP "25"

12in. 30 watt 4, 8 or 16 ohms.

£12.00

Post £1

### GROUP "35"

12in. 40 watt 4, 8 or 16 ohms.

£14.00

Post £1

### GROUP "50/12"

12in. 60 watt professional model 4, 8 or 16 ohms

£21.00

Post £1.60

Response = 30 - 18,000 cps. With aluminium pressure dome.

### GROUP "50/15"

15in. 75 watt 8 or 16 ohms.

£26.00

Post £1.60

Send for leaflets on Disco, P.A. and Group Gear.

## BAKER 150 WATT QUALITY TRANSISTOR MIXER/AMPLIFIER



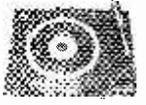
Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4-8-16 ohm. Slave output. A/C mains. Guaranteed. Distels S.A.E. £75 Carr. £1.60

## 100 WATT DISCO AMPLIFIER

MADE BY JENNINGS MUSICAL INSTRUMENTS 4 Speaker outputs volume, treble, bass, controls CAN BE USED AS 100 WATT SLAVE £59 Carr. £1

## B.S.R. SINGLE PLAYER DECK

3 speed. Plays all size records. Stereo Cartridge. Cueing device. Ideal Disco Deck.



£17.50 Post £1.00

## DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Will control up to 500 watts AC mains. Post 35p £3.25

STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high medium or low gain per channel, with volume control and F.C. Board. Can be changed to make multi-way stereo mixers. Post 35p £2.95

## R.C.S. SOUND TO LIGHT DISPLAY MK 2

Complete kit of parts with R.C.S. printed circuit. Three channels. 600 to 1,000 watts each. Will operate from 200V to 100 watts signal source. Suitable for home use. Cabinet extra £4. £17

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw Fitting 75p. Each.

## MAINS TRANSFORMERS Post 60p

6 VOLT 1 AMP. £1.00 3 AMP. £1.95 9 VOLT 3 AMP. £2.75  
12 VOLT 800 MA. £1.00 750 MA. £1.30  
30 VOLT 5 AMP. AND 24 VOLT 2 AMP. C.T. £3.45  
230 VOLT 1 AMP. £2.00 20-0-20 VOLT 1 AMP. £2.95  
30 VOLT 1 AMP. £2.50 40 VOLT 2 AMP. £2.95  
0-20-40-60 VOLT 1 AMP. £3.50 2 x 18 VOLT 6 AMP. £9.  
GENERAL PURPOSE LOW VOLTAGE. Voltages available at 2A, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £2.30  
1A, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £2.30  
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £2.50  
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11.00  
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £14.50

## R.C.S. TEAK BOOKSHELF SPEAKERS

18 x 10 x 6in. 60 to 14,000 cps. 12 watts rms. 8 ohms

£19 pair Post £1.50

## BAKER DISCO SPEAKERS HIGH QUALITY - BRITISH MADE 2 x 12" CABINETS

for Disco or PA all fitted with carrying handles and corners. Black vinyl covered. Other cabinets in stock. SAE for leaflet

### 60 WATT R.M.S. £52

With one horn £60

With two horns £68 Carr. £3

### 80 WATT R.M.S. £56

With one horn £64

With two horns £72 Carr. £3

### 100 WATT R.M.S. £69

With one horn £78

With two horns £86 Carr. £3

SINGLE 12inch CABS COMPLETE  
30 WATT R.M.S. £32. WITH HORN £40.  
40 WATT R.M.S. £34. WITH HORN £42.  
60 WATT R.M.S. £41. WITH HORN £49.  
CARR £3 EA.

## "SUPERB HI-FI"

### 12in 25 watts

A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance 25cps  
Flux Density 16,500 gauss  
Useful response 20-17,000cps  
8 or 16 ohms models.

£22.00 Post £2.60

## "AUDITORIUM"

### 12in. 35 watts

A full range reproducer for high power. Ideal for Hi-Fi and Discoteques. Electric Guitars, public address, multi-speaker systems, electric organs.

Bass Resonance 35cps  
Flux Density 15,000 gauss  
Useful response 25-18,000cps  
8 or 16 ohms models.

£21.00 Post £1.60

## "AUDITORIUM"

### 15in. 45 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discoteques, Electronic Instruments and the home Hi-Fi.

Bass Resonance 36cps  
Flux Density 15,000 gauss  
Useful response 20-14,000cps  
8 or 16 ohms models.

£26.00 Post £1.60

Loudspeaker Cabinet Wadding 18in wide, 20p per ft.

Hi-Fi Enclosure Manual containing plans, designs, crossover data and cubic tables, 85p.

## E.M.I. 13 1/2 x 8in SPEAKER SALE!

With tweeter. And crossover. 10W. State 3 or 8 ohm. £7.95 Post 45p

15W model £10.50 8 ohms. Post 65p

GOODMANS 20W Woofer £9.95

Size 12 x 10in 4 ohms. Rubber cone surround. Hi-Fi base unit. Post 65p

# RADIO COMPONENT SPECIALISTS

Minimum post 30p. Components List 20p. Cash price incl. VAT. Access & Barclay cards welcome. H.P. available. Phone your order Tel. 01-684 1665

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