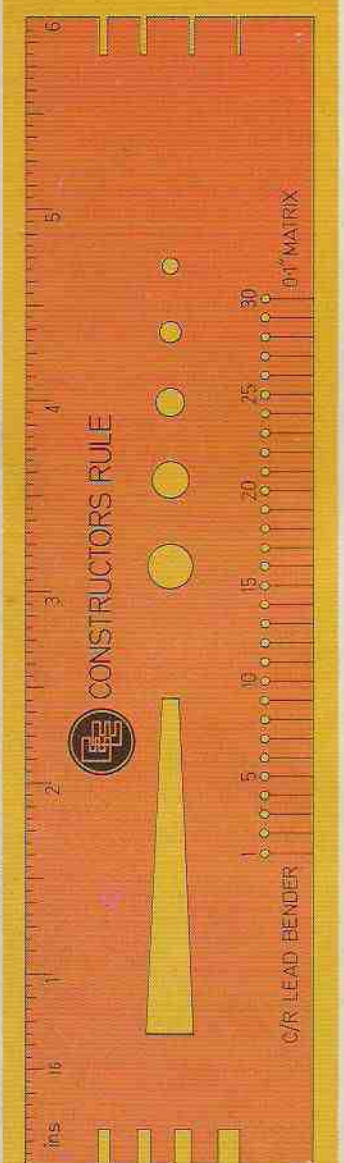
Easy to build projects for everyone

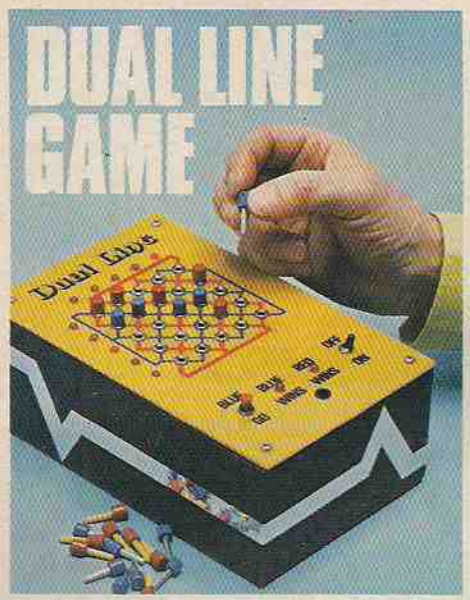
Everyday ELECTRONICS

MAY 80
50p

FREE



DUAL LINE GAME



PRETUNED 4 STATION RADIO

Watch your battery !

LIGHTS WARNING SYSTEM

BATTERY VOLTAGE MONITOR

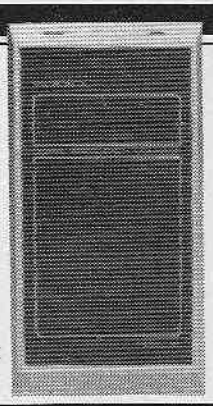
Australia $1·00 South Africa R1·00 New Zealand $1·10 Malaysia $3·50

MORE BIG VALUE FROM YOUR TANDY STORE

1000 OHMS/VOLTS AC/DC 8 RANGES

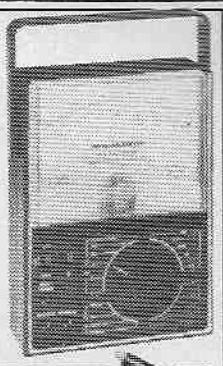
Handy multitester for home and work-shop. Easy-to-read two colour 5cm meter, pin jacks for all 8 ranges. Reads AC and DC volts: 0-15-150-1000 DC current; 0-150 mA. Resistance: 0-100,000 ohms. Accuracy: ± 3% full scale on DC ranges, ± 4% on AC ranges. Complete battery. **22-027.** REG. PRICE **£6.95**

6-DIGIT FREQUENCY COUNTER



Counts frequencies from 100 Hz to over 45 MHz with 100 mS gate time. Accuracy is 3 ppm at 25°C or less then ± 30 Mkz on 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Req. 9V battery. **22-351.** REG. PRICE **£79.95**

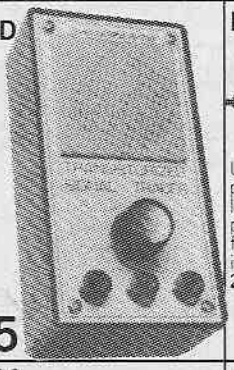
MULTITESTER



Dual FET imput for accuracy and minimum loading. 11.5cm mirrored scale. DC volts. 0-1-3-10-30-100-300-1000. DC current 0-100 a. 0-3-30-300 milliamp. Resistance 0-30-300-3k-30 IC-1 megaohm. 0-100-1k-10 IC-100K-3 megaohms. Req. 9V battery. **22-209.**

REG. PRICE **£29.95**

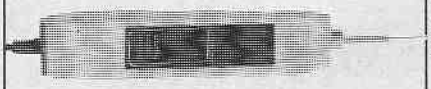
TRANSISTORIZED SIGNAL TRACER



Spot circuit troubles and check RF, IF and audio signals from aerial to speaker on all audio equipment. With 9V battery, instructions. **22-010.**

REG. PRICE **£9.95**

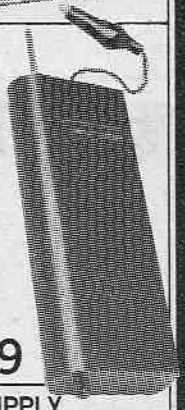
DIGITAL IC LOGIC PROBE



Unique circuitry makes it a combined level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1". Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high frequency signals (up to 1.5 MHz). Input impedence: 300K ohms. With 36" power cables. **22-300.**

REG. PRICE **£19.95**

SIGNAL INJECTOR



For RF, IF, AF circuits. Maximum accuracy. Easy pushbutton operation. Needs two "AA" batteries. **22-4033.**

REG. PRICE **£2.79**

AC/DC CIRCUIT TESTER

Accuracy in 1-300 volts ranges. Safe in live/dead circuits. Needs two "AA" batteries. **22-4034.**

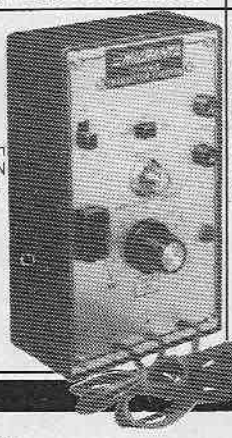
REG. PRICE **£1.99**

REALISTIC DX 300

General coverage receiver. Quartz-synthesised tuning, digital frequency readout. 3-step RF Attenuator. 6-range preselector with LED indicators. SSb and CW demodulation. Speaker. Code oscillator. Batteries (not included) or 12V DC. **20-204.**

REG. PRICE **£229.95**

DYNAMIC TRANSISTOR CHECKER



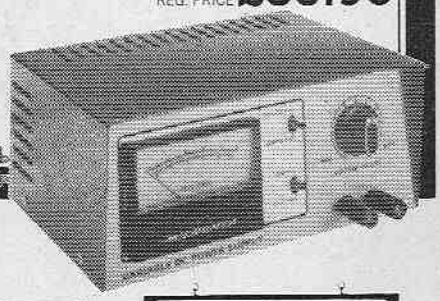
Shows current gain and electrode open and short circuit. Tests low, medium or high power PNP or NPN types. Go/no-Go test from 5-50mA on power types. **22-024.**

REG. PRICE **£9.95**

VARIABLE POWER SUPPLY

Power project boards. IC's, other low-voltage DC equipment. Load regulation: less than 450mV at 1 amp at 24V DC. Ripple: less then 25mV. Maximum output current: 1.25 amps. Switchable colour-coded meter reads 0-25V. DC and 0-1.25 amps. Three-way binding posts take wires, banana plugs or dual banana plugs with 0.75" centres. For 220/240V AC. **22-9123**

REG. PRICE **£35.95**



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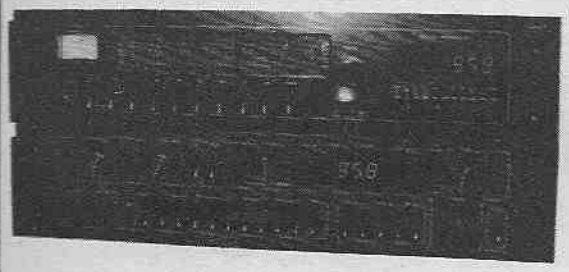
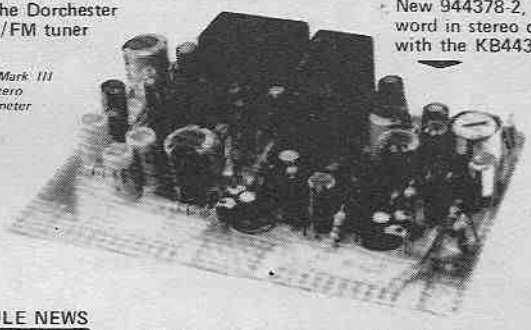
BEWARE! RADIO ACTIVITY



The new MK III FM tuner sitting under the Dorchester multiband AM/FM tuner

Revisions to the Mark III include a centre zero tuning indicator meter and silent preset switching



New 944378-2, the last word in stereo decoders with the KB4437/4438.

Choosing the products to advertise each month can be quite a task at AMBIT, since we tend to introduce at least one new line per week. So it is nearly impossible to say all we would like in this space - other than to bring you as far up to date as possible with current events. The major medium for finding out about what we have to offer is our unique catalogue system, and we ask that you invest in a copy of parts 1,2 & 3 since many questions we are asked can be readily answered by reference to these.
Each part costs 60p, or £1.60 for all three current editions.
We are also launching a new and greatly elongated version of our PRICE LIST, which now includes a large number of quantity listings, and many items not previously listed. The new style price list is a quick reference short form to our general catalogues - available FOC with a large (A4) SAE please.

As a result of the soaring price of oil - and the subsequent huge increases in the cost of wax for Mr Tom Jackson's famous moustache, the Post Office have increased their charges (Feb. 4th). Accordingly, our standard cover charge has been increased to 35p per order (CWO).

MODULE NEWS

We are at last able to quote for quantities of our modules, following a program of standardization and revision to speed manufacture and test. The following types are the results of the standardization program:

UM1181	5 varicap MOSFET input VHF band 2 tunerhead	£12.00 inc
911225 A	High Performance FM IF system, with switched BW	£23.95 inc
911225 B	Single BW filters, single tuned detector	£14.95 inc
91072 A	DC tuned and single pole switched MW LW tuner	£14.43 inc
91072 B	As type 'A' but with either SW1 or SW2 band	£15.90 inc
92242 A	Combined LW/MW tuner, with FM IF/detector section	£29.00 inc
92242 B	As 92242A but with 5-10MHz SW section	£34.00 inc

All are supplied housed in screened metal cases 97x56x24mm, with all connections along a single edge, suitable for verticle or horizontal mounting.

Previously advertized units are still available - although there may have been some price changes in the latest edition of the Price List (Date Feb.80). A separate leaflet covering the new range of modules is available from April 80, with an A4 SAE please.

COMPONENTS

DIGITAL FREQUENCY READOUTS / SYNTHESISER SYSTEMS

Ambit has the biggest range of digital frequency readout systems for various applications in Broadcast and Communications. Prices range from £18.50 for a complete AM/FM broadcast frequency display (kit of DFM2). Most are detailed in the latest catalogue.

TUNING SYNTHESIZERS are also heavily featured, and we offer our first complete system covering MW/ LW/ SW2 and FM based on Hitachi parts. The unit is retrofittable to voltage tuned radio systems - and will shortly be incorporated in a complete tuner project. Cost for the synthesiser will be circa £40
A versatile communications system based on the new Mullard 2 IC system is nearing completion, together with 16 station CMOS memory and optical shaft encoder system with fast tune facility. Synthesiser circa £70, memory £50.

Latest semiconductor news:

CMOS, TTL and LPSN TTL are in stock (ask for our OSTS price leaflet). Some of the very popular types are still "difficult" but we have things like 4011s, 4017s at the time of writing.

RADIO ICs - - -interesting developments here, we now have the Hitachi HA11225 and the HA12412 ultra high specification members of the CA3089E family. The PLESSEY SL1600 range now includes the SL6600 high performance PLL NBFM IF and detector.

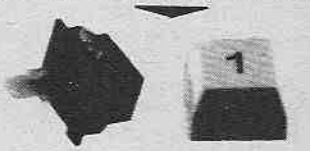
CA3089E	2.11	HA1197	1.61	SD6000	4.31	SL1610	1.84	SL1626	2.80
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59	SL1611	1.84	SL1630	1.86
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38	SL1612	1.84	SL1640	2.17
HA11225	2.47	TBA651	2.53	MC1350P	1.38	SL1613	2.17	SL1641	2.17
HA12412	2.81	TDA1090	3.51	KB4412	2.24	SL1620	2.50	SL6600	4.31
KB4420	1.95	TDA1220	1.61	KB4413	2.24	SL1623	2.80	SL6640	3.16
TBA120S	1.15	TDA1083	2.24	KB4417	2.53	SL1624	3.77	SL6690	3.68
KB4406	0.80	TDA1062	2.24	MC3357P	3.16	SL1625	2.50	MC1496	1.44

TRANSISTORS : New lower prices, wider range, large stocks. Also the world's lowest noise audio devices (2SC2546E and 2SA1084E) first from AMBIT of course. Power MOSFETs & all sorts of other devices. Our 3SK51 MOSFET replaces the 408XX and 40673 families.

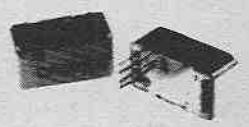
BC237-8-9	0.092	2SC1775	0.207	2SA1084E	0.368	BF256	0.437	BFY90	1.03
BC307-8-9	0.092	2SA872A	0.207	2SC2547E	0.391	2SK55	0.368	BF224	0.253
BC413-5	0.115	2SD666A	0.345	2SA1085E	0.391	2SK168	0.402	BF274	0.207
BD414-6	0.126	2SB646A	0.345	2SK133	6.32	3SK51	0.62	BFT95	1.138
BC546-556	0.138	2SD760	0.52	2SJ48	6.32	3SK60	0.667	VN66AF	1.092
BC550-560	0.138	2SB720	0.52	2SK135	7.29	BF960	1.426	2N4427	0.977
BC639-640	0.265	2SC2546E	0.368	2SJ50	7.29	3SK48	1.426	J176	0.747

RADIO CONTROL: A special section for all RC fans. New and exciting stuff:
KB4445/KB4446 : complete 4 channel RX/TX dig.prop IC pair RF&control in one 4.75pr
MSL9362/MSL9363 : logic section of a four channel dig.prop link, with switch opt. 3.75pr
NE5044 : Signetics versatile 7 channel encoder, suitable for mixing etc. £2.14 ea
NE544 Signetics famous servo driver IC £2.07 MC3357P as used in RCME design £3.16 ea
AMBIT RCRX4 - RCME FM system compatible, complete RX kit with box/connector and AMBIT design screened front end with 27MHz ceramic filter £16.10 (kit)
XTALS: FM pairs £3.74 (no splits) TX is fund. ½ op frequency, RX 3rd OT- 455kHz
AM pairs £3.57 (no splits. Both 3rd OT types, again RX IF at 455kHz

NEW LINE : ALPS switches and rotary potentiometers. With a general catalogue that's over 3 inches thick, we cannot begin to offer a comprehensive list of what we can offer - but we are already stocking the keyboard switches, keyswitches, pushbutton switches etc. In particular, the pushbutton switches really put all others in the shade (schadow?) when it comes to quality and price. A special new shortform is being prepared (and may be ready when you read this). All the potentiometers and switches you could ever need from a single source. Keypad switches cost as little as 15p ea (1 off), with a range of two part caps for easy ledgending. You must see the shortform catalogue (30p) and our new pricelist for full details of this huge range of components



Keyboard switch
SCK41505
typ 6m ops
23p each (1-24)



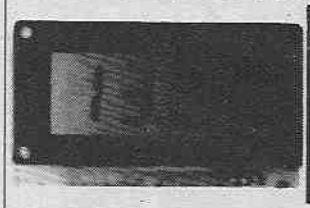
AMBIT SHOP NOW OPEN

We are gradually getting our caller sales area sorted out, with displays of the products on offer and a browsers corner to sit and study data/catalogues. Call in next time you are in the area - parking outside the door.

COMPUTER CAPABILITIES

Ambit has been keeping a low profile on the subject of the MPU and its applications. Interestingly enough, the first project we offer with MPU content does rather more in the way of processing than simply playing a daft game, or looking like an enormous calculator. Our MPU facility and expertise is now for hire on a fully commercial basis. Z80, 6800, 6809, 2650 etc.

NEW LINE : DC/DC+AC converters for fluorescent displays. TOKO CPS series 12v IN, –20 and 3v AC out at 65mA. Thick film design £2.34 ea Qty. prices OA



GENERAL INFORMATION

Ambit stocks the following ranges of components for ex-stock volume delivery: SIGNAL COILS, CERAMIC, MECHANICAL and CRYSTAL FILTERS, RADIO ICs for AM/FM/SSB, TOROID CORES FOR RADIO and EMI FILTER CIRCUITS, INDICATING AND PANEL METERS, AUDIO ICs, RF TRANSISTORS, FETS, MOSFETS, DIODES (PIN,VARICAP,SCHOTTKY), PASSIVE DBMs (like MD108 etc), IC SOCKETS, LEDS, TRIMMER CAPS, SWITCHES, KEYBOARD SWITCHES, TUNERHEADS, IF AMPS, AM RADIO MODULES, etc etc

NEW LINE : DVM176 - the definitive ICM7106 LCD DVM module. 3½ digit £22.37 ea.

CM161: LCD 12/24hr alarm clock/day/date/backlight (eq.RS308-499) 7mm digits £11.44 each
CM174: LCD 12hr alarm clock/stopwatch/backlight with 30mm height digits £14.32 each

CATALOGUES 60p ea, all three for £1.60
PRICES SHOWN HERE INCLUDE VAT
POST/PACKAGE CHARGE NOW 35p

CWO PLEASE - Commercial MA terms on application
Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt

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- Instant all-weather starting
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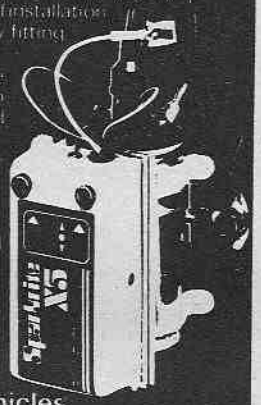
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
- Improved acceleration/top speed
- Extended energy storage

..in kit form

SPARKRITE X5 is a high performance, top quality, inductive discharge electronic ignition system designed for the electronics D I Y world. It has been tried, tested and proven to be utterly reliable. Assembly only takes 1 -2 hours and installation even less due to the patented 'clip on' easy fitting.

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current by 95% of the norm.

There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes built in static timing light, systems function light, and security changeover switch. Will work all rev counters.



Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Die pressed case. Ready drilled aluminium extruded base and heat sink, coil mounting clips and accessories. All kit components are guaranteed for a period of 2 years from date of purchase. Fully illustrated assembly and installation instructions are included.

Roger Clark the world famous rally driver says "Sparkrite electronic ignition systems are the best you can buy"

Sparkrite

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CABLE & PIPE LOCATOR. Mar. 80. £3·40 less coil former.
KITCHEN TIMER. Mar. 80. **£12·46.**
DOORBELL REGISTER. Mar. 80. **£3·39.**
TOUCH SWITCH. Mar. 80. **£8·65.**
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5 RANGE CURRENT LIMITER. Mar. 80. **£4·24.**
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SIMPLE SHORT WAVE RECEIVER. Feb. 80. **£20·47,** headphones £3·28.
SLIDE/TAPE SYNCHRONISER. Feb. 80. **£10·46.**
MORSE PRATICE OSCILLATOR. Feb. 80. **£3·75.**
UNIBOARD BURGLAR ALARM. Dec. 79. **£4·95.**
LIGHTCALL. Dec. 79. **£8·30.**
BABY ALARM. Nov. 79 **£8·20**
OPTO ALARM. Nov. 79 **£5·77** inc. optional ports.
MW/LW RADIO TUNER. Nov. 79 **£15·50** less dial.
3 FUNCTION GENERATOR. Nov. 79 **£18·44** less pointer, case extra **£7·16.**
ONE ARMED BANDIT. Oct 79. **£18·39.** case extra **£3·98.**
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VARICAP M.W. RADIO. Sept. 79. **£8·98.**
SIMPLE TRANSISTOR TESTER. Sept. 79. **£8·28.**
ELECTRONIC TUNING FORK Aug. 79 **£9·15.** Suitable microphone & plug £1·59 extra.
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SWANEE WHISTLER Aug. 79 **£3·19**
TOUCH ON PILOT LIGHT Aug. 79 **£3·36.**
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QUAD SIMULATOR. June 79. **£6·25.**
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"HOT LINE" GAME. Nov. 78. **£4·65** less case & rod.
AUDIO EFFECTS OSCILLATOR. Nov 78. **£3·81** inc. board.
FUSE CHECKER. Oct. 78. **£1·97.**
C.MOS RADIO. Oct. 78. **£9·39.**
TREASURE HUNTER. Oct. 78. **£17·86** less handle & coil former.
GUITAR TONE BOOSTER. Sept. 78. **£4·99** inc. p.c.b.
SOUND TO LIGHT. Sept. 78. **£6·98.**
FILTER. £1·66
SLAVE FLASH. Aug. 78. **£3·20** less SK1.
LOGIC PROBE. July 78. **£2·53.**
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VISUAL CONTINUITY CHECKER. June 78. **£3·72** inc. probes.
FLASHMETER. May 78. **£12·84** less calc and diffuser.
POCKET TIMER. April 78. **£2·98.**
WEIRD SOUND EFFECTS GENERATOR. Mar. 78. **£4·61.**
CHASER LIGHT DISPLAY. Feb. 78. **£23·59** inc. p.c.b. case extra **£5·21.**
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Metac

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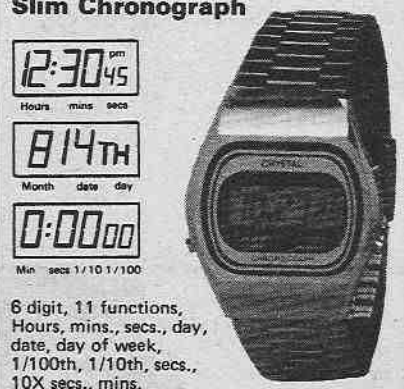
11 Function
Slim Chronograph



6 digit, 11 functions, Hours, mins., secs., day, date, day of week, 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet.

Price only **£9.95**

Also available: SOLAR CHRONOGRAPH M9 Price £11.95

SAME DAY DESPATCH.

M3 Price includes POST & PACKING

QUARTZ LCD
ALARM
with Snooze Alarm

6 functions plus Alarm. Conference signal, 5 minute snooze alarm, Conference signal sounds 4 secs. before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins. after main alarm and is always preceeded by the conference signal.

Price only **£9.95**

SAME DAY DESPATCH.

M4 Price includes POST & PACKING

QUARTZ LCD
ALARM CHRONOGRAPH
with 12/24 display

Hours, mins, secs, day of week. Month, date, day of week, alarm, hour, mins., a.m./p.m. 24 or 12 hour display mode. Alarm test. Chronograph, lap time, stop watch 1/10 secs.

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M16 Price includes POST & PACKING

QUARTZ LCD
Ladies Day Watch

Hours, mins., secs., day, date, back light, auto calendar.

Fully adjustable bracelet. Only 25 x 20mm and 6mm thick. Silver or Gold.

Price only **£7.95**

M15 SAME DAY DESPATCH. P.&P. included

QUARTZ LCD
Ladies Cocktail Watch

Beautifully designed with a very thin bracelet.

Hours., mins., secs., day, date, backlight and autocalendar. Bracelet fully adjustable to suit slim wrists. State Gold or Silver finish. Only 25 x 20 x 6mm.

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M18 SAME DAY DESPATCH. P.&P. included

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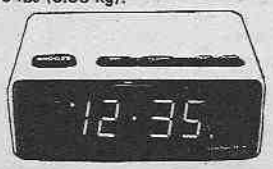

M13

Price only **£10.20** Mains operated. Thousands sold!

QUARTZ LCD
5 Function

Hours, mins., secs., month, date, auto calendar, back light, quality metal bracelet. 6mm thick.

Price only **£6.95**

M1 SAME DAY DESPATCH. P.&P. included

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QUARTZ MELODY
Alarm Chronograph

INCREDIBLE WATCH — 34 Functions

5 independent working modes, day of week in English, French or German. (Just select the one you like). Hours, mins., secs., day, date, countdown alarm, dual time zone, 1/100th sec., stopwatch. Lap/split time, 1st and 2nd place times. Melody test function.

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Price includes POST & PACKING

M30 SAME DAY DESPATCH.

CASIO CHRONO
95QS — 32B

Stainless steel case, water resistant to 66 feet. Hours, mins., secs., am/pm, year, month, date, day. Auto calendar. Pre-programmed until the year 2029. 12/24 hour. Stopwatch function. Range 7 hours, 1/100 sec. (Mode) Net time/lap-time/ 1st - 2nd place times. Dual time function. Accuracy 15 secs. per month. Battery life approx. 4 years.

Price only **£23.95**

M22 SAME DAY DESPATCH.

CASIO F-200
Sports Chrono

Attractive Mans watch in black resin with mineral glass. Hours, mins., secs., am/pm. Month, date, alpha-numeric day. Auto-calendar set 28th Feb. Stopwatch working range 1 hour, units 1/100 sec. Mode, Net Time/lap/ time/1st - 2nd place times. Accuracy approx. 15 secs. per month. Battery 12 months.

Price only **£15.95**

M24 SAME DAY DESPATCH.

CASIO ALARM CHRONO
81CS - 36B

Hours, mins, secs., day, and also day, month and year perpetual automatic calendar. 100th sec. chronograph to 7 hours. Net time/lap/time/1st and 2nd place times. User optional 12/24 hr. display. 24 Alarm. User optional, hourly chime. Backlight, mineral glass, stainless steel. Water resistant to 100 ft. Battery life approx. 4 years.

Price only **£35.95**

M25 SAME DAY DESPATCH.

CASIO F-8C
3 year battery life

Hours, mins., secs., am/pm, date, day. Auto calendar set 28th February.

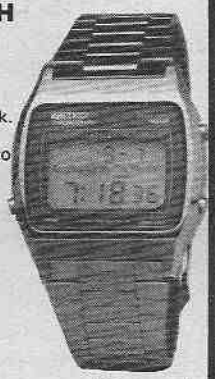
Accuracy 15 secs. per month.

Battery life approx. 3 years.

Price only **£10.95**

M36 SAME DAY DESPATCH.

SEIKO CHRONOGRAPH



Hours, mins., secs., and day of the week. Month date and day of the week. Stopwatch display — Hours., mins., secs., up to 12 hours (mins., secs., 1/100 secs. up to 20 minutes). Lap timing. Continuous time measurement of two competitors. Stainless steel, mineral glass.

Price only **£39.95** including POST & PACKING

SAME DAY DESPATCH. **M33**

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With WEEKLY Alarm, Hours, mins., secs., month, date, day, am/pm. Weekly alarm — can be set for every day at designated time, e.g. 6.30 am on Monday, Wednesday and Friday. Alarm set time displayed above time of day. Full stopwatch functions, laptime, split etc.

Price only **£57.50** including POST & PACKING

SAME DAY DESPATCH. **M10**

SEIKO DIGI-ANA CHRONOGRAPH

TIME AND CALENDAR FUNCTION

Analog part display Hour, mins., secs. Digital part display: Hour, mins., secs., date, day and colon. Calendar-month, date, day, stopwatch — Hour, mins., secs., 1/100 secs. LAP/ STOP and stop marks. Counter-function. Time and calendar setting function.

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SAME DAY DESPATCH. **M62**

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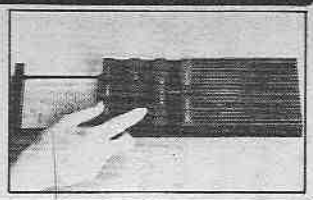
24 TUNE DOOR CHIMES

DOOR TUNES £17·13 + VAT.

Waddington's Videomaster announce a doorbell that doesn't go Brrringgg, Ding-Dong or Bzzzzz. Instead it plays 24 different classical and popular tunes. It will play the tune you select for your mood, the season or the visitor you are expecting to call. Door tunes is not only great fun and a wonderful ice breaker, but is also very functionally and beautifully designed to enhance your home. There is something for Christmas, something for your continental visitors or your relations from the states, and even something for the Queen. Door tunes is easy to install and has separate controls for volume, tone and tempo.



T.V. GAMES

PROGRAMMABLE £29·50 + VAT.
COLOUR CARTRIDGE T.V. GAME.

The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug-in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase of additional cartridges as new games are developed. Each cartridge contains up to ten different action games and the first cartridge containing ten sports games is included free with the console. Other cartridges are currently available to enable you to play such games as Grand Prix Motor Racing, Super Wipeout and Stunt Rider. Further cartridges are to be released later this year, including Tank Battle, Hunt the Sub and Target. The console comes complete with two removable joystick player controls to enable you to move in all four directions (up/down/right/left) and built into these joystick controls are ball serve and target fire buttons. Other features include several difficulty option switches, automatic on screen digital scoring and colour coding on scores and balls. Lifelike sounds are transmitted through the TV's speaker, simulating the actual game being played.
Manufactured by Waddington's Videomaster and guaranteed for one year.

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Grand Prix motor racing with gear changes, crash noises

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10 different games of blasting obstacles off the screen

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STAR CHESS – £55·09 + VAT.
PLAY CHESS AGAINST YOUR PARTNER.

using your own TV to display the board and pieces. Star Chess is a new absorbing game for two players, which will interest and excite all ages. The unit plugs into the aerial socket of your TV set and displays the board and pieces in full colour for black and whitel on your TV screen. Based on the moves of chess. It adds even more excitement and interest to the game. For those who have never played, Star Chess is a novel introduction to the classic game of chess. For the experienced chess player, there are whole new dimensions of unpredictability and chance added to the strategy of the game. Not only can pieces be taken in conventional chess type moves, but each piece can also exchange rocket fire with its opponents. The unit comes complete with a free 18V mains adaptor, full instructions and twelve months guarantee.

CHESS CHALLENGER 7 – £85·65 + VAT.
PLAY CHESS AGAINST THE COMPUTER.

The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including "Mate in two" and "Chess by mail". The computer will only make responses which obey international chess rules. Castling, en passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computor memory recall button.
Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.

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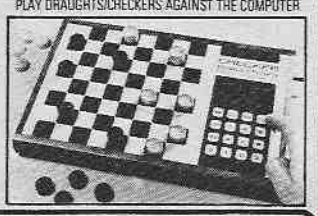
PLAY DRAUGHTS/CHECKERS AGAINST THE COMPUTER



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Contains hundreds of brand new resistors, capacitors, transistors diodes and I.C.'s. All useful values, carefully chosen to help the new constructor pursue his hobby without finding himself short of some vital parts!

All parts contained in clearly marked bags in a plastic storage cabinet 232 × 121 × 165mm with 9 drawers into which all parts can be neatly located.

If bought individually parts plus case would cost over £47 but we are offering this for ONLY £31·95 + £1 p & p. Simply send a cheque or P/O for £32·95 for immediate despatch.

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200	¼ watt resistors
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70	Ceramic Capacitors
70	Mylar Capacitors
50	Polyester Capacitors
56	Electrolytic Capacitors
61	Transistors
12	I.C.'s
20	L.E.D.'s
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Altogether 614 components.

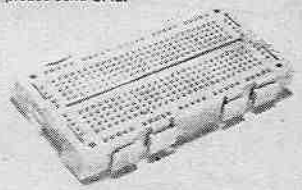
Price includes current catalogue and Greenweld pen for reordering supplies. Plus FREE surprise gift.

PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. £4·95

KITS OF BITS FOR EE PROJECTS

We supply parts for nearly all EE projects—for a detailed components list of this month's, and previous articles, please send SAE.



VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs and be joined together. Bus strips on X & Y axis—total 360 connexion points for just £3·70.

VU METERS

V002 Twin type. 2 meters 40 × 40mm and driver board, supplied with circuit and connexion data, £3·50.
V003 New type, just in. Twin type moulded in one piece. 80 × 40mm (no driver board but suitable circuit supplied). £2·50.

THE NEW 1980 GREENWELD *CATALOGUE*

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Solid core—ideal for breadboards etc. 50 × 2m lengths many assorted colours, total 100m for £1·30.
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EX-COMPUTER PANELS

Z528 Pack of boards containing 100's R's, C's diodes, including at least 50 transistors. Only £1·30.
Z529 TTL pack—Panels with 74 series on, together with code sheet. From simple gates to complex counters. 20 IC's £1; 100 IC's £4.

COMPONENT TRAY

Attractive yellow tray 285 × 165 × 42mm with clear hinged lid and movable compartments. Up to 15 can be made from dividers supplied. As an added bonus, a selection of new surplus components are included, all for the special low price of £3·95.

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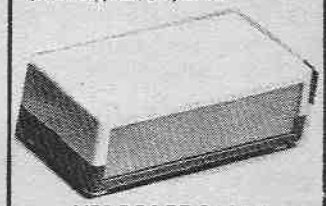

VEROCASE SALE!!

3 popular sizes of Verocase at drastically reduced prices—these were part of their standard range (75-1411 etc.) but are in GREEN and have been discontinued by Vero. We have purchased their entire stock and offer them as below:

Type No.	Size	Price
21051	180 × 120 × 65mm	£2·30
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VERO OFFCUTS

Packs of 100 sq ins of good size pieces about 4 × 3" in the following types:
K511 0.1" copper clad ..... £2·00
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Z401 Powerful 6V DC Buzzer all metal construction 50mm dia × 20mm 70p.
Z402 Miniature type Buzzer 6, 9 or 12V, only 22×15×16mm. Very neat 53p.
Z450 Miniature 6V DC motor, high quality type 32mm dia × 25mm high, with 12mm spindle. Only £1.
Z459 115/230V ac high torque motor with geared reduction down to 60 rpm. Sturdy construction, 70mm dia × 20mm. Spindle 6mm dia × 20mm long. Only £2·00.
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W847 Low profile PC mntg 10 × 33 × 20 mm 6V coil. SPCO 3A contacts. 93p.

TEACH IN 80

We are again supplying all parts required for this major series which started last October. The price for all the Tutor Deck parts is **£19·50.** Also supplied *without* breadboard for **£13·50.** The price for the additional components required for Parts 1-6 is **£2·00** and Parts 7-12 is **£3·00.** All prices include VAT and Postage. Reprints of parts **30p** per month

BI-PAK SEMICONDUCTORS,

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	£0·25	BC134	£0·21	BD178	£0·78	BFR40	£0·29	ZTX108	£0·12	2N3415	£0·18
AC113	£0·23	BC135	£0·17	BD179	£0·86	BFR79	£0·22	ZTX109	£0·12	2N3416	£0·33
AC115	£0·23	BC136	£0·21	BD180	£0·86	BFR80	£0·32	ZTX300	£0·14	2N3417	£0·33
AC117	£0·35	BC137	£0·21	BD181	£0·98	BFX29	£0·25	ZTX301	£0·14	2N3614	£1·15
AC117K	£0·39	BC139	£0·37	BD182	£1·04	BFX30	£0·35	ZTX302	£0·18	2N3615	£1·21
AC121	£0·23	BC140	£0·35	BD183	£1·09	BFX84	£0·25	ZTX303	£0·18	2N3616	£1·21
AC122	£0·16	BC141	£0·32	BD184	£1·27	BFX85	£0·28	ZTX304	£0·23	2N3646	£0·10
AC125	£0·21	BC142	£0·25	BD185	£0·78	BFX86	£0·29	ZTX330	£0·17	2N3702	£0·09
AC126	£0·21	BC143	£0·25	BD186	£0·78	BFX87	£0·25	ZTX500	£0·15	2N3703	£0·09
AC127	£0·21	BC145	£0·53	BD187	£0·86	BFX88	£0·25	ZTX501	£0·14	2N3704	£0·08
AC128	£0·18	BC147	£0·08	BD188	£0·86	BFX90	£0·43	ZTX502	£0·18	2N3705	£0·08
AC128K	£0·30	BC148	£0·08	BD189	£0·90	BFY50	£0·18	ZTX503	£0·14	2N3706	£0·09
AC132	£0·23	BC149	£0·08	BD190	£0·90	BFY51	£0·20	ZTX504	£0·29	2N3707	£0·09
AC134	£0·23	BC150	£0·23	BD195	£1·04	BFY52	£0·20	ZTX531	£0·29	2N3708	£0·08
AC137	£0·23	BC151	£0·25	BD196	£1·04	BFY53	£0·20	ZTX550	£0·18	2N3708A	£0·08
AC141	£0·25	BC152	£0·25	BD197	£1·09	BIP19	£0·44	2N388	£0·41	2N3709	£0·08
AC141K	£0·35	BC153	£0·29	BD198	£1·09	BIP20	£0·44	2N388A	£0·64	2N3710	£0·08
AC142	£0·42	BC154	£0·22	Type	Price	BIP19/20	£0·60	2N404	£0·23	2N3711	£0·08
AC142K	£0·35	BC157	£0·12	BD199	£1·14	BSX25	£1·67	2N526	£0·46	2N3772	£1·84
AC151	£0·23	BC158	£0·12	BD200	£1·14	BSX19	£0·21	2N527	£0·58	2N3773	£2·53
AC153	£0·25	BC159	£0·12	BD201	£0·92	BSX20	£0·21	2N598	£0·46	2N3819	£0·21
AC153K	£0·35	BC160	£0·30	BD202	£0·92	BSY25	£0·18	2N599	£0·53	2N3820	£0·40
AC154	£0·23	BC161	£0·44	BD201/		BSY26	£0·18	2N696	£0·15	2N3821	£0·69
AC155	£0·23	BC167	£0·14	202mp	£1·96	BSY27	£0·18	2N697	£0·14	2N3823	£0·69
AC156	£0·23	BC168	£0·14	BD203	£0·92	BSY28	£0·18	2N698	£0·14	2N3903	£0·12
AC157	£0·29	BC169	£0·10	BD204	£0·92	BSY29	£0·18	2N699	£0·37	2N3904	£0·12
AC165	£0·23	BC169C	£0·12	BD203/		BSY38	£0·22	2N706	£0·12	2N3905	£0·12
AC166	£0·23	BC170	£0·10	204mp	£1·96	BSY39	£0·22	2N706A	£0·14	2N3906	£0·12
AC167	£0·23	BC171	£0·10	BD205	£0·92	BSY40	£0·33	2N707	£0·55	2N4058	£0·14
AC168	£0·29	BC172	£0·10	BD206	£0·92	BSY41	£0·33	2N708	£0·16	2N4059	£0·16
AC169	£0·23	BC173	£0·10	BD207	£0·92	BSY51	£0·29	2N711	£0·35	2N4060	£0·16
AC171	£0·29	BC174	£0·17	BD208	£0·00	BSY95	£0·15	2N717	£0·35	2N4061	£0·14
AC175	£0·21	BC175	£0·40	BD222	£0·00	BSY95A	£0·15	2N718	£0·29	2N4062	£0·14
AC176K	£0·30	BC177	£0·18	BD225	£0·54	BRY39	£0·52	2N718A	£0·58	2N4921	£0·63
AC178	£0·29	BC178	£0·18	BD232	£0·63	BU105	£1·84	2N726	£0·33	2N4923	£0·75
AC179	£0·29	BC179	£0·18	BD233	£0·55	BU105/02	£2·24	2N727	£0·33	2N5135	£0·12
AC180	£0·23	BC180	£0·29	BD234	£0·63	BU204	£1·81	2N743	£0·23	2N5136	£0·12
AC180K	£0·29	BC181	£0·10	BD235	£0·63	BU205	£1·81	2N744	£0·23	2N5138	£0·12
AC181	£0·23	BC182	£1·25	BD236	£0·67	BU208	£2·19	2N914	£0·17	2N5172	£0·16
AC181K	£0·32	BC182L	£0·10	BD237	£0·63	BU208/02	£2·58	2N918	£0·35	2N5194	£0·64
AC187	£0·21	BC183	£0·10	BD238	£0·69	MJE2955	£1·04	2N929	£0·23	2N5245	£0·46
AC187K	£0·32	BC183L	£0·10	BD239A	£0·58	MJE3055	£0·69	2N930	£0·21	2N5294	£0·39
AC188	£0·21	BC184	£0·10	BD240A	£0·58	MJE3440	£0·60	2N946	£0·46	2N5296	£0·41
AC188K	£0·32	BC184L	£0·10	BDX32	£2·53	MP8113	£0·60	2N1131	£0·21	2N5457	£0·37
ACY17	£0·40	BC186	£0·25	BDY11	£1·50	MPF102	£0·32	2N1132	£0·21	2N5458	£0·37
ACY18	£0·40	BC187	£0·25	BDY17	£2·07	MPF104	£0·40	2N1302	£0·17	2N5459	£0·40
ACY19	£0·40	BC207	£0·13	BDY20	£0·92	MPF105	£0·40	2N1303	£0·21	2N5551	£0·41
ACY20	£0·40	BC208	£0·13	BDX77	£1·04	MPSA05	£0·23	2N1304	£0·21	2N6027	£0·39
ACY21	£0·40	BC209	£0·14	BF115	£0·25	MPSA06	£0·23	2N1305	£0·21	2N6121	£0·81
ACY22	£0·40	BC212	£0·10	BF117	£0·58	MPSA55	£0·23	2N1306	£0·29	2N6122	£0·81
ACY27	£0·40	BC212L	£0·10	BF118	£0·86	MPSA56	£0·23	2N1307	£0·29	2S301	£0·58
ACY28	£0·37	BC213	£0·10	BF119	£0·86	ND120	£0·21	2N1308	£0·35	2S302	£0·49
ACY29	£0·58	BC213L	£0·10	BF121	£0·58	OC20	£2·13	2N1309	£0·35	2S302A	£0·49
ACY30	£0·40	BC214	£0·10	BF123	£0·69	OC22	£1·73	2N1599	£0·40	2S303	£0·64
ACY31	£0·40	BC214K	£0·10	BF125	£0·58	OC23	£1·73	2N1613	£0·23	2S403	£0·82
AD130	£0·81	BC225	£0·30	BF127	£0·68	OC24	£1·55	2N1711	£0·23	2S305	£0·92
AD140	£0·69	BC226	£0·41	BF152	£0·29	OC25	£1·15	2N1889	£0·52	2S306	£0·92
AD142	£0·98	BC227	£0·18	BF153	£0·29	OC26	£1·15	2N1890	£0·52	2S307	£0·92
AD143	£0·86	BC238	£0·18	BF154	£0·25	OC28	£0·92	2N1893	£0·35	2S321	£0·66
AD149	£0·69	BC251	£0·17	BF155	£0·40	OC29	£1·09	2N2147	£0·86	2S322	£0·49
AD161	£0·40	BC251A	£0·18	BF156	£0·30	OC35	£1·04	2N2148	£0·81	2S322A	£0·49
AD162	£0·40	BC301	£0·32	BF157	£0·32	OC36	£1·04	2N2160	£0·90	2S323	£0·66
AD161/2	£0·81	BC302	£0·33	BF158	£0·32	OC41	£0·23	2N2192	£0·44	2S324	£0·82
AF124	£0·35	BC303	£0·32	BF159	£0·32	OC42	£0·25	2N2193	£0·44	2S325	£0·90
AF125	£0·35	BC304	£0·44	BF160	£0·35	OC44	£0·28	2N2194	£0·44	2S326	£0·82
AF126	£0·35	BC327	£0·18	BF162	£0·35	OC45	£0·23	2N2217	£0·25	2S327	£0·82
AF127	£0·37	BC328	£0·17	BF163	£0·35	OC70	£0·28	2N2218	£0·25	40311	£0·42
AF139	£0·40	BC337	£0·17	BF164	£0·55	OC71	£0·17	2N2218A	£0·23	40313	£1·09
AF178	£0·69	BC338	£0·17	BF165	£0·55	OC72	£0·28	2N2219	£0·23	40316	£1·09
AF179	£0·69	BC440	£0·35	BF167	£0·28	OC74	£0·30	2N2219A	£0·28	40317	£0·46
AF180	£0·69	BC441	£0·35	BF173	£0·23	OC75	£0·35	2N2220	£0·23	40326	£0·46
AF181	£0·67	BC460	£0·44	BF176	£0·44	OC76	£0·40	2N2221	£0·23	40327	£0·32
AF186	£0·58	BC461	£0·44	BF177	£0·30	OC77	£0·58	2N2221A	£0·25	40346	£0·52
AF239	£0·44	BC477	£0·23	BF178	£0·30	OC81	£0·25	2N2222	£0·23	40347	£0·75
AL102	£1·38	BC478	£0·23	BF179	£0·35	OC81DD	£0·28	2N2222A	£0·23	40348	£0·92
AL103	£1·36	BC479	£0·23	BF180	£0·35	OC82	£0·28	2N2368	£0·21	40360	£0·41
ASY26	£0·44	BC547	£0·12	BF181	£0·35	OC82D	£0·35	2N2369	£0·16	40362	£0·44
ASY27	£0·46	BC548	£0·12	BF182	£0·35	OC83	£0·30	2N2369A	£0·16	40406	£0·52
ASY28	£0·44	BC549	£0·12	BF183	£0·35	OC84	£0·44	2N2411	£0·29	40407	£0·40
ASY29	£0·44	BC550	£0·16	BF184	£0·23	OC139	£0·92	2N2412	£0·29	40408	£0·60
ASY30	£0·35	BC556	£0·16	BF185	£0·23	OC140	£0·92	2N2646	£0·54	40409	£0·86
ASY51	£0·35	BC557	£0·15	BF186	£0·30	OC169	£0·40	2N2711	£0·25	40410	£0·86
ASY52	£0·35	BC558	£0·14	BF187	£0·30	OC170	£0·40	2N2712	£0·25	40411	£0·96
ASY54	£0·35	BCY30	£0·63	BF188	£0·46	OC171	£0·40	2N2714	£0·25	40430	£1·09
ASY55	£0·35	BCY31	£0·63	BF194	£0·12	OC200	£0·44	2N2904	£0·21	40476	£1·84
ASY56	£0·35	BCY32	£0·69	BF195	£0·12	OC201	£1·09	2N2904A	£0·24	40494	£0·81
ASY57	£0·35	BCY33	£0·63	BF196	£0·12	OC202	£1·38	2N2905	£0·21	40495	£0·92
ASY58	£0·35	BCY34	£0·69	BF197	£0·14	OC203	£0·98	2N2905A	£0·23	40512	£1·55
ASY73	£0·35	BCY70	£0·17	BF198	£0·16	OC204	£1·04	2N2906	£0·18	40594	£1·04
AU104	£1·61	BCY71	£0·17	BF199	£0·16	OC205	£1·32	2N2906A	£0·22	40636	£1·27
AU110	£1·61	BCY72	£0·17	BF200	£0·35	TIC44	£0·33	2N2907	£0·23		
AU113	£1·61	BCZ10	£0·69	BF202	£1·04	TIC45	£0·40	2N2907A	£0·25		
BC107	£0·09	BCZ11	£0·69	BF222	£1·04	TIP29A	£0·46	2N2923	£0·17		
BC107A	£0·09	BCZ12	£0·69	BF224	£0·20	TIP29B	£0·48	2N2924	£0·17		
BC107B	£0·10	BD115	£0·58	BF240	£0·20	TIP29C	£0·51	2N2925	£0·17		
BC107C	£0·12	BD116	£0·92	BF241	£0·20	TIP30A	£0·46	2N2926G	£0·10		
BC108	£0·09	BD121	£0·75	BF244	£0·35	TIP30B	£0·48	2N2926Y	£0·09		
BC108A	£0·09	BD123	£0·75	BF257	£0·29	TIP30C	£0·51	2N2960	£0·09		
BC108B	£0·10	BD124	£0·81	BF258	£0·29	TIP31A	£0·46	2N2926R	£0·09		
BC108C	£0·12	BD131	£0·40	BF259	£0·40	TIP31B	£0·48	2N2926B	£0·09		
BC109	£0·09	BD132	£0·40	BF262	£0·69	TIP31C	£0·51	2N3010	£0·75		
BC109A	£0·00	BD131/		BF263	£0·69	TIP32A	£0·46	2N3011	£0·17		
BC109B	£0·10	132mp	£0·92	BF270	£0·41	TIP32B	£0·48	2N3053	£0·20		
BC109C	£0·12	BD133	£0·46	BF271	£0·36	TIP32C	£0·51	2N3054	£0·46		
BC113	£0·18	BD135	£0·44	BF272	£0·92	TIP41A	£0·51	2N3055	£0·46		
BC114	£0·18	BD136	£0·40	BF273	£0·41	TIP41B	£0·53	2N3391	£0·23		
BC115	£0·22	BD137	£0·40	BF274	£0·44	TIP41C	£0·55	2N3391A	£0·25		
BC116	£0·22	BD138	£0·41	BF324	£0·40	TIP42A	£0·51	2N3392	£0·23		
BC116A	£0·22	BD139	£0·41	BF336	£0·35	TIP42B	£0·53	2N3393	£0·23		
BC117	£0·23	BD140	£0·41	BF337	£0·35	TIP42C	£0·55	2N3394	£0·23		
BC118	£0·16	BD139/		BF338	£0·44	TIP2955	£0·69	2N3395	£0·25		
BC119	£0·29	140mp	£0·92	BF457	£0·43	TIP3055	£0·53	2N3402	£0·24		
BC120	£0·46	BD155	£0·92	BF458	£0·43	TIS43	£0·25	2N3403	£0·24		
BC125	£0·20	BD175	£0·69	BF459	£0·44	TIS90	£0·21	2N3404	£0·33		
BC126	£0·25	BD176	£0·69	BF596	£0·32	UT46	£0·23	2N3405	£0·48		
BC132	£0·21	BD177	£0·78	BFR39	£0·28	ZTX107	£0·12	2N3414	£0·18		

74 SERIES TTL ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0·10	7427	£0·28	7473	£0·29	74110	£0·41	74166	£0·90
7401	£0·13	7428	£0·30	7474	£0·29	74111	£0·67	74174	£0·75
7402	£0·13	7430	£0·15	7475	£0·33	74118	£0·92	74175	£0·71
7403	£0·13	7432	£0·25	7476	£0·29	74119	£1·36	74176	£0·67
7404	£0·13	7433	£0·35	7480	£0·51	74121	£0·28	74177	£0·67
7405	£0·13	7437	£0·24	7481	£0·98	74122	£0·45	74180	£1·73
7406	£0·25	7438	£0·24	7482	£0·78	74123	£0·46	74181	£0·67
7407	£0·25	7440	£0·14	7483	£0·67	74136	£0·60	74182	£0·81
7408	£0·15	7441	£0·58	7484	£1·01	74141	£0·63	74184	£0·81
7409	£0·15	7442	£0·46	7485	£0·78	74145	£0·63	74190	£0·78
7410	£0·13	7443	£0·81	7486	£0·25	74150	£0·78	74191	£0·71
7411	£0·20	7444	£0·81	7489	£1·96	74151	£0·55	74192	£0·69
7412	£0·17	7445	£0·75	7490	£0·37	74153	£0·55	74193	£0·67
7413	£0·28	7446	£0·69	7491	£0·74	74154	£0·94	74194	£0·71
7414	£0·58	7447	£0·55	7492	£0·49	74155	£0·58	74195	£0·69
7416	£0·26	7448	£0·64	7493	£0·35	74156	£0·58	74196	£1·21
7417	£0·26	7450	£0·13	7494	£0·86	74157	£0·58	74197	£1·21
7420	£0·13	7451	£0·13	7495	£0·58	74160	£0·67	74198	£2·13
7421	£0·23	7453	£0·13	7496	£0·58	74161	£0·71	74199	£2·13
7422	£0·18	7454	£0·13	74100	£0·98	74162	£0·71		
7423	£0·24	7460	£0·13	74104	£0·45	74163	£0·71		
7425	£0·22	7470	£0·29	74105	£0·44	74164	£0·78		
7426	£0·26	7472	£0·23	74107	£0·28	74165	£0·78		

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·16	CD4015	£0·94	CD4026	£1·38	CD4043	£1·01	CD4070	£0·20
CD4001	£0·23	CD4016	£0·49	CD4027	£0·58	CD4044	£0·94	CD4071	£0·20
CD4002	£0·18	CD4017	£0·94	CD4028	£0·78	CD4045	£1·61	CD4072	£0·20
CD4006	£1·06	CD4018	£0·98	CD4029	£0·98	CD4046	£1·50	CD4081	£0·20
CD4007	£0·20	CD4019	£0·43	CD4030	£0·55	CD4047	£1·00	CD4082	£0·25
CD4008	£1·06	CD4020	£1·04	CD4031	£2·30	CD4049	£0·55	CD4510	£1·27
CD4009	£0·52	CD4021	£0·94	CD4035	£1·38	CD4050	£0·55	CD4511	£1·44
CD4010	£0·55	CD4022	£0·94	CD4037	£1·09	CD4054	£1·27	CD4516	£1·15
CD4011	£0·23	CD4023	£0·22	CD4040	£1·01	CD4055	£1·15	CD4518	£1·15
CD4012	£0·22	CD4024	£0·75	CD4041	£0·87	CD4056	£1·55		
CD4013	£0·48	CD4025	£0·22	CD4042	£0·83	CD4069	£0·20		

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£1·12	LM301	£0·33	MC1312	£2·19	72710	£0·35	SL414A	£2·24
CA3014	£1·55	LM304	£1·84	MC1350	£1·38	UA711C	£0·37	TAA550B	£0·40
CA3018	£0·75	LM308	£1·15	MC1352	£1·61	72711	£0·37	TAA621A	£2·30
CA3020	£1·86	LM309	£1·73	MC1469	£3·39	UA723C	£0·52	TAA621B	£2·88
CA3028	£0·92			MC1496	£1·04	72723	£0·52	TAA661	£1·73
CA3035	£1·61			NE536	£3·06	UA741C	£0·28	TAD100	£1·50
CA3036	£1·15			NE550	£1·09	72741	£0·28	TBA120	£0·80
CA3042	£1·73			NE555	£0·23	741P	£0·23	TBA540	£2·42
CA3043	£2·13			NE556	£0·69	UA747C	£0·69	TBA641A	£1·84
CA3046	£0·81			NE565	£1·38	72747	£0·69	TBA641B	£2·53
CA3052	£1·84			NE566	£1·73	UA748	£0·40	TBA810S	£0·86
CA3054	£1·27			NE567	£1·96	72748	£0·40	TBA810	£1·13
CA3075	£1·73	LM380	£0·98	UA702C	£0·53	748P	£0·40	TBA820	£0·81
CA3081	£1·73	LM381	£1·67	72702	£0·53	SN76013N	£2·01	TBA9200	£2·88
CA3089	£2·30	LM3900	£0·67	UA703	£0·29	SN76023	£2·01	TCA270S	£2·30
CA3090	£4·14	MC1303L	£0·98	UA709	£0·29	SN76110	£1·73	TBA800	£0·92
CA3123	£2·19			72709	£0·53	SN76115	£2·19	ZN414	£1·15
CA3130	£1·07	MC1304	£2·19	709P	£0·29	SN76660	£0·86		
CA3140	£0·81	MC1310	£1·09	UA710C	£0·46				

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0·09	BAX13	£0·08	BY164	£0·59	OA10	£0·40	SD10	£0·07
AA120	£0·09	BAX16	£0·09	BY176	£0·86	OA47	£0·09	SD19	£0·07
AA129	£0·09	BY100	£0·25	BY206	£0·35	OA70	£0·09	IN34	£0·08
AAY30	£0·10	BY101	£0·25	BYZ10	£0·52	OA79	£0·12	IN34A	£0·08
AAZ13	£0·17	BY105	£0·25	BYZ11	£0·52	OA81	£0·12	IN914	£0·07
BA100	£0·12	BY114	£0·25	BYZ12	£0·46	OA85	£0·12	IN916	£0·07
BA102	£0·37	BY124	£0·25	BYZ13	£0·46	OA90	£0·12	IN4148	£0·07
BA148	£0·17	BY126	£0·17	BYZ16	£0·47	OA91	£0·12	IS44	£0·06
BA154	£0·14	BY127	£0·18	BYZ17	£0·41	OA95	£0·12	IS920	£0·07
BA155	£0·16	BY128	£0·18	BYZ18	£0·41	OA182	£0·15		
BA173	£0·17	BY130	£0·20	BYZ19	£0·41	OA200	£0·09		
BB104	£0·46	BY133	£0·24	OA5	£0·69	OA202	£0·09		

TRIACS

2 amp Volts	T05 Case No.	Price
100	TR12a/100	£0·36
200	TR12a/200	£0·59
400	TR12a/400	£0·82

6 amp Volts		
100	TR16a/100	£0·59
200	TR16a/200	£0·70
400	TR16a/400	£0·89

10 amp Volts		Price
100	TR110a/100	£0·89
200	TR110a/200	£1·06
400	TR110a/400	£1·29

10 amp Volts		
400	TR110a/400p	£1·29

Diacs

BR100	£0·23	D32	£0·23

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1 50	£0·23
100v RMS	BR1 100	£0·25
200v RMS	BR1 400	£0·29
400v RMS	BR1 400	£0·41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2 50	£0·52
100v RMS	BR2 100	£0·55
200v RMS	BR2 200	£0·60
400v RMS	BR2 400	£0·67
1000v RMS	BR2 1000	£0·78

SILICON 10 amp

Type	No.	Price
50v RMS	BR 10 50	£1·73
200v RMS	BR10 200	£1·96

SILICON 25 amp

Type	No.	Price
50v RMS	BR25 50	£2·19
200v RMS	BR25 200	£2·53

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Projects... Theory... and Popular Features...

The integrated circuit ("microchip") is nowadays a commonplace component widely used in all manner of projects, from the simplest to the quite complex designs.

Indeed we have become dependent on this device to a very marked degree, for without it many projects would just not be possible. This month, as it happens, four out of the six projects presented use i.c.s.

The circuit diagram of any project where one or several i.c.s are used gives a much simplified picture of the true or actual state of affairs circuit-wise. Within the outline symbol representing the i.c. exists another world of microcircuitry, made up of elements that are the microscopic counterpart of those discrete resistors, diodes and transistors we are also dependent upon.

But is it important what lies within the i.c.? Maybe not to the average constructor who sticks to published designs. The i.c.s can remain simply "black boxes" performing their allotted functions. The inside "works" need not concern the user.

Most significantly of all, thanks to the widespread use of i.c.s we have become accustomed to low component counts for many projects. So when some moderately ambitious circuit is presented today in an entirely discrete form we are likely to be staggered by the number of individual components involved.

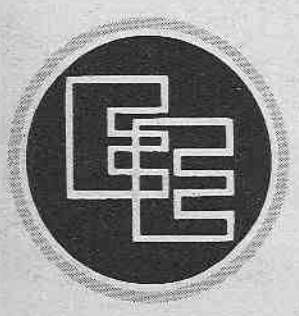
The *Dual Line Game* (an analogue computing system) uses 67 resistors, 49 transistors and 139 diodes. Truly profligate, one might exclaim. But we needs must refocus to the discrete scene, and regain true perspective in terms of actual basic circuit elements.

Of course using a large number of discrete components makes for more physical assembly work. But to the hobbyist that should not be any punishment. As a matter of fact the method of assembly adopted for the *Dual Line Game* is interesting and instructive in itself; it illustrates a compact "book form" of construction where stacked circuit boards are interconnected by ribbon wiring—a method often used in advanced professional equipment.

The hobby of electronics construction undoubtedly owes much of its advancement and popular appeal to microelectronics. Yet there is still plenty of fun and instruction to be derived from the use of discrete semiconductors, which bring one into more intimate contact with the basic circuitry. And suitable devices are generally obtainable at attractive prices.

Fred Bennett.

Our June issue will be published on Friday, May 16. See page 337 for details.



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We cannot undertake to engage in discussions on the telephone.

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Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 9 NO. 5 MAY 1980

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PRETUNED

By F. G. Rayer

4-STATION RADIO

Frequency Coverage	
1 — Range	850 – 1800kHz
2 — Range	500 – 950kHz
3 — Range	850 – 1800kHz
4 — Range	150 – 230kHz

THIS receiver allows switch-selection of Radio 1, 2, 3 or 4, without any need for tuning adjustments when in use. For a good performance without too much circuit complication, two i.c.s and a transistor are employed.

With the aerial and trimmer values shown, approximate possible coverage at each switch position is: *1* and *3*, 1800 850kHz; *2* 500-950kHz; and *4* 150-230kHz (longwave). This includes the alternative programme frequencies where applicable.

Note that in the London area, Radio 4 is best received using the 720kHz frequency (medium wave), switch position 2. Other frequencies include the following: *Radio 1*, 1053kHz, 1089kHz; *Radio 2*, 693kHz, 909kHz; *Radio 3*, 1215kHz; *Radio 4*, 720kHz, 200kHz; *Radio Wales* 882kHz; *LBC*, 1152kHz; *Radio London* 1458kHz; *Luxembourg* 1439kHz; *Capital* 1548kHz.

DETECTOR SECTION

The circuit diagram is shown in Fig. 1. The 2-pole 4-way switch S1a allows the choice of four pre-set frequencies. With S1 at *1* trimmer C1 is in circuit, while position 2 introduces C2 instead, and *3* connects C3. Positions *1*, *2* and *3* of S1b short the longwave aerial winding L2, for medium wave reception by L1. Position *4* gives longwave reception, with trimmer C4.

To avoid the additional tuning and extra components of the superhet, the ZN414 10-transistor t.r.f. integrated circuit IC1 is used. The r.f. resulting from the resonant tuned circuit composed of C1, 2, 3 or 4 with L1 and L2 is fed to the input (pin 2) of IC1 which provides audio frequency output at pin 1, so that it is only necessary to follow this with an audio amplification stage.

The ZN414 i.c. requires a supply of about 1·3 volts and small changes in voltage have a significant effect on its performance. Insufficient voltage reduces sensitivity, while excessive voltage tends to cause instability.

The positive supply is at pin 1, via R3, and obtained from a potential divider formed by R2 to the battery negative line, and VR1 with R5 to the positive line. VR1 allows adjustment to cover component tolerances, to avoid any difficulty in this direction.

Audio output is via R4 and C9 to the volume control VR2.

AUDIO SECTION

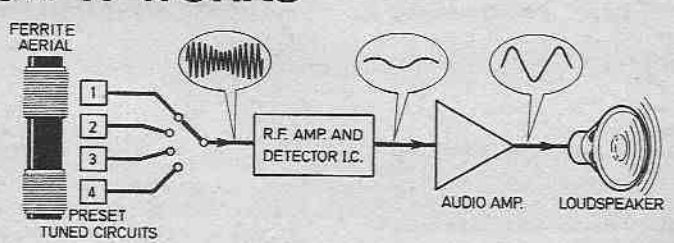
The amplification section consists of TR1 and IC2, the latter requiring very few external components.

Transistor TR1 is connected as a common emitter amplifier with feedback biasing via R6. This acts as a pre-amplifier for IC2 giving additional boost to the output of IC1.

IC2 has a gain of 50, set internally and an output power rating of over 1 watt into a 4 ohm loudspeaker. In this design an 8 ohm loudspeaker is used to reduce the peak current drawn and conserve battery. This still provides adequate power output for normal listening.

In areas of strong signal TR1 could be omitted. Anyone wishing to reduce the number of components and experiment with this can omit R4, R6, R7, R8, TR1, C10, C11 and C12, taking pin 2 of IC2 to the wiper tag of VR2.

HOW IT WORKS



Radio frequency signals from the transmitter induce voltages in the coils on the ferrite rod aerial. Four r.f. tuned circuits are formed with the aerial which can each be inputted to the r.f. amplifier/detector i.c. The output from this is the required audio signal which receives boost from the audio amplifier to be heard in the loudspeaker.

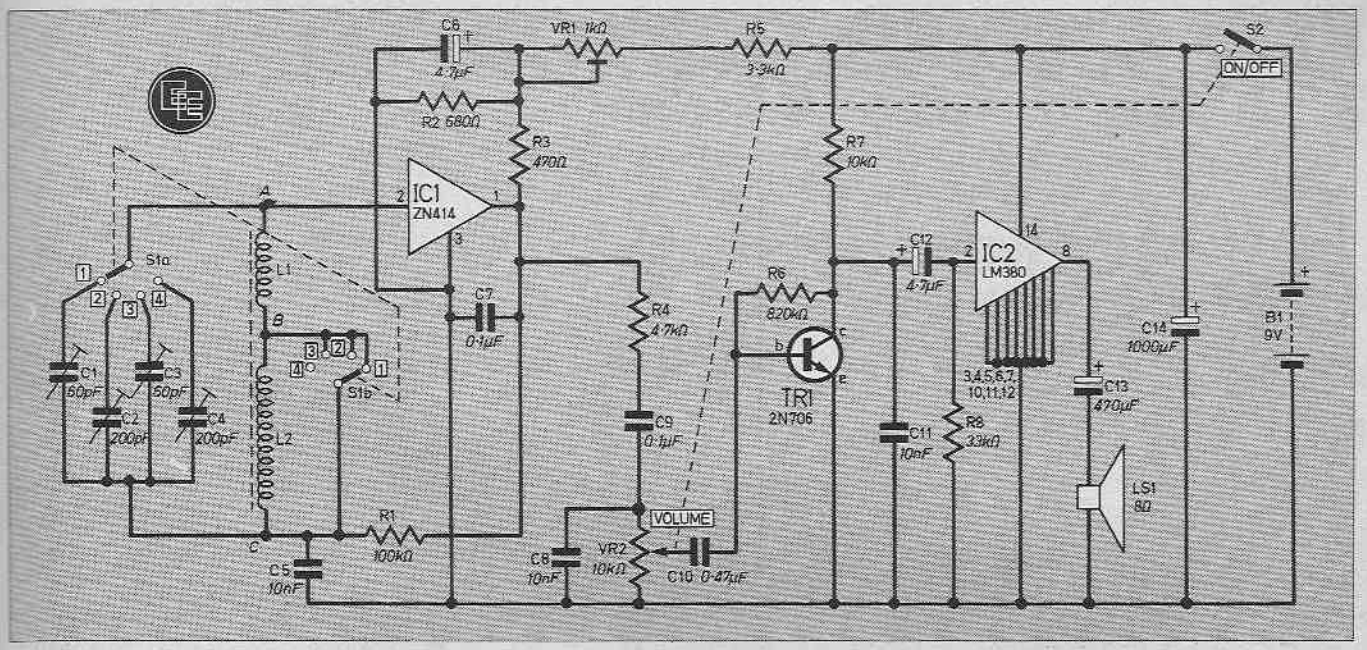


Fig. 1. The full circuit diagram for the Pretuned 4-Station Radio. The coils with ferrite rod core is a standard ready made component type FR5.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit board employed is 0·1 inch matrix perforated s.r.b.p. measuring 15×37 holes.

Both sides of this are shown in Fig. 2. First drill the board for the two metal brackets, and the bolt to secure tab MC. Both brackets are made from aluminium to the dimensions shown and can be fixed in place.

When fitting the board mounted components as shown, their wire ends will be long enough for many connections. Elsewhere, use 20 s.w.g. or similar tinned copper wire. With IC1, note that pins 1 and 2 are well separated, with the earth lead 3 between. The preset VR1 is placed so that it can be adjusted from the rear of the completed radio with back panel removed.

IC2 is fitted in a holder, and must of course be the right way round. An indentation exists between pins 1 and 14 to aid polarity identification. Note that there are eight pins of IC1 that connect to the negative line.

Connect suitable lengths of flying leads to reach the chassis mounted components and the loudspeaker. Multistrand wire is recommended.

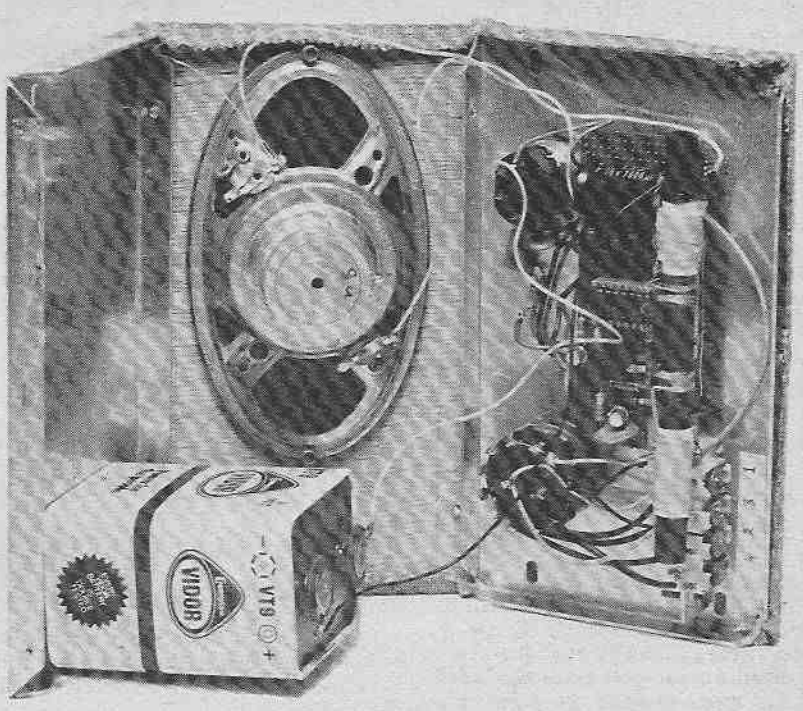
CHASSIS

The chassis, which finally forms the top of the case, consists of a 7×4in "universal chassis" flanged member. Drill or punch holes for VR2 and S1. Also drill the fixing holes to match those near the corners of the board, to enable the board to be fixed to the chassis. These bolts are countersunk headed, and at least 15mm long. Spacers or extra nuts hold the board clear of the metal panel, and the tag MC (Fig. 2) must provide a sound connection from negative line to panel.

Connections between board, S1 and S2 can now be made according to Fig. 2.

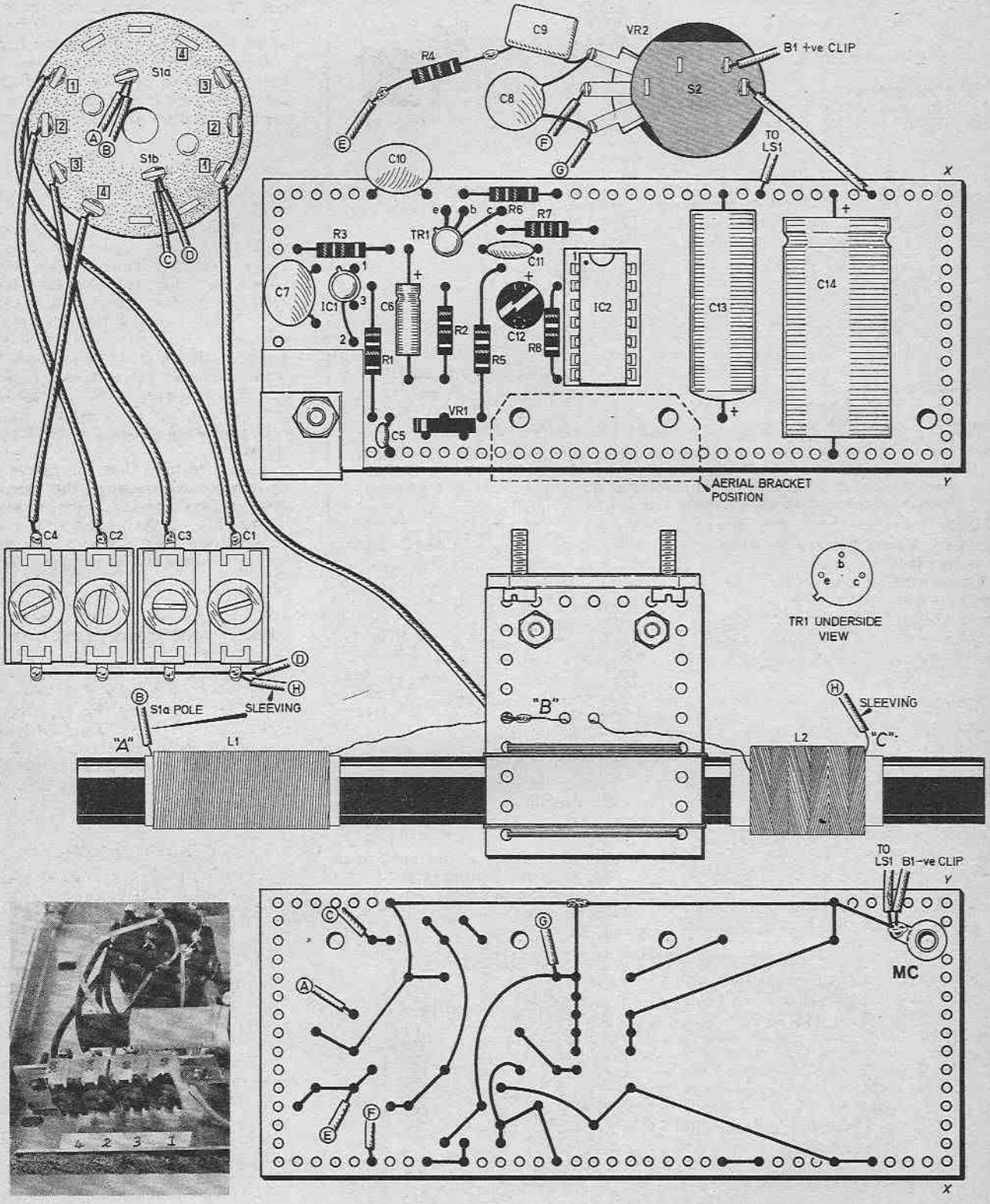
SELECTOR SWITCH

A 2-pole 4-way rotary switch may be supplied as 6-way, with a stop which can be moved before the switch is



The completed prototype with back and side panels removed.

PRETUNED 4-STATION RADIO



A close-up view of the trimmer capacitor bank showing fixing brackets used in the prototype.

Fig. 2. Full construction details showing the board and components in their relative positions in the case. The L-shaped aerial bracket is bolted to the circuit board. The trimmer capacitor brackets will need to be constructed to suit the trimmers obtained. One bracket is fitted by one of the board fixing bolts with the other on the chassis. However, this may need alteration.

COMPONENTS

Resistors

R1	100kΩ	R5	3·3kΩ
R2	680Ω	R6	820kΩ
R3	470Ω	R7	10kΩ
R4	4·7kΩ	R8	33kΩ

All ¼W carbon ± 5%

See Shop Talk Page 323

Potentiometers

VR1 1kΩ vertical miniature pre-set
VR2/S2 10kΩ log. pot with ganged switch

Capacitors

C1	60pF ⎫ Compression trimmers	C8	10nF ceramic
C2	200pF ⎭ (type VC 29LC 60pF or	C9	0·1μF ceramic or polyester
C3	60pF ⎫ VC29L 180pF suitable	C10	0·47μF ceramic or polyester
C4	200pF ⎭ —Home Radio)	C11	10nF ceramic
C5	10nF ceramic	C12	4·7μF 10V elect.
C6	4·7μF 10V elect.	C13	470μF 10V elect.
C7	0·1μF ceramic	C14	1000μF 10V elect.

Semiconductors

TR1 2N706 *npn* silicon
IC1 ZN414 t.r.f. radio i.c.
IC2 LM380 audio amplifier i.c.

COMPONENTS approximate cost **£8·50** excluding case

Miscellaneous

S1 2-pole 4-way rotary switch
LS1 8 ohm moving coil loudspeaker
L1/L2 ferrite rod aerial type MW/LW FR5 (Denco)
0·1 inch perforated s.r.b.p. size 37 × 15 holes; s.r.b.p. board size 30 × 40mm (for aerial mount); 14 pin d.i.l. socket; control knobs (2 off); PP9 battery clips; materials for case; aluminium for brackets; 6BA nuts, bolts and washers; "universal chassis" flanged member size 7 × 4 inch (2 off).

mounted. Fixing the switch holds the stop in place.

Those with an experimental inclination can use the two spare ways of a 6-way switch for l.w. and m.w. manual tuning, with a 200pF variable capacitor.

FERRITE AERIAL

Bolt a strip of perforated board 30×40mm (approx) to the central bracket. Secure the rod to this, as shown in Fig. 2, with adhesive and cotton passed through holes in the board. L1 (medium wave) and L2 (long wave) windings are then slid on. The small coupling winding provided on L1 is not needed, so this should be removed.

The beginning of L1 is denoted by *A*. Put sleeving on this lead and solder it to S1a. The end of L1 and beginning of L2 is denoted by *B*, and these are joined at the strip supporting the rod, and a lead run from this point to S1b.

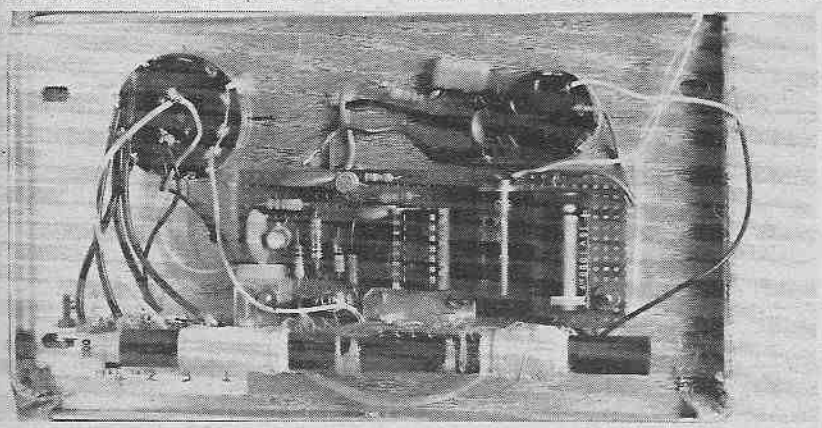
The end of L2, *C*, runs to one side of all trimmers and then S1b. The windings of L1 and L2 must be in the same direction. This can be seen. Alternatively, if tuning of 200kHz is impossible, take L2 off the rod, reverse it and replace it.

TRIMMER BANK

The four trimmers are supported by a strip spanning two brackets, see photo. Stick a strip of paper marked 1, 3, 2, 4 close to the trimmers on the chassis to identify adjustment from behind. Wire the trimmers to S1, connect LS1 and a battery.

Initially position L1 and L2 each about 20mm from the ends of the rod, and check that with S1 in position 1, Radio 1 can be received with adjustment of C1. Similarly, that positions 2, 3 and 4 allow Radio 2, Radio 3 and Radio 4 to be tuned by C2, C3 and C4 respectively. If not, move L1 slightly, or L2 for Radio 4. When in order, cement L1 and L2 to the rod.

Other radio stations may be pretuned in place of any of the above mentioned; see frequencies and recommended position discussed earlier.



The fully wired chassis assembly with aerial secured to board.

CASE

The case can be made with negligible cost and difficulty, but with good appearance. In the prototype, another 7×4in "universal chassis" flanged member formed the bottom panel. Each side is wood, cut 115mm high by 130mm. Four 6BA countersunk bolts fit each side to the chassis members. The bottom is flush, but the top panel is set down 5mm or so. The front is another piece of 4mm plywood size 178×115mm, with an aperture cut for the speaker, which is held with countersunk bolts, or self-tapping screws.

After checking that the pieces will fit, temporarily remove the sides. A piece of fabric about 215mm wide and 305mm long is then fixed with a suitable quick-drying adhesive along the front of the bottom member. When this is dry, stretch the fabric upwards over the front, across the top panel, and cement it at the back edge of this panel. It is necessary to cut holes for the controls.

When the adhesive is dry, apply more adhesive to the end flanges at one side, and along the edge of the front. Pull the fabric taut, fold it over, and screw on the side. Repeat for the other side. The back panel is the same size as the front panel and held with self-tapping screws.

FINAL ADJUSTMENTS

Glue on a facia and label as seen in the photographs. Carefully check the four trimmers. Also set VR1 so that about 1·2V to 1·3V is present across C6 (using a high resistance voltmeter) or so that sensitivity is good without instability.

For best reception in some areas it will be found necessary to rotate the receiver, for best volume of the wanted transmission, and minimum pick-up of other signals.

In many areas VR2 should not need to be advanced very far and the receiver will in general be operated at considerably lower volume than the maximum which could be obtained.

Final adjustment to the trimmers, for the transmissions which are required in any particular region, are preferably made with a completely insulated tool, with all the assembly completed. ⌑

LIGHTS WARNING SYSTEM

K.CUMMINS

ALL drivers must at some time have left their lights on when parking. This is particularly likely to happen when driving in daytime with lights on, during rain or foggy conditions, and also when setting off in darkness and arriving at one's destination in daylight.

The circuit to be described will alert one to this condition. It has the advantage that no setting or cancelling switches are required; in some cases, no additional warning light may be needed. Instead, an existing panel lamp may be used.

The indicator lamp (which may be replaced by a buzzer if required) flashes when the engine is switched off with the lights left on. Turning the lights off cancels the alarm. If required, the lights can then be turned on again without any alarm indication. This allows for parking with lights in awkward or hazardous circumstances. If the alarm is activated and the engine re-started, the alarm is cancelled.

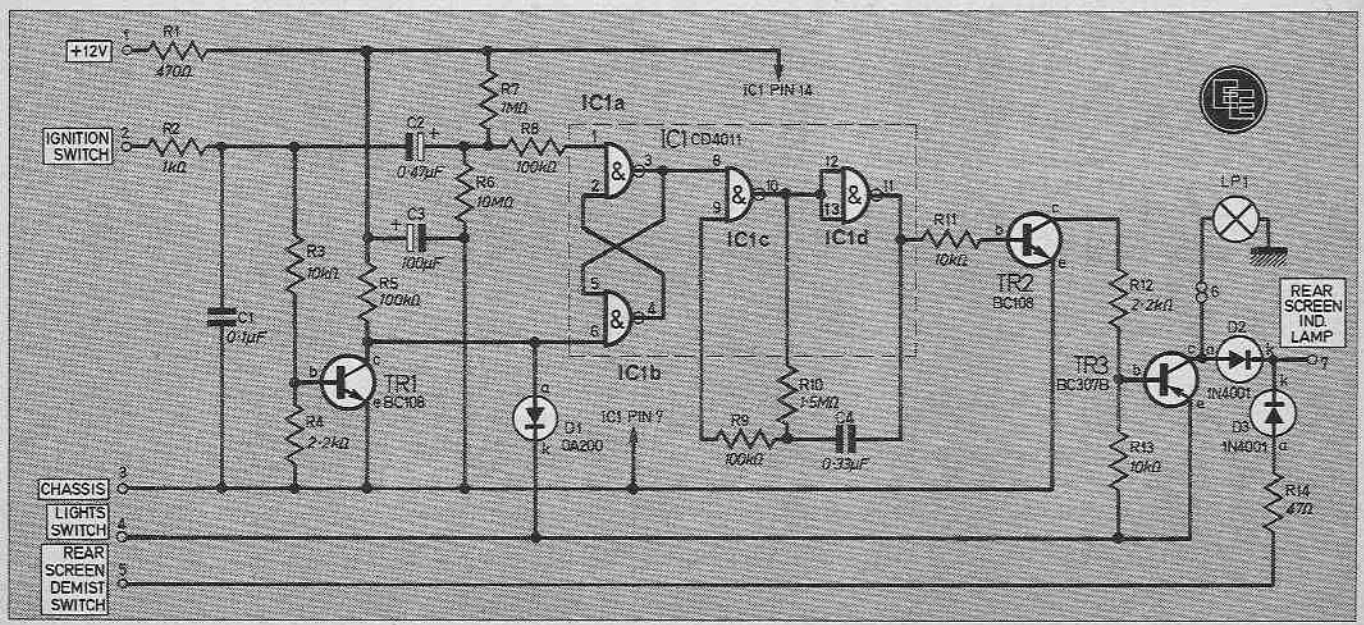
CIRCUIT DESCRIPTION

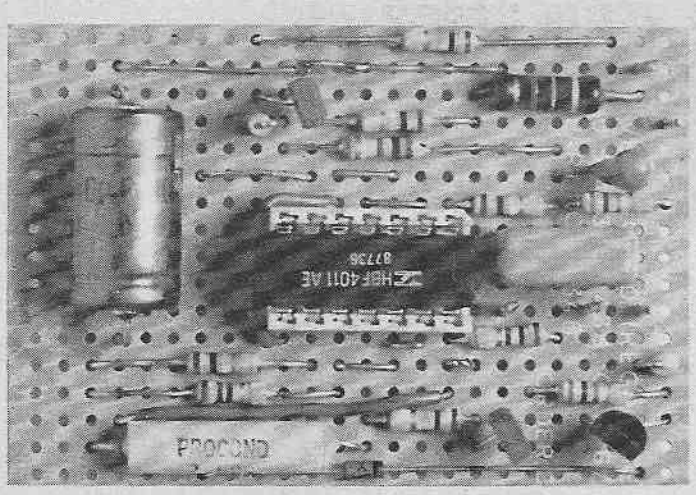
The circuit diagram is shown in Fig. 1. The circuit has three basic inputs, +12V, IGNITION and LIGHTS. The 12 volt supply (car battery) is connected at all times. The current drain of the circuit is negligible and the car could be left for weeks without the battery becoming flattened. A car clock consumes far more.

The +12V supply is filtered by R1 and C3 which removes any noise on the line. The filtered supply is taken to R5, R7 and pin 14 of IC1, a quad dual-input NOR gate.

The ignition line is also filtered, this time by R2 and C1. When the ignition is turned on, TR1 is turned on via the flow of current through its base network R3 and R4. The collector of TR1 is therefore pulled low, taking the input to pin 6 with it.

Fig. 1. The complete circuit diagram of the Lights Warning System. LP1 is a 12V bulb up to 2 watts and is only required if no in-built panel light is available.





The prototype component board. This differs from that shown below where D2, D3 and R14 have been incorporated on the board.

COMPONENTS

Resistors

R1	470Ω ¼W	R8	100kΩ
R2	1kΩ	R9	100kΩ
R3	10kΩ	R10	1·5MΩ
R4	2·2kΩ	R11	10kΩ
R5	100kΩ	R12	2·2kΩ
R6	10MΩ	R13	10kΩ
R7	1MΩ	R14	47Ω ¼W carbon

All ¼W carbon ± 5% unless stated otherwise

See **Shop Talk** page 323

Capacitors

C1 0·1μF polyester
C2 0·47μF 16V tantalum
C3 100μF 16V elect.
C4 0·33μF polyester

Semiconductors

D1 OA200 or similar silicon diode
D2, 3 1N4001 or similar 1A rectifier (2 off)
TR1, 2 BC108 *npn* silicon (2 off)
TR3 BC307B *pnp* silicon
IC1 CD4011 CMOS Quad 2-input NAND gates

Miscellaneous

0·1 inch matrix stripboard size 25 strips × 18 holes; Veropins (7 off); 14 pin d.i.l. i.c. socket; 7-way 2-amp screw terminal block; case.

COMPONENTS approximate cost £2·20 excluding case

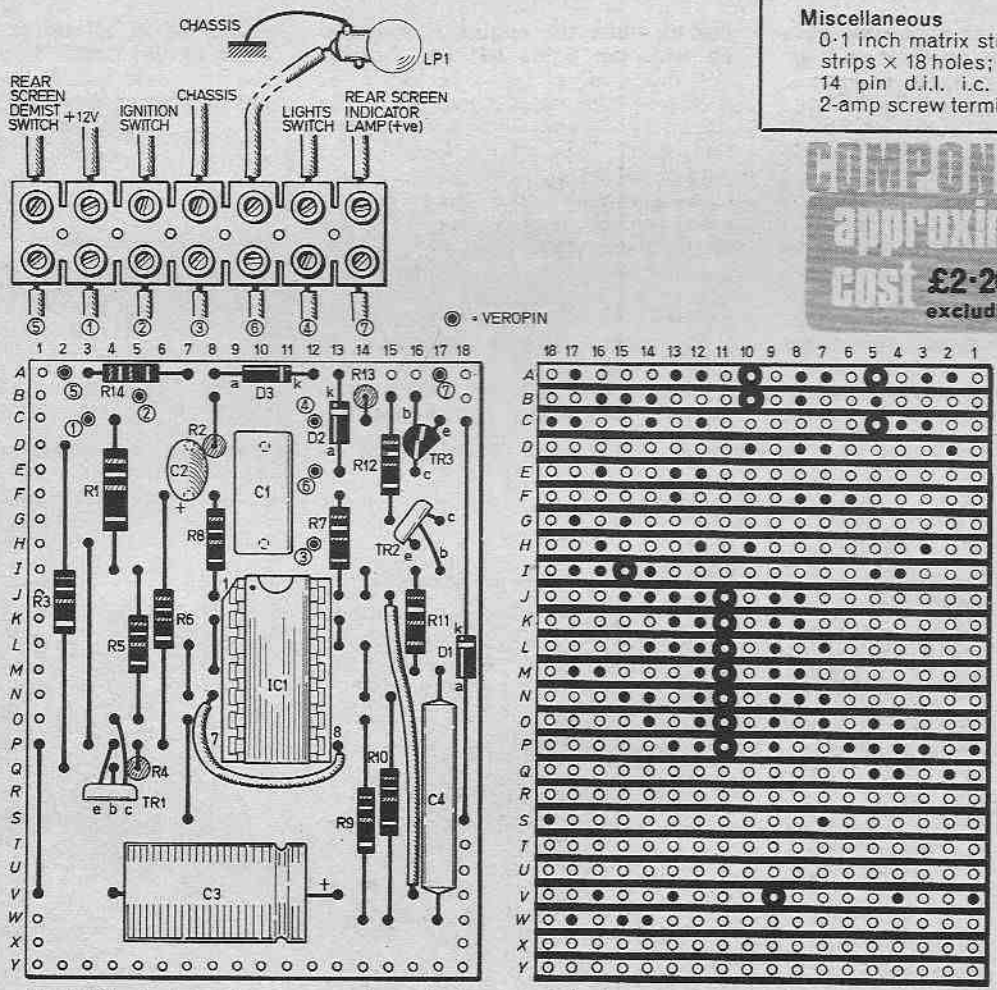
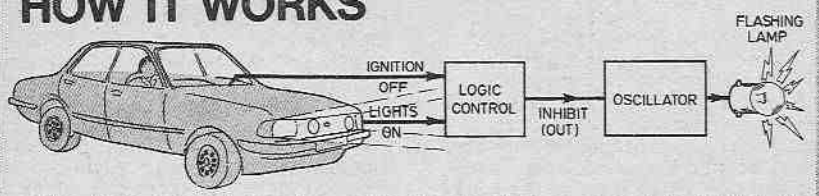


Fig. 2. The layout of the components on the topside of the board and the breaks to be made in the copper strips. Numbered leads from the terminal block refer to Veropins on board. Only one indicator lamp should be used, either LP1 or existing panel lamp for some other function (e.g. rear screen demister indicator).

HOW IT WORKS



The logic control circuitry normally provides an output to inhibit the operation of the oscillator (it does not oscillate). However, when a condition arises where the lights are on and the ignition is turned off, the logic output changes and allows the oscillator to operate. This activates a warning lamp (or buzzer) inside the car to flash (or sound). The logic circuitry has a built-in parking facility which is enabled by turning the lights off and then on after the alarm has sounded.

A bistable latch is formed with IC1a and IC1b which can be set and reset by placing a low on pins 1 and 6 respectively. Once the latch is set or reset it remains in that condition indefinitely until the corresponding input is taken low to change it.

Pin 1 is normally held slightly below positive rail voltage (logic 1) by the network R6 to R8. We shall now assume that the car is being driven with the lights on. The IGNITION and LIGHTS lines are both high (logic 1) and TR1 collector is low. The output from pin 3 is low.

OPERATION STAGES

The driver arrives at his destination and turns off the ignition. The ignition line goes low, and TR1 turns off; pin 6 goes high. The low excursion of the ignition line takes pin 1 low, via C3. Capacitor C3 then charges via R7 so that pin 1 is high again. The low on pin 1 has, however, set the latch, so that the output from pin 3 is high. This output is taken to pin 8 where it enables the relaxation oscillator consisting of IC1c and IC1d to operate.

The output from pin 11 pulses alternately high and low, at a rate determined by the time constant (C4×R10). In this case a rate of approximately 1Hz is obtained.

The output from pin 11 is taken via R11 to TR2, and turns TR2 on and off. Likewise, the output from TR2 turns TR3 on and off, via the network R12 and R13. Transistor TR3 is a *pnp* transistor fed from the LIGHTS rail. Its output is taken to a suitable indicator lamp LP1, for example 12V 100mA.

In the author's prototype, the lamp used was the fitted rear screen demister indicator. This is fed via D2, R14 and D3, so that the light is on dimly when the demister is in use, but when the alarm turns on, the lamp flashes brightly.

PARKING FACILITY

It will be noticed that D1 is also connected to the LIGHTS line. When the driver turns the lights off, the cathode of D1 goes low, and the input to pin 6 is pulled low. This resets the latch, and cancels the alarm. The lights can then be turned on again, but since the latch has been reset, the alarm condition is no longer given. The output at pin 3 will now be low, and so will pin 11. Thus TR2 and TR3 are turned off.

If the driver, instead of switching his lights off, starts his engine after an alarm has been given, TR1 turns on again and pulls pin 6 low, so resetting the latch and cancelling the alarm.

It will be observed that pin 6 is permanently low while driving. This ensures that no transient pulses from the car can set the latch and give a spurious alarm. This could be a most disturbing situation in the middle of a motorway, for example.

This system has been in use from the winter of 1977 onwards without malfunction and has proved very useful.

Those readers wishing to use a separate alarm lamp or buzzer may dispense with D2, D3 and R14. The lamp is then connected between chassis and the collector of TR3.

CONSTRUCTION starts here

CIRCUIT BOARD

All the components (except the indicator lamp or buzzer) are mounted on a small piece of 0·1 inch matrix stripboard size 25 strips by 18 holes. The component layout on the topside of the board and the breaks to be made on the underside are shown in Fig. 2. This differs slightly from the author's prototype as shown in the photograph where D2, D3 and R14 were mounted around the alarm lamp.

The prototype was wrapped in foam sponge and this held the board in position in the case. If a bolt fixing is preferred, the board should be extended to accommodate the fixing holes. The screw-terminal block can be fitted to the outside of the case which should be equipped with lugs.

ASSEMBLY

Begin by making the breaks on the underside and fitting the Veropins and i.c. socket. Continue with the link wires, resistors, capacitors and semiconductors in this order. Solder sufficient lengths of flying leads and secure these to the terminal block. Finally insert IC1 and the unit is ready for assembly in its case and installation in the vehicle.

Note that if a buzzer is used in place of a lamp, a diode, must be connected across its coil to prevent the back e.m.f. generated when activated, from damaging TR3. The cathode of the diode should connect to TR3 collector with its anode connected to chassis, i.e. the diode is normally reversed biased.

INSTALLATION

It is recommended that the unit be installed inside the car in an area not prone to excessive temperature changes (e.g. heater flow duct) or moisture build-up. The glove compartment is a likely position.

All the connections from the terminal block should be made with flexible (multistrand) wiring to reduce possibility of vibration fractures. Connection to the required points in the electrical system are best made with push-fit spade connectors or the "piggy-back" type. Self-adhesive foam pads are suitable for fixing the case to a horizontal surface and do provide some form of shock absorption. □

"I was going to construct a Time Machine, but there's no future in it."

By Dave Barrington

For The Workbench

We would think that with the "shrinkage" in size of most electronic components over the years, a light duty vice is now considered a must for most workshops. Two such products worthy of consideration for addition to the workshop are the OK VV-1 vice and the Absonglen Minibench.

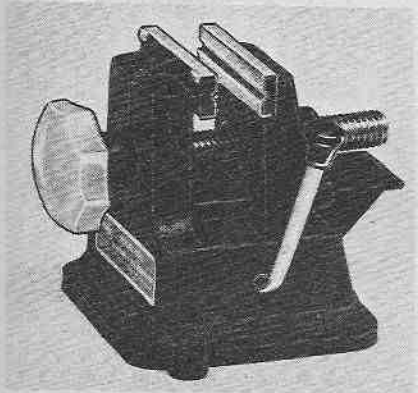
Both professional and amateur will find OK's new VV-1 light duty vice ideal for handling small components and assemblies.

The 33mm jaws are adjusted by a knob which takes the place of the usual "tommy" bar. Normally the vice would be fixed to worksurfaces by a lever operated suction mechanism but where permanent installation is required it can be screwed down.

The VV-1 vice is available from OK Machine & Tool (UK) Ltd., Dept EE, Dutton Lane, Eastleigh, Hants., SO5 4AA, price £3·58 inclusive of packaging.

Although we have not had the pleasure of trying the Minibench we like the idea of gripping small boards in its jaws and being able to "flip" the workpiece over for component mounting and soldering. Another good feature is the facility for flexible arms terminating in crocodile clips to hold components and possibly to act as heat sinks.

Further information can be obtained from Absonglen Ltd., Dept EE, The Forge, Staplow Cottage, Staplow, Ledbury, Herefordshire, HR8 1NP.



VV-1 vice from OK Machine & Tool

Magnetised

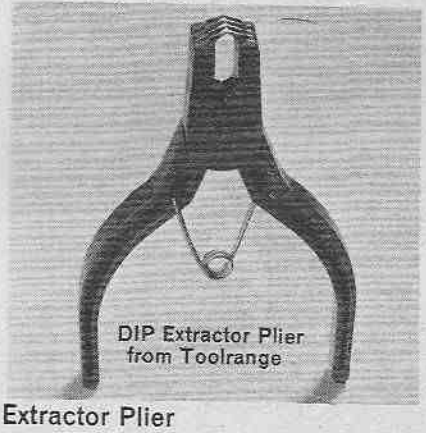
An item which you would not normally associate with the amateur workshop, but once used soon becomes an invaluable "tool" is the magnetiser/demagnetiser.

Ideal for demagnetising those screwdrivers and drills which have a habit of becoming magnetised, without reason and picking up any metal debris, including nuts and bolts, often found on the workbench and depositing them in the workpiece before you can take any action. Then there's the opposite case where you wish you had a magnet to reclaim an item which had accidently dropped into the "works" and caused untold time wasting and curses trying to devise other methods of retrieval.

A suitable magnetiser/demagnetiser, at a fairly low budget price of £9·95, is available from Magnadyne Products and may prove to be a worthwhile investment for those "butterfinger" types like myself.

Claimed to be capable of producing a bar magnet up to 9mm diameter and any length, the magnetiser/demagnetiser is available from Magnadyne Products, Dept EE, 6 Lulworth Road, Welling, Kent, DA16 3LQ.

Magnadyne magnetiser/demagnetiser



DIP Extractor Plier from Toolrange

Extractor Plier

Another unusual item, available from Toolrange, which may appeal to the constructor who has tried to remove i.c.s from circuit boards is the DIP Extractor Plier, price £6·50 plus VAT.

It is claimed that this new hand tool will remove 8 to 40 pin dual-in-line devices from sockets and desoldered circuit boards in seconds. The teeth of the pliers grip devices as close as 0·25in in densely packed boards. The pliers are insulated for live board work and the metal teeth also act as a heat sink and shorting bar.

PLEASE NOTE

All prices quoted in this issue are **Pre-Budget**

Soldering Irons

A new range of soldering irons from S & R Brewster Ltd., may be worth further investigation.

These irons are the Ceco Vari-Stat range, for which they have acquired the manufacturing and sales rights, used extensively by the trade.

Amongst the range is the S.R.B. "Mighty Midget" which is an excellent 18 watt iron with interchangeable bits suited for our type of work. The more robust of their range, primarily designed for industrial use, are temperature controlled and rated from 50W to 500W. For more details readers should contact S & R Brewster Ltd, Dept EE, 86-88 Union Street, Plymouth, PL1 3HG.

Another company we must not overlook when we are talking about soldering iron requirements is Light Soldering Developments Ltd.

They cover such an extensive range that you can practically hand pick one to meet your own personal needs, including a "carry-it-anywhere" cordless type with built-in recharger.

For more details and leaflets readers should write to Light Soldering Developments Ltd., Dept EE, 97/99 Gloucester Road, Croydon, CRO 2DN.

CONSTRUCTIONAL PROJECTS

Availability of components for this month's constructional articles should not cause too much difficulty and should only be a matter of looking through advertisers catalogues.

Dual Line Game

In view of the large quantities of transistors and diodes called for in the *Dual Line Game* it would seem to be a good idea to approach advertisers regarding a special "bulk purchase" price for these items. A discount price may also be available for the 3·5mm jack plugs and sockets. The rest of the components for this project should be ready available items.

Most advertisers will probably supply the BC108 in the metal TO-18 can. This also applies to the Lights Warning.

Battery Voltage Monitor

The multiturn preset potentiometer VR1 listed in the *Battery Voltage Monitor* project is available from Watford Electronics and Maplin Electronic Supplies. However, there is no reason why a standard miniature preset potentiometer should not be used with a slight loss in fine adjustment.

Lights Warning System

The CD4011 used in the *Lights Warning System* is a standard CMOS i.c. and is usually generally available from most advertisers. Transistor type BC307B is listed by Watford Electronics. The suffix B denotes the gain of the device.

Pretuned 4-Station Radio

The ferrite coil needed in the *Pretuned 4-Station Radio* is the Denco type MW/LWFR5 and is stocked by Watford, Maplin and Ambit International. Suitable trimmer capacitors for C1 to C4 are available from Home Radio as types VC29LC and VC29L.

We cannot foresee any buying problems for the *Uniboard—Audio Tone Generator* and the *Auto Fade* projects.

Part 8

By S. R. Lewis, B.Sc.

ENTER THE EXCITING WORLD OF ELECTRONICS

TEACH-IN 80

FOLLOWING last month's description of the basic principles of transistors, we will now go on to look at one of the most important uses of transistors—as simple **two-state devices,** with a clearly defined ON state and OFF state.

In isolation such circuits can be used to drive simple devices such as indicator lamps or relays but together with other similar circuits they can form part of a logic circuit such as may be found in a digital computer.

ANALOGUE AND DIGITAL

Over the past twenty years or so electronics has divided into two main fields: **analogue** and **digital.** They have almost become two separate disciplines since the techniques used in each appear to be completely different.

Analogue electronics is concerned with the generation and manipulation of continuously changing signals. The term "analogue" is used since the electrical signals are often an analogue of some physical quantity. For instance, an amplifier has voltages inside it which are analogies of the sounds which we want to hear—voltage is used to represent air pressure.

In digital circuits only two states are normally to be found for any particular section. These two states are used to represent the two logical alternatives **true** and **false.** By coding information in terms of complicated patterns of true and false, complex and manipulations can be carried out on the data at incredible speeds.

Analogue electronics is the older field, probably since continuously variable signals occur more often in nature than discrete signals. A wave in water or sound travelling through the air can be simulated using electronic voltage to represent height of the wave or sound pressure. Fig. 8.1 shows an analogue and a digital signal compared.

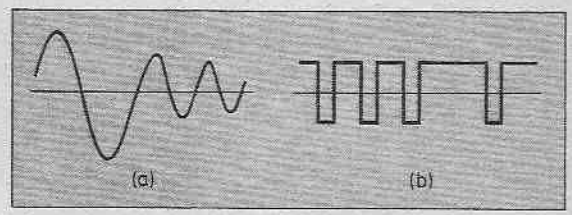


Fig. 8.1. The analogue signal shown at (a) varies continuously between its limits whilst the digital signal at (b) only takes two distinct values, the change from one to the other being very rapid.

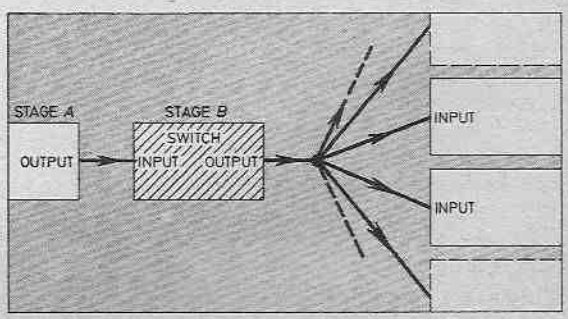


Fig. 8.2. A switch which is part of a system must be able to switch other similar circuits and must be capable of being switched by a circuit similar to itself.

Digital circuitry implies a more abstract conception of real situations but the power of this approach can be judged by the proliferation of digital machines in more and more aspects of modern life.

The purpose of this month's part is not to look at **"logic"** in the abstract but to look at how transistors can be used as two-state devices and how they can be combined to do useful tasks.

THE TWO STATES

The basis of the digital approach is that the transistor is used simply as an on/off switch, the two states representing "true" and "false."

It does not matter which state we use to represent true provided *all* the circuits are designed with the same convention. Also it does not matter what the absolute voltages are which are used to indicate true and false; provided there is no possible way in which they can be confused we are quite safe.

The two states which we are trying to achieve must therefore be stable, repeatable and independent of variations in the transistors themselves.

Of course, there must be a time when the transistor is in neither the ON state or the OFF state, that is when it is changing from one state to the other, but we must make sure that the time the transistor spends in this intermediate state is as small as possible and that it cannot get stuck in this undesirable position.

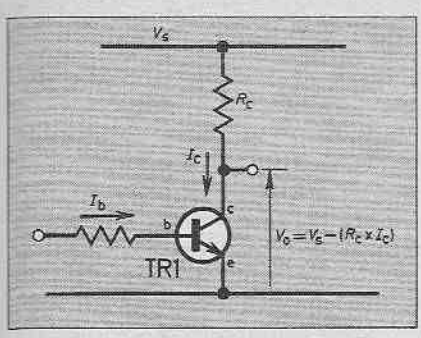


Fig. 8.3. A simple transistor switch using the common emitter configuration. The base current must be greater than that just needed to saturate the transistor.

Let us look at how the circuitry around a transistor can be designed so as to achieve the conditions we require.

If the switch that we are designing is to be used along with other similar switches in a system, then it must both be capable of being switched by another stage and of switching other similar stages.

Fig. 8.2 shows how the switch might fit into a system. Note that we do not allow *outputs* of different switches to be connected together as we could get into a situation where one switch is trying to switch on and the other off—which one wins will be a matter dependent on the circuitry rather than the inputs to the two switches.

However more than one *input* can be connected together since a switch will often be required to drive many other switches.

THE OFF STATE

If we define the transistor as being off when no current flows in its collector then we can achieve this quite simply with a common emitter circuit by either leaving the base open circuit or by making sure that the voltage on the base is not high enough to forward bias the base-emitter junction.

Now, since we have said that the switch must be able to be driven by another similar switch, the option of open-circuiting the base is not possible. We must therefore make sure that the voltage on the output of our switch is well below the voltage needed to forward bias base-emitter, that is about 0·7V for a silicon transistor.

As we saw last month, the current through the collector will never be exactly zero as some leakage current will flow even when the base is not forward biased. However, this current is so small that it can be ignored in this context.

When the transistor is in this state we say that it is "cut-off".

THE ON STATE

Looking at the circuit of Fig. 8.3, if the base current is gradually increased from zero the current in the collector resistor R_c will gradually increase and the voltage at the collector will fall steadily because of the increasing voltage across the resistor.

Now the voltage at the collector cannot fall to zero but reaches a minimum of about 0·2V for a silicon transistor. In order that this voltage is reached no matter what the gain of the transistor, we can use a safety factor of ten by making the base current ten times that which is needed to just saturate the transistor, assuming minimum gain.

For a BC108 the minimum gain is 110 so providing the base resistor is ten times the value of the collector resistor we can be certain that even at worse case the output voltage will be around 0·2V when the input is taken to the positive supply.

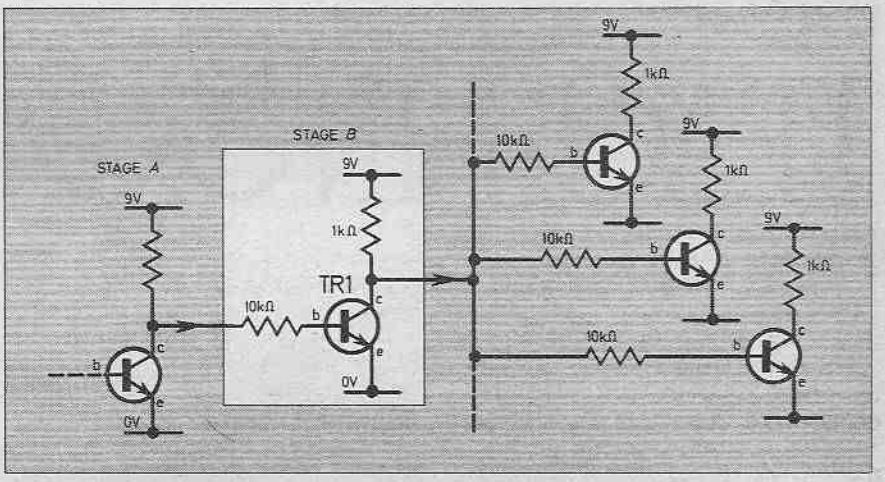


Fig. 8.4. The transistor switch (Fig. 8.3) as it looks when in a system. Note that only one output feeds it whilst it feeds many inputs.

Increasing the base current still further produces a lower voltage at the collector until a point is reached when increasing the base current any further produces virtually no change in the collector voltage.

What has happened is that the base current has produced a current in the collector which produces a voltage across the collector resistor which is almost equal to the supply voltage. Obviously this resistor cannot drop more than the supply voltage so the extra base current has very little effect.

We call this state **saturation** for obvious reasons. To define saturation more rigorously we say that saturation will be reached when the base current exceeds the maximum collector current (the power supply voltage divided by the collector resistor) divided by the h_{FE} of the transistor.

$$\text{Saturation: } I_b > \frac{V_s}{R_c} + h_{FE}$$

RESISTOR VALUES

To put in some resistor values then let us use a 1 kilohm collector resistor and a 10 kilohm base resistor. Does the circuit thus produced fulfil our needs? To find this out we have to slot the circuit we have produced back into our original system of Fig. 8.2 (see Fig. 8.4).

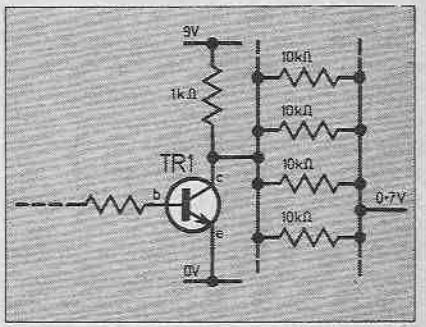


Fig. 8.5. The loading on the switch in Fig. 8.4 can be redrawn thus. The load appears as a number of 10kΩ resistors in parallel all to 0·7V.

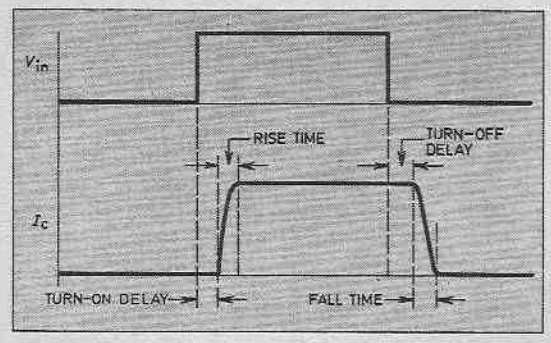


Fig. 8.6. When a pulse is applied to the input of our switch the output does not change instantly but with the delays as shown here.

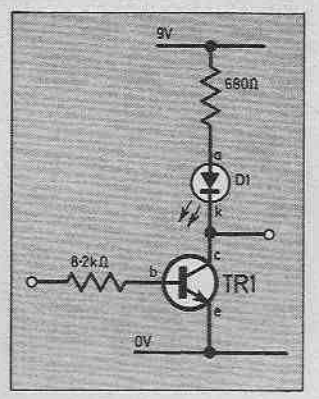


Fig. 8.7. If it is desired to drive a light emitting diode from one of our switches then the circuit shown can be used.

Assume the first stage (*A*) is on so that the output voltage is 0·2V. The base emitter junction of the second stage (*B*) cannot be forward biased as the voltage to do this is 0·7V. Thus stage *B* will be off (no current in its collector resistor). Now the collector resistor of stage *B* has to supply the base current to all the other stages to which it is connected.

Each stage has a 10 kilohm input resistor, all of which have 0·7V on their lower ends if their respective transistors are conducting. We can thus draw the loading on stage *B* output as in Fig. 8.5.

Note that if ten stages are connected to output *B* then the voltage drop across its collector resistor will be 4·15 volts and the current through each of the base resistors will be only half of that stipulated in the first design.

If we now say that this current is our absolute minimum then we are merely stating that one of these circuits can drive no more than ten similar circuits.

This figure is called the **fan-out** of the circuit since it defines how many other circuits we can fan out our output to.

Apart from this restriction our circuit seems to meet the criteria of two distinct states, independent of the transistor variations. But how long does it take to switch from one state to the other?

SWITCHING SPEED

To predict how long a switching circuit takes to go from one state to the other requires a much deeper investigation of the workings of a transistor that it is possible to present in this series. However, we can look at the actual behaviour of the circuit and make some remarks about the speed of switching circuits in general.

Assuming we are driving the switch with a voltage that changes from high to low and back again in zero time, what will the output of the circuit under consideration look like? Fig. 8.6 shows the input and output waveforms that we are likely to see.

We see that the output does not follow the input immediately but both at "switch on" and "switch off" it goes through two stages.

There is a delay when nothing appears to be happening followed by a gradual change from one state to the other. The delay before the transistor switches on is due to the time taken for the base voltage to build up to a value sufficient to forward bias the base-emitter junction. After this the collector current increases steadily to its final value. We call these two times the **turn-on delay** and the **rise time.**

Now, we are putting much more base current into the transistor than is needed to produce the collector current that we have. When the input voltage is taken to zero this extra current is "remembered" in the form of a charge within the transistor which tends to keep the transistor on for a short time. This is called the **turn-off delay.** After this the collector current falls steadily to the off state. This is called the **"fall time".**

You may have got the impression that we have a very slow circuit but it must be realised that the times we are talking about are measured in millionths of a second (microseconds or μs) or less so that even this very crude switch is extremely fast by everyday standards.

HIGH CURRENT LOADS

Quite often the requirement will arise to be able to drive some sort of output device such as a lamp or a relay using a simple switch such as the one we have described. We used light emitting diodes in an earlier section of this series to indicate the flow or absence of current, so how would one of these be driven by a transistor?

First ascertain the current needed through the load; for an l.e.d. this would be about 10mA. Now the l.e.d. will drop about 1·6V when it is conducting. The transistor if fully on will drop about 0·2V so that we must use a series resistor to drop the remaining voltage which will be the power supply minus (1·6+0·2)V. For a 9V supply the resistor must drop 7·2V at 10mA. This works out as 720 ohms, the nearest preferred value being 680 ohms.

Assuming the transistor has a minimum gain of 100 then a base current of 0·1mA will just saturate the transistor. Allow a safety factor of ten, giving a required base current of 1mA. If we are driving this switch from a similar one then we must be rather careful in selecting our base resistor since our base current has to flow through the l.e.d. of the previous stage.

A base resistor of 8·3 kilohm is needed if connected to the power supply, so dropping this to 6·8-kilohm should give some allowance for the voltage drop across the l.e.d. and its resistor.

But note: if we try to feed two similar stages then the current through the output l.e.d. will be 1·5mA, enough to illuminate it! Therefore this circuit has a much lower fan-out than the transistor switch described previously. In fact it has a fan-out of only 1. Fig. 8.7 shows the circuit.

A TWO-STAGE CIRCUIT

As an alternative to a l.e.d. we might want to drive a relay which needs say 100mA. Out first problem is that 100mA is the maximum current for a BC108 transistor so right away we must look for a transistor with a greater current capability than this.

The next problem is that using our "ten times" criterion means that we need 10mA to switch on the driving transistor and if we want to drive it from the output of one of our simple transistor switches, this value of current is just not available.

The answer to the problem is that we will have to use a two-stage circuit of some kind: the first one to "buffer" the output of the driving switch from the high current demand of the relay driver.

A simple circuit is shown in Fig. 8.8. The first transistor (TR1) needs only 1mA to switch it on. When it is on there is only 0·2V on the base of the driver (TR2) so the latter is off. When the first transistor is off then 10mA base current flows into the driver through the collector resistor of the first transistor which now becomes the base resistor of the second.

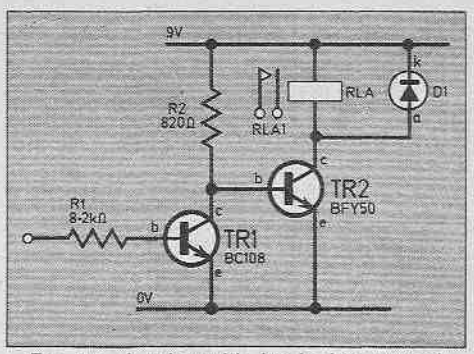


Fig. 8.8. A relay with its higher current requirement and back e.m.f., requires a slightly more complicated circuit. This circuit also produces an inversion of the logic input.

DIODE PROTECTION

Note the diode across the coil of the relay. This is to protect the transistor from the large back e.m.f. which is produced when the transistor switches off.

The current which flows when the transistor is on cannot disappear instantaneously as the inductance of the relay coil acts as a store of current. If the diode is not there the voltage at the collector would rise to many tens of volts and could destroy the transistor.

The diode clamps the voltage at the collector to the supply voltage plus one diode forward voltage drop (0·7V). This does mean that the energy in the relay takes longer to be dissipated but we are not interested in this time for our particular application.

One further point to note about this circuit is that it inverts the sense of the input. When the input is high (near the positive supply) the relay is off and when the input is low (near the 0V supply) the relay is on.

EXPERIMENT 8.1: LED DRIVER

Components needed: 680Ω ¼W resistor (2 off), 10kΩ ¼W resistor (2 off), BC108 transistor (2 off).

In this simple experiment we use a switch to provide the input signals for a light emitting diode driver which then drives another similar stage. The circuit is shown in Fig. 8.11a and the layout on the Tutor Deck in Fig. 8.11b.

With the switch in one position, l.e.d. D1 is on and l.e.d. D2 is off. The situation is reversed when the position of the switch is changed, showing the inverting action.

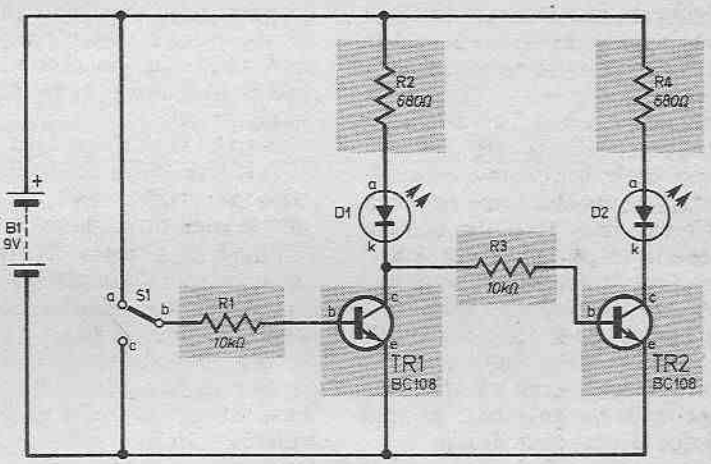


Fig. 8.11a

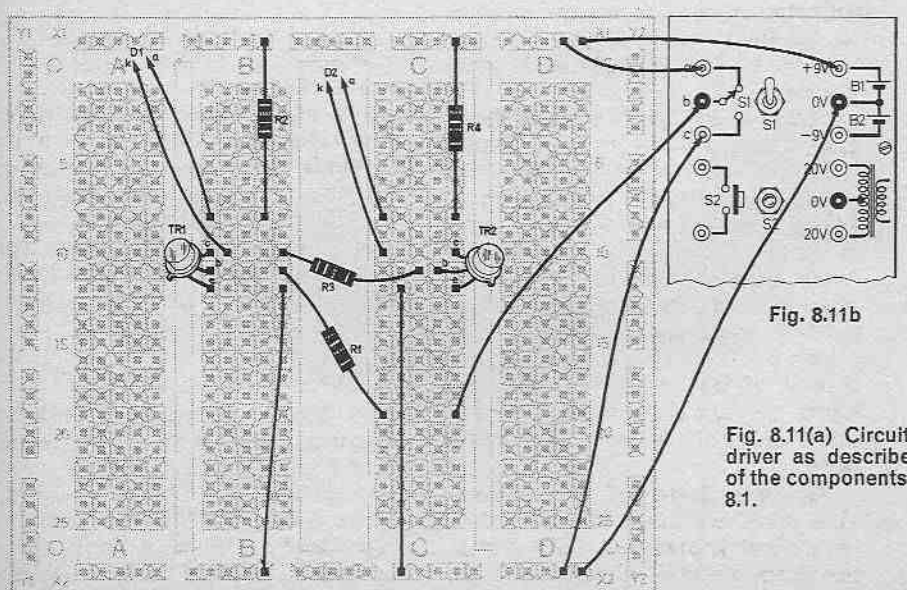


Fig. 8.11b

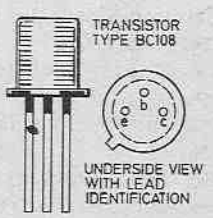
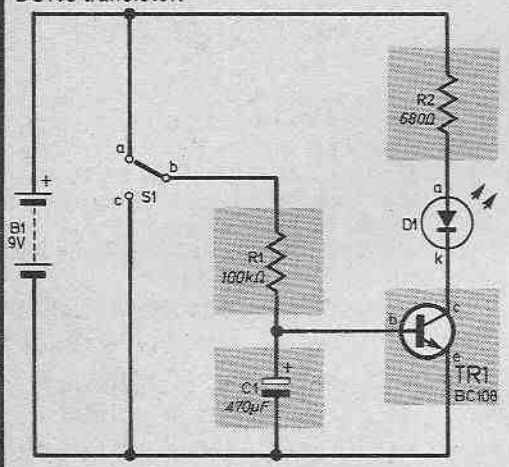


Fig. 8.11(a) Circuit diagram of the two stage l.e.d. driver as described in Experiment 8.1. (b) Layout of the components on the Tutor Deck for Experiment 8.1.

EXPERIMENT 8.2:
SWITCH WITH DELAY

Components needed: 680Ω ¼W resistor, 100kΩ ¼W resistor, 470μF 16V capacitor, BC108 transistor.



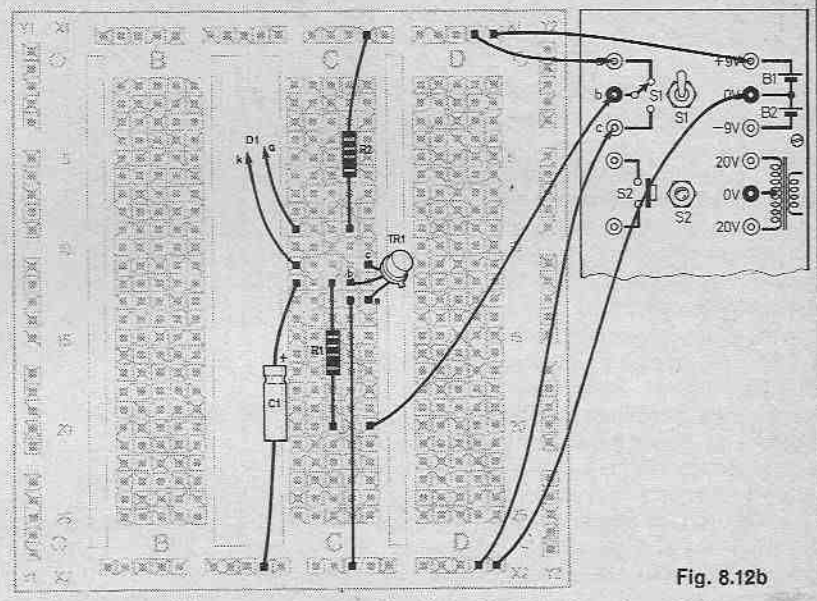
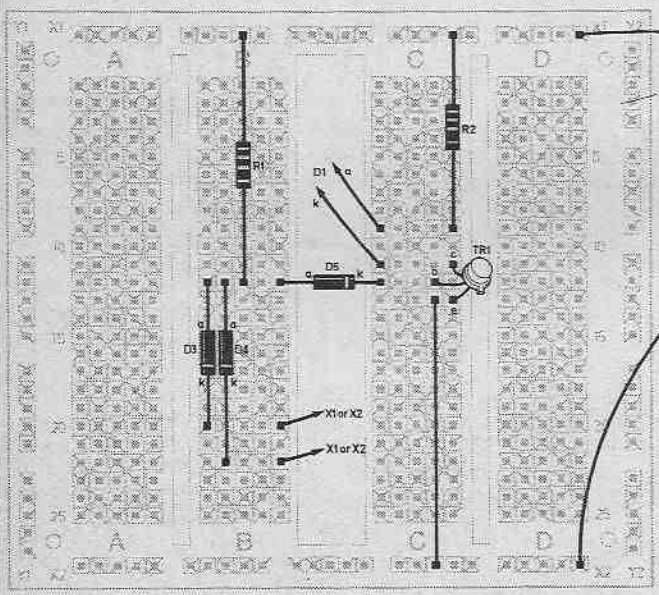


Fig. 8.12b

Fig. 8.12(a) Circuit diagram of Experiment 8.2. (b) Layout of the components on the Tutor Deck for Experiment 8.2.

This experiment shows how the charging time of a capacitor can be used to produce a delayed switching circuit. The circuit is shown in Fig. 8.12a and the layout in Fig. 8.12b.

The switch is used to switch the l.e.d. on and off but the change in the state of the l.e.d. occurs some time after the change in the state of the switch. The capacitor has to charge (or discharge) through the base resistor before the base becomes forward biased and the transistor switches on (or off).



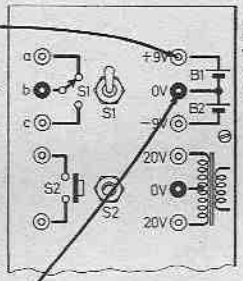


Fig. 8.13b

EXPERIMENT 8.3:
TRANSISTOR-DIODE NAND GATE

Components needed:
680Ω ¼W resistor,
10kΩ ¼W resistor,
IN4148 diodes (3 off),
BC108 transistor.

Fig. 8.13(a) Circuit diagram of the two input NAND gate as described in Experiment 8.3. (b) Layout of the components on the Tutor Deck for Experiment 8.3.

In this experiment the simple AND gate using two diodes (see Fig. 4.11) is improved by adding a transistor switch. Note, however, that the diode AND gate is now a diode-transistor NAND gate because the transister switch produces an inversion of the logic levels.

The circuit is shown in Fig. 8.13a and the Tutor Deck layout in Fig. 8.13b.

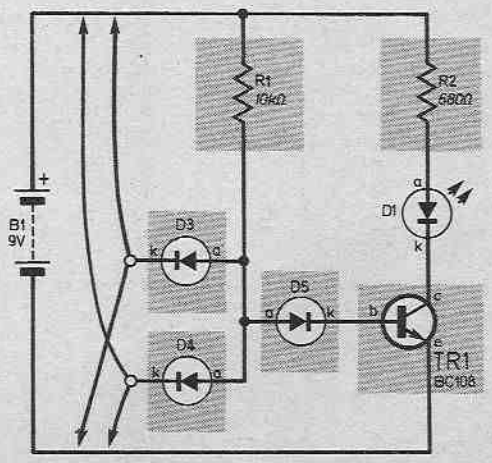


Fig. 8.13a

LOGIC GATES

When we looked at diodes (Part 4) we saw how a simple logic "gate" could be formed which gave a "true" output only when *both* inputs were "true". The problem with the gate shown there (Fig. 4.8, Fig. 4.9) was that it could not easily be connected to other circuits of the same type.

Combining the *diode gate* with a *transistor switch* produces a gate circuit which can be connected to many other circuits.

Note the extra diode D3 that is needed in the base circuit of the transistor (Fig. 8.9). This is necessary because even with both diodes (D1, D2) fed with a low voltage (0·2V) from previous stages, the voltage at the base of the transistor without the extra diode would be 0·2+0·7V. This is more than enough to forward bias the base-emitter junction and switch the transistor on when it should be off. The extra diode reduces the voltage at the base to 0·2V so that it is well and truly **off.**

DIGITAL INTEGRATED CIRCUITS

Because of the importance of digital techniques, a lot of work has gone into producing switching circuits which act at extremely high speeds yet consume as little power as is possible. The huge number of switches needed in a large digital computer led to the development of **integrated circuits** which are packages in which a large number of transistors and resistors and diodes are fabricated on a single piece of silicon (a "chip").

PART 8 QUESTIONS

8.1. The collector to emitter voltage of a saturated transistor is:
a) 2V c) 5V
b) 0·2V d) 0·7V

8.2. What current into the base is needed to saturate a transistor with h_{FE} = 50 and collector current of 100mA:
a) 100mA c) 2mA
b) 1mA d) 10mA

8.3. To increase the fan-out of our switch we could use a transistor with different characteristics. Which of the following is most useful, all other parameters being the same:
a) higher gain
b) higher power
c) higher collector current capability
d) higher speed

8.4. Switching time of a transistor switch depends on which of the following:
a) type of transistor
b) the circuit used
c) both of these
d) neither of these

8.5. What does TTL stand for:
a) Two transistor levels
b) Transistor timing logic
c) Transistor transistor logic

PART 7 ANSWERS

7.1. a) 7.2. c) 7.3. b) 7.4. a) 7.5. b)

The most dominant technology in digital integrated circuits over the last ten years has been **Transistor Transistor Logic** or **TTL** for short.

TTL circuits have now become extremely cheap because of the vast quantities in which they are made. They are very fast, switching speeds being measured in thousandths of millionths of a second (nano seconds or ns) rather than microseconds. They are reliable and can drive many other similar circuits. Nowadays improved versions of these circuits have been produced which are even faster and consume far less power.

A typical TTL circuit is shown in Fig. 8.10. Some special features worth noting are the input transistor TR1 with its multiple emitters which act just like the diodes in our simple gate, and the fact that the collector resistor of the output transistor TR3 has been replaced by another transistor TR4. This gives the circuit the capability of driving other circuits at higher speeds than would be possible with just a simple resistor.

Other technologies that are popular are CMOS which has the advantage of working with a wide range of supply voltages whilst consuming only miniscule amounts of power and PMOS which is used for cramming vast numbers of circuits onto a single piece of silicon since each transistor can be made very small.

In a later part of this series we will look at CMOS logic and go a little further into its capabilities.

Next month we will consider the transistor as a linear amplifier.

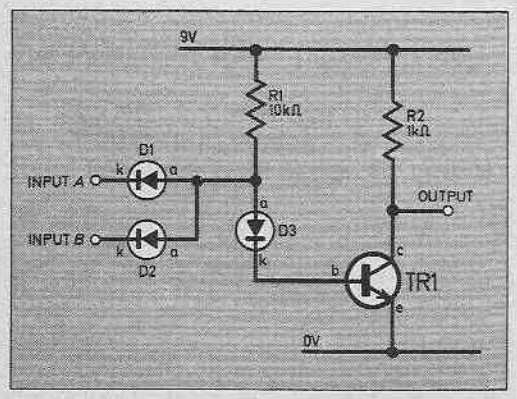


Fig. 8.9. The circuit shown is a logical NAND gate. Only when both inputs are high does the output go low.

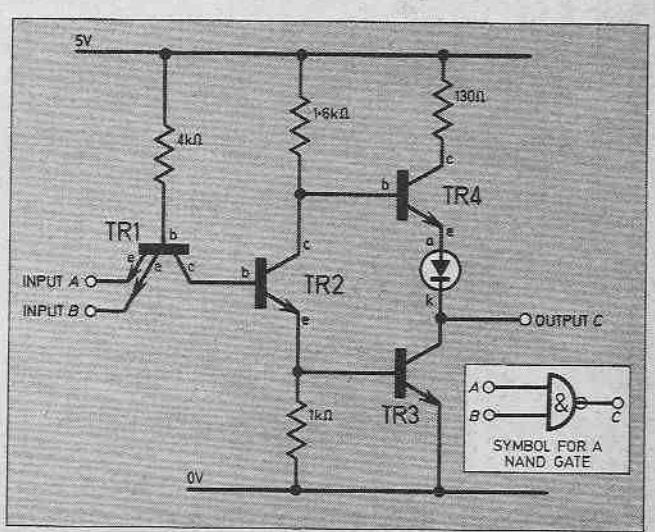


Fig. 8.10.(right) The circuit of a TTL two-input NAND gate which performs exactly the same logical function as the circuit of Fig. 8.9 but a great deal more effectively.

ELECTRONIC WARFARE

BY G. A. G. BROOKE

A TELEVISION feature described some of the secret cat and mouse activities in World War II that are now called Electronic Warfare. And from time to time this intriguing term appears in the press, as for instance the announcement by Decca Radar of the order for £2 million work of "EW equipment" to be installed in new Danish warships. Little else was said and in fact intimate details are never published by the manufacturers or armed forces conconcerned.

This is generally in line with military necessity; but new aircraft, for instance, are often itemised minutely, particularly in American specialist magazines, so why this secrecy about Electronic Warfare equipment and what is it anyway?

A major chess game is in continuous operation between NATO and Iron Curtain electronic design engineers, each side trying to get a step ahead of the other. As made clear in the TV programme, there is nothing new about this, the first instance of the use of EW having been by the Royal Air Force in April 1942.

As soon as a radar is switched on, either by an aircraft, ship or ground station, two things follow. First, a suitable receiver can supply its operator with several of the radar parameters (from which can be obtained considerable information about their source) and second, after an internal delay for assessment, a jamming device can be set in operation which will confuse the radar's operator.

Bearing in mind that radar first came about for warlike purposes, it was natural that these two activities should follow its introduction almost immediately.

EARLY JAMMING DEVICES

It was a jamming device that first appeared, RAF bombers using it against the German "Freya" early warning radars, and within months an improved version was in use along a 200 mile front. The next year US bombers used "Chaff", thousands of small strips of aluminium foil that were released to provide an effect somewhat similar to dense sea clutter, in order to obscure their own echoes.

Chaff is still in use (a Squadron Leader was recently on record describing an amusingly Heath-Robinson method he thought up for dispensing it from the Jaguar aircraft) but enormous strides have since been made in both monitoring and jamming. Nor is that all: anti-jamming measures on behalf of the radar have been developed and the scene soundly set for our international chess game.

Here it is necessary to introduce the accepted EW jargon. The passive side—monitoring—is ESM (Electronic Support Measures); the active side — jamming — is ECM (Electronic Counter Measures); the defence against jamming is ECCM (Electronic Counter Counter Measures); and there is also Elint (Electronic intelligence, of a future tactical rather than immediately useful nature).

The early jammers (ECM) were simply radio transmitters that radiated a continuous amplitude noise-like signal across the enemy radar's frequency band, already deduced by special aircraft with sensitive receivers (ESM). Generally speaking the radar would receive a strong signal that obliterated that of the inevitably weak echo-return.

In the case of Plan Position Indicator displays, the jamming signal served to illuminate a wedge-shaped sector whose angular width corresponded to the beamwidth of the radar aerial. Because the early radars had relatively wide beamwidths an air-

borne jammer could nullify a large portion of the display. The early aerials also had significant sidelobes and this further assisted the jammer by expanding the width of the "whited-out" section.

COUNTER COUNTER MEASURES

With the Cold War, followed by conflict in Korea and Vietnam, EW continued to develop, particularly ECCM. The airborne jammer had weaknesses that the ground radar could exploit, one being limited power due to limited size and weight. Not so restricted, the ground radar designer had recourse to greater power, defying jamming, and larger aerials with reduced beamwidth and sidelobes.

Another ploy was the use of radar magnetrons which could be rapidly retuned to a different frequency, forcing the jammer either to carry a special operator with radio receiver for monitoring, or to resort to "barrage jamming" across an active band which reduced available jamming power.

Yet another technique was to have two or three different transmitters, so that perhaps three successive radar pulses would all go out on different frequencies. This necessitated a separate jammer for each frequency and the jammer was further embarrassed by the introduction of new types of high power valves which could be retuned more quickly and over a broader band. The advent of the digital computer provided new techniques for processing radar signals that made it easier to detect weak target echoes among jamming.

It might be thought that ECM was now well on top of ECCM but developments in microwave valves were also helping the designers of jammers. For example, valves such as the backward-wave oscillator and voltage-tuned magnetron enabled the jammer to retune more rapidly or to sweep the jamming signal across the known band. The chess game was gathering momentum!

TRAVELLING WAVE TUBE

The travelling wave tube (TWT) amplifier, a broadband linear device was the next ally of the jammer, offering an entirely different approach in that in company with the frequency memory loop it could be used to deceive a radar rather than overwhelm it.

This combination made it possible to receive and transmit back to a ground radar a copy of its own pulses, however varied these might be by ECCM techniques. They stored the received pulse in a memory device and then retransmitted it, so that the radar first received the weak echo return and then an identical but stronger one. The result was a series of spurious targets, each at a different range. This type of jammer was of particular use against radars used for fire control, in particular the many types of missiles which depend on radar for guidance.

MISSILES

The sinking of the Israeli destroyer Eilat by a single (Russian) missile from an Egyptian gunboat one tenth its size in the Six Days War awoke the armed forces of the entire world to the efficiency of missiles. Their cost-effectiveness was such that here was a long range, powerful, accurate weapon that could be carried in a fast patrol boat as easily as in a cruiser.

Almost from that moment there was a rush to arm with missiles, and also of course to arm with the anti-missile capabilities of Electronic Warfare. From then on, activity has been immense and as varied as there now are radar systems to be assisted or combated with specialised departments of major electronics firms doing nothing else.

Fire control radars normally track the target automatically once the human operator has designated it. He does this by assigning it a range tracking gate. The radar locks on and, in effect, turns off its receiver until an echo can be expected at the approximate range of the chosen target, taking its speed into account. This procedure is open to deception jamming by "range gate stealing".

At the outset, the jammer immediately repeats back the received pulse, which allows the radar's

Our heading picture (artist's impression) shows a Vosper Type 21 frigate in an "EW environment". The anti-missiles are intercepting a sea skimming missile and a high flying aircraft, while the ship engages enemy ships with Exocet missiles.

A Decca hand-held lightweight ESM system for use in helicopters and small vehicles.

A typical small ship ESM for gleaning information about enemy radars and their sources.

automatic gain control to adjust to this stronger signal (because it assumes it to be the chosen target). The deception jammer then gradually introduces increasing delays before transmitting back. The radars range-gate circuiting begins to track the stronger jammer signal and gradually wanders off from the correct target range.

BEAM SPLITTING

In order to measure target position within the beam more accurately, modern surveillance radars use a signal processing technique called beam-splitting. This boils down to measuring the point of strongest return because it corresponds to the centre of the beam. A deception-repeater can upset such a technique by using a procedure called inverse-gain. This effects the direct reversal of the normal method of retransmission of the received radar pulse using power proportional to the strength of the received signal.

When the leading edge of the radar beam first (weakly) strikes the jamming aircraft, this retransmits the pulse with *higher* power; and when struck by the strong signal from the centre of the radar beam, the jammer replies weakly. Thus the beam-splitting process is turned on its head.

CONICAL SCAN

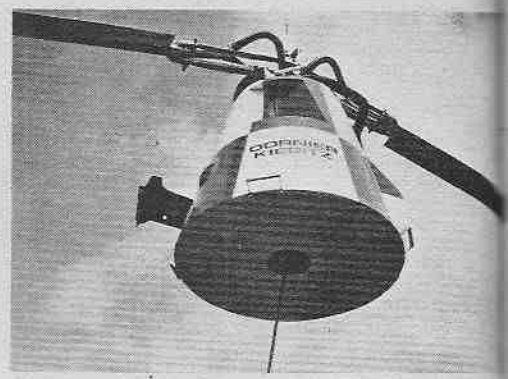
Some fire control radars, both ground and airborne, employ a conical-scan technique to track their targets. The aerial points in the last-known direction of the target and its narrow beam is made to scan across a small arc around the aiming point to ensure that the beam will catch the target occasionally, despite the latter's movements.

This small volume scan is usually effected by a high speed, off-centred rotation of the aerial or its feed. The return will be strongest when the beam is directly on target, it will be weak to zero when the target is only partially or not illuminated at all. The radar continuously compares echo strength with aerial position to determine target position (and to redirect the aerial centre in the right direction).

A deception-jammer can disrupt this type of radar every effectively by retransmitting pulses that are modulated with spurious amplitudes at the conical-scan frequency, i.e. displaced in time-phase. This will cause the radar to sense that the target is, for instance, below and to the left of its aerial position when in fact it is above and to the right. The jammer can gradually introduce errors by increasing the spurious time-phase shift.

An alternative radar design which is not vulnerable to this jamming technique is to use a non-scanning transmit aerial and a separate receive only aerial the beam of which does the scanning. This means that the jammer cannot tell the frequency of the radar's receive aerial, forcing the former to sweep its modulation across a band.

The Electronic Warfare Engagement Simulator built by Plessey. Under development for four years, it can simulate, in real time, many different combat conditions including intensive use of ECM techniques by the supposed enemy. Its purpose is to aid development of new ECM techniques that can be used to protect aircraft flying against fire control radar systems.



Spy in the sky. A German Dornier "Kiebitz" tethered rotor platform goes aloft from its support truck. Unmanned, it takes electronic equipment up to 1,000ft greatly increasing its operation range.

Monopulse radar is another method of frustrating angle-deception jammers. This employs the interferometer principle to measure target angle, using two or more separated receiving aerials for training and two others for elevation (the displaced aerials measuring the relative phase, or amplitude, of the echoes to determine angle).

DOPPLER SYSTEMS

When continuous wave and pulse Doppler type radars were introduced to detect low flying aircraft in ground clutter (see *Rapier Missile System*, EVERYDAY ELECTRONICS, April, 1977) special deception procedure had to be developed. The basic principle of these radars concerns the Doppler shift of echoes due to target velocity.

For the first mentioned (continuous wave) the method of deception is to retransmit the signal with a spurious Doppler shift, gradually increasing its magnitude to cause break-up of velocity tracking. Apart from introducing errors into the system's computation of lead angle, velocity gate wander can result in loss of target tracking when the jammer stops its retransmission.

Against the pulse Doppler type, a TWT is used, the jammer introducing a spurious Doppler shift when it retransmits the received pulses.

AT SEA

Though the foregoing has concentrated on land and air, navies are equally dependent on Electronic Warfare. Ships are loath to use their radars for fear of giving

their presence away to an ESM equipped enemy. When they do, ECCM is employed to the full to confuse the ESM operator.

Chaff is fired from rockets or guns, ships sometimes putting up a modern version of the old smoke screen, behind which they manoeuvre to outwit the detected missiles.

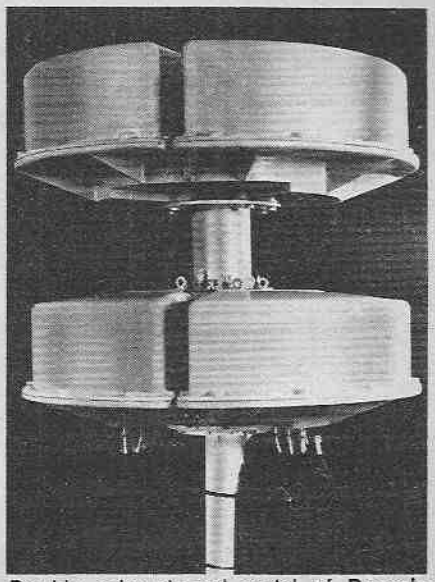
Missiles do not always fly straight, some rise to a great height and plunge down on their target, though the mechanism to ensure accuracy to the necessary few yards beggars the imagination and is of course hideously expensive.

Many types of missiles can be launched from over the horizon, directed by near real-time targeting data provided by reconnaissance aircraft or air/ship—based Elint receivers and data linked to the launching platforms. These can be small fast patrol boats, as mentioned or submarines below the surface. It is also thought that the integration of data obtained by satellite is possible. Probably the best defence is a mixture of weapons (such as guns and anti-missile missiles), the EW techniques touched on above, and suitable tactics.

SUPERIORITY BATTLE

Further examples of move and counter move are endless, sometimes one side gaining the ascendancy, sometimes the other. It is obvious why secrecy is vital. Historically, the Soviet invasion of Czechoslovakia was a big plus to them, since their ECM technique was successful in blinding NATO's early warning devices on the frontier. Later the Americans can be said to have won the EW battle against the Russian supplied N. Vietnamese air defence system.

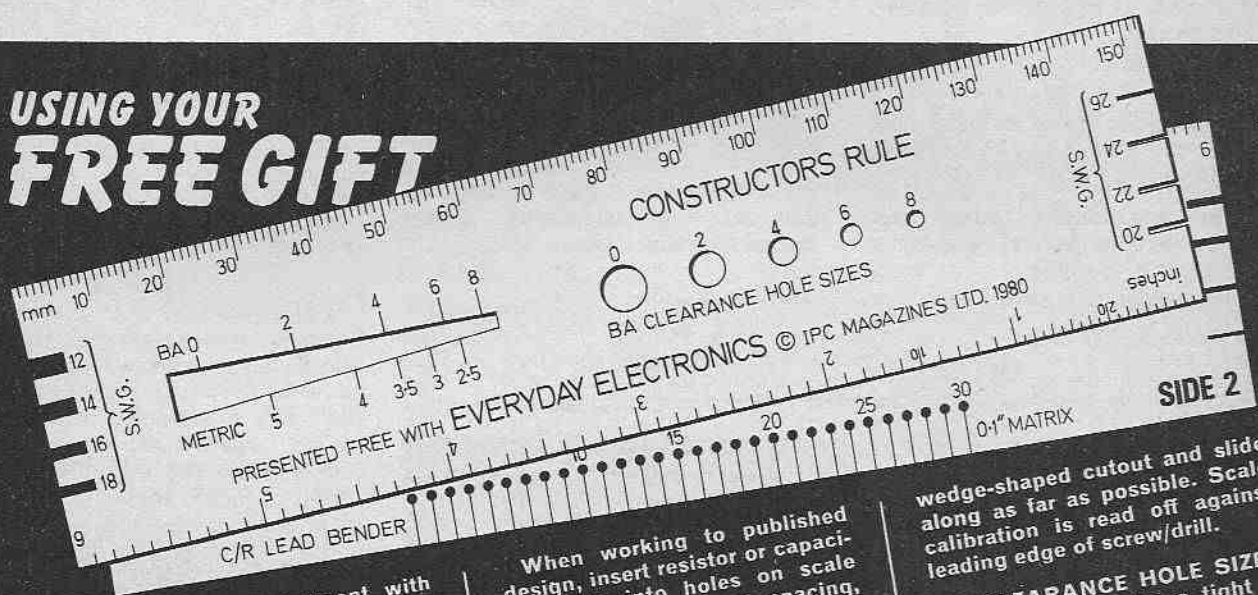
Lastly, in the Israeli-Egyptian "October" war, Electronic Warfare was a key element all round, both at sea and in the air. The Israelis used a pilotless decoy plane that on one occasion was attacked by a total of 32 missiles but returned safely and in a naval engagement the Eilat defeat was reversed by four Israeli fast patrol boats who hit eleven Egyptian ones, all concerned armed with missiles.



Double cake shaped aerial of Decca's EW equipment. Being designed to fit around a mast, it does not compete for the sought after masthead position.

It is a fair conclusion that all radiating electronics can be jammed and any jamming technique can be countered eventually. So an end to Electronic Warfare is not in sight, nor ever seems likely to be. ☐

USING YOUR FREE GIFT



Pocket size instrument with Imperial and metric scales 0—6 inches (0—153mm), plus four gauges of particular usefulness to electronics conductors.

CAPACITOR/RESISTOR LEAD BENDER. The holes correspond to holes in 0·1 in matrix stripboard or perforated plain s.r.b.p. In general, component leads should be bent not less than 0·1 in. from the body of the component.

When working to published design, insert resistor or capacitor leads into holes on scale giving the required spacing, as denoted on component layout diagrams.

Push component body close to Rule surface, straighten and parallel the leads. Finally trim off both leads about 1mm from Rule and remove.

BA AND METRIC GAUGE Insert screw or drill into wide end of wedge-shaped cutout and slide along as far as possible. Scale calibration is read off against leading edge of screw/drill.

BA CLEARANCE HOLE SIZES Correct drill will be a tight fit in appropriate hole.

S.W.G. GAUGE for Sheet metal and connecting wires in the most common sizes from 12 to 26 s.w.g. Especially useful for matching drills and wires.

BATTERY VOLTAGE MONITOR

A.P. DONLEAVY

THIS article describes a simple car voltmeter using l.e.d.s to give a continuous indication of battery voltage. The instrument can be calibrated over a range of about 11 to 15 volts and is easily constructed and installed in any car whether positive or negative earth.

CIRCUIT

The circuit is shown in Fig. 1. The LM324 integrated circuit contains four operational amplifiers (op-amps). The inverting terminal of each op-amp is connected via R13 to the junction of R14 and D5 (D5 is a Zener diode, providing a fixed reference voltage of about 6V).

REFERENCE VOLTAGE

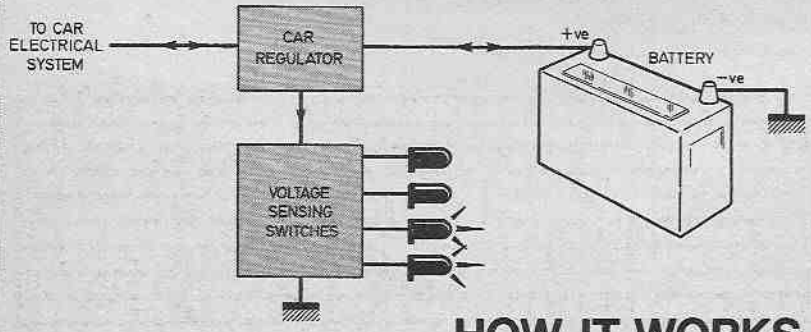
Resistors R1, R3, R6, R9 and VR1 form a potential divider chain. The values of these resistors are chosen to give voltages of between 5 and 7 volts at the non-inverting terminals of the op-amp.

The actual values will vary with the supply voltage, that is the battery voltage. Each op-amp will amplify the difference in voltage between its inverting and non-inverting inputs several thousand times.

If the voltage at pin 10 of IC1 is higher than that at pin 9 (which is the reference voltage), then the output at pin 8 will be high (12V approximately) and the l.e.d. D1 will be on.

As the supply voltage increases, more of the non-inverting inputs will be at a higher potential than the reference voltage, hence more l.e.d.s will be turned on. VR1 is adjusted to give the range of voltage measurement required.

The diode D6 is used to prevent damage to IC1 if the instrument is wrongly connected to the supply. It could be omitted but this is not advised.



HOW IT WORKS

The output from the car regulator is fed into the unit. As the output from the generator increases so the voltage going into the sensing switches rises. The l.e.d.s are switched on one by one by the voltage comparators within the voltage sensing switch circuitry. The number of illuminated l.e.d.s gives an indication of the size of the input voltage and hence the battery voltage.

COMPONENTS

Many components used in this design are not critical and there is a wide range of tolerances in the published values and types.

The variable resistor VR1 is a multi-turn preset, although the more usual skeleton type could be used instead.

D6 is any diode which has a reverse voltage greater than 20V and D5 is any Zener diode with a value between 5 and 6V.

Resistor R1 may need to be a slightly different value to compensate for the actual Zener value used.

The l.e.d.s D1 to D4 may be of any type or colour. A different colour may also be used for the last l.e.d. D4 giving a warning of too high a battery voltage, indicating a faulty voltage regulator.

The brightness of the l.e.d.s may be altered by changing the values of R4, R7, R10 and R12.

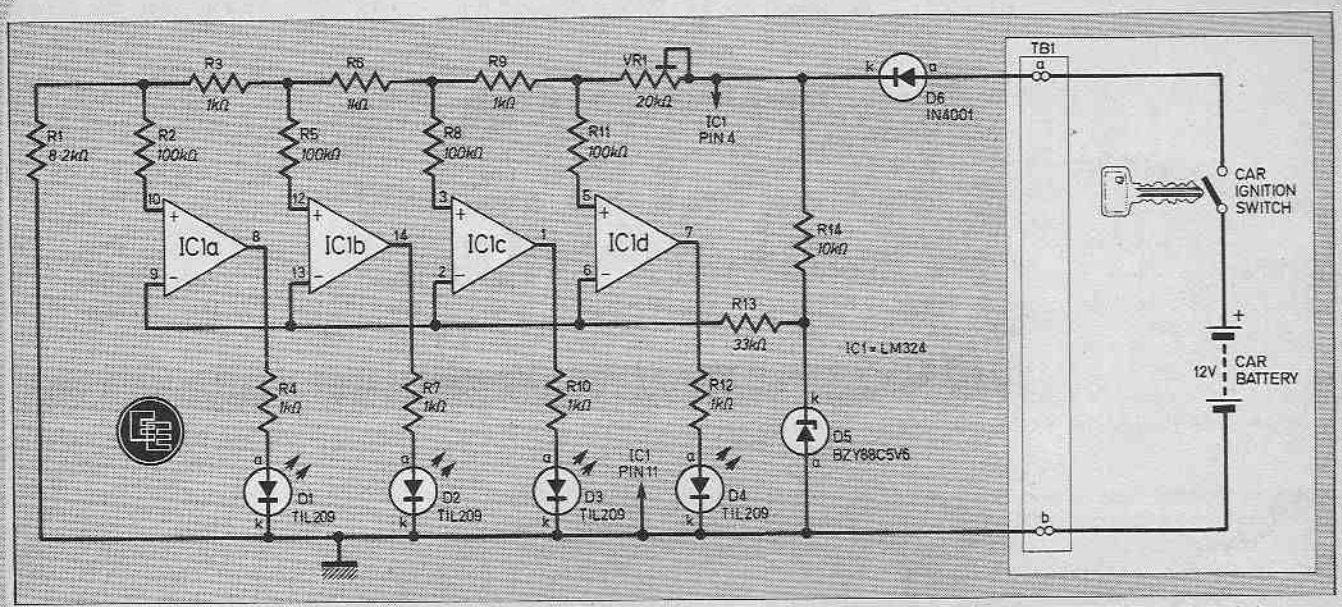


Fig.1. Complete circuit diagram for the Battery Voltage Monitor.

COMPONENTS

Resistors

R1	8·2kΩ	R11	100kΩ
R2	100kΩ	R12	1kΩ
R3	1kΩ	R13	33kΩ
R4	1kΩ	R14	10kΩ
R5	100kΩ		
R6	1kΩ		
R7	1kΩ		
R8	100kΩ		
R9	1kΩ		
R10	1kΩ		

All ¼W carbon ± 5%

See Shop Talk page 323

Semiconductors

IC1	LM324 quad op-amp i.c.
D1-D4	TIL209 l.e.d. (4 off)
D5	BZY88C5V6 5.6 volt 400mW Zener diode
D6	1N4001 rectifier diode

Miscellaneous

VR1 20kΩ multi-turn preset potentiometer

TB1 2-way screw connector block

Stripboard, 0·1 inch matrix, 17 strips × 32 holes; case, 100 × 50 × 25mm (optional); connecting wire; screws for fixing unit to vehicle; d.i.l. socket for IC1.

COMPONENTS approximate cost £3

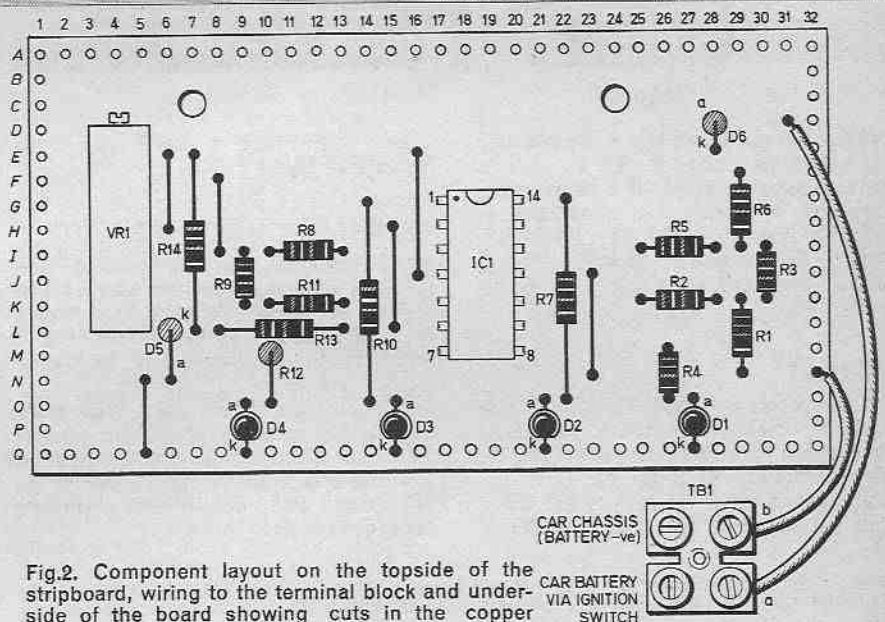
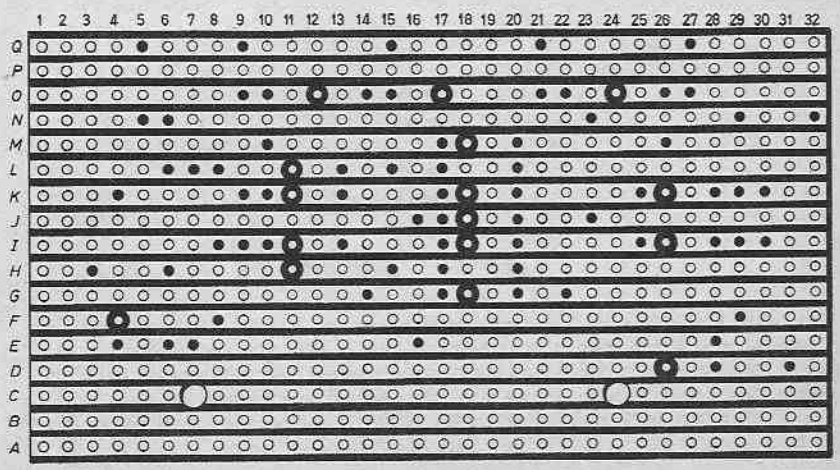


Fig.2. Component layout on the topside of the stripboard, wiring to the terminal block and underside of the board showing cuts in the copper track. The l.e.d.s may be mounted separately from the board, see text.



CONSTRUCTION starts here

ASSEMBLY

All the components, including the l.e.d.s, are mounted on a piece of 0·1 inch matrix stripboard, 17 strips by 32 holes. The layout is shown in Fig. 2.

The unit is housed in a small box, 50 x 100 x 25mm. Drill the lid of the box in such a way that the l.e.d.s protrude through the surface and fit tightly into these mounting holes.

The constructor may like to alter these mounting arrangements. One possibility is to mount the l.e.d.s separately in the case. Another is to drill the dashboard and mount them where they can clearly be seen, fitting the stripboard somewhere behind the dashboard.

The input from the battery is made via a double screw connector block TB1 glued on the outside of the case.

CALIBRATION

Calibration is best done before iustallation. Connect a voltmeter across the input terminals and adjust VR1 so that the fourth l.e.d. D1 turns on at about 15V.

Check that all the l.e.d.s are extinguished at somewhere between 10·5 and 11V. The value of resistor R1 may need to be altered to achieve this, either 6·8 or 10 kilohms may be necessary depending on the value of D5.

An 18V supply to feed the current through a 1 kilohm variable resistor will suffice for a power supply to calibrate the instrument. The current consumed will be about 18mA with all four l.e.d.s alight.

INSTALLATION

When installing the unit in the car use an auxiliary lead from the ignition switch to provide power. In normal operation D3 and D4 should light when the ignition is switched on. D2 may also light when the engine is running.

If D4 lights up on its own, this indicates that the battery voltage is low and so the battery needs recharging or replacing. If all the l.e.d.s come on, the voltage regulator may be suspect (assuming the instrument has been properly calibrated). ⌑

COUNTER INTELLIGENCE BY PAUL YOUNG

First Exhibition

In December I visited the "Breadboard Exhibition" and splendid it was too. I do wish that they would rename it. Several people thought it was a Bakery Exhibition.

I must say it bought back memories. It was held in the Horticultural Hall at Westminster and I remember years ago that one of the first of these exhibitions was held there. It was called the "Radio Hobbies Exhibition".

We had a stand there, and three incidents stick in my mind. My brother had pre-fabricated our display on hardboard. We arrived at the hall and started to erect it. Blunder number one; up rushes a Union Official and told us we had to employ a Union man to do it.

We had no alternative but to agree. As it turned out our chap was quite useful and didn't object to our helping him.

The next calamity was even more worrying. Thirty minutes before the show was officially opened, along comes an Inspector. He takes one look at our hardboard and says, "That's not fire proof, I can't allow the show to open".

Fortunately in the end he compromised, andsaid that if we painted the backs of the display boards with fire proof paint he would lift the ban. I remember us slapping on black paint as hard as we could go, and the day was saved. Between you and me, the paint we put on would have made it burn better than ever, but as they say, what the eye doesn't see the heart doesn't grieve about.

Finally, when we were packing up to go, I carried out a beautiful display case made of quarter inch plate glass. It was raining and I stood it on the bonnet of our van. Slowly, it slid to the edge while I stood and watched hypnotised. then it plunged into the road and shattered into a thousand fragments.

My brother came along a few seconds later, while I was still gazing at the mess in sheer disbelief. His only cryptic comment was, "Oh! dear, what a pity, I would like to have seen it!"

Component problems

Over two years ago, I forecast that the range of components might be reduced, and I pointed out that it was not likely to inconvenience the constructor. This has now happened. Toggle switches for example are reduced to two types, single-pole on/off and double-pole double-throw, but since this covers the whole of our needs it is of no great consequence.

Sometimes we run out of a particular value of quarter-watt resistor so we send a half-watt. This upsets no one and only worries the un-enlightened.

I had a case recently, of a customer returning a small transformer and complaining it was open circuit. I remembered that I had had a similar experience myself, but I refused to believe that both the primary and secondary windings were faulty, so I rubbed the connecting wires with "emery" and re-tested it. It was perfect.

These transformers are obviously dipped in a clear varnish which invisibly coats the connecting wires and prevents contact. I mention this in case you come across a similar problem.

JACK PLUG & FAMILY... BY DOUG BAKER

Next Month

SOUND EFFECTS

AUTOPHASE

One of the most popular effects units with pop bands. A four-stage phasing unit that has continuously variable symmetrical automatic sweep. The sweep rate is adjustable by externally mounted control. Suitable for all musical instruments and vocals.

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Allows for a delay—adjustable 0 to 30 seconds—in the operation of the car interior light so that driver and passenger may settle down with doors closed and to start the engine before the light goes out automatically. A boon for every motorist. Easy to build and install.

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A valuable item of test gear covering the entire audio frequency spectrum in three ranges. Sine and square waves. Continuously variable attenuator. High level of performance. Low noise and distortion.

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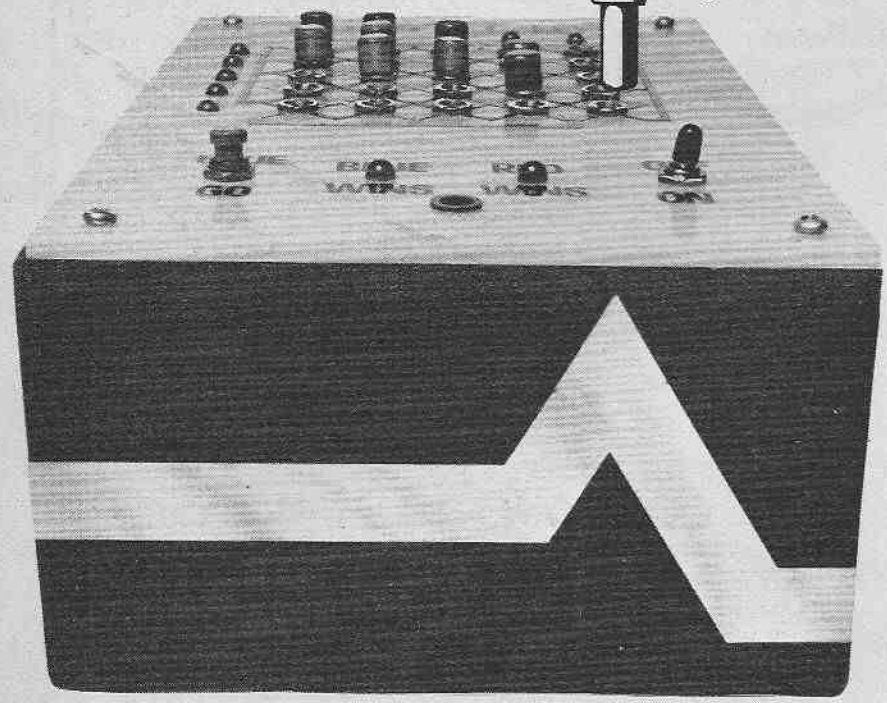
An add-on effects unit for the pop guitarist and organist. This produces the usual waa-waa sound without the use of a foot-operated pedal. This has been simulated electronically and has variable speed and adjustable sweep contour.

Everyday ELECTRONICS

JUNE 1980
ISSUE ON SALE
FRIDAY, MAY 16
Price 50p

Dual Line Game

By A. Russell



RULES OF THE GAME

THE GAME of Dual Line is played by two contestants on a board marked out with a lattice of interwoven red and blue lines. One contestant (for example BLUE) has a supply of blue plugs, the other (RED) has red plugs. Each player takes turns to insert a plug into an unoccupied socket on the board (there are sockets at each point on the board where red and blue lines cross).

The object of the game, for the RED player, is to create an unbroken red line from top to bottom of the board. When a red plug is inserted into a socket, the red line through that point is assumed to be completed, and the blue line broken. A winning line may zigzag about all over the board so long as it connects the two opposite sides of the board with an unbroken line.

Similarly the BLUE player is trying to complete a blue line stretching between the left and right hand sides of the board. Unlike the game of noughts and crosses the game can never end in a draw because one player can only prevent his opponent from winning by winning himself.

RESISTOR ANALOGUE

The unit decides the moves for one of the players (in this case BLUE). It operates on the following principle. A resistor network (Fig.1) corresponds to the lines of play open to the BLUE player (lines of play for the RED player are shown on the same diagram as dotted lines). All resistors have the same value.

When BLUE inserts a plug into a jack socket, the resistor corresponding to that socket is short-circuited. When RED inserts a plug into a jack socket, the resistor corresponding to that socket is open-circuited. Thus when BLUE completes his line from left to right hand side of the board and wins, the entire network is short-circuited.

Similarly when RED completes a line from top to bottom of the board the network is open-circuited. These two conditions are detected by the win detecting circuit (Fig.3) and cause the RED WINS or BLUE WINS l.e.d.s to light.

MAKING A MOVE

When the circuit is called upon to decide its next move, a voltage source is applied across the network. The strategy of the machine consists of choosing the resistor across which the maximum voltage occurs. If two or more resistors show the same maximum voltage, one is selected at random.

The move is indicated to the human contestant by lighting two l.e.d.s which point to the row and column co-ordinates of the socket where the machine would like its move made. Of course this requires a measure of integrity on the part of the human contestant because the machine cannot tell when it is being cheated.

A simple machine may be made by using light bulbs, instead of resistors, in the network of Fig.1. The machine moves can then be determined by observing which bulb glows the brightest. It is often difficult to decide which of several bulbs is brightest and so a more sophisticated circuit was developed to automate this decision.

The difficulty here is how to detect the network resistor with the highest voltage across it, bearing in mind that there is no common point in the circuit to measure the voltage with respect to.

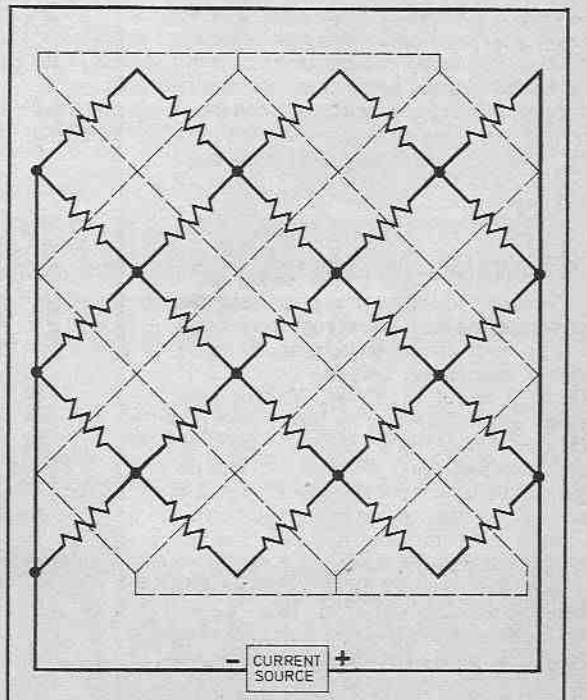


Fig.1. Resistor analogy network for the Dual Line Game.

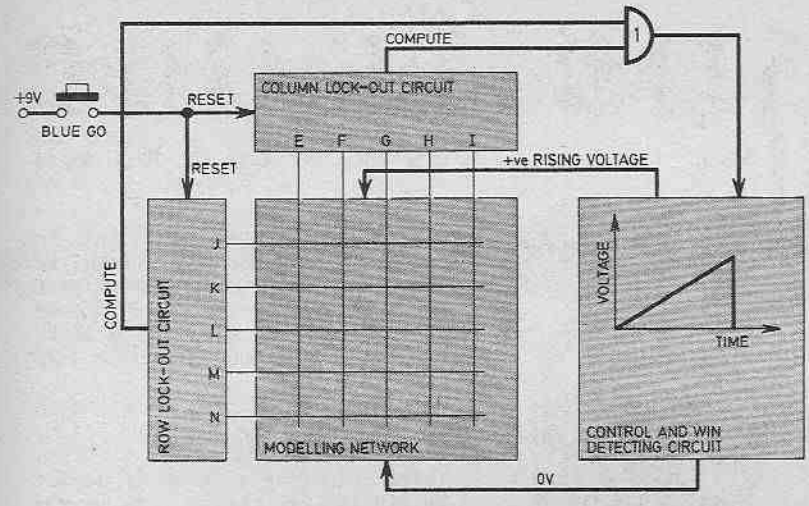
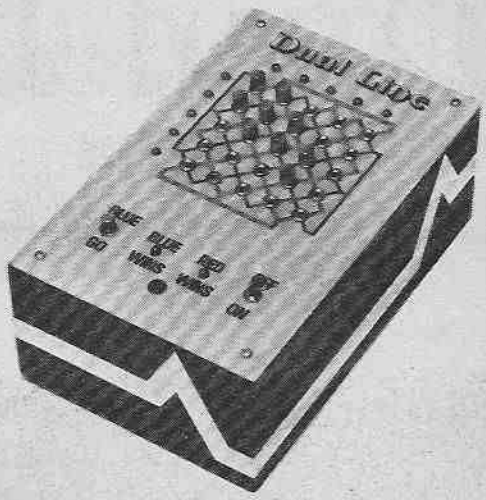


Fig.2. Block diagram showing all sections of the game.



The completed Dual Line Game.

In this circuit the emitter-base voltage of a silicon transistor (which is the same between transistors at the same temperature) is used as a reference. Each resistor in the *modelling network* has a transistor emitter-base junction across it. Those resistors where current could flow in either direction depending on the state of play have two transistors connected in opposite senses.

BLOCK DIAGRAM

The sequence of events, which takes place when the machine decides its next move, is best visualised by refering to the block diagram (Fig.2). When the BLUE GO button is pressed, row and column *lock-out circuits* (Fig.4) are reset which in turn send compute signals to the *control circuit* (Fig.3). Compute signals cause a variable voltage generator in the control circuit to apply an increasing voltage to the modelling network (Fig.5).

POTENTIAL DIFFERENCE

Voltage continues to rise until the potential difference across one resistor is enough to switch on its associated transistor. Sensing lines (*E, F, G, H, I* and *J, K, L, M, N*) from the row and column lock-out circuits (Fig.4) detect row and column coordinates of the switched on transistor, light the appropriate l.e.d.s and take away the compute signals which causes the output of the voltage generator to return to zero.

Lock-out circuits hold the row and column l.e.d.s on until BLUE GO is pressed again. If either BLUE or RED has won, no voltages will be developed across any resistor in the modelling network. The output of the control circuit will rise until the win detecting circuit comes into play and identifies the winner.

COMPONENTS

Resistors

R1	10kΩ	R18	10kΩ	R35	10kΩ
R2	47kΩ	R19	100kΩ	R36	100kΩ
R3	1kΩ	R20	2·2kΩ	R37	2·2kΩ
R4	220Ω	R21	2·2kΩ	R38	10kΩ
R5	10kΩ	R22	100kΩ	R39	100kΩ
R6	2·7kΩ	R23	2·2kΩ	R40	2·2kΩ
R7	27kΩ	R24	100kΩ	R41	100kΩ
R8	10kΩ	R25	2·2kΩ	R42	2·2kΩ
R9	10kΩ	R26	10kΩ	R43-67	2·2kΩ (25 off)
R10	100kΩ	R27	100kΩ		
R11	2·2kΩ	R28	2·2kΩ		
R12	10kΩ	R29	10kΩ		
R13	100kΩ	R30	100kΩ		
R14	2·2kΩ	R31	2·2kΩ		
R15	10kΩ	R32	10kΩ		
R16	100kΩ	R33	100kΩ		
R17	2·2kΩ	R34	2·2kΩ		

All ¼W carbon ±5%

COMPONENTS approximate cost £20

Capacitors

C1 50μF 15V elect.
C2 50μF 15V elect.

Semiconductors

TR1, 2, 3 BC108 *npn* silicon (3 off)
TR4-TR15 BC557 *pnp* silicon (12 off)
TR16-TR49 BC108 *npn* silicon (34 off)

D1-D4, D9-D14, D16-D21, D23-D28, D30-D35, D37-D48, D50-D55, D57-D62, D64-D69, D71-D76, D78-D139 — IN 4148 or similar small signal silicon diode (126 off)

D6-8, D15, D22, D29, D36, D49, D56, D63, D70, D77 — TIL 220 red light emitting diode (12 off)

D5 BZX85 5·1V Zener diode

See Shop Talk Page 323

Miscellaneous

SK1-SK25 3·5mm jack sockets with one normally closed switch (25 off)
S1 single-pole on/off toggle
S2 miniature push-to-make single-pole switch
B1 9V type PP3

Stripboard: 0·1 inch matrix, 36 strips × 51 holes (3 off); 6 metres of ten-way ribbon cable; PP3 battery connector; size 10 knitting needles, one set plastic one set metal, for pegs; 7mm diameter wood dowelling and red and blue enamel paint for pegs; materials for cabinet; three 4BA nuts and bolts with spacers for mounting circuit boards.

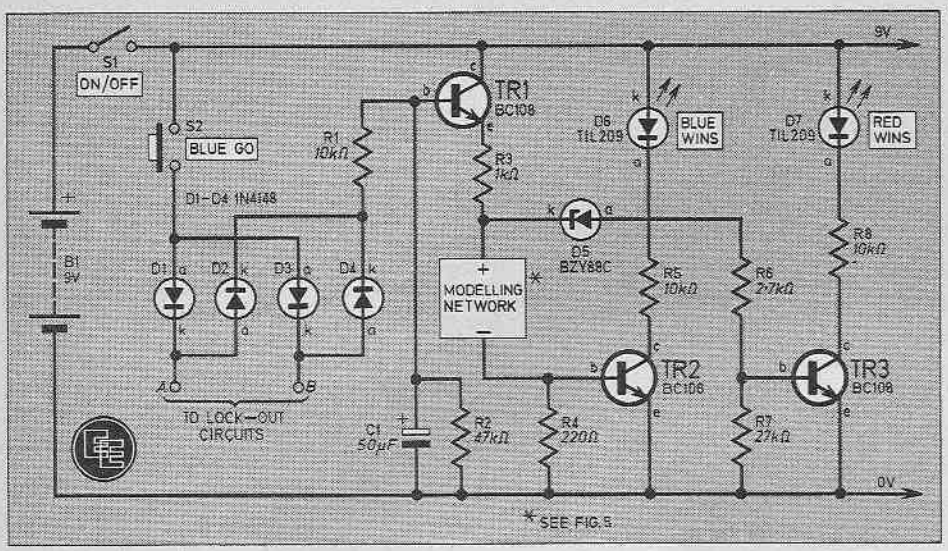


Fig.3. Complete diagram of the control and win detecting circuit. This is built on board A.

CONTROL CIRCUIT

The complete circuit of the control and win detecting circuit is shown in Fig.3.

When the BLUE GO button is pressed 9V is applied via diodes D1 and D2 to lines *A* and *B* of the row and column lock-out circuits. This resets the system and in turn applies 9V back to the control and win detecting circuit via the diode OR gate D3 and D4.

Because of the *C*-R network (made up of R1 and C1), the voltage at the base of TR1 rises exponentially towards 9V. This rising waveform is buffered by the emitter follower stage formed by TR1 and fed into the modelling network (Fig.5).

If nobody has won yet, the voltage across the modelling network continues to rise until the voltage across one of the resistors in the network is sufficient to cause the associated BC108 transistor (TR16 to TR49) to conduct. Current is then fed from this transistor, through two isolating diodes, onto two sensing lines from the lock-out circuits.

WIN OR LOSE

If RED has won, the modelling network is open circuit and the emitter voltage of TR1 is free to rise toward 9V. When this voltage reaches 5·8V, D5 starts to conduct and feeds current into the base of TR3 which switches on and lights the RED WINS l.e.d. D7.

Similarly, if BLUE has won, the modelling network is short circuit and the current through TR1 rises until about 3mA is flowing at which time the voltage drop across R4 is about 0·7V; TR2 switches on and the BLUE WINS l.e.d. D6 is lit.

LOCK-OUT CIRCUITS

The modelling network is flanked by two lock-out circuits, one for the rows, one for the columns, and their function is to record and display the network element with the highest voltage across its terminals.

When the BLUE GO button is pressed, line *A* or *B* (depending on whether we are considering row or column lock-out circuits) is taken to +9V (see Fig.4). This energises TR9 (or TR15) which switches off TR4, 5, 6, 7 and 8 (or TR10, 11, 12, 13 and 14). At the same time compute signals are applied to the control and win detect circuit which in turn applies a rising voltage to the modelling network.

Assuming neither player has won, one of the elements in the modelling network switches on causing a volt-

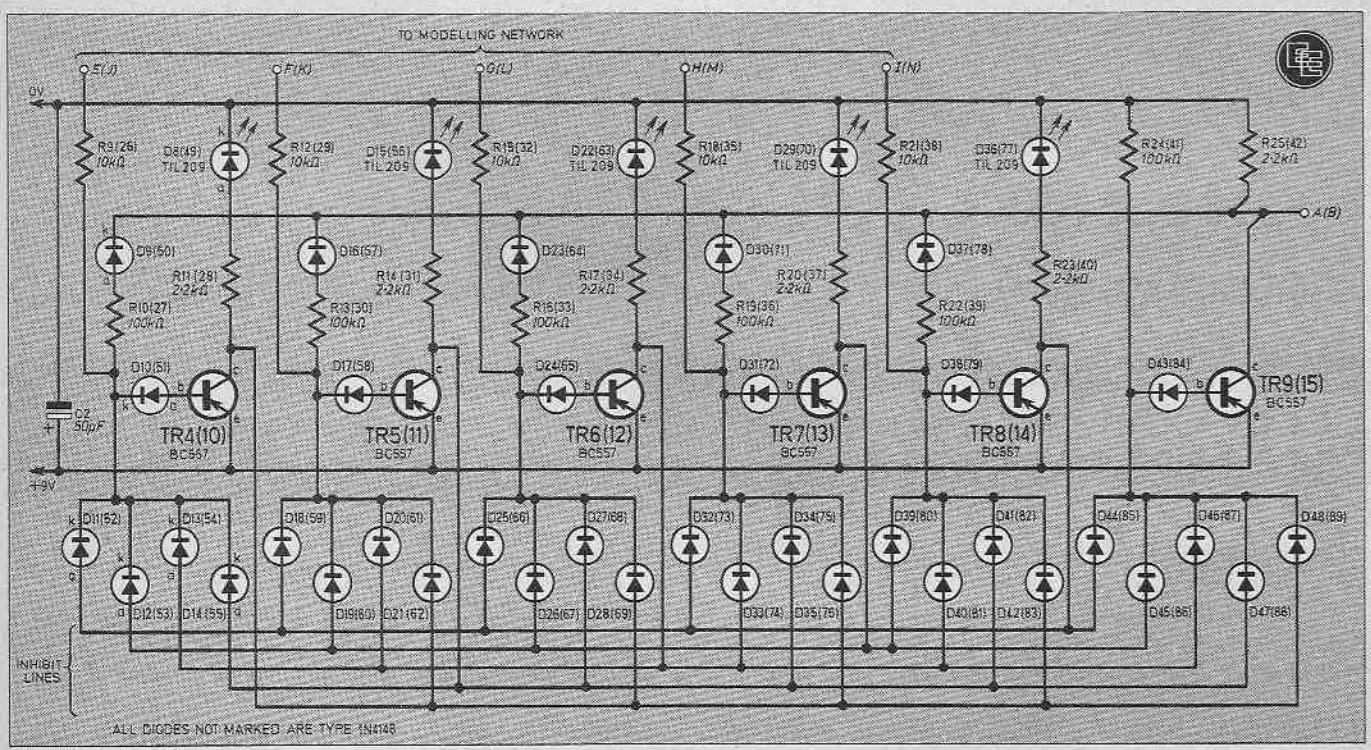
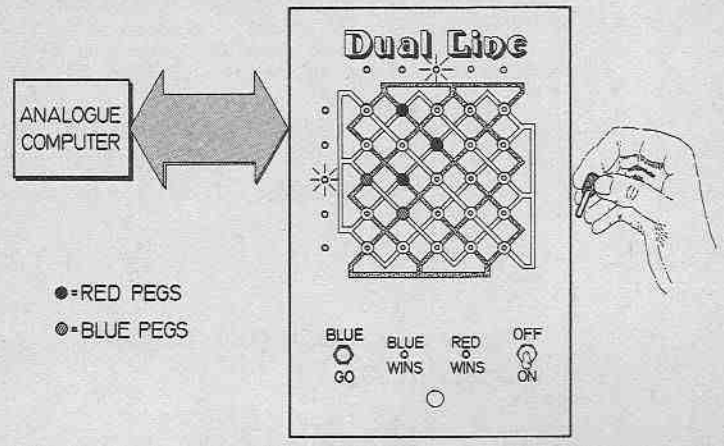


Fig.4. Complete diagram of the lockout circuits. Note that two of these are required, one for the rows and one for the columns. Bracketed component references are for the column lockout circuit and unbracketed ones for the row lockout circuit. These are both built on board B.

HOW IT WORKS



In this electronic game of Dual Line, the machine always uses blue pegs and the human contestant red pegs.

Assuming red moves first, the appropriate colour peg is taken and placed in the selected position. The BLUE GO button is then pressed. This causes the analogue computer within the unit to work out the best counter-move and indicate its position by lighting up two l.e.d.s on the front panel.

The player then inserts a blue peg in the position given and the whole process is repeated again and again until there is a complete line of pegs—either blue or red.

When this happens, the machine works out who has won the game and lights up the correct WIN l.e.d.

age to appear on its respective sensing line. When this happens, the associated transistor in the lock-out circuit switches on illuminating the l.e.d. in its collector line.

To stop other transistors being activated at the same time, a set of inhibit lines are provided. These are initially all at 0V. When one transistor turns on it immediately clamps its associated inhibit line to +9V which turns off TR9 and prevents any of the other lock-out transistors from turning on.

MODELLING NETWORK

The complete circuit of the modelling network is shown in Fig.5. You will notice that there are two types of circuit elements. However, both essentially consist of a resistor connected across a semiconductor junction, the ends of which are connected into the matrix. There are also two sensing outputs X and Y each connected to the sensing lines from the lock-out circuits.

When the applied voltage across the network is sufficient to turn the transistor on in a particular element, these outputs go high energising their respective sensing lines. This causes the lock-out circuits to register this condition and indicate the next move.

CONSTRUCTION starts here

CIRCUIT BOARDS

Most of the components in the Dual Line Game are mounted on three circuit boards. These are all identical pieces of 0·1 inch matrix stripboard 36 strips by 51 holes and full details of component mounting and drilling are given in Figs. 6, 7 and 8.

Construction should start with the control and win detecting circuit board (Fig.6). It will be noticed

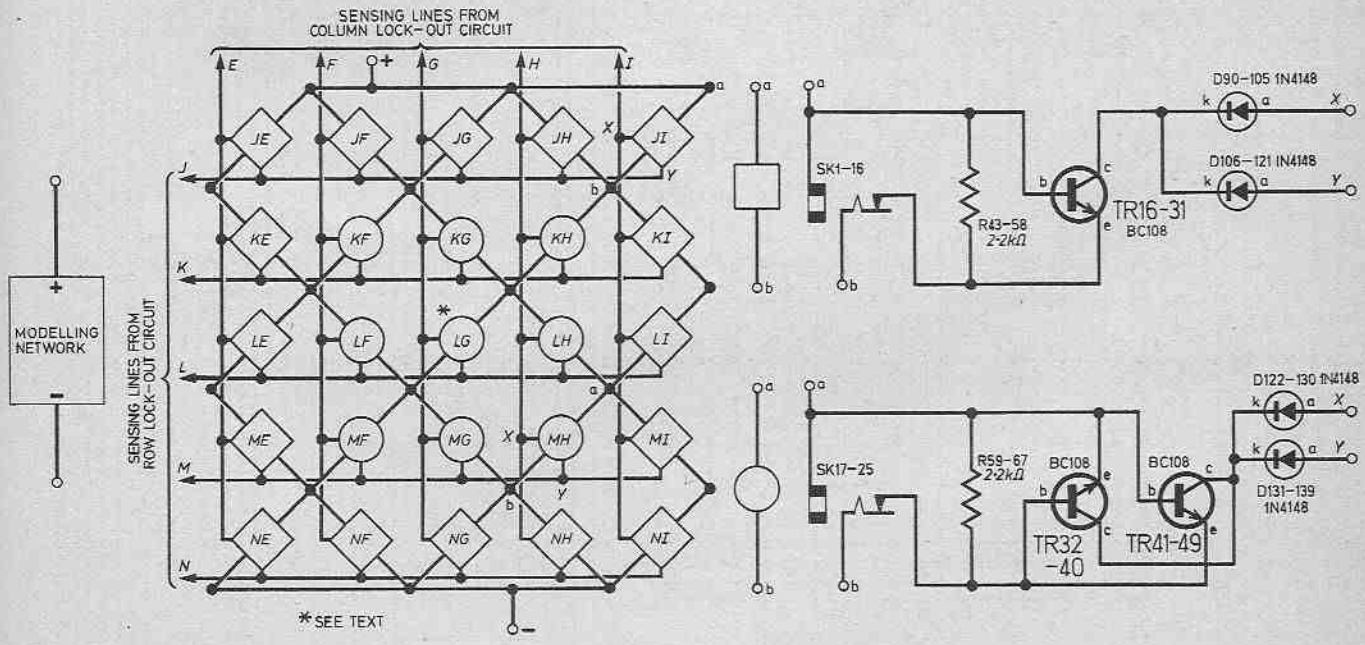
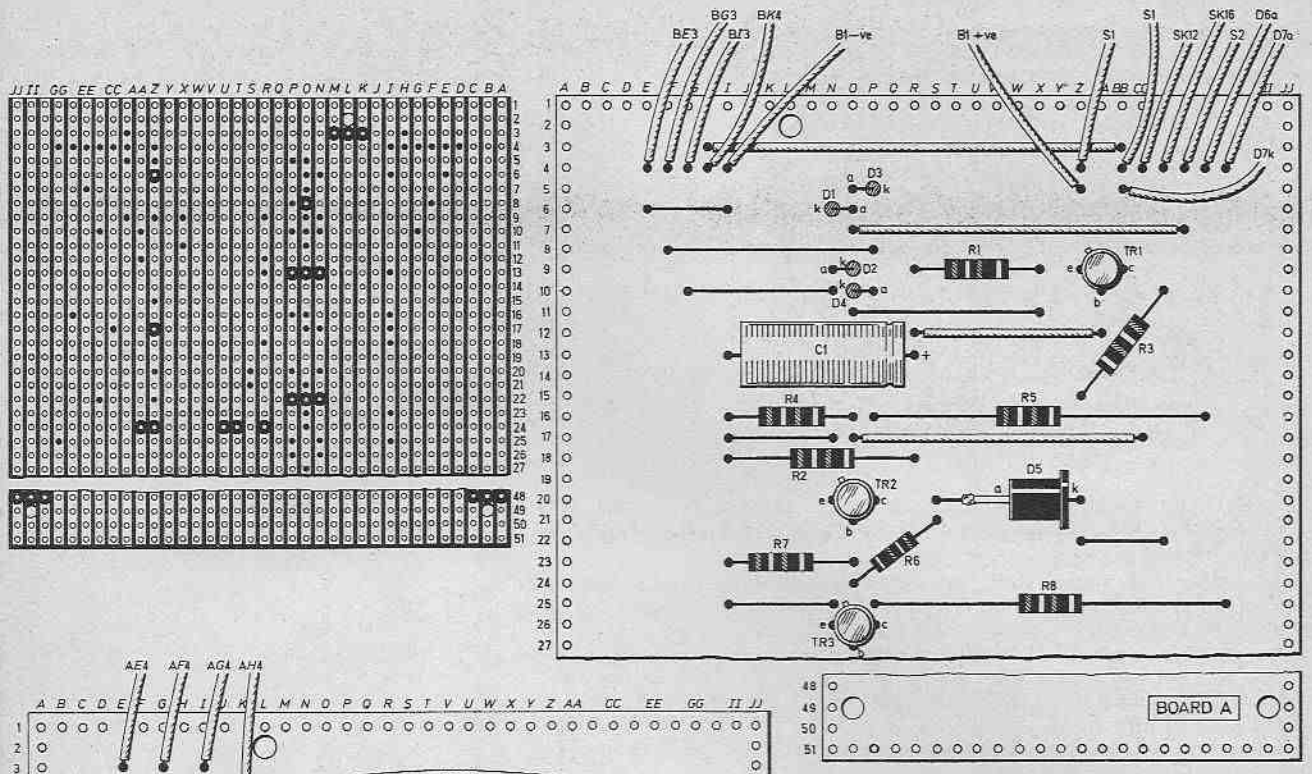
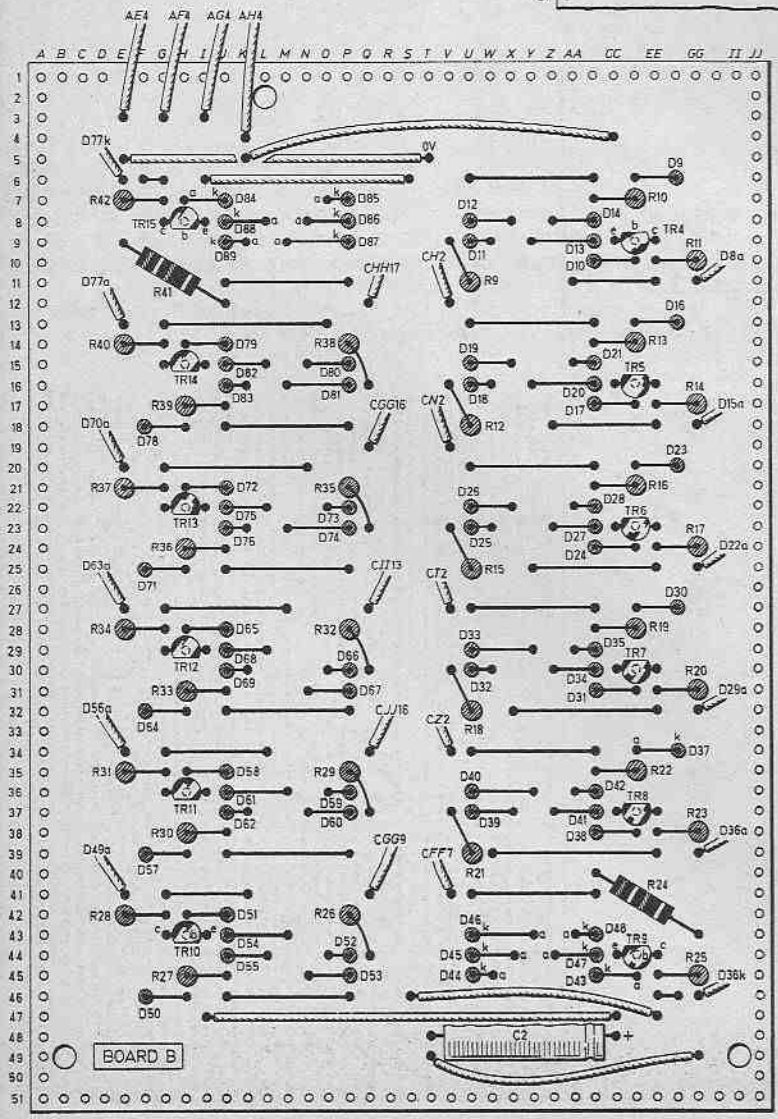


Fig.5. Circuit diagram of the modelling network. Note that this is made up of identical network elements, the circuit diagrams of which are shown on the right. This is built up on board C.





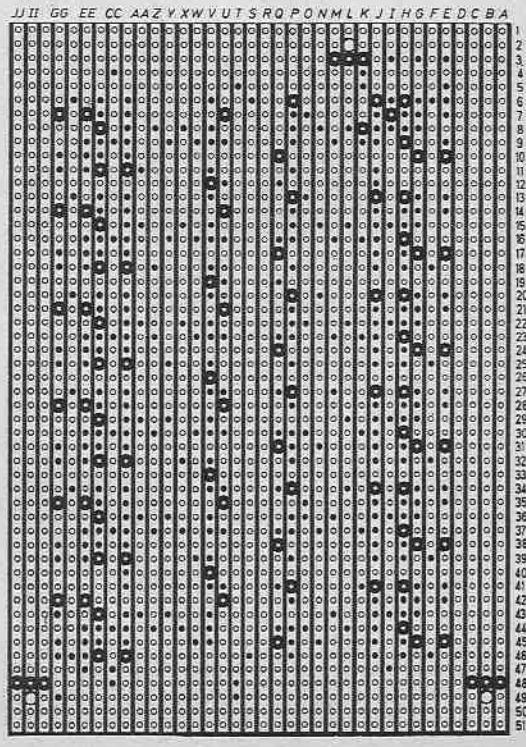
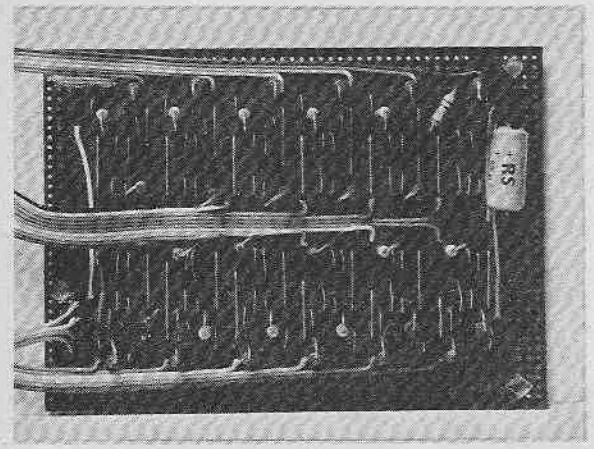
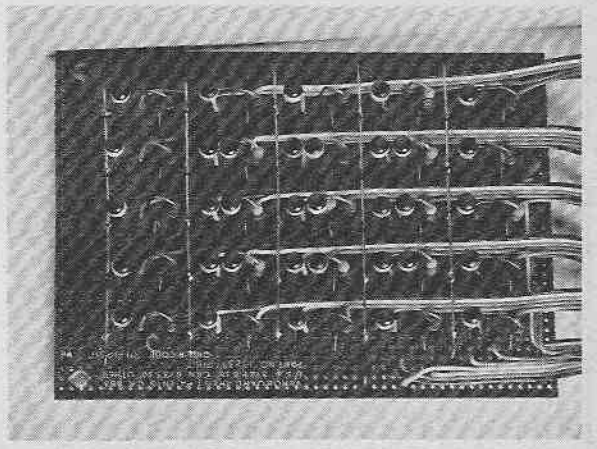


Fig.6. (above and left). Circuit board layout of the control and win detect circuit (Board A).

Fig.7. (below and left). Circuit board layout of the lockout board (Board B). See text for an explanation of the inter-board wiring references.





The left hand photograph shows a view of the top of the lockout board. Note the use of ribbon cable for off-board connections. The other photo shows a view of the modelling network board. Note the circular shaped plastic encapsulated BC108 transistors and copper bus wires.

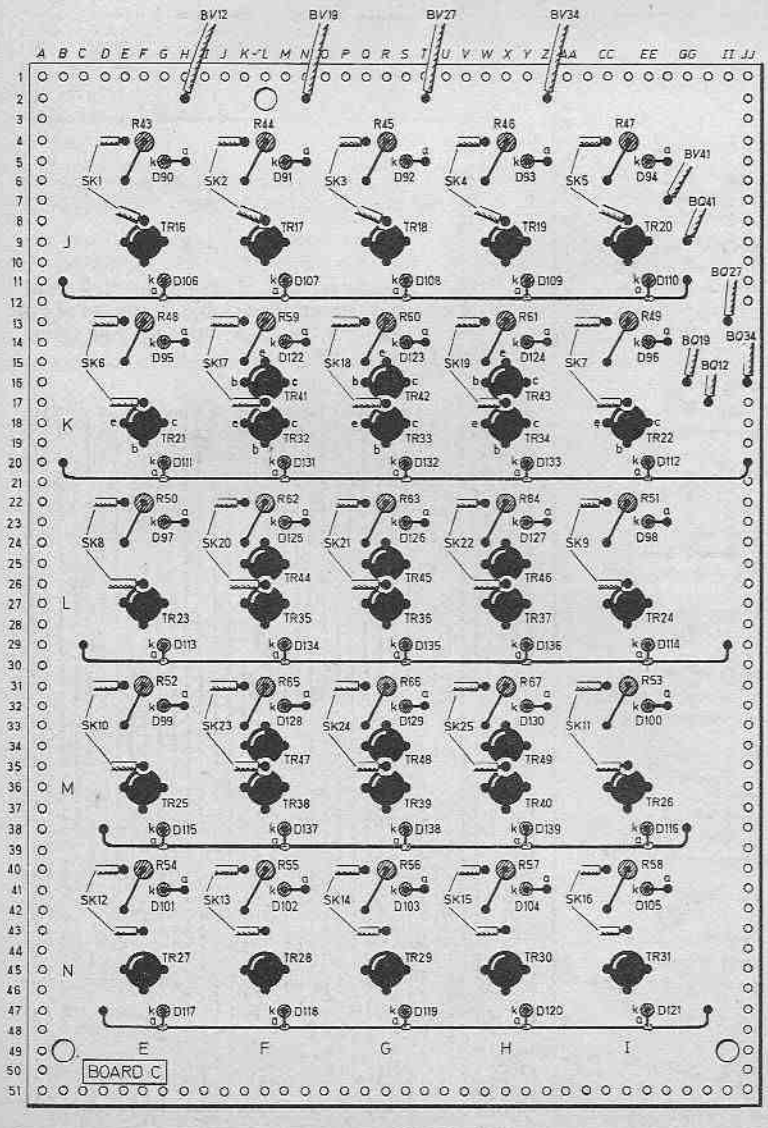


Fig.8. Circuit board layout for the modelling network board (Board C).

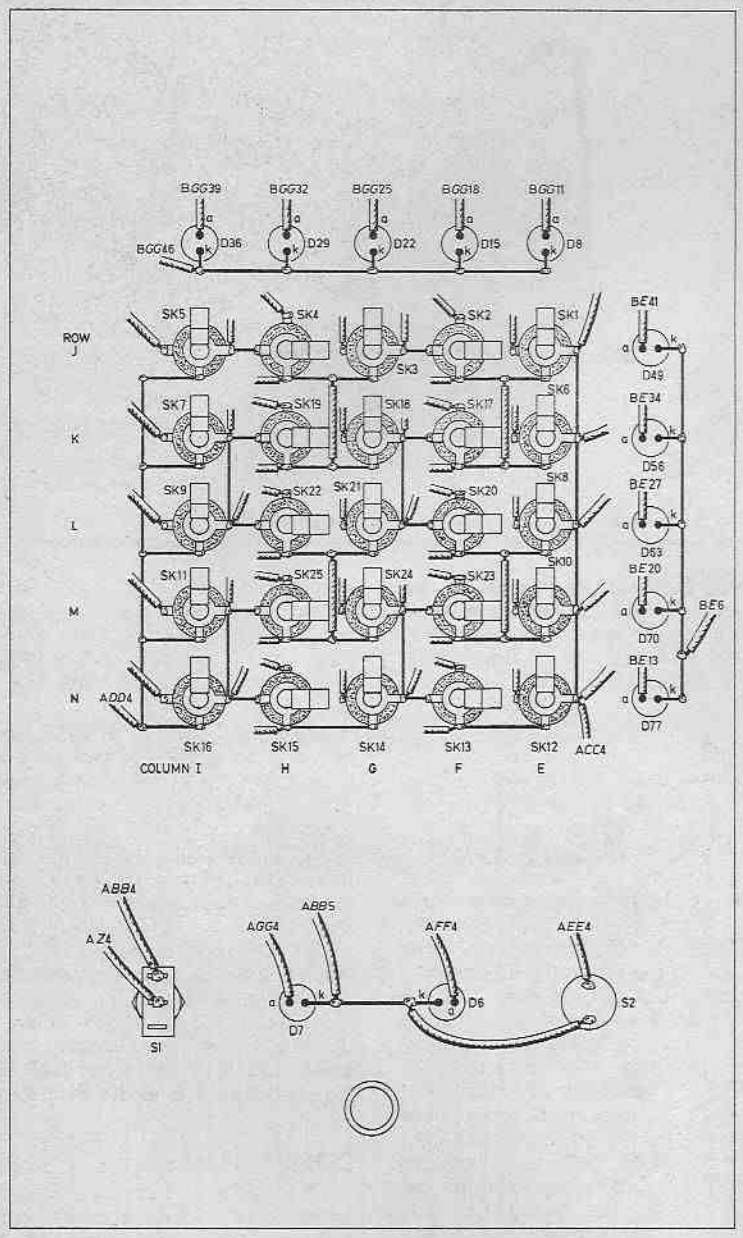


Fig.9. Wiring of the rear of the front panel.

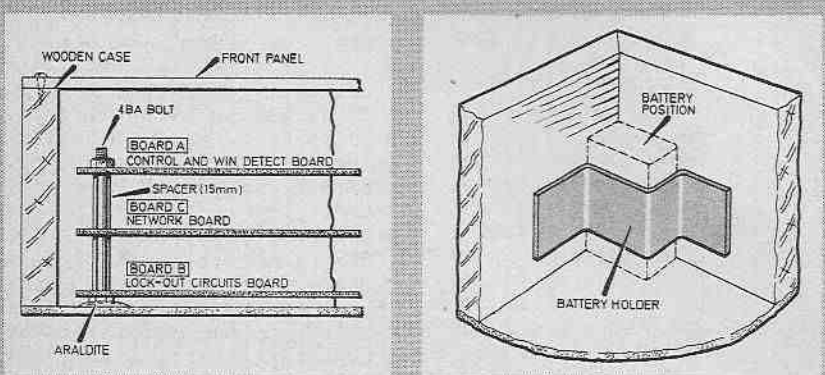


Fig.10. Interior views of the cabinet. The diagram left, shows the circuit board mounting arrangement and the one on the right shows the battery mounting clip.

immediately that only half the board area is used. However making all circuit boards the same size, means that mounting them in the cabinet is a lot simpler and this is what has happened here.

Multi-way ribbon cable is used for front panel connections both on this board and the others as this makes lead identification much easier and keeps the wiring reasonably neat.

To make it easier to keep track of interboard wiring, a simple system of board location identification has been adopted. The first letter refers to the board itself, and the rest of the letters and numbers refer to the strip/hole co-ordinates of a particular location in the usual way.

For example location *CAA17* refers to location *AA17* on board C (the modelling network board).

The lock-out circuit board (Fig.7) can be tackled next. Both row and column lock-out circuits are accommodated on the same piece of stripboard and apart from C2 are identical.

NETWORK BOARD

Finally the network board can be assembled. A quick glance at Fig. 8 will confirm that this consists of a large number of separate small circuits each with two wires going to a socket on the front panel and one each to the appropriate row and column lock-out circuit.

Bus wires made up of thick gauge copper wire are mounted about 7mm clear of the board from one side to the other to provide common returns for the lock-out circuit board input lines. This can be seen clearly in the layout diagram.

You will see that plastic encapsulated BC108 transistors have been used in the prototype. The more familiar TO-18 types can be used instead but take care that their cans do not short circuit to other parts of the circuit.

Component identification is made very simple by the fact that all transistors, all resistors and all diodes are of the same type and value. On the other hand, lead out wires from each section should be made easily identifiable so that they can be connected to the correct socket on the front panel. Care must also be taken to get the polarities of circuits round the edge of the board correct.

CABINET AND FRONT PANEL

In the prototype the cabinet (dimensions 200×130×70mm) was made up from 75×15mm (3×$\frac{1}{2}$ inch) softwood with a hardboard bottom.

The front panel is made up from a piece of 3mm coloured Perspex. Great care is needed in drilling this material and a hand powered drill is best. Red and blue lines are made

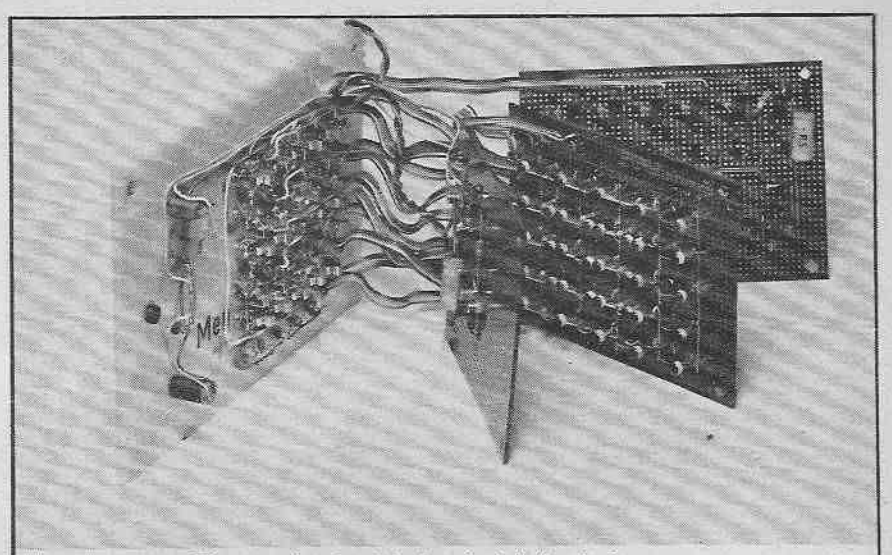
with coloured drafting tape and captions with rub on lettering protected by clear sticky tape.

The interior layout can be seen both in Fig. 9 and in the accompanying photographs. It is sensible to mark out and drill all the holes in the Perspex panel before mounting any components and it is also a good idea to check each jack socket. Some may need their contacts adjusting and this is easier to do before they are attached to the front panel.

A battery holder can also be made from a suitably shaped piece of plastic (or metal) and glued into position in one corner of the box (see Fig.10).

The completed circuit boards are mounted one above the other on three 4BA bolts which have been fixed with Araldite to the floor of the case. Spacers can be made up from old ball point pen cases.

Once interwiring between the boards is complete, they can be fixed in position using 4BA nuts, and wiring to the front panel completed. The unit is now ready for testing.



The completed unit before installation in its case.

BLUE AND RED

To complete and test the Dual Line Game a set of plugs (or pegs) is required, 12 for RED and 12 for BLUE.

The red pegs are made up from size 10 plastic knitting needles. A 25mm section of needle is cut and Araldited to a 7mm long section of 7mm diameter wooden dowel. The pegs are finished off by giving the top a couple of coats of red enamel.

The blue pegs are made up in a similar way, the only difference being that metal knitting needles should be used, sanded down to ensure a good contact in the sockets.

Testing and setting-up the equipment can now proceed.

TESTING

When the circuit is first switched on it should draw about 10mA from a 9V battery and two l.e.d.s should be lit, one row and one column indicator. Pressing BLUE GO will cause the l.e.d.s to flash briefly, during which time current consumption will rise to about 25mA. A row and column l.e.d. will again be lit, probably different.

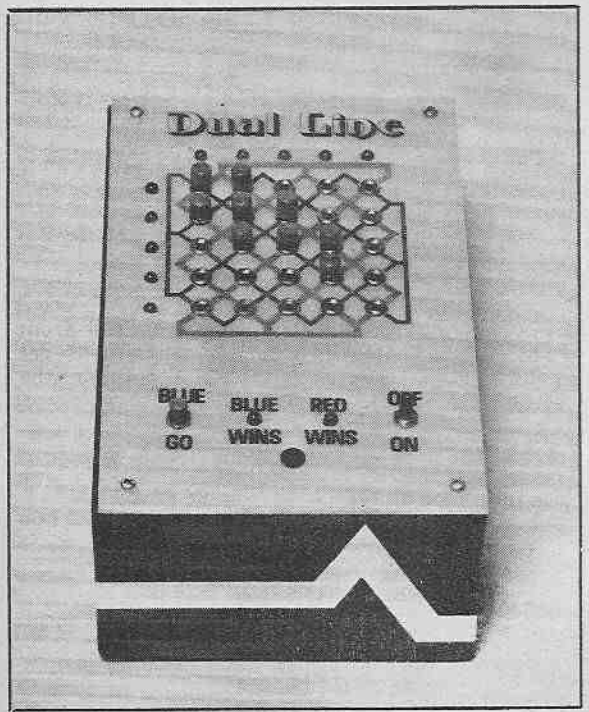
The 2·2 kilohm resistor on the modelling network board, board C, in circuit *LG* (R63) should now be increased in value (to about 3·3 kilohms) until every time BLUE GO is pressed D22 and D63 come on (no jack plugs should be in the board for this adjustment). This ensures that when the circuit is given the first go in a game it will choose the centre position which is the best first move.

Each position on the board can then be tested by forcing the machine to choose every position in turn. This is done by making a line of red pegs from top to bottom of the board, broken only at the point you wish the machine to choose.

Obviously, if the circuit is working correctly, it must choose to place its plug in the gap this being the only move which can prevent immediate defeat. Any fault shown by this test must be traced back from the front panel to modelling network board to lock-out circuit board until the error is found.

After passing this test the machine is ready to challenge you to a game. If you give it the first move you can expect to lose the game on most occasions. (Only one line of play has been found that can defeat it when it has first move.) When you take first move it has less chance of winning, but will if you make a bad mistake.

The advantage of the first player can be reduced if it is agreed that the first move may not be in the centre position. Under these rules the machine cannot calculate its first move, but it plays rather well if it is give position *MG* as its first move.

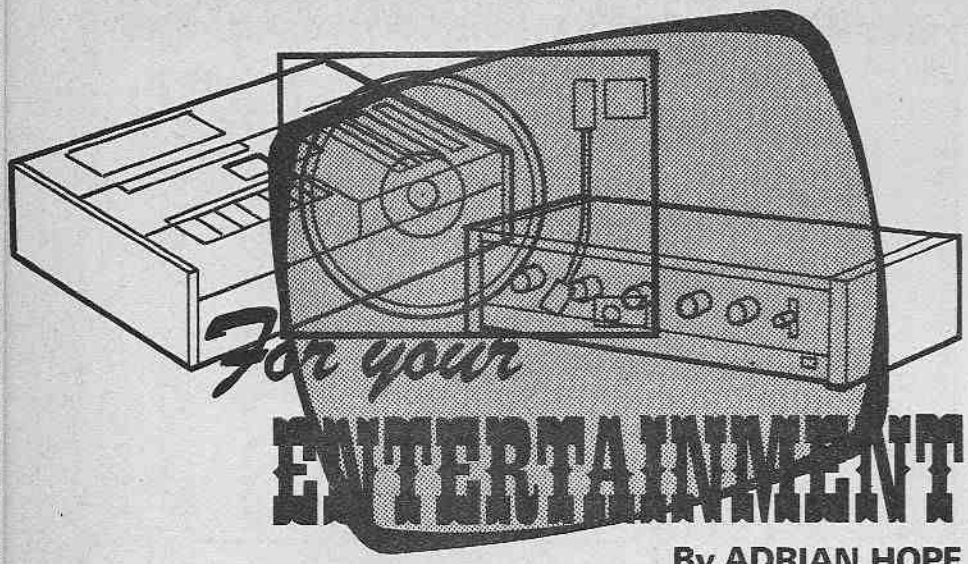


COMPONENTS

This circuit uses quite a large quantity of rather a small range of common components. For this reason it pays to shop around to find the best value. The advertisements in this magazine are a good place to start.

The semiconductors used in this circuit are not critical, any small signal silicon *npn* transistor will do instead of BC108 and any silicon *pnp* instead of BC557. The TIL220 and 1N4148 diodes may be replaced by any reasonable equivalent. It is not recommended that manufacturers "fall outs" be used in this circuit.

This article has described an analogue electrical resistance network which calculates moves for a simple game. There are similar resistance analogues for some other games. The processing power of these and more complex networks containing inductors, capacitors and other elements are overlooked in these days of digital computers. ☐



By ADRIAN HOPE

Protective Words

Specialists in any area tend to talk their own particular language. This is partly because it is all too easy for an "expert" in electronics, hi fi, video or computers to forget that others are less expert in that field. But it is also a defence mechanism; a protective moat of words to ward off critics.

It isn't just electronics specialists who talk in jargon. Professionals, such as doctors, solicitors and accountants are past masters at the art of staying "one up" by using long words understandable only to other professionals in the same field. (An animal vet once told me that a cat which licked off its fur had "chronic licktitis"). Some shop assistants, especially in the electronics area, play exactly the same game, assuming that no one will want to risk losing face by admitting that they don't understand a technical term.

Don't fall for it. If you are being sold something, whether it's advice from a professional, education from an instructor or equipment from a shop, *you are entitled to understand what is being said.* If you don't understand a technical term when it's thrown at you, don't try and disguise the fact. Instead own up and ask for an explanation.

As often as not you'll find that those who use the most exotic technical terms, and gabble them the fastest, don't really understand what they mean. It is they who will be embarrassed, not you, if you ask for an explanation. If you don't believe me, try it just once when you are next shot a piece of jargon by an expert . . .

Headphone Stereo

This train of thought was triggered by the realisation that it still isn't safe to write, even in the hi fi press, about "binaural" or "dummy head" stereo without also adding a brief explanation of what this technique involves. The idea of binaural stereo reproduction, which provides a very wide spread of sound from a two channel recording heard over headphones, dates back to the early part of the century and long before anyone succeeded in reproducing a stereo spread of sound from a pair of loudspeakers.

When you think about it, binaural recording is the obvious way to reproduce a realistic all-round image of sound. In real life we hear sound from all around, and identify the direction of individual sounds, by listening with our two ears. The brain is able to decode subtle directional clues in the sound arriving at each ear because the size and shape of a human head introduces phase, time and level differences into similar sounds arriving at both ears.

In theory, if you put a microphone in each ear of a human stereo head and record sound picked up at each ear on a two channel stereo recording system you will capture an accurate replica of the original sound field. You can achieve a similar effect by building a dummy head of the same shape, size and mass as a human head.

For reproduction you simply feed sound from the left recorded channel into the left side of a pair of stereo headphones, and feed the sound from the right channel into the right headphone. This gives each ear the artificial equivalent of what the ears of the recording head heard. The brain then decodes the phase, time and level difference to produce a mental illusion of the original sound field.

You'll notice that I used the phrase "in theory". A binaural (two-eared) or dummy head stereo recording system can work remarkably well but it isn't quite as straight forward in practice as it sounds on paper.

A microphone, which is an electromechanical transducer and not flesh and bone, obviously can't accurately imitate the audio characteristic of the human inner ear, especially when it's fixed outside in the ear lobes. Likewise a headphone unit, which is another electromechanical transducer and is clamped over the outside of the ear lobe can't completely accurately mirror the sound of nature.

In practice the main audible shortcoming of binaural sound reproduction is what has become known as "front back ambiguity". A sound recorded from the centre in front of the recording head may sound on replay as if it is coming from behind, and *vice versa.*

This is why many binaural recordings cheat a little by giving the listener an artificial fix on the sound field. For instance someone on the recording conveniently announces that they are "standing in front". It also has to be said that some binaural recordings are technically much better than others in this respect and recordings that produce a good illusion of the sound field for one listener may not sound so realistic to another.

Bad Image

Why hasn't binaural sound recording ever been a commercial success? In short it's anti-social and inconvenient to listen on headphones. So engineers soon lost interest in headphone stereo after they had devised a system of producing a stereo spread of sound from a pair of loudspeakers in a room.

Unfortunately a binaural stereo recording will not produce good stereo from loudspeakers. Moreover, a conventional stereo recording intended for loudspeaker reproduction (which in effect means virtually every commercially available recordings) will not produce a true surround of sound when heard on headphones. In fact an ordinary stereo recording usually sounds as if it is coming from inside the listener's head when heard on headphones.

When a binaural recording is played over loudspeakers the stereo image is muzzy and diffuse unless the listener sits in just the right position so that only sound from the left speaker reaches the left ear and only sound from the right speaker reaches the right ear. In fact this neatly sums up the basic difference between the two types of stereo.

With binaural stereo the sound for each ear is at all times kept separate: for loudspeaker stereo the sound from the left and right channels mixes and blends in the room after it leaves the loudspeakers. This mix or blend is heard slightly differently by each ear of the listener and the slight differences produce an illusion of natural sound.

Binaural Sounds

For anyone whose appetite has been whetted by this brief introduction to binaural sound, the BBC occasionally broadcasts a binaural programme and there are several binaural records on the market. But because many record shopkeepers haven't a clue what binaural is all about (another good example of disguised specialist ignorance) they will often file binaural under "quadraphonic" and recommend that the records need to be played on "special" reproduction equipment. In fact *all* you need is a stereo gramophone system and a pair of stereo headphones.

So where to buy binaural records? A good starting point is Quadramail, the Huntingdon based mail-order company which specialises in specialist discs and usually has a sales stand at major hi fi exhibitions. Also, part-time audio journalist Mick Skeet has produced a range of binaural EP discs which are available at £1·50 each (including postage) from Whitetower Music, 2, Roche Gardens, Bletchley, Milton Keynes MK3 6HR.

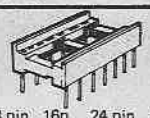
Some discs are far more worthwhile than others but if you like rock music I'd suggest AMC 705 (which features a semi-pro rock band called "Sinner") and if your musical tastes are more conservative I'd suggest AMC 704 (which on one side features some delightfully original organ and trumpet music recorded in a church).

STEVENSON
Electronic Components

OPTO

	0.125in.	0.2in	each
LED's			
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	15p
Yellow	TIL213	TIL223	15p
Clips	3p	3p	
DISPLAYS			
DL704	0.3 in CC		130p
DL707	0.3 in CA		130p
FND500	0.5 in CC		100p

SKTS



Low profile by Texas

8 pin	10p	18 pin	16p	24 pin	22p
14 pin	12p	20 pin	18p	28 pin	26p
16 pin	13p	22 pin	20p	40 pin	38p

3 lead T018 or T05 skt. 12p each.
Soldercon pins: 100 for 60p.

PCBS

VEROBOARD

Size in.	0.1in.	0.15in.	Vero
25 x 1	16p	–	Cutter 110p.
2.5 x 3.75	52p	45p	
2.5 x 5	60p	55p	Pin insertion
3.75 x 5	70p	70p	tool 150p.
3.75 x 17	250p	210p	

SS pins/100 45p 45p
Fibreglass board: 80p each.
Alfac – 33p per sheet.

RESISTORS

Carbon film resistors. High Stability, low noise 5%.

E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.85p
0.5W	2p	1.5p	1.3p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £8.50. 0.25W £5.30.

METAL FILM RESISTORS
very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

	each	100+	1000+
0.25W	4p	3.7p	3.5p

POTENTIOMETERS
Preset vertical or horizontal 100 ohms - 1M 6p
Rotary 5K-2M2 Log or Lin single . 30p
Rotary 5K-2M2 Log or Lin double 90p
Slide 60mm travel 5k-500k Log or Lin, single 60p
Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary controls 16p each. Slide type 12p each.

MISC.

Murata Ultrasonic Transducers	350p pair
64mm 8 ohm speakers	100p each
64mm 64 ohmspeakers	100p each
SRB 17W soldering iron	430p each
Reel of 22swg solder (39.6m)	320p each
Desoldering tool	510p each
Precision screwdriver set	170p each
Titan Electric drill	1095p each
Minaiture 606 and 909 at 100mA transformers	110p each

SWITCHES

TOGGLE

Standard	SPST 36p	DPDT 50p
Miniature	SPDT 75p	DPDT 85p
Subminiature	SPST 58p	DPDT 78p

SLIDE
Standard . . . . . DPDT 17p
Miniature . . . . . DPDT 16p

ROCKER (10A rating)
SPST 34p each. SPST 46p each.

ROTARY
1P12W, 2P6W, 4P3W or 3P4W 51p each
Key operated DPDT (Yale key) 395p each

PUSH
Non locking - push to make 16p each
- push to break 22p each
Locking - SPST 75p each
- DPDT 100p each

REGULATORS

LM309K 140p
LM317T 220p
LM323K 480p
LM723 40p

100mA + ve		1A + ve		1A – ve	
78L05	30p	7805	70p	7905	85p
78L12	30p	7812	70p	7912	85p
78L15	30p	7815	70p	7915	85p

TRANSISTORS

AC127	22p	BC548	11p	TIP32C	60p
AC128	22p	BCY71	16p	TIP2955	66p
AC176	22p	BCY72	15p	TIP3055	53p
AD161	40p	BD131	40p	ZTX107	12p
AD162	40p	BD132	40p	ZTX108	12p
BC107	12p	BD139	33p	ZTX300	14p
BC108	10p	BD140	33p	ZTX500	15p
BC108C	12p	BFY50	23p	2N3053	25p
BC109	12p	BFY51	23p	2N3054	56p
BC109C	12p	BFY52	23p	2N3055	50p
BC147	9p	MJ2955	100p	2N3702	9p
BC148	9p	MPSA06	16p	2N3704	9p
BC177	16p	MPSA56	16p	2N3706	9p
BC178	16p	TIP29C	60p	2N3819	20p
BC182	10p	TIP30C	48p	2N3904	10p
BC182L	10p	TIP31C	50p	2N3905	10p
BC184	10p	**DIODES**		2N3906	10p
BC184L	10p	1N914	4p	2N5459	33p
BC212	10p	1N4148	3p	2N5777	50p
BC212L	10p	1N4002	5p	1N4006	7p
BC214L	10p	1N4148 £1.50 per 100.		1N5401	14p
				BZY88ser.	8p

CAPACITORS

POLYSTYRENE
High quality foil type. 63V working, 5% tol.
22pf to 100pf . . . . . 7p each
1500pf to 0.01uF . . . . . 9p each

TANTALUM BEAD
0.1, 0.15, 0.22, 0.33, 0.47, 0.68
1 & 2.2uF @ 35V . . . . . 10p each
4.7, 6.8, 10uF @ 25V . . . . . 18p each
22 @ 16V, 47 @ 6V, 100 @ 3V . . 22p each

MYLAR
0.001, 0.01, 0.022, 0.033, 0.047 . . . 4p each
0.068, 0.1 . . . . . 5p each

POLYESTER
Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 6p ea.
0.15, 0.22 . . . . . 8p each
0.33, 0.47 . . . . . 12p each
0.68 . . . . . 17p each
1.0uF . . . . . 22p each

CERAMIC
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . . . 2p each

MINIATURE TRIMMERS
Miniature film type, in 1.4pF – 5pF, 2pF – 22pF, 2pF – 22pF, 2pF – 10pF, 5.5pF – 65pF. 22p each

RADIAL LEAD ELECTROLYTICS

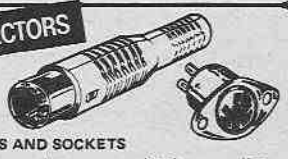
63V	0.47	1.0	2.2	4.7	10	6p each
			22	33	47	8p each
	100					16p each
			220			20p each
25V	10	22	33	47		6p each
	100					8p each
		220				12p each
				470		18p each
	1000					28p each

PACKS

Specially developed packs intended for development work.

¼W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total) . 530p each
½W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total) 850p each
¼W MF 1% resistor, 10 each value E24 series 51 ohms to 330K (930) . . . 2950p each
Preset potentiometers 5 each value from 100 ohms to 1 Megohm (65) . 390p each
Polyester capacitors 5 each value 0.01 to 2.2uF (70) . . . . . 690p each
Ceramic plate capacitors 10 each value 22pF to 0.01uF (310) . . . . . 575p each

CONNECTORS



DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2 pin	8p	8p	12p
3 pin	12p	10p	12p
5 pin 180°	12p	11p	17p
5 pin 240°	14p	11p	22p

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	10p	15p	8p
3.5mm	10p	16p	9p
Standard	16p	30p	19p
Stereo	23p	39p	22p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits, Red & Black. Plugs: 7p each. Sockets: 8p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs: 12p each. Sockets: 13p each.

CMOS

		4023	20p	4054	120p	4502	120p
		4024	50p	4060	120p	4507	60p
		4025	20p	4063	120p	4508	330p
		4026	160p	4066	60p	4510	80p
		4027	45p	4068	20p	4511	90p
4000	20p	4028	85p	4069	20p	4512	80p
4001	20p	4029	85p	4070	20p	4516	80p
4002	20p	4031	220p	4071	20p	4518	80p
4006	90p	4033	150p	4072	20p	4520	80p
4007	20p	4036	350p	4073	20p	4527	90p
4008	95p	4039	300p	4075	20p	4528	90p
4011	30p	4040	110p	4076	90p	4529	150p
4012	20p	4041	85p	4077	20p	4531	150p
4013	35p	4042	80p	4078	20p	4532	130p
4014	80p	4043	95p	4081	20p	4538	160p
4015	80p	4046	110p	4082	20p	4543	110p
4016	30p	4048	60p	4086	75p	4566	170p
4017	65p	4049	45p	4093	60p	4558	120p
4018	90p	4050	45p	4095	110p	4559	420p
4020	100p	4051	70p	4098	120p	4581	330p
4022	100p	4053	80p	4501	20p	4585	110p

LSTTL

		74LS47	80p	74LS126	45p	74LS175	90p
		74LS48	90p	74LS132	80p	74LS190	90p
74LS00	16p	74LS54	22p	74LS136	50p	74LS191	90p
74LS01	22p	74LS73	35p	74LS138	75p	74LS192	90p
74LS02	16p	74LS74	35p	74LS139	75p	74LS193	90p
74LS03	22p	74LS75	40p	74LS151	60p	74LS195	90p
74LS04	16p	74LS76	40p	74LS155	65p	74LS196	90p
74LS08	22p	74LS78	45p	74LS156	80p	74LS197	85p
74LS10	22p	74LS83	68p	74LS157	70p	74LS221	100p
74LS13	38p	74LS85	85p	74LS158	65p	74LS251	70p
74LS14	65p	74LS86	40p	74LS160	75p	74LS266	35p
74LS20	22p	74LS90	40p	74LS161	68p	74LS290	80p
74LS21	22p	74LS93	55p	74LS162	80p	74LS365	55p
74LS27	28p	74LS95	65p	74LS163	80p	74LS366	55p
74LS30	22p	74LS107	45p	74LS164	80p	74LS367	55p
74LS32	30p	74LS114	40p	74LS165	80p	74LS368	55p
74LS37	40p	74LS123	80p	74LS173	135p	74LS386	60p
74LS42	60p	74LS125	45p	74LS174	95p	74LS670	200p

TTL

		7442	40p	7493	30p	74157	40p
		7445	50p	7496	38p	74164	55p
7400	12p	7447	50p	74121	29p	74165	55p
7402	12p	7448	45p	74123	40p	74174	55p
7404	14p	7473	23p	74125	38p	74177	50p
7408	16p	7474	23p	74126	36p	74190	50p
7410	14p	7475	26p	74132	46p	74191	50p
7413	24p	7476	25p	74141	48p	74192	50p
7414	39p	7485	55p	74145	48p	74193	50p
7420	14p	7486	18p	74148	90p	74194	50p
7427	22p	7490	30p	74150	55p	74196	50p
7432	18p	7492	30p	74154	68p	74197	50p

LINEAR

		LM10	400p	LM3909	72p	TBA800	80p
		LM301A	30p	LM3914	280p	TBA810S	110p
		LM308	70p	LM3915	280p	TDA1008	350p
709	40p	LM318	85p	LM3911	120p	TDA1022	630p
741	18p	LM324	52p	LM13600	160p	TDA1024	120p
747	50p	LM339	55p	MC1496	80p	TDA2020	360p
748	35p	LM348	100p	LM1458	40p	TL071	75p
7106	850p	LM377	170p	LM1830	180p	TL072	135p
AY-1-0212	660p	LM378	230p	MC3340P	135p	TL074	200p
CA3046	70p	LM3795	410p	MC3360P	135p	TL081	45p
CA3080	75p	LM380	80p	MM57160	650p	TL082	85p
CA3130	90p	LM381	140p	NE531	110p	TL084	125p
CA3140	50p	LM382	120p	NE555	23p	TL170	60p
FX209	820p	LM383	200p	NE556	60p	XR2206	390p
ICM7555	100p	LM386	90p	NE566	120p	XR2207	450p
ICM7556	POA	LM387	120p	NE567	120p	ZN414	80p
LF347	135p	LM389	100p	NE570	420p	ZN419	POA
LF351	45p	LM391	170p	NE571	460p	ZN424	150p
LF353	85p	LM1310	140p	NE5537	POA	ZN425E	420p
LF355	92p	LM2917	280p	RC4136	100p	ZN460	360p
LF356	95p	LM2924	160p	SAD1024	1310p	ZN1034	230p
LF357	92p	LM3900	60p	SN76477	230p		

MICRO

						SUPPORT	
		2112	220p	CPU's		6810	350p
		2114LP	420p	6800	650p	6821	600p
		4116	620p	8080A	610p	6850	550p
		2708	680p	Z80	1090p	AY5-1013	370p
21L02	120p	2716	1980p				

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Everyday News

AN IDEAL HOME FOR CHIPS

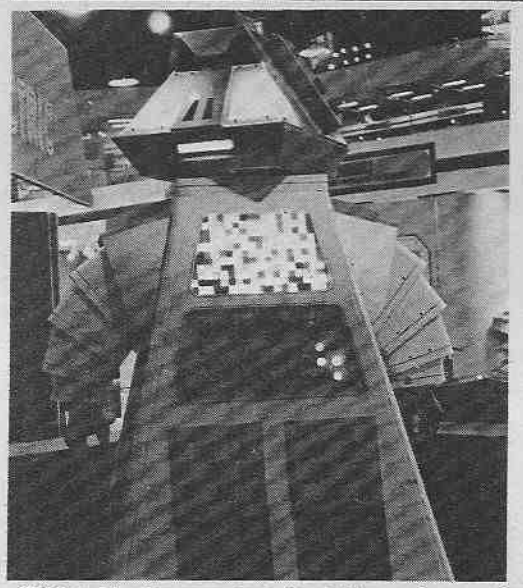
"Contrariwise," continued Tweedle-dee, "if it was so, it might be; if it were so, it would be; but as it isn't it aint. That's logic!"

Try asking the man in the street what he knows about the silicon chip and you may end up feeling like Alice. Indeed the very mention of the "mighty-micro" will probably cause his eyes to glaze over and conjure up visions of Star Trek and a certain Italian car commercial.

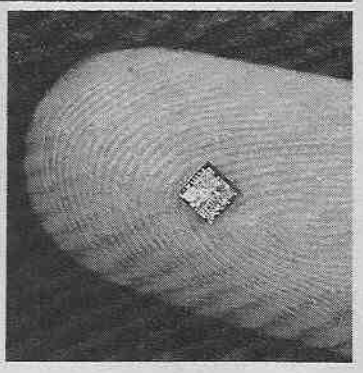
In the Home

In fact the microprocessor is more commonly used than we think although you wouldn't really know unless you looked closely. The Daily Mail Ideal Home Exhibition held last month at Earls Court gave ample opportunity to seek out examples of the "new technology" applied around the home—and we do mean seek out, despite what you may have been led to believe by pre-show publicity.

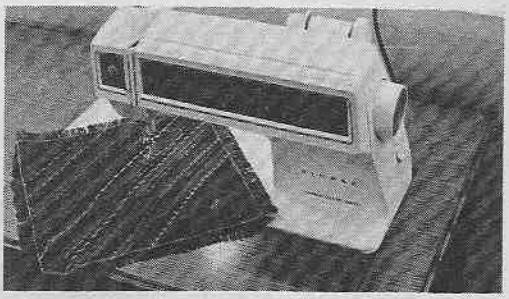
It is clearly evident from the exhibition that domestic appliance manufacturers seem notoriously slow in adopting new ideas. It's true that the odd one or two washing machines, cookers and sewing machines use microprocessor control, but we are still a long way off complete electronic control—strange, when it is cheaper and more reliable than equivalent electromechanical systems. Perhaps it's not a strong selling point.



Choose Electric says Fred the talking robot on the Electric Council Stand



This is a silicon "chip"



Singer Futura 2001 touch sensitive machine

Creda Carefree Electronic Cooker

The one exception to this was Plessey Ltd. Their whole stand was devoted to silicon chip technology and many devices one would expect in the Ideal Home of the '80s were on display. These included a new infra-red remote controlled slide projector, a heat sensitive hair dryer and a special set-up designed to illustrate silicon chip manufacturing techniques.

So perhaps next year we can look forward to a true Ideal Home of the future.

Quartz watches are now being produced in China for the growing world market. They use a Japanese electronic assembly but the cases are made locally.

GOLD RUSH

Electronic component manufacturers have been rushing ahead with gold surcharges following the huge lift in world gold prices. First in the field was RCA with a gold surcharge, quickly followed by TI, Fairchild and National.

Gold is used extensively in semiconductors, thick and thin film microcircuits, and edge connectors. Surcharges can be as little as 0·3p for a simple low-cost plastic packaged device but as much as 50p for a complex ceramic assembly.

Fly Electric

A new concept in aviation is the all-electric plane proposed by research engineers in Lockheed. It would still use aviation fuel for propulsion but would substitute very efficient electric generators and motors for the present hydraulic systems.

This, says Lockheed, would use less overall power and reduce fire risk because an all-electric system would be lighter and hydraulic fluid is prone to ignition.

Reduction in fuel consumption, first costs and maintenance costs over the lifetime of a medium-sized transport aircraft could be as much as £50 million. Electronic solid state control would be an essential feature in any new design.

Colour Blind

Advice for the component manufacturer for selecting suitable colours for marking resistors and capacitors is the subject of the new British Standard BS5890 "Guide for the Choice of Colours to be used for the Marking of Capacitors and Resistors." Price £1·20.

The object of the new standard is to reduce errors or misunderstandings which may result from improper selection or interpretation of colours.

. . . from the World of Electronics

Exhibition

"Hands on Experience" is the title of a series of new exhibitions currently being planned by Eurofairs to appear throughout the country, commencing in Bristol on 27 to 29 June.

The exhibitions aim to introduce the latest home computers, electronic games and remote control equipment/models to potential buyers. For further details write to Eurofairs, 9 Park Place, Clifton, Bristol BS8 1JP.

Inta-Stella Encounters

Scientists working on high energy physics are sending each other scientific data through the European OTS communications satellite.

The new scientific data network is called Stella and it enables participating laboratories to exchange data with high accuracy at a rate of a million bits of information a second. This is roughly the same speed as a scientific computer and will obviate the long delays of sending magnetic tapes by post.

Stella will link the Rutherford Laboratory in the UK with other laboratories in Germany, France, Italy, Austria and Ireland.

CB FINES

In 1979 there were 78 prosecutions for illegal use of CB Radio with another 56 cases pending. This compares with only three prosecutions in 1978 and four in 1977.

The Irish Republic, reversing an earlier decision, is now to legalise CB but the waveband to be used is still in question.

ANALYSIS

HOT STUFF

We know now that the electromagnetic spectrum is enormous extending from wavelengths of 100km at the low frequency end up to mere fractions of a micrometre (10^{-6} metre). Visible light is only a small part of the spectrum with wavelengths between 0·4 and 0·8 micrometres (i.e. 750-375GHz in frequency).

During this century, scientists and inventors have managed to exploit the whole of the spectrum in various applications. At the low frequency end for terrestrial communications, long wave, medium wave, short wave radio in the first quarter of the century, gradually extending up to v.h.f., u.h.f. and microwaves which gave us more communication channels including television, plus radar and a number of navigational aids as well as satellite communications. At the frequencies higher than the visible spectrum, X-rays and gamma rays are used extensively in medicine and industry.

Either side of the visible spectrum are the infra red and ultra-voilet which also have medical, industrial and military applications.

It is the infra red region which has attracted so much research in the past twenty years. Most people don't realise that any and all objects emit radiation in the infra red region, the amount depending on temperature. Even as you are reading these words you are unconsciously radiating infra red rays, as indeed are all the objects around you.

Such emissions can be detected with an infra red sensor and by scanning a scene it is possible to build up, point-by-point an infra red "picture" and, by electronics, convert it to a visible picture. The process is known as thermal imaging.

Who would want to use infra red imaging? More than at first appears. In medicine an infra red picture will show up incipient breast cancer because a tumour has a higher temperature than the surrounding tissue. Point an infra red camera at high voltage power lines and you can pick out instantly the hot spots that could lead to breakdown, and without climbing the pylon.

An infra red sensor is a good intruder alarm, sensing the heat of a body against a less hot background. In air-sea rescue the body in the water shows up plainly against the cooler background of the sea. An overflight of a housing estate will show which houses have roof insulation and which haven't. Fire brigades can locate the seat of a fire in a building even though inaccessible and obscured by smoke.

Obscured by smoke! This is the clue that leads up to the reason why infra red imaging is a top military priority. Infra red operates through cloud, smoke, camouflage and in dark shadow. Ordinary TV can't do this.

Brian G. Peck

COMPSTAT '80

The fourth Symposium on Computational Statistics, COMPSTAT '80, is being held at University of Edinburgh from 18 to 22 August.

Papers will include reviews of current methodology as well as descriptions of recent research on new techniques and software. An exhibition featuring the main statistical packages, computational aids and microprocessors is also planned, including "hands on" demonstrations.

Since Compstat '80 coincides with the first week of the Edinburgh Festival accommodation is obviously going to be limited and anyone interested in attending is advised to register early.

Further information and registration forms can be obtained from Compstat 80, Program Library Unit (Dept EE), University of Edinburgh, 18 Buccleuch Place, Edinburgh EH8 9LN.

On-Line Computers

A computer-controlled voice and data radio link is to be introduced on the St. Pancras-Bedford line of British Rail. It is being supplied under a £750,000 contract by Ultra Electronics and the German company AEG-Telefunken.

London Transport has invested in two extra Honeywell computers for control of times, routes and frequencies of trains to Cockfosters.

Carfax

Some 450 cars fitted with radios adapted for the BBC's Carfax motoring information service should be on the road by the end of June. The service is only in its trials stages but if proved successful later this year the go-ahead will be given for car radio manufacturers to produce equipment.

Motorists can stay tuned to Carfax or listen to other programmes with Carfax automatically overriding the programme whenever there is a motoring announcement. Additional cost to the motorist for a Carfax radio is expected to be in the region of £5 to £20.

Credit Card Petrol

A pilot experimental scheme in the Norwich area allows motorists to pay for their petrol at the pump by direct debit using their Barclay cards. The service is available at a number of Esso garages.

Automatic funds transfer is the basis of the cashless society which reduces "mugging" and the risk of robbery where there are large concentrations of cash.

Video Pirating

Illegal recording which has cost the audio industry millions of pounds is now worrying the video companies who are now researching encoding systems which will make it difficult or impossible to copy a video recording successfully on a home recorder.

Cheap Video

Japanese researchers are reported to be active in developing techniques to enable digital video signals to be recorded on a standard audio cassette although the tape may need to be of special type.

. . . . . AND NOW AN ELECTRIFYING NUMBER FROM EE

BY STEVE BEECHING

THE UNIT TO be described here was originally designed with a factory background music system in mind to provide voice-operated paging which overrides the music, when calling the required personnel.

This Auto Fade Unit can also be used by a DJ with a disco system to provide voice announcements over the music. The unit has provisions for stereo music and a mono microphone, where the speech can be switched into both channels at once. There is no problem in using a mono system, one input being left unconnected.

The unit cannot really be used as a simple voice-operated switch, for example in transmitter applications, as there is no relay in the circuit to switch external power circuitry. Nevertheless the unit can be considered versatile and no doubt be used for other applications to those originally intended.

CIRCUIT DESCRIPTION

The full circuit of the Auto Fade Unit is shown in Fig. 1. The actual switching between music and speech is provided by IC4a to IC4d, a CD4016 quad bilateral switch CMOS i.c. Normally, in the off condition there is a very high resistance between input and output of each switch for example IC4a. Here, between input, pin 1 and output, pin 2 there is a resistance of approximately 10MΩ. The control terminal for this gate is pin 13, which is normally low when the switch is considered to be off.

The remaining three switches operate in a similar manner. When the control input is taken high the switch is turned on and a low resistance appears between input and output, this being about 300 ohms.

In the normal rest state the control inputs to gates IC4a and IC4b are high, thus the switches are on and the music is able to pass straight through to the output.

The remaining two gates, IC4c and IC4d have their respective inputs connected together to which the speech signal is applied. Their outputs, pins 9 and 10 are connected to the LEFT and RIGHT channels respectively. Thus when these gates are turned on speech is applied to both channels at the same time. In the normal rest state the control inputs are low.

AMPLIFIER

An LM382 dual amplifier is used in two stages as a microphone amplifier with a gain of about 20dB. The first stage consisting of IC2a amplifies the low level signal from the microphone to a sufficient level so that it can pass through the remaining stages with little attenuation. A proportion of this signal is tapped off by the TRIGGER LEVEL control, VR1 and applied to the second stage, IC2b.

The second stage provides a high gain limiting action, amplifying the signal to a more than sufficient level for applying to the d.c. rectifying circuit. The rectifying circuit comprising R4, D1, D2 and C8 provides a d.c. switching level which is used to change the states of IC3a and IC3b.

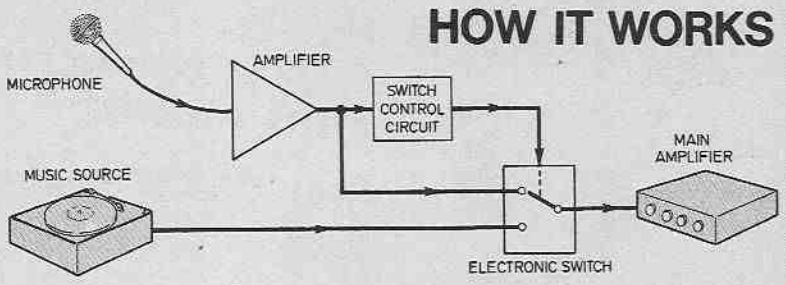
Normally pin 3 is high, and pin 4 low. We thus have the required conditions applied to the switches to enable them to assume the states mentioned earlier.

When speech is applied through the various stages, the d.c. level causes the high condition at pin 3 of IC3a to go low, thus turning off the music, and the low condition at pin of IC3b to go high thus turning on the speech enabling the speech to be connected through to the output.

When there is no further speech, there is a delay of about half a **second** before the circuit reverts back to its original state and the music is once more able to pass through.

Power for the unit is provided by two batteries giving 18V. A 15V regulator i.c., IC1 is then used to provide a stable 15V supply to the circuit.

HOW IT WORKS



Music is fed into an electronic switch inside the unit. When the microphone is not in use, this music is directed straight through to the amplifier, but when an announcement is made the electrical signals from the microphone are amplified and passed to the electronic switch.

A control signal is also produced from the voice input in the switch control circuit which causes the switch to change over and direct the speech signals to the amplifier.

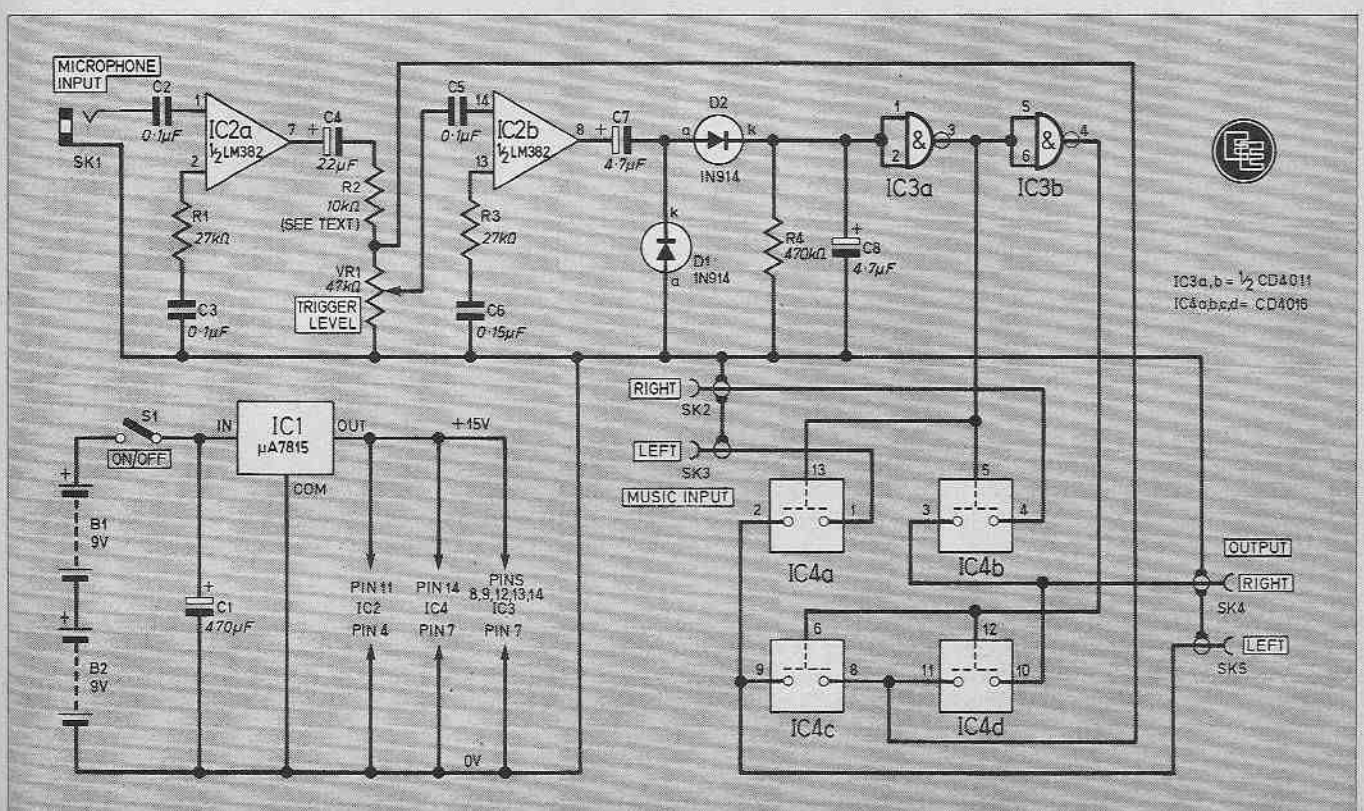
At the end of the announcement, the switch changes back to its original state and the music will again be heard.

CONSTRUCTION starts here

CONSTRUCTION

The entire circuit is built on a piece of 0·1 inch matrix stripboard 26 strips x 49 holes. The layout for this board is shown in Fig. 2. There is nothing critical about the layout and it could if desired be mounted on a printed circuit board.

Fig. 1. Complete circuit diagram of the Auto Fade Unit.



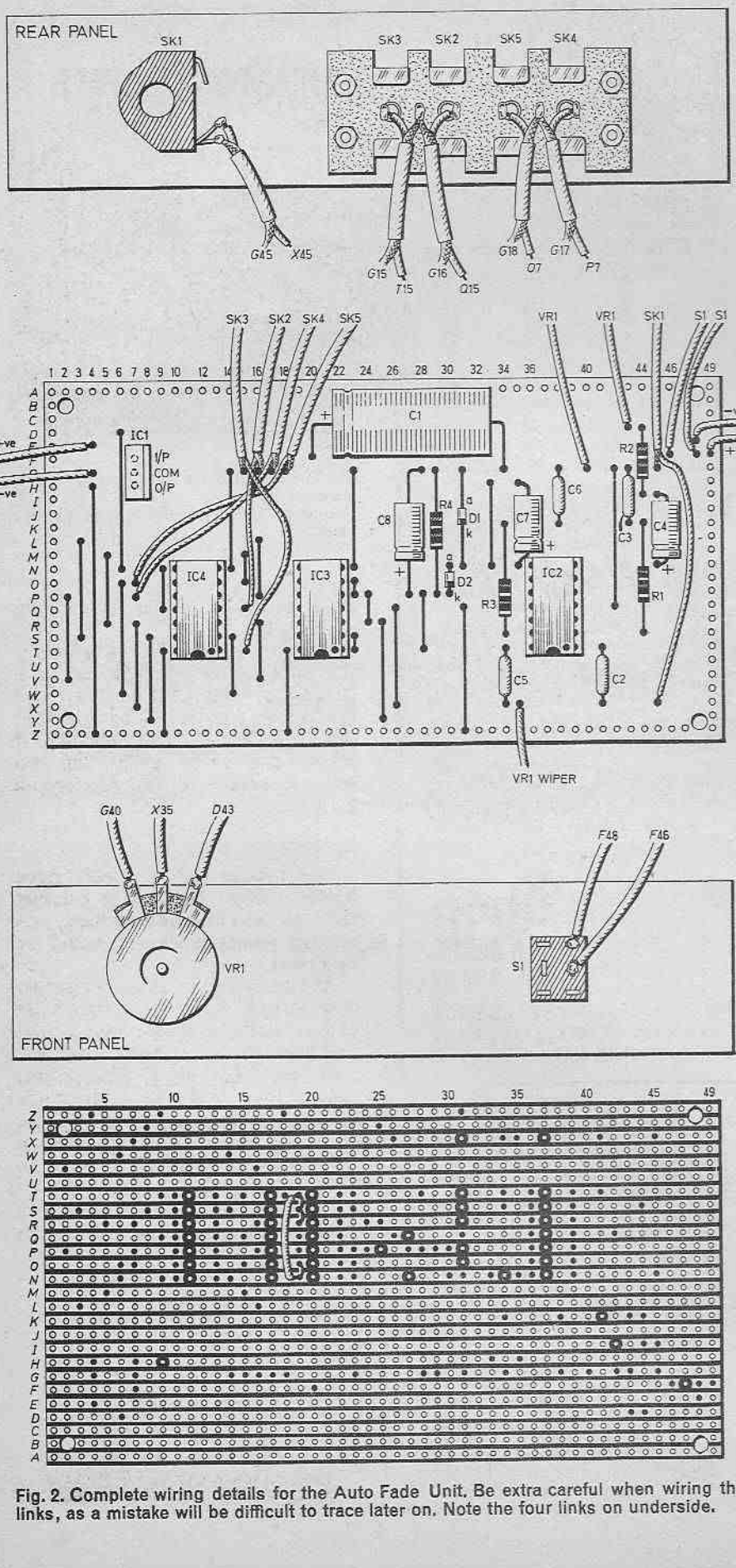
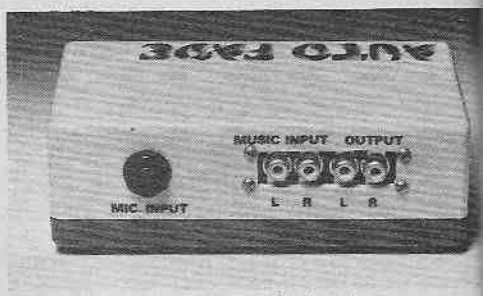


Fig. 2. Complete wiring details for the Auto Fade Unit. Be extra careful when wiring the links, as a mistake will be difficult to trace later on. Note the four links on underside.



Rear view of the unit showing the phono socket strip and mic. input jack socket.

Also shown in this diagram is the front and rear panel wiring details. The case used was a small Verobox type 65-2520J, with dimensions of 150 x 80 x 50mm, although any similar size case can be used. It does not have to be metal to provide screening for the circuit.

Remember to observe the usual precautions when handling the CMOS i.c.s. Sockets were used in the prototype, but providing you are fairly swift with a soldering iron, they could be dispensed with.

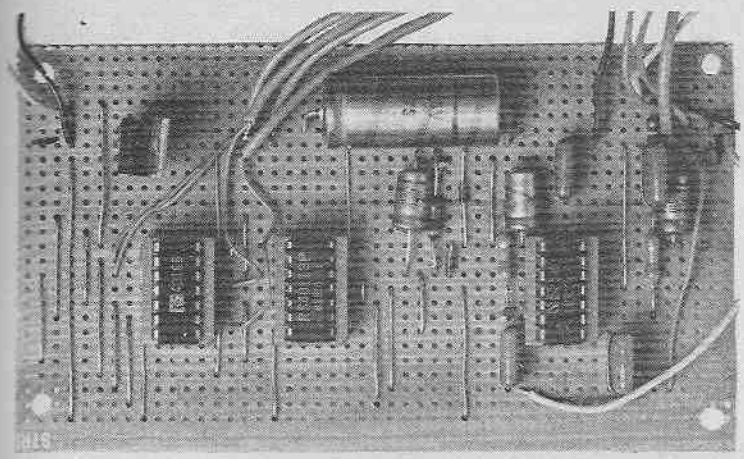
Screened lead is used for the input and output sockets. It is not advisable to use ordinary connecting wire as there is a possibility of hum appearing. This is especially true of the input.

TESTING

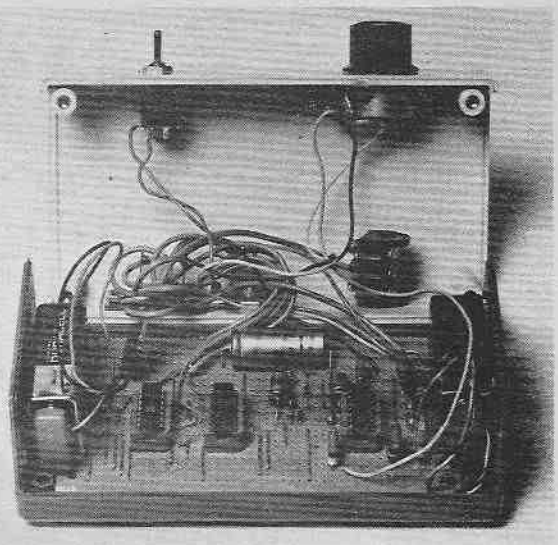
After assembly is complete, it is a good idea to check over for errors, particularly because of the large number of link wires. It is easy to miss one or two. If all seems well the batteries may be connected and the unit switched on. If possible check with a voltmeter that 15V appears across the supply.

Connect a mono audio source to one channel of the MUSIC inputs and connect the corresponding output to an amplifier. If the circuit is functioning correctly the audio will pass through with little or no attenuation. Do the same with the other channel.

Now connect a microphone to the SPEECH input, start with the trigger level control fully anti-clockwise and slowly rotate it clockwise until a point is reached where the circuit switches, and the speech appears across the output. You may find that after speech is removed the circuit tends to oscillate very slowly, not switching off cleanly. If this happens, it is probable that VR1 is



Layout of components on the completed circuit board for the Auto Fade. We strongly recommend the use of i.c. sockets as the i.c.s can easily be damaged during soldering.



The completed Auto Fade with top cover removed.
Note the careful positioning of the two batteries.

COMPONENTS

Resistors
R1 27kΩ
R2 10kΩ
R3 27kΩ
R4 470kΩ
All ¼W carbon ± 5%

Capacitors
C1 470μF 18V elect.
C2 0·1μF polyester
C3 0·1μF polyester
C4 22μF 18V elect.
C5 0·1μF polyester
C6 0·15μF polyester
C7 4·7μF 18V elect.
C8 4·7μF 18V elect.

Potentiometer
VR1 47kΩ lin. carbon

Semiconductors
IC1 μA7815 15V voltage regulator
IC2 LM382 dual preamplifier
IC3 CD4011 quad 2-input NAND gate
IC4 CD4016 CMOS quad bilateral switch
D1,2 1N914 silicon diode (2 off)

COMPONENTS approximate cost £7 excluding case

See Shop Talk page 323

Miscellaneous
S1 miniature single-pole toggle
B1,2 9V PP3 battery (2 off)
SK1 standard jack socket
SK2-SK5 phono sockets (4 off)
Stripboard 0·1 inch matrix 26 strips × 49 holes; Verobox type 65-2520J 150 × 80 × 50mm or similar size case; 14 pin i.c. sockets (3 off); small knob; miniature screened cable; stranded connecting wire.

set too high or that the value of R4 is too high. Rotate VR1 until the circuit switches off. This must be done slowly. Then recheck that, with speech applied, the circuit switches.

At this stage you may notice that the microphone signal is somewhat larger than the music signal. If this is the case then the value of R2 should be increased until the two signal levels are roughly the same.

If the tests are satisfactory the unit is then ready for use. Remember though that the level control is only adjusted for that one particular microphone, if others are to be used then the control needs to be readjusted each time.

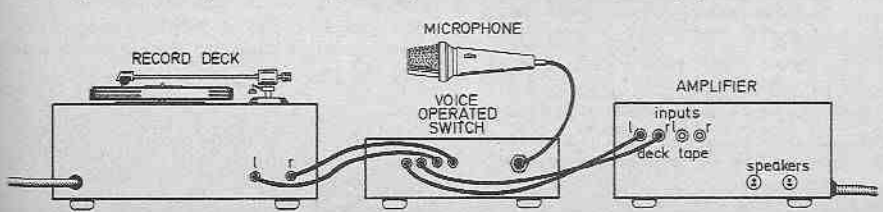
IN USE

The reader will probably have his own ideas on how to connect the unit into an audio system, one or two points however should be observed.

As the unit is in effect a change-over switch, both the microphone output and the music source output should be suitable for the same amplifier input. This means that if for example a magnetic cartridge is used, it will need some form of pre-amp and equalisation before being fed into the auto-fade unit.

The diagram of Fig. 3 shows one suggested arrangement. ☐

Fig. 3. Example of how to connect the unit into an audio system. This is for guidance only—there will probably be variations with the equipment used.



The completed Auto Fade ready for use.

UNIBOARDS

SIMPLE TRANSISTOR DESIGNS

By A. R. Winstanley

5

AUDIO TONE GENERATOR

Both the *Burglar Alarm Module* and *Opto Alarm* projects earlier in this series have utilised a miniature audible warning device as the alarm tone generators. Being solid state, these units have the advantage of low current consumption (about 15mA) as well as small size when compared with electromechanical buzzers.

The project described here is a two-transistor circuit which produces an alarm tone via a miniature 8 ohm loudspeaker. It can be used in place of the audible warning device mentioned above.

The Audible Tone Generator is easily constructed from readily available parts and is ideal for beginners. This device incorporates a preset control enabling the frequency of the tone to be varied to a certain extent.

It can be used in any project which operates from a 9 volt rail; 12 volts must be considered the absolute maximum supply voltage for the unit. Being a direct replacement for the audible warning device described earlier, this unit also draws in the region of 15 to 20mA.

CIRCUIT DESCRIPTION

The circuit diagram of the Audible Tone Generator is shown in Fig. 1. Regular readers will recognise this as a unijunction transistor oscillator, TR1, followed by a single-transistor amplifier, TR2.

TR1 has three terminals which, unlike a "normal" transistor, are designated emitter, base 1 and base 2. The transistor is connected to form a relaxation oscillator operating at audio frequencies. When power is applied to the circuit, the capacitor C1 will charge up through the resistors R1 and VR1. Eventually a point is reached when the transistor will switch over, and C1 will discharge itself into the emitter of TR1 and R4 to 0V.

TR1 will then switch back over to its high impedance state, and so C1 starts to charge up again. The whole cycle repeats itself, a constant stream of pulses being present at base 1.

By adjusting the timing components (R1, VR1 and C1), the frequency of the pulses can be altered. In fact by varying VR1 this particular unit was measured as operating between 100 and 350 Hertz.

The output pulses are coupled to TR2 by R3. This second transistor amplifies the audio tone generated by TR1 and associated components, and directly drives the loudspeaker LS1. The speaker used in the prototype was a 45mm diameter type, although a larger size (e.g. 65mm) could be used.

Capacitor C2 decouples the power supply and enables the peak current requirements to be met.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit can be built onto a standard-sized piece of 0·1 inch matrix stripboard measuring 10 strips x 24 holes, Fig. 2. This particular size is available from suppliers, but it can if necessary be cut out from a larger piece.

Commence by drilling two 6BA clearance holes in the positions *B3* and *I3* as shown. These will enable the completed board to be fixed down with 6BA hardware and spacers.

There are six breaks to be made in the copper strips, in order to prevent the mounting hardware from shorting together adjacent copper strips. After doing this, the components may be soldered in.

The transistors being semiconductors of course are sensitive to heat, so it is wise to use a heatshunt on the transistor leads being soldered.

Transistor TR2 was fitted with a push-on TO-18 heatsink purely as a precaution, as the transistor temperature did rise slightly after prolonged use with a 12V supply rail. The heatsink can be omitted if it is not available, but if one is used, it must be fitted to the transistor *before* the device is soldered into position. Otherwise the possibility exists of the leads of the transistor being accidentally bent or deformed, because of the pressure required to push on the tight-fitting heatsink.

The only points to watch are correct orientation of the transistor leads, plus proper polarisation of the electrolytic capacitor C2. Four flying leads connect up the loudspeaker switch and the power supply; these can be made up from standard multi-purpose hook-up wire (preferably stranded) and can either be soldered to terminal pins or straight to the circuit board.

INSTALLATION

The completed unit can either be installed in a separate box (together with the loudspeaker) or it can be fitted into the same case (if there is any room) as the equipment from which it is to be powered.

The miniature loudspeaker is carefully glued to the inside of the case: a smear of Uhu or similar adhesive around the rim of the speaker should be enough to fix down the loudspeaker, but do not apply any glue to the actual cone of the speaker. A series of holes should be made in the case where the speaker is to be positioned, so that the sound of course can get out.

Testing the generator comprises applying 9 volts (from a battery) and setting VR1 until a tone of the desired frequency is obtained.

Next Month: Voltage Converter

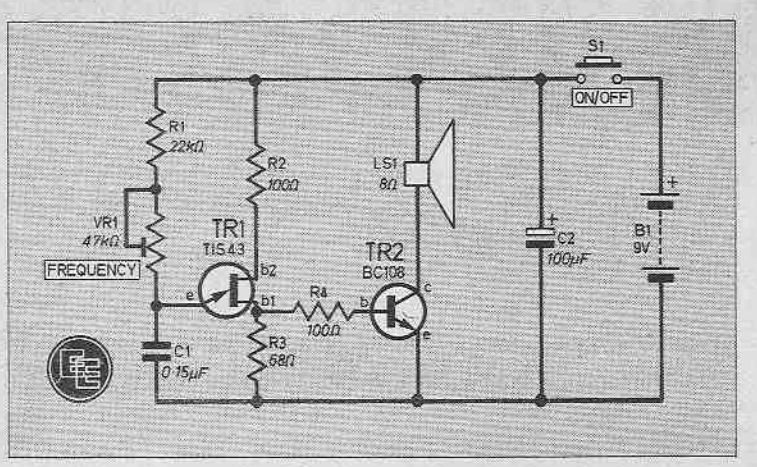
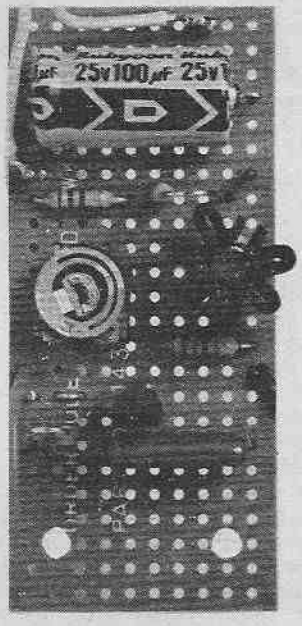


Fig. 1. Circuit diagram for the Audio Tone Generator.



(above) The completed circuit board. The use of a heatsink for TR2 is optional.

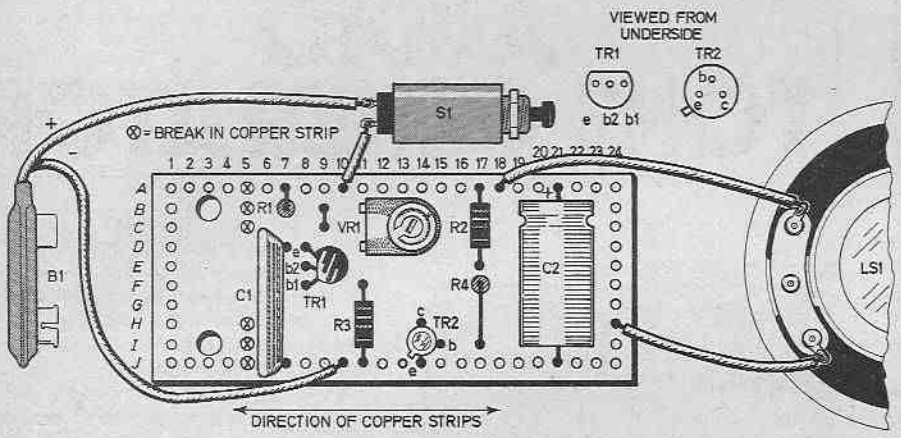


Fig. 2. Layout of components on the topside of the circuit board together with interwiring to loudspeaker, on/off switch and battery connector. Note that there are six breaks to be made in the copper strips on the underside.

COMPONENTS

Resistors

R1	22kΩ	All ¼W carbon ± 5%
R2	100Ω	
R3	100Ω	
R4	68Ω	

Capacitors

C1	0·15μF polyester type C280
C2	100μF 10V elect.

Semiconductors

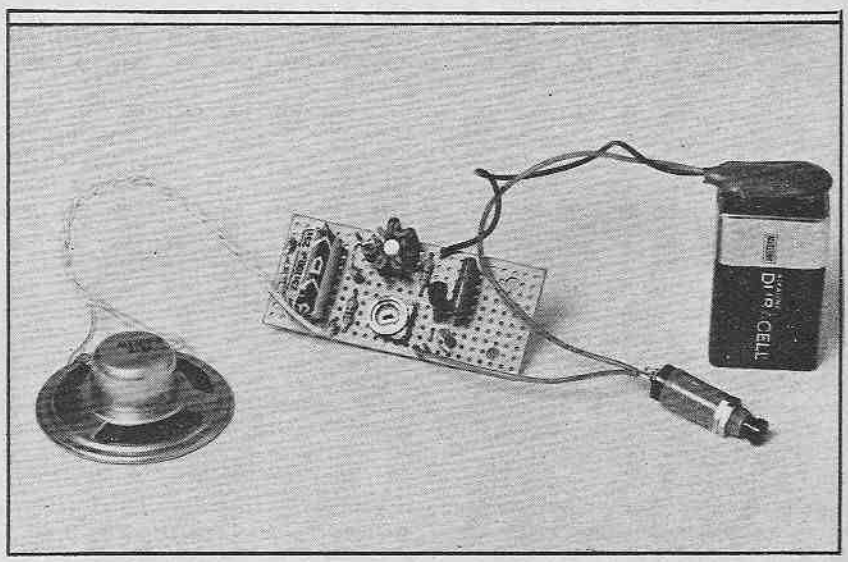
TR1	TIS43 *n*-channel unijunction transistor
TR2	BC108 *npn* silicon

Miscellaneous

VR1	47kΩ miniature horizontal preset
LS1	miniature 8-ohm moving coil loudspeaker
S1	push-to make pushbutton switch
B1	9V type PP3 or in-built supply—see text

Stripboard 0·1 inch matrix size 10 strips × 24 holes; push-on TO-18 heatsink (optional, see text); 6BA mounting hardware; case to suit; PP3 battery clip.

Approx. cost Guidance only £2.20



The completed Audio Tone Generator. The method of housing the finished unit is left to individual choice.

RADIO WORLD

By Pat Hawker, G3VA

Power for Radio

When most of us think of radio, telecommunications and broadcasting, we think in terms of electronics rather than electric power. Yet, in practice, as soon as one moves equipment away from the electric supply mains, the basic problem of providing electricity looms very large indeed.

A simple radio receiver can be run from dry batteries, although the cost, in terms of power delivered, is several hundred times as much as from supply mains.

Rechargeable cells, particularly the convenient nickel-cadmium (nicad) units, are the most popular and practical means of powering small amateur-radio transceivers, but this assumes moderate loads and regular access to the mains. What about equipment that needs to run, day-in day-out, often unattended, in remote loacations?

Many exotic, high-density power sources are regularly announced yet relatively few of these prove in the end to be as cost-effective as the traditional methods. Remember when in the sixties "fuel cells" were so confidently predicted as being about to sweep normal large capacity storage batteries off the market? Somehow Leclanche dry batteries and lead-acid car batteries seem to have survived!

Some ingenious power sources were exploited during World War II for clandestine and infiltration radio links: stationary bicycle generators (an energetic "rider" can develop over 100 watts for a limited period of time); the more sophisticated form of this approach was a "beach chair" version that could be folded up and carried as a back-pack; wind-generators of course; thermo-couple chargers using the Seebeck effect of dissimilar junctions (In the 1930s this was used to permit radio receivers to be "run from the gas mains"); there was even a small steam-driven generator with a boiler that could be suspended in a charcoal-burning brazier, coupled to a twin-cylinder engine which, with a steam pressure of 30 to 35lb, could charge a 6V battery at about 4A.

More recently the solar generator has found increasing application, not only for space satellites, but also for many purposes in remote, sunny areas. Even the early form of zinc-air batteries (once used to operate door bells in many houses) has been very successfully revived and used in South Africa to run remote radio repeaters; the trick is to use the disposable but very large zinc-air battery to keep large nicad cells (better able to supply intermittent loads) fully charged.

Many systems have been used for rural telecommunications in Australia. For example Telecom Australia has over 50 solar power systems in use and these are proving cost-effective for loads of up to about 200 watts.

This organisation has also used thermoelectric generators, mostly for powers of under 60W. Originally these were heated from propane gas but suffered from high costs and poor reliablility; however a new range of improved units, delivering up to 120W, with hermetically-sealed thermopiles and all-stainless-steel construction, are now being developed for locations where there are adequate supplies of propane, butane or natural gas.

Wind Generators

Wind generators have been found to need careful design since their performance in low wind conditions is usually much more important than their ability to deliver considerable power in strong winds. Current work is on a 5kW design that is expected to "cut-in" and deliver useful power whenever the wind exceeds a modest 10km/hour; these are expected to support (with the aid of storage batteries) ten times the load of earlier 2kW units.

The Americans are thinking of very large wind-generators to feed power into the electric grid; some of these may be in the form of tall, elegant windmills. Some people, however, are concerned lest the large revolving blades upset television reception over large areas, in much the same way as reflections from aircraft can do, or as happens in areas where there are large moving cranes producing a changing pattern of multipath ("ghosty") pictures.

Late last year, an experimental American medium-wave broadcasting station, WBNO at Bryan, Ohio, began using a large solar array of 33,600 photovoltaic cells that can generate 15kW from sunlight; they are used in conjunction with four large unitized diesel tubular batteries.

The rising costs of electric power, even from the mains, is already worrying American broadcasters; a couple of years ago an engineer at one of the very high power u.h.f. stations told me that his station had given up late night TV as it was too expensive: not the cost of programming but the power bill!

Lines on TV

The Science Museum in London is currently staging a special exhibition (open until September) called "The Great Optical Illusion" and marking 50 years of television broadcasting. The anniversary is based a little tenuously on one of the many events surrounding the early Baird 30-line mechanical system which helped pave the way for good TV pictures but which was never itself of real home-entertainment value.

The poor performance was due to poor synchronisation as well as the poor resolution of the pictures; though mechanical systems of televison subsequently proved capable of providing very acceptable pictures on 180 lines, 240 lines and even (with the Scophony large screen system) on 405 lines. The limit of 30 lines was due to the restricted bandwidth available on medium waves; it was only when television moved up to v.h.f. that real progress became possible.

In the UK we all recognise the extremely valuable work done by the Marconi-EMI research team leading to the 405-line system that opened (alongside the Baird 240-line sequential system) in November 1936 at Alexandra Palace. But I do feel that we tend, a little chauvinistically, to overlook the important work during the thirties in France and Germany.

A 180-line service was officially opened in Berlin in 1935 and soon included the use of electronic cameras; at the same time many firms in Germany were working on 375-lines and a public service opened in 1938 using 441 lines.

The Germans televised the 1936 Olympic Games using both mechanical and electronic cameras and, at the Berlin Radio Exhibition that year, receivers for 180 and 375 lines were exhibited by Fernseh, Telefunken, Loewe, Lorenz, Philips and Te-Ka-De (a firm that specialised in mechanical systems); the German Post Office (which had opened a video telephone link between Berlin and Leipzig using a co-axial cable and a 180-line system) showed iconoscope-type cameras as well as an intermediate film system similar to that used by Baird at Alexandra Palace. With this technique the film was processed in just about a minute (the main drawback curiously enough was the poor sound of the film recording).

Although the BBC television service closed down on September 1, 1939, the sound transmitter later being used to "bend" German navigational beams, the Germans kept their Berlin service going until November 1943 when the transmitter was destroyed by Allied bombing; they also ran a service for Wehrmacht occupation troops from the Eiffel Tower that actually stayed on the air until ten days before the Liberation of Paris in August 1944. Pictures from this service were monitored on the Kent coast and it has been claimed that useful information was obtained from this Intelligence operation.

Our three-colour eyes

The truly remarkable colour-fidelity that can be achieved with modern television based on the transmission of three colour signals (red, green and blue) becomes more understandable now that it is firmly accepted that human colour vision similarly depends on just three classes or retinal receptors and that these, also like colour TV, have overlapping spectral sensitivities.

Apparently these human colour sensitivities are centred on violet, green and yellow, though spectrally these are not far away from TV's red, green and blue.

If one could only find a way of stimulating the brain directly from video signals, it might be possible to transmit a colour picture without the need for a picture tube or having to keep our eyes open! But of course if we could do that, and similarly with sound, we would be well on our way to enabling the deaf to hear and the blind to see.

WATFORD ELECTRONICS

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POLYESTER CAPACITORS: Axial lead type (Values are in μF)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10m, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n, 24p; 330n, 470n **41p**; 680n **52p**; 1μF **64p**; 2μ **82p**.
160V: 39μF, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1μF **22p**; 1μ5, 2μ2 **32p**; 4μ7 **36p**.
1000V: 10nF, 15n, **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **53p**; 1μF **175p**.

POLYESTER RADIAL LEAD CAPACITORS (250V)
10nF, 15n, 22n, 27n, **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1μF **22p**; 1μ5 **30p**; 2μ2 **34p**.

FEED THROUGH CAPACITORS
1000pF 350V **8p**

ELECTROLYTIC CAPACITORS: (Values are in μF) 500V: 10 **40p**; 47 **68p**; 250V: 100 **65p**; 63V 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, **8p**; 10, 15, 22, **10p**; 47, 32, 50 **12p**; 63, 100 **27p**; 50V 50, 100, 220, **25p**; 470 **32p**; 1000 **50p**; 40V: 22, 33, 9p; 100 **12p**; 2200, 3300 **85p**; 4700 **98p**; 35V: 10, 33 **7p**; 330, 470 **32p**; 1000 **49p**; 25V: 10, 22, 47, 80, 100 **8p**; 160, 220, 250, **15p**; 470 **25p**; 640, 1000 **35p**; 1500 **40p**; 2200 **45p**; 3300 **77p**; 4700 **85p**; 16V: 10, 40, 47 **7p**; 100, 125 **8p**; 220, 330 **14p**; 470 **20p**; 1000, 15000 **77p**; 2200 **34p**; 10V: 100 **6p**; 640 **12p**; 1000 **14p**.
TAG-END TYPE: 450V: 100μF **180p**; 70V: 4700 **165p**; 64V: 3300 **130p**; 2500 **110p**; 50V: 3300 **98p**; 2200 **99p**; 50V: 15,000 **399p**; 4700 **120p**; 4000 **92p**; 3300 **98p**; 2500 **85p**; 2200 **85p**; 2000 + 2000 **120p**; 30V: 4700 **90p**; 25V: 15000 **195p**; 6400 **120p**; 4700 **98p**; 3000 **85p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS 35V: 0·1μF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2μF, 3·3, 4·7, 6·8 **25V:** 1·5, 10 **20V:** 1·5 **16V:** 1·0μF **13p** each 47, 100 **40p**. **10V:** 22μF, 33 **25p 6V:** 47, 68, 100, **30p 3V:** 68, 100μF. **20p**

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF **6p**
0·015, 0·02, 0·04, 0·05, 0·056μF **7p**
0·1μF **8p** 0·2 **9p** **50V:** 0·47 **12p**

MINIATURE TYPE TRIMMERS
2–5·6pF, 3–10pF, 10–40pF **22p**
5–25pF, 5–45pF, 60pF, 88pF **30p**

COMPRESSION TRIMMERS
3–40pF, 10–80pF **30p**; 25–190pF **33p**
100–500pF **45p** 1250pF **58p**.

POLYSTYRENE CAPACITORS
10pF to 1nF **8p**; 1·5nF to 10nF **10p**.

SILVER MICA (Values in pF) 3–3, 4–7, 8–8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 **11p** each
220, 250, 270, 300, 330, 360, 390, 470, 500, 800, 820 **16p** each
1000, 1200, 1800, 2200 **26p** each

CERAMIC CAPACITORS: 50V
0·5pF to 10nF **4p**; 22n to 100n **6p**.

EURO BREADBOARD £5·30.

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.
500 Ω, 1K & 2K (Lin. only) Single **29p**
5K-2 MΩ single gang **29p**
5K-2 MΩ single with DP switch **69p**
5K-2 MΩ double gang **88p**

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
[illegible]·500K Ω single gang **60p**
10K Ω-500K Ω dual gang **80p**
Self Stick Graduated Bezels **30p**

PRESET POTENTIOMETERS
Vertical & Horizontal
0–1W 50Ω—5MΩ Miniature **7p**
0–25W 100Ω—3·3M Ω Horiz **10p**
0–25W 200Ω—4·7MΩ Vert **10p**

RESISTORS: Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

Range	Val.	1–99	100+
¼W 2Ω2–4M7	E24	2p	1p
½W 2Ω2–4M7	E12	2p	1p
1W 2Ω2–10M	E12	5p	4p

2% Metal Film 10Ω–1M **6p** **4p**
1% Metal Film 51Ω–1M **8p** **6p**
100+ price applies to Resistors of each value not mixed.

TGS 812 or 813 gas and smoke detector **415p**. Socket for above **30p**.

OPTO ELECTRONICS
LEDs plus clips

TIL209 Red	13
TIL211 Grn	17
TIL212 Yellow	18
.2" Red	15
2" Yellow Green	18
Square LED	36
OCP71	120
ORP12	63
ORP61	85
2N5777	45

7 Seg Displays

TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DL704 C Cth .3"	99
DL707 C.A. .3"	99
DL747 C.A. .6"	180
FND357	120
MAN3640	175
.3" Green C.A.	180
.6" Green C.A.	225
LCD 3½ Digit	875
TIL32 Inf. Red	58
TIL78 detector	70

Opto Isolators

IL74	48
TIL111, 112,	75p.
TIL116, 117	100p.

Bargraph Red.
Ten segment **225p**

SWITCHES
TOGGLE 2A 250V

SPST	28p
DPDT	38p

SUB-MIN TOGGLE

SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT c/off	79p
DPDT Biased	115p

SWITCHES Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER: SPST on/off 10A 250V **30p**
ROCKER: Illuminated (white)
Lights when on: 3A 240V **70p**
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. **43p**
ROTARY: Mains 250V AC, 4 Amp **52p**

DIL SOCKETS (Low Profile – Texas)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **43p**; 20 pin **22p**; 24 pin **25p**; 28 pin **39p**; 40 pin **52p**.

VOLTAGE REGULATORS*

1A	TO3	+ve	—ve	
5V	7805	**145p**	7905	**220p**
12V	7812	**145p**	7912	**220p**
15V	7815	**145p**		—
18V	7818	**145p**		—
1A	TO220	Plastic Casing		
5V	7805	**65p**	7905	**75p**
12V	7812	**65p**	7912	**75p**
15V	7815	**65p**	7915	**75p**
18V	7818	**65p**	7918	**75p**
24V	7824	**65p**	7924	**75p**
100mA	TO92	Plastic Casing		
5V	78L05	**30p**	79L05	**65p**
6V	78L62	**30p**		—
8V	78L82	**30p**		—
12V	78L12	**30p**	79L12	**65p**
15V	78L15	**30p**	79L15	**65p**

CA3085	95	LM323K	625	TAA550	50
LM300H	170	LM325N	240	TBA625B	95
LM305H	140	LM326N	240	TDA1412	150
LM309K	135	LM327N	270	78H05	595
LM317K	350	LM723	39		

SLIDE 250V:

1A DPDT	14p
1A DP c/off.	15p
½A DPDT	13p
4 pole c/over	24p

PUSH BUTTON
Spring Loaded

SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

JACKSONS VARIABLE CAPACITORS

Dilicon		0 2 365pF with	
100/300pF	205p	slow motion	
500pF	250p	Drive	450p
6 1 Ball Drive		00 208/176	350p
4511/DAF	145p	" " with slow	
Dial Drive 4103		motion drive	410p
6 1/36 1	775p	C804-5pF 10 15	
Drum 54mm	55p	25 50 pF	250p
0-1·365pF	325p	100, 150pF	335p
00 2 365pF	395p	'L' 3 x 310pF	725p
		00·3 x 25pF	550p

DENCO COILS

'DP' VALVE TYPE	RFC 5	104p
Range 1 to 5 Bl.,	RFC 7 (19mH)	120p
Rd., Yl. Wht.	92p	IFT 13; 14; 15;
6–7 B.Y.R.	85p	16; 17 110p
1·5 Green	99p	IFT 18/1·6 104p
'T' 1 to 5 Bl., Yl.,		IFT 18/465 114p
Rd., Wht. 1·05p		TOC 1 92p
B9A Valve Holder		MW5FR 112p
28p		MW/LW 5FR 120p

VEROBOARD

	0·1 (copper clad)	0·15 (plain)	0·15
2½ × 3½	46p	39p	24p
2½ × 5	55p	50p	31p
3½ × 3½	55p	50p	—
3½ × 5	62p	57p	43p
2½ × 17	169p	135p	92p
3½ × 17	218p	180p	120p
4½ × 17	280p	—	183p
Pkt of 35 pins			22p
Spot face cutter			105p
Pin insertion tool			144p

DIODES

AA129	20
BA100	10
BA102	15
BY126	12
BY127	12
CR033	148
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

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ZENERS
Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V. 1·3W **15p each**

NOISE
Z5J **160**

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

DIAC
ST2 25

SCRs Thyristors

0·6A/200V	30p
0·8A/100V	30p
0·8A/200A	35p
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A/700V	195p
2N4444	140p
2N5062	28
2N5064	35
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130p
16A100V	95
16A500V	150
25A800V	295
25A1000V	480p
T28000D	120

TTL 74		74126	55	LS54	30	LS673	750	4095	105	ICL7107	975
7400	11	74128	74	LS55	70	LS674	850	4096	105	ICL8038	340
7401	12	74132	70	LS63	150			4097	350	ICM7205	1150
7402	12	74136	65	LS73	40	**CMOS**		4098	115	ICM7216	1950
7403	14	74141	85	LS74	40	4000	18	4099	190	ICM7217A	790
7404	14	74142	195	LS75	48	4001	18	4160	125	ICM7555	89
7405	18	74143	350	LS76	45	4002	24	4161	125	LD130	452
7406	48	74144	350	LS78	45	4006	92	4162	125	LF356	98
7407	48	74145	90	LS83	105	4007	22	4163	125	LM10	350
7408	22	74147	180	LS85	105	4008	82	4174	130	LM300H	170
7409	22	74148	145	LS86	45	4009	40	4175	120	LM301A	23
7410	19	74150	150	LS90	50	4010	48	4194	125	LM308	70
7411	25	74151	75	LS91	125	4011	24	4408	790	LM318	205
7412	20	74153	75	LS92	75	4012	24	4409	790	LM324	45
7413	33	74154	140	LS93	75	4013	45	4410	790	LM339	70
7414	52	74155	75	LS95	115	4014	85	4411	1020	LM348	90
7416	31	74156	80	LS96	180	4015	85	4412F	1520	LM379	375
7417	31	74157	75	LS107	45	4016	42	4412V	1520	LM380	80
7420	19	74159	185	LS109	75	4017	82	4415F	850	LM381	145
7421	38	74160	99	LS112	80	4018	88	4415V	850	LM381AN	248
7422	26	74161	99	LS113	65	4019	48	4419	320	LM382	125
7423	32	74162	99	LS114	49	4020	99	4422	570	LM1458	40
7425	30	74163	99	LS123	95	4021	105	4432	1050	LM3900	60
7426	44	74164	120	LS124	180	4022	95	4435	1050	LM3909N	70
7427	32	74165	120	LS125	60	4023	25	4440	999	LM3911	125
7428	35	74166	155	LS126	60	4024	75	4450	350	LM3914	240
7430	20	74167	240	LS132	95	4025	25	4451	350	M253AA	795
7432	28	74170	230	LS136	55	4026	180	4452		MC1304P	260
7433	38	74172	420	LS138	70	4027	48	4490F	750	MC1310	149
7437	35	74173	120	LS139	90	4028	82	4490V	750	MC1312P	195
7438	30	74174	105	LS151	90	4029	105	4501	28	MC1488	85
7440	20	74175	82	LS153	85	4030	60	4502	125	MC1489	90
7441	74	74176	90	LS155	98	4031	225	4503	75	MC1495	350
7442	71	74177	90	LS156	98	4032	125	4506	75	MC1496	92
7443	120	74178	149	LS157	78	4033	175	4507	60	MC1710	79
7444	116	74180	90	LS158	85	4034	210	4508	325	MC3340P	120
7445	116	74181	290	LS160	120	4035	125	4510	99	MC3360P	120
7448	132	74182	88	LS161	98	4036	365	4511	150	MC3401	52
7447	99	74184	145	LS162	110	4037	115	4512	98	MC3403..	135
7448	99	74185	145	LS163	100	4038	118	4520	115	MFC6040	97
7450	20	74188	299	LS164	164	4039	360			MK50398	635
7451	20	74190	135	LS165	165	4040	105	**LINEAR IC's**		MM5303	635
7453	20	74191	135	LS168	210	4041	80	702	75	MM5307	1275
7454	20	74192	135	LS170	288	4042	80	709C 14 pin	35	NE518	210
7460	20	74193	135	LS173	105	4043	95	710	67	NE543	210
7470	41	74194	105	LS174	147	4044	95	723	38	NE544	185
7472	31	74195	198	LS175	110	4045	175	733	125	NE555	20
7473	40	74196	130	LS181	295	4046	130	741C 8 pin	17	NE556	55
7474	34	74197	90	LS183	298	4047	98	747C	78	NE560	325
7475	56	74198	195	LS189	120	4048	65	748C	36	NE561	395
7476	41			LS190	120	4049	45	753	150	NE562	410
7480	55	**74LS**		LS191	120	4050	48	810	159	NE564	425
7481	120	LS00	13	LS192	125	4051	80	2102	120	NE565	120
7482	75	LS01	13	LS193	125	4052	80	2112	110	NE566	160
7483	94	LS02	15	LS194	125	4053	80	2114	435	NE567	170
7484	113	LS03	15	LS196	120	4054	130	81LS97	135	NE571	420
7485	121	LS04	20	LS197	120	4055	135	AY-1-0212	580	SN76003	210
7486	33	LS05	23	LS199		4056	135	AY-1-1313A	660	SN76013	170
7489	215	LS06	23	LS200	345	4057	1900	AY-1-1320	315	SN76023	170
7490	57	LS09	23	LS202	345	4059	575	AY-1-5050	190	SN76033	195
7491	85	LS10	20	LS221	120	4060	130	AY-1-5051	145	SN76477	200
7492	59	LS11	32	LS240	225	4061	1225	AY-3-6721/6	195	TAA621	250
7493	59	LS12	32	LS241	225	4062	995	AY-3-8500	390	TBA120F	70
7494	95	LS13	40	LS242	232	4063	120	AY-5-1224A	260	TBA641	250
7495	75	LS14	75	LS244	225	4066	58	AY-5-1230	450	TBA800	90
7496	95	LS15	40	LS245	270	4067	430	CA3011	110	TBA810	98
7497	180	LS20	21	LS247	135	4068	26	CA3018	68	TCA965	120
74100	130	LS21	32	LS251	130	4069	25	CA3020	235	TDA1008	310
74104	62	LS22	40	LS253	130	4070	30	CA3023	170	TDA1022	575
74105	62	LS26	48	LS257	115	4071	25	CA3028A	80	TDA1024	105
74107	35	LS27	45	LS258	120	4072	25	CA3035	235	TDA2020	320
74109	60	LS28	48	LS259	160	4073	25	CA3043	275	TLO61	54
74110	54	LS30	24	LS261	450	4075	25	CA3046	71	TLO74	140
74111	68	LS32	30	LS266	75	4076	99	CA3048	214	TLO81	42
74112	150	LS33	39	LS273	180	4077	48	CA3080E	65	TLO83	95
74116	198	LS37	39	LS279	88	4078	30	CA3081	190	UAA170	150
74118	99	LS38	39	LS280	250	4081	88	CA3085	85	Z80CPU	990
74119	125	LS40	28	LS299	420	4082	28	CA3089E	215	ZN414	80
74120	105	LS42	80	LS324	200	4085	90	CA3090AQ	375	ZN424E	130
74121	42	LS47	85	LS367	65	4086	90	CA3123E	150	ZN425E	415
74122	55	LS48	120	LS368	65	4089	150	CA3130	85	ZN1034	200
74123	95	LS49	120	LS373	180	4093	89	CA3140	48	ZN1040E	685
74125	45	LS51	25	LS670	270	4094	240	ICL7106E	795	ZN1046E	1150

TRANSISTORS

AC125	35	BC172	11	BDY17	195	MJ2955	90	TIP36A	145	2N2905A	22
AC126	25	BC173	11	BDY56	170	MJE340	54	TIP36C	185	2N2906	22
AC127	22	BC177	15	BDY60	110	MJE370	58	TIP41A	50	2N2926G	10
AC128	20	BC178	14	BDY61	165	MJE371	54	TIP41B	55	2N3053	18
AC141	27	BC179	15	BF115	26	MJE2955	99	TIP42A	72	2N3054	55
AC142	28	BC181	10	BF154	25	MJE3055	70	TIP42B	82	2N3055	48
AC176	25	BC182	10	BF156	29	MPF102	66	TIP2955	60	2N3121	40
AC188	24	BC182L	10	BF167	30	MPF103	38	TIP3055	48	2N3133	43
ACY17	60	BC183	10	BF173	25	MPF104	36	TIS43	30	2N3135	33
ACY18	60	BC183L	10	BF177	24	MPF105	40	TIS44	45	2N3250	30
ACY19	60	BC184	10	BF178	25	MPF106	40	TIS88A	35	2N3442	140
ACY20	53	BC184L	10	BF179	30	MPSA05	15	TIS90	20	2N3663	14
ACY21	35	BC187	22	BF180	38	MPSA06	16	TIS91	24	2N3702	10
ACY22	60	BC212	9	BF194	10	MPSA12	22	ZTX107	11	2N3703	10
ACY28	60	BC212L	9	BF195	11	MPSA55	22	ZTX108	11	2N3704	10
ACY39	80	BC213	9	BF196	12	MPSA56	22	ZTX109	11	2N3705	10
AD140	70	BC213L	9	BF197	12	MPSU05	50	ZTX300	13	2N3706	10
AD149	75	BC214	10	BF198	16	MPSU06	56	ZTX301	15	2N3707	10
AD161	42	BC214L	10	BF199	18	MPSU56	60	ZTX302	20	2N3708	11
AD162	42	BC307	12	BF200	29	OC28	120	ZTX303	25	2N3709	11
AF114	60	BC308	12	BF224A	18	OC35	125	ZTX304	17	2N3710	10
AF115	60	BC309	12	BF244B	24	OC36	130	ZTX314	24	2N3711	10
AF118	75	BC327	12	BF244	30	OC41	125	ZTX326	45	2N3713	215
AF139	40	BC328	12	BF256	60	OC42	48	ZTX341	20	2N3771	179
AF178	75	BC338	12	BF256B	45	OC43	55	ZTX500	15	2N3772	195
AF180	70	BC441	27	BF257	30	OC44	55	ZTX501	15	2N3773	283
AF186	50	BC461	27	BF258	28	OC45	38	ZTX502	17	2N3819	20
AF239	50	BC447	35	BF259	28	OC46	28	ZTX503	15	2N3820	45
BC107	11	BC477	35	BF274	38	OC70	35	ZTX504	25	2N3822	130
BC107B	11	BC547	10	BF594	30	OC71	28	ZTX531	25	2N3823	70
BC108	11	BC549C	10	BF595	30	OC72	35	ZTX550	25	2N3866	90
BC108B	11	BC557	15	BFR40	28	OC74	50	2N696	36	2N3903	20
BC108C	12	BC558	10	BFR41	24	OC76	45	2N697	25	2N3904	18
BC109	11	BC559C	10	BFR79	24	OC77	76	2N698	40	2N3905	18
BC109B	12	BCY70	14	BFR80	24	OC81	36	2N699	39	2N3906	17
BC109C	12	BCY71	14	BFR81	24	OC82	50	2N708	19	2N4037	52
BC117	20	BCY72	16	BFX29	28	OC83	48	2N918	33	2N4058	17
BC119	23	BD131	42	BFX81	45	OC84	45	2N930	18	2N4061	17
BC137	20	BD132	42	BFX84	26	OC140	110	2N961	61	2N4859	65
BC140	26	BD133	50	BFX85	28	OC170	85	2N1131	22	2N5135	42
BC142	26	BD135	30	BFX86	28	OC171	45	2N1132	24	2N5136	42
BC143	28	BD136	30	BFX87	28	OC202	95	2N1302	35	2N5138	20
BC147	9	BD137	30	BFX88	28	TIP29	31	2N1303	50	2N5179	60
BC148	8	BD138	35	BFY50	24	TIP29C	60	2N1304	50	2N5180	80
BC149	9	BD139	30	BFY51	21	TIP30	32	2N1305	35	2N5191	70
BC153	20	BD140	30	BFY52	21	TIP30C	43	2N1671B	129	2N5305	40
BC154	13	BD142	68	BFY56	32	TIP31A	38	2N2160	350	2N5457	32
BC157	10	BD145	175	BFY71	20	TIP31C	50	2N2219A	22	2N5458	32
BC158	10	BD205	110	BRY39	39	TIP32A	40	2N2220A	23	2N5459	35
BC159	11	BD222	75	BSX20	20	TIP32C	55	2N2222	20	2N5777	45
BC160	28	BD378	70	BSY65	30	TIP33A	40	2N2369	15	2N6027	40
BC167A	11	BD434	32	BSY95A	18	TIP33C	55	2N2476	125	3N128	112
BC168	10	BD517	70	BU105	115	TIP34A	63	2N2484	25	3N140	112
BC169	10	BD859A	65	BU205	125	TIP34C	75	2N2646	48	40360	43
BC170	15	BD695	85	BU208	215	TIP35A	135	2N2894	30	40361	45
BC171	11	BD896A	85	MJ491	175	TIP35C	165	2N2904	24	40673	68

SQUARE one FOR BEGINNERS

STOCKING UP

THIS month we suggest a range of capacitors for the new constructor to purchase as part of an initial stock of components.

Capacitors are not used to the same extent as resistors, but they do come in a variety of forms, shapes and sizes, to say nothing of the capacitance values.

Therefore the holding stock will be numerically much smaller than in the case of resistors. On the other hand the choice of actual types and values is more difficult. In the tables below we have set out our recommendations concerning type and value. This selection of capacitors should meet most general requirements.

NON-POLARISED CAPACITORS

Capacitors are classified according to the material used to form the dielectric (the insulating surface between the two "plates" of the capacitor).

Table 1 lists the more frequently used values and the types of capacitor in which they are available.

Recommended minimum quantities are in italics. If resources permit, it would be wise to multiply all these quantities by a factor of two or even five.

POLYESTER CAPACITORS: These are widely used and cover the middle range of capacitances: typically from 0·01μF to 2·0μF. Tubular, tablet and block forms are common. Tolerance 10 and 20 per cent.

CERAMIC: These include the smallest capacitors and range from 1·8pF to (0·1μF) typically. Close tolerance, low loss, and high stability are their important characteristics. They are small, thin disc- and plate-shape components.

POLYSTYRENE: These capacitors are available in the range 10pF to 0·1μF. Thus they cover very nearly the same range as ceramics. They have a better electrical performance than the ceramics, and are available with close tolerances such as 5, $2\frac{1}{2}$ and 1 per cent. However polystyrene capacitors are rather more expensive and are only used where their special characteristics are essential.

Polystyrene capacitors are tubular in shape and rather more bulky than ceramics.

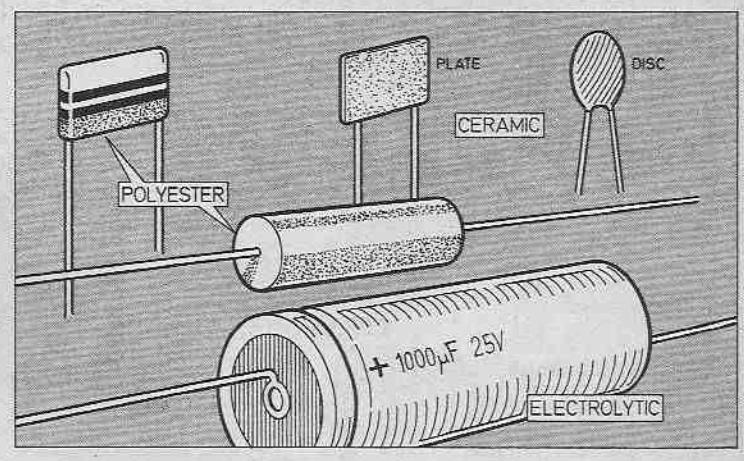
ELECTROLYTIC CAPACITORS

Electrolytic or polarised capacitors are a special case. They provide quite a large value of capacitance, but must be connected right way round in circuit. They are made with specific working voltages, which must not be exceeded in practice. It is however permissible to use them at a *lower* voltage than the stated working voltage (WV).

Generally, always follow the recommendations given in Component Lists for projects and use the specified type of electrolytic.

Table 2 gives a selection of electrolytics that should cover many needs. A working voltage of 25V is adequate for most battery operated projects. The higher rating of 63V has been given for the three smallest capacitors, since this is the lowest WV in which they are available.

Electrolytics are available as "double-ended" types with the connecting leads emerging from either end; also as "single-ended" types with both leads at same end of component. Double-ended types are recommended for the present purpose, see illustration in Fig. 1.



Some typical capacitors drawn to scale and showing their characteristic physical forms. The electrolytic is a double-ended type with axial leads.

TABLE 1

NON-POLARISED CAPACITORS

Value	Polystyrene	Ceramic	Polyester
10pF	*2*		
47	*2*		
100	*2*	*2*	
220	*2*	*2*	
470	*2*	*1*	
0·001μF	*2*	*2*	
0·0022	*2*	*2*	
0·0047		*3*	
0·01		*3*	*3*
0·022		*2*	*2*
0·047		*3*	*3*
0·1		*3*	*5*
0·22			*2*
0·47			*2*
1·0			*1*

TABLE 2

ELECTROLYTIC CAPACITORS

Value	WV	Qty	Value	WV	Qty
1μF	63	*1*	47μF	25	*1*
2·2	63	*1*	100	25	*2*
4·7	63	*1*	220	25	*1*
10	25	*2*	470	25	*1*
22	25	*1*	1,000	25	*1*

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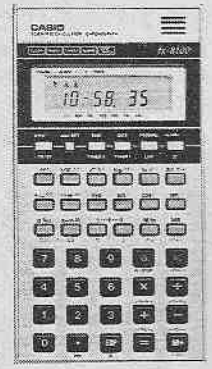

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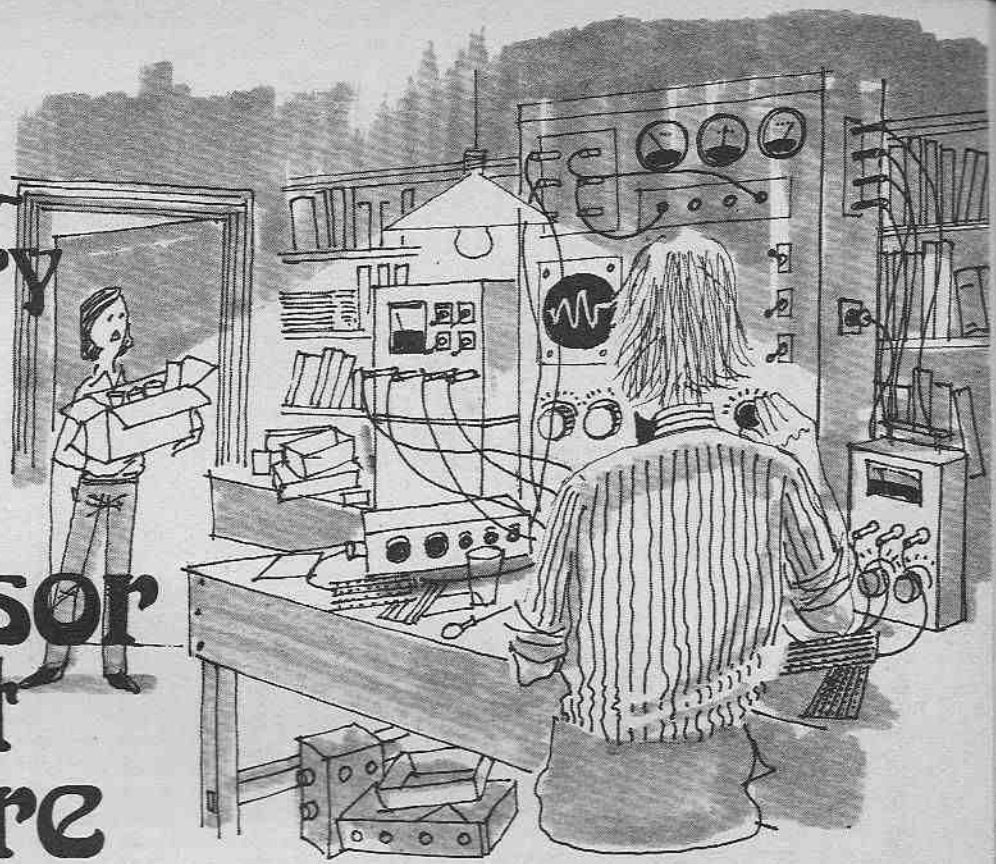

by Anthony John Bassett

As BOB arrived once again at the Laboratory to be greeted by the Prof., his mind was full of thoughts of the Simulated Space Environment which the Prof. had produced with the aid of a giant vacuum chamber equipped with a wide range of electronic equipment; computers and lasers, electron-guns and other beam-producing equipment for experiments on energy beams, and many other applications of vacuum electronics.

The Prof's experimental robots could enter the vacuum chamber through the air-lock and Bob could see through the large windows that they and the Prof. had been at work installing more equipment.

FLYING SAUCERS

"Your Space Environment Simulator looks more like real space exploration equipment every time I see it, Prof! I dream that we might even take a real space-trip in it!"

"Then you'll be interested in my latest experimental device, Bob."

"Wow, Prof. are you going to turn the experimental gravity control down past zero, and actually take-off and fly in the vacuum-chamber?"

"No, Bob, last time I tried that it caused yet another flying saucer scare around here, and also a UFO defence alert. I had quite a difficult job dodging the modern radar trackers and the latest batch of highly sensitive UFO detectors which have been built by investigators of such phenomena.

RADAR JAMMER

I had to rig-up an emergency radar jammer to produce pictures of hundreds of flying saucers all over the radar screens for a short time whilst I gave them the slip and got back here safely! It must have caused quite a flap!"

"How does a radar jammer work, Prof?"

"When a craft is being scanned by radar, receiving instruments on board can detect the radar beam. To jam the radar, the craft may then transmit a series of pulses of energy at the frequency of the radar beam. This results in a number of false images on the radar screen to confuse the radar observer.

"Just as with TV games, electronic circuits operating in synchronism with the scan frequencies of the TV set can produce a great variety of images on the TV screen. So, by detecting the scan frequencies of the radars and transmitting a variety of synchronous pulses, a whole range of interesting 'objects' can be made to appear on the radar screen to divert the operator whilst the craft escapes!

"The radar jamming beam or broadcasting can produce an almost endless series of replicas of the image of the craft to appear all over the radar screen. It is amazing what can be carried on a beam of energy and your interest in the study of various energy beams and their widely differing properties can lead you to some fantastic discoveries!

ABOLITION OF SPACE

"Some investigators consider that force fields can cause matter to become organised into objects whose structure and function are direct results of the 'originating' force fields, which are in some cases considered to precede and 'mould' the objects, which may include living creatures!"

"But Prof., if that is so, won't it result in the abolition of space itself? Because magnetic, electrical and gravitation fields can extend for infinite distances in space, if they were really responsible for the formation of objects and living creatures, surely space would soon become so filled-up there would be no gaps left in it!"

COMPLICATIONS

"If that were so, Bob, we could all retire relatively smartly at a speed of $c-\triangle c$ into our brand new individually pre-packed black holes, but fortunately things are more complicated than that. In most known instances, for example, force fields merely act in readily understood ways to guide the formation of objects, and the growth of crystals, for instance, is an example of this which is taught in many science classes. Here an object is formed under the influence of electrostatic field forces with no danger from black holes or other apocalyptic phenomena—the force fields merely acting to guide the atoms and molecules into places in the crystal lattice structures.

REPLICATION BEAM

"With other objects less regular than crystals the picture is more complex and my latest experiment uses energy beams to influence the force-fields in space to induce the formation of replicas of objects, in regions where interfering energy-beams have produced congruent antinodal and nodal structures in the fields which exist in space."

"Prof., the ways in which force-fields and energy beams can influence one another, and in turn influence material objects are fascinating areas for advanced study—but how can antinodes and nodes be congruent with one another?"

SCIENCE FAIR PROJECT

"An apparatus for demonstration of the existence of congruent nodes and antinodes would make a good practical construction project for your School Science Society, Bob, and could make a good, entertaining and educational School Fair exhibit. Think about it; such a project could demonstrate simultaneously a number of scientific principles and there is plenty of scope in it for the use of electronics!

"It would be quite easy, for instance, to arrange that the nodes and antinodes of a microwave low power field, for example, should be congruent with those of, say, an acoustic field of the same, or different wave length, and with the different forms of energy travelling in transverse directions or at various angles. Then, of course, there are quite a variety of mechanical shear or transverse waves, compression waves, surface-displacement waves and so on, to experiment with, which could make spectacular mystifying and educational displays where luminescent, reflective or refractive media can be used."

"I understand now, Prof! The nodes and antinodes of different fields of standing-waves or interfering waves, whose energy may be travelling in differing directions or in the same direction, may quite readily be congruent with one another and produce interesting and sometimes complicated combined effects!'

"That's right, Bob. Now watch this!"

TELE-PORT

The Prof. placed a small metal object upon a low pedestal which was surrounded by strange electronic sensors connected to an energy beam projector apparatus.

When he operated the apparatus, Bob saw that, just for a moment, the metal statue seemed to be surrounded by a phosphorescent halo of light, and also to glow with a light which seemed to come from within the very core of the solid metal.

But the statue seemed to come to no harm.

"This is because," explained the Prof., "what I am doing is merely making a record of the structure of the object—it does no more harm than taking an ordinary photograph. Now, the beam-projectors are set to focus and converge on that table. Watch, and also observe carefully what happens to the small heap of grey crystals on the pan of the nearby laboratory weighing balance."

The balance tilted sharply as the crystals turned from the grey of lead sulphide to the yellow of sulphur, and thus rapidly lost weight. Bob saw that one of the Prof's experimental robots had to remove quite a lot of weights from the opposite pan before the scales would balance again. At the same time a shimmering replica of the small lead statue formed on the table. The Prof. picked it up and handed it to Bob.

"It is identical to the original," Bob explained, "down to the last tiny scratch—and I'll bet it weighs exactly the same."

"Yes—the Robot has just confirmed that." The Prof. switched the machine into reverse, and with a shimmering sparkle and a sudden loss of weight, the statue faded from Bob's hand, and at the same time the crystals on the scale returned rapidly to their customary weight and grey colour.

"Will this work with living creatures too, Prof?"

"Yes, Bob, try it!" Bob himself stood on the pedestal and as the Prof. once again operated the device, this time with the assistance of a couple of his robots, Bob seemed to find his whole body and consciousness filled for just a moment with a flash of shimmering light. Then a perfect replica appeared on the table a few metres away, together with another replica of the Prof's lead statue which was still on the pedestal of the Replication Machine.

As Bob picked up the statue and examined it once again, his replica on the table picked up the replica of the statue and examined that.

After a short time the Prof. switched the machine into reverse and once again the replicas disappeared. Bob stepped down from the pedestal.

"That was amazing!' he reported to the Prof.

"As I was examining one side of the statue, the replica was examining the other side, and so I could see both sides of the statue simultaneously. Also I could see you in close-up with my own eyes, and from a distance through those of the replica. I could see the whole lab from two standpoints, like being in two places at once! Really great! Want to try it again—but tell me, can this machine produce more than one—several replicas simultaneously."

"That is possible Bob, but the mental and psychological problems would be multiplied, and could easily reach dangerous proportions even with one replica of an unbalanced person. So my next Extraordinary Experiment will be aimed not at increasing the number of the replicas, but the distance to which they can be projected!"

To be continued

The Adventures of Tanty Bead

By Matthew Reed

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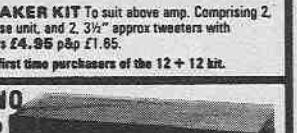

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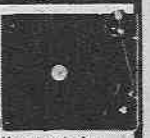

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WORKSHOP MATTERS

By Harry T. Kitchen

Signal Sources

In an earlier article I covered the choice of a multimeter, and in the next article or so I want to cover signal sources. These can be very broadly defined as a signal that is injected into equipment in order to ascertain whether it is working within its parameters, or if it is not working, to ascertain where it has failed. Such sources cover a vast range: from the "tickle" induced into sensitive stages by an educated finger, to the more sophisticated sources. It is these that I want to discuss.

Let us start by drawing a division between the source that is very closely controlled for frequency and voltage accuracy, and that which is less closely controlled if at all. The former is defined as a generator, the latter as an oscillator.

A.F. Sources

If you are an a.f. or hi fi type then you will almost certainly be interested in such sources as a means of checking your equipment, or if you are into design work, of checking your designs. What should such a source offer? Opinions differ, but my order of priorities, in descending order, would be:

1 Very low distortion.

2 High frequency accuracy

3 High voltage output accuracy

4 High resetting accuracy of frequency and voltage

5 Wide frequency range

6 Square wave output

Having detailed my order of priorities, let me now justify them! Most modern audio equipment has distortion figures that are extremely low, and if we are to measure these, or design amplifiers that are similarly rated, then our signal source must have an output that has distortion figures that are very much lower; a factor of ×10 is not unrealistic for work of the highest calibre.

Faced with equipment with a distortion figure of 0·01 per cent we must use a source that has, at the most, 0·001 per cent distortion. It is possible to reduce this distortion figure, but then our results will be less reliable.

Frequency Response

For the plotting of frequency response curves, a high degree of frequency scale calibration is necessary, and this also helps when "spot" frequencies must be set. Greater accuracy is possible if the frequency varying element—almost always resistance or capacitance with modern designs—has some form of slow motion tuning incorporated. This has the additional advantage of permitting frequency sweeping to be effected.

Another important factor is freedom from frequency voltage bounce, an effect where the output voltage literally bounces up and down when the frequency is altered. It is very difficult to make any source completely free from bounce, but it should be closely controlled, and should settle down very rapidly.

The output voltage should be closely controlled so that it is possible to accurately set any required voltage. This can be effected by calibrated attenuators, sometimes complimented by an output meter that monitors the voltage applied to the attenuators. There should be at least two attenuators, one for the coarse adjustment of output voltage, the other for fine adjustment.

Both frequency and output voltage should be capable of being reset to any previously set figure, and should be adequately buffered so that neither is affected by any external loads. This is not always the case with simple designs where the output is extracted directly from the oscillator, and it is quite possible to alter both frequency and output voltage by an appreciable amount by varying the load applied to the output terminals. This can invalidate any results obtained; as such, simple designs must be used only for non-critical work.

Although it is accepted, by tradition, that the audible frequency range is from around 20Hz to 20kHz, the source must possess a much wider frequency range, ideally 10Hz to 100kHz. Such a wide frequency range is essential to check reproducing equipment for vagaries that, though they may well be outside the audible bandwidth, may yet affect the reproduction.

Subsonic instability may be inaudible, yet it can modulate the reproduced signal and cause audible distortion. Similarly, supersonic instability may be well above 20kHz, yet it can degrade the signal and in extreme cases it is not unknown for multi-unit 'speakers to have the tweeters ruined through overheating of the voice coil due to an amplifier oscillating vigorously and applying an almost perfect square wave to the 'speaker. With a wide frequency source, the amplifier can be checked for misbehaviour at both ends of the frequency spectrum.

Square Wave

If you own an oscilloscope you will find a square wave output invaluable. This is, in comparison to the sinewave output we have so far considered, a signal having perfectly vertical sides, and perfectly parallel tops and bottoms.

The square wave is usually derived from the sinewave oscillator and thus has the same frequency. The two outputs sometimes share the same output terminal and attenuators, though separate attenuators and output terminals increase the versatility of the instrument since both waveforms can be used simultaneously if desired.

The great attraction of a square wave is the ease, and speed, with which it can tell the practised user the characteristics of the equipment through which it has passed. If the verticals slope and the originally sharp corners are rounded off, it indicates a poor high frequency capability.

Sloping tops and bottoms indicate a poor low frequency capability. The greater the sloping and rounding-off, the worse the h.f. or l.f. response.

Supplies

Last, but not least, the power supply used for the source, and the case in which it is placed. Batteries are expensive, and if the equipment is much used, have a limited life. A mains supply thus seems to be attractive.

For certain work the mains power supply is no disadvantage, but at low levels the mains frequency of 50Hz, and some of its harmonics can cause problems. For critical low level work I believe that there is no alternative to battery power, expensive though it may be.

For screening, a metal case is essential, but this should be well insulated on the outside, by the liberal use of paint or Vinyl covering, so that if two cases touch there is no unintentional earth path between them that may cause problems with earth-loops.

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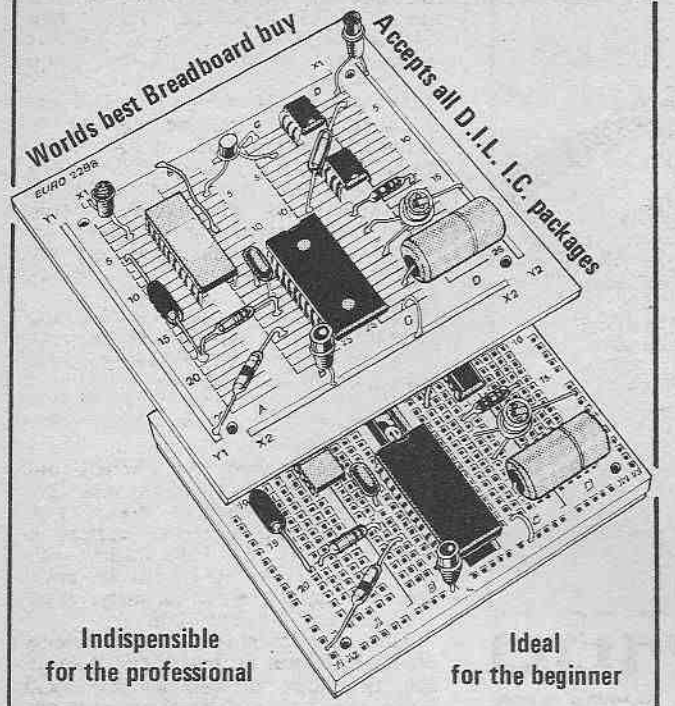

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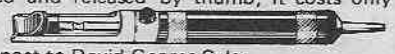

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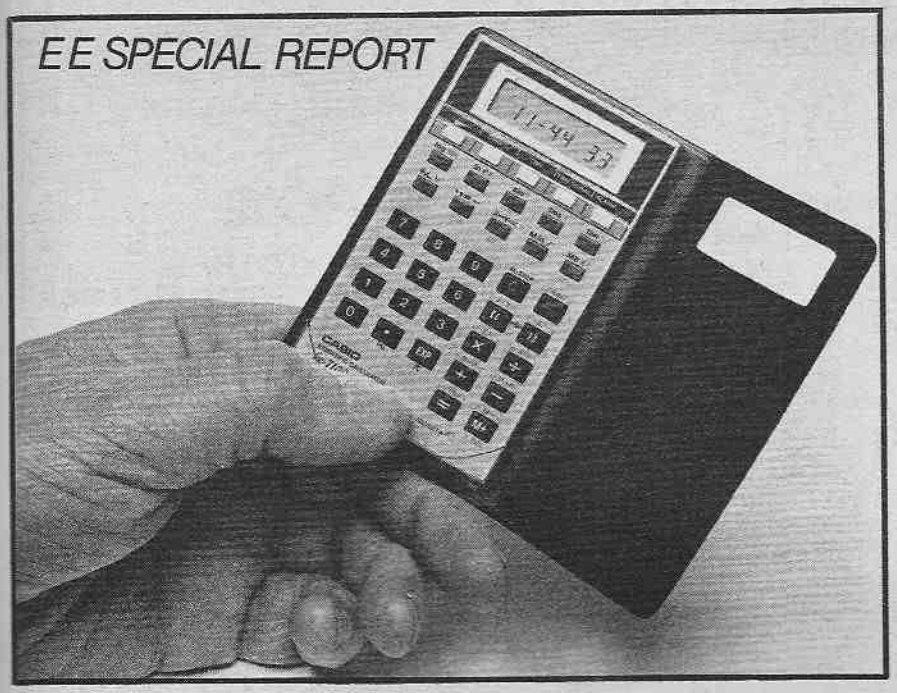

THE CASIO fx-7100 SCIENTIFIC CALCULATOR

ELECTRONIC pocket calculators have been with us for almost ten years now and electronic digital watches and clocks for a little less. It was only a matter of time before the two were combined. This time has come, and it is no surprise to find that it is from a Japanese company. Casio, the world's leading calculator manufacturer have just released some calculating timepieces, one of which is the *fx*-7100. Strangely though, this is only called a "scientific calculator".

The *fx*-7100 is truly a pocket (or handbag) sized instrument, measuring only 98 x 65 x 10mm in its leather-look wallet having a window over the display. It is similar in size to a season ticket/bankers card wallet and can thus be carried with comfort in the breast pocket for example.

The display is the more economical and popular liquid crystal type (5mm high digits). Current consumption is therefore very low giving long life to the two silver oxide batteries fitted. Depending on the battery types obtained, continuous use over 9 to 12 months can be expected.

There are thirty-seven actual keys on the unit, most of them having dual functions and some having three. At first, this multilayer key arrangement caused problems, with wrong functions being keyed in, but in a short time one becomes accustomed to the key shift modes. Also the small size of the keys and the closeness in relation to the human digit takes a little getting used to.

CLOCK

The clock has a 12-hour format with a PM flag to indicate the same. The readout is in hours, minutes and seconds and is accurate to within ±3 seconds per day. The clock is also equipped with an alarm.

The decimal keyboard is used for setting the alarm time which is entered in hours and minutes. This is much more convenient than the step setting on most digital watches. The new alarm time overwrites the existing alarm time. Once activated a piercing modulated tone sounds for 20 seconds. The alarm facility can be "switched" out. Alarm ready state is shown on the displays by a "sound" flag.

STOPWATCH

Another useful facility is the stopwatch. This counts in 1/100ths of a second up to 0·01 secs short of 10 hours. This stopwatch once started can be stopped in either of two modes and these modes may be alternated throughout the timing sequence.

In one mode, the "watch" can be stopped and when restarted will continue to count from the displayed time. In the other mode, the counting sequence carries on counting internally displaying the halted time. When operated a second time, the display leaps to the counting time. Very useful for sports events where lap times can be recorded. The stopwatch would also be very useful in the electronic workshop where time delay circuitary is being tested and time constants observed.

COUNTDOWN

The housewife is also catered for. In the kitchen, the device may be used as a cooking timer when put in its countdown mode. Here the cooking time may be entered by means of the decimal keyboard, and when initiated will count down to zero at which time the alarm sounds, again for 20 seconds.

Countdown is from a maximum 9 hours 59 minutes or may be in minutes only from 99 minutes maximum. This is a repeat timer i.e. when it reaches zero, it reverts to the set countdown time. This facility should prove very useful once again for sport events such as when competitors set off at pre-arranged intervals, e.g. car rallying.

During both countdown and count-up (stopwatch), the display may be returned to regular time display without affecting the counting.

CALCULATOR

Calculations may be carried out without affecting any clock functions that may be running. A break from calculation back to clock function is possible, but any information you have accumulated and wish to retain must be transferred to memory. Other registers will be cancelled.

This tiny machine has enormous ability handling no less than 39 scientific functions as well as the usual basic calculations including constants for $+/-/\times/\div/x^y/x^{1/y}$.

Positive and negative numbers may be entered up to 8-digits in length (with or without decimal point) or in exponent form, 6-digits with 2-digit exponent up to 10^{99}. The accuracy of the scientific functions in ±1 in the 8th digit.

We were pleased to see the inclusion of "brackets" on this machine which allows quite complex formulae to be "worked out" without recourse to the memory and inverse keys as with many other calculators. A five-deep nest of brackets is available.

A statistical mode package is included which calculates all the common statistical functions.

As would be expected, a memory is included. This can be added to, subtracted from, recalled and overwritten. Memory contents may also be exchanged with display register. Whenever there is a number in memory this calls yet another flag, M, to appear on the display.

A useful feature included in the design is to exchange the contents of the display register with the working register. This enables the last but one entered number to be recalled.

These and the rest of the functions, including the versatile percentage key, are contained in a comprehensive 70-page manual that comes with the calculator.

The recommended retail price of the *fx*-7100 is £27·95, but can be obtained from Tempus (Dept. EE), Talk of the Town, 19-21 Fitzroy Street, Cambridge CB1 1EH, at a discount price of £24·95 including postage and packing.

A larger version (135 x 75 x 12mm, with 6mm high display digits) the *fx*-8100 Scientific Calculator/ Chronograph has all the facilities of the *fx*-7100 and more and costs the same.

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- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
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- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
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...and the Sinclair teach-yourself BASIC manual.

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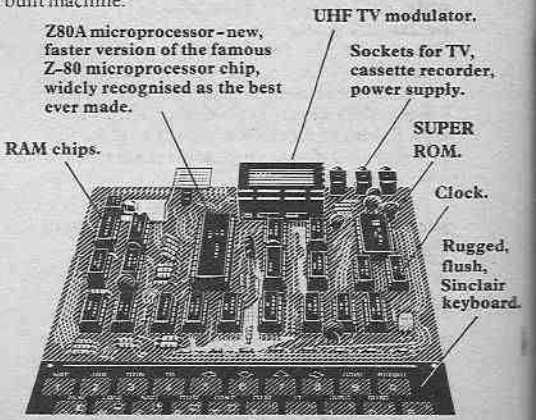

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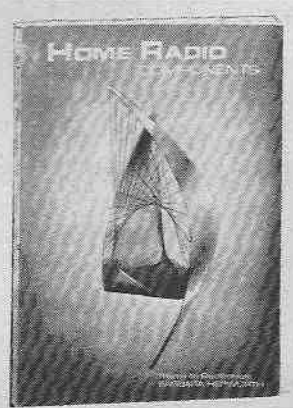

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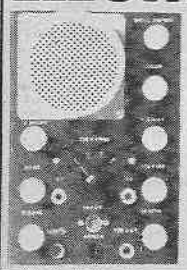

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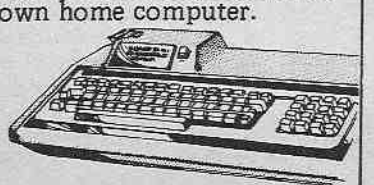

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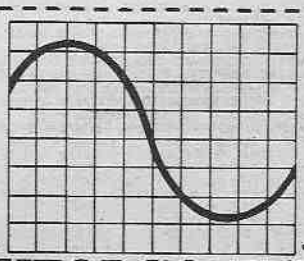

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You will not be too late

For most of the bargains listed in the newsletter reprinted below, even though it is our JAN/FEB issue, because the part of the newsletter with the items in short supply is not reprinted. However, you will receive the **whole** *of our MARCH/APRIL newsletter if you send us an order this month and as an extra inducement we will send you our MAY/JUNE newsletter directly it is printed, which is usually about two months before it can appear in this magazine.*

SIX DIGIT COUNTERS

One pulse moves one digit—Type 1 for 230v AC or 100v DC not resettable. Price **80p**—Type 2 for 48v DC or 115v AC and resettable **£1·85.**

COMPONENTS BARGAIN

Ref. W0998. Modern fibre glass board, contains a multitude of very useful parts, some of which are:— SCR ref. 2N 5060/2, 35 assorted rectifiers including four 3 amp 400v types (made up in a bridge) 8 transistors type BC 107 and 2 type BFY 51 electrolytic condensers. 250uf 100v DC and 100uf 25v DC and over 100 parts including variable, fixed and wire wound resistors, electrolytics etc. Don't miss this snip at **£1·15.**

SIREN OR BLEEPER

American Delta mechanical type, works on 6 to 12v to DC or 12 to 24v AC. Price **75p** or **£60** per 100. **Electronic Bleeper TH3S** emits high pitched wailing note of varying pitch. In red plastic case with fixing bracket. **£5·00.**

CASSETTE PLAYER/RECORDERS

With record and playback heads, all electronics, switches and speaker. Price **£9·95** (surely this must be the bargain of the year). Music centre replacement stereo with heads but not electronics. **£14·95.**

DESOLDERING PUMP

Ideal for removing components from computer boards as well as for service work generally. Price **£6·35.**

ENGRAVER

Very useful tool will engrave on metal or plastic. Kit comprises mains solenoid, micro-switch and instructions. A few other parts are required but you will probably have these in your junk box. Price **£3·00.**

HEADPHONE AMPLIFIER (STEREO)

With volume, tone and balance control 9v operation. All made up ready to go. Price **£4·50.**

MAINS SOLENOIDS

All have powerful pull.
TT2 size 1⅜" × 2⅛" × 2". Price **£2·95**
TT6 size 2⅜" × 1" × 2". Price **£3·50**
TT10 size 3" × 2⅛" × 2". Price **£4·86**

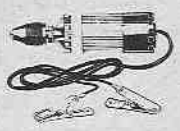
ELECTRONIC JIGSAW PUZZLE

One of the many things you can make with this miniature uni-selector. We give the circuit free when you order. Price **£3·45.**

MAINS OPERATED VALVES

Made by Asco. Two models available both suitable for water and non-corrosive liquids, both for normal mains operation. Ref. V1 for ¼" pipes and low pressure operation. V2 is for ½" pipe and high pressure operation. Only **£4·60** either type.

VERSADRILL



A 12 volt battery operated power drill, not just suitable for printed circuit boards but will do all the jobs and is powerful enough to perform all the functions and operations normally expected of Black & Decker and other mains drills. Its chuck accepts up to ¼" drills. Size approx. 150mm × 50mm. Price **£16·75.**

DOOR SWITCH

Neat tubular pattern for letting into door frame. This is a changeover switch so can be used in opening or closing circuits. Price **57p.** D.I.Y. burglar alarm parts available, request diagram and price list of our mains operated system.

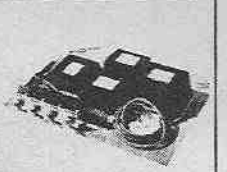
V3 MICROSWITCHES

Over 50,000 in stock, all 250 AC working, all with 3 silver contacts for c/o circuits. 10 amp **25p** each or **£20** per 100, 15 amp **35p** each or **£30** per 100.

DOOR MOVING MOTOR

Franco reversible single phase 140v AC motor with gear box giving final speed 56 rpm very powerful motor, weight approx. 13lb. Price **£15** carriage **£3** mainland only.

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 easy-to-assemble modular form 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 **£16** including VAT and postage.
FREE GIFT—Buy this month and you will receive a pair of **Goodman's** elliptical 8"×5" speakers to match this amplifier.

MINIATURE MAGNETIC CIRCUIT BREAKERS

Operate faster than fuses. 1 amp, 2 amp, 5 amp, 10 amp, 15 amp and 25 amp types. All **£2·30** each.

NEW KIT

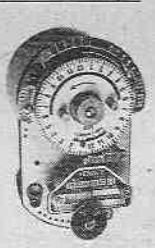
6 WAVE BAND SHORT WAVE KIT Bandspread covering 13·5 to 52 metres. Complete kit includes case, materials, six transistors and diodes, condensers, resistors, inductors, switches etc. Nothing else to buy, if you have an amplifier to connect it to or a pair of high resistance headphones. Special price is **£11·95** inc.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45**

Made up model **£2·00** extra

VENNER TIME SWITCH mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2·95.** These are new but without case, but we can supply plastic cases (base and cover) **£1·75** or metal case with window **£2·95.** Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2·30.**



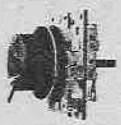
FLUORESCENT TUBE INVERTER

For camping—car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting, it will offer plenty of well distributed light and is economical. We offer Phillips inverter for 12" 8 watt miniature tube for only **£2·75** with tube and tube holders as well.

THIS MONTH'S SNIPS

3 CHANNEL SOUND TO LIGHT KIT Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.
The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special snip price is **£13·50** in kit form or **£16·50** assembled and tested.
REMOTE CONTROL for Sound to Light (ours or any other circuit) saves connecting to speaker or amp—kit consists of 1 watt amplifier, crystal mike, case, sundries and diagram. Price **£3·95.**
LIGHT EXPANDER AND LATCH for Sound to Light, enables 3000 watts of lighting to be controlled by single channel or each channel and enables lights to be latched on. Kit consists of latching relay, control switch, case, sundries and diagram. Price **£4·25.**
SINGLE CHANNEL KIT still available. Price **£5·18.**

DELAY SWITCH



Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens a few minutes after 1st contact. **95p.**

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only **£6·75** + **50p** post and insurance.
FREE Amps ranges kit to enable you to read DC 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 **£2·50.**

IT'S FREE . . . so you will only have yourself to blame if you miss the 150 or so bargains listed in each issue of our Advance Advertising News. Produced bi-monthly the newsletter also includes topical tips, special snips and "too few to advertise" items. You will get the current copy whenever you buy from us, or if you send us some long, stamped addressed envelopes we will send them as they are printed.

12V SUBMERSIBLE PUMP

Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming etc. Suitable for water, paraffin and any non-corrosive non-explosive liquid. One use if you are a camper, make yourself a shower. Price **£6** + **90p.** A free gift, first 100 purchasers will get tap with built in switch and length of plastic tubing.

THIS MONTH'S ELECTRICAL SNIP

Parcel of M.E.M. White flush 13 amp sockets, switches etc. Total retail value over **£56** + VAT. For only **£28** + **£4·20** you get 10 double 13 amp sockets and 6 single 13 amp S. Sockets with neons, 14 power (20 amp dpt switches and spurs some with neons) 20 single ganged one way, two way and intermediate switches and super free gift worth **£3.** If not collecting please add **£2·00.**

DELAY SWITCH

Mains operated, delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact **£1·50.**

6 DIGIT COUNTER—RESETTABLE

Coil voltage 48DC or 115v AC current 100mA approx. Price **£1·95** + **30p.**

DRY FILM LUBRICANT

In aerosol can for easy application and for putting lubricant into places where the normal oil cannot reach. Offered at about half the original list price **50p** + **7p** per can (8 oz.) or 12 cans for **£4·60** post **£1·50.** The lubricant is I.C.I. Fluon L169.

ASSORTED MICROSWITCHES

10 different small, medium and large sizes to suit most projects and repair jobs. Price **£1·50** + **22p.** If this pack does not contain the one you want give us a ring and we may have it.

TELEPHONE PICK UP

Coil attaches by suction to phone body, enabling conversation to be recorded, put through amp or headphones. Price **£1** + **15p.**

MAINS TRANSISTOR POWER PACK

To operate transistor radio, cassettes, amplifiers etc. take the place of any of the following batteries, PP1, PP3, PP4, PP6, PP9 and others. You can make voltage output anything from 3V to 16V at up to 300 mA. Complete kit but no case **£1·75** + **25p.** Case **75p** + **13p.**

INTERRUPTED BEAM KIT

This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price **£2** + **30p.**

FM TUNER

Nicely boxed in wooden case and has a smart dial with cord drive and pointer, it covers the range 88-108 mhz, has an input sensitivity of 10uV, uses 6 transistors and 3 diodes. It is an excellent performer and when tested here we have had results quite equal to a tuner costing over **£40.** Price only **£7·50** + **£1·12** or with stereo decoder **£11·50** + **£1·72** + post **£1·00.**

INTERCOM OUTFIT

Brand new intercoms with 50' inter-connecting lead. Master and sub, in neat plastic cases suitable for office or home or as a baby alarm etc. These are new stock but please expect a little fault. Offered at less than the price of the 2 speakers, switches and cases. Only **£3·74** the pair.

WANT A CHEAP ELECTRIC FAN? We offer a quiet running induction motor and a 6" five-bladed fan for only **£2·95.** Mount this on a stiff wire frame or a piece of handy angle and you will be able to keep yourself cool this summer.

EXTRACTOR FANS

By Woods still available 5" **£6·00,** 6" **£7·00.**

HEATING PAD

11" × 8½" wafer thin 250 watt. Price **£1·16.**

PAPST MOTORS

Sometimes described as the motor with the built-in flywheel. Used in good quality tape recorders and in other equipment where wow and flutter has been reduced to a minimum. We have five different motors in stock, these are all physically about the same size (about 3" dia. × 2½" deep). We quote their type numbers but we have no other technical information. Price includes the capacitor required. HSZ 20.50-4 540D dual voltage 125/220 50Hz **£8·50.** HSZ 20.50-4 255D 110V 50/60Hz **£8·50.** KLZ 20.50-4 540D 220V 50Hz **£9·50.** KLZ 20.50-4 425D 115V 60Hz **£6·50.** KLZ 20.50-4 468D 110V 50Hz **£6·50.**

TWO TRACK RECORD/PLAYBACK HEADS

For transistor circuits, separate erase head. Special offer this month **£1** or mounted on tape guide plate **£1·75.**

EX GPO TELEPHONES

Normal desk instrument with dial and internal bell, latest type **£8·85** each, preceding type **£5·00** each.

TANGENTIAL BLOWER

Metal bladed Smithe made super silent with dozens of applications, cooker hoods, fume extractor—blower heater fresh air impeller etc. Air outlet is rectangular size approx. 10½" × 2½" **£4·95.** Post **£1·50.**

8 BATTERY MOTORS

For model makers, smallest is about as big as a thimble and the biggest is powerful enough for a drill. **£2** the 8.

12V MOTOR BY CROUZET

A powerful motor virtually impossible to stop by hand, size approx. 2¾" long and 2½" dia. permanent magnet so reversible simply by changing polarity and has a relatively constant speed with or without load. Fitted with a splined shaft which could directly engage a toothed wheel or to which a pulley could be attached. Ideal for large models, or small machines etc. Priced **£4·25.**

MAINS OPERATED LOW SPEED MOTORS

Programmer type as used in time switches etc. The following final speeds in stock:—
1r 24 hrs — 1r 8 hrs — 1r 4h — 1rh — 2 rh — erh — 4rh — 12 rh — 20 rh — 30 rh — 1r min — 2rm — 4 rm — 8 rm — 15 rm — 25 rm — 30 rm — 200 rm — all at **£3·50** each.

SPIT MOTORS

These are powerful mains operated induction motors with gear box attached with easy to fix to, squared shaft, final speed is approx. 5 revs. per min., price **£5·25**—similar motor but with final speed 110 rpm, 80 rpm **£5·15.**

SUB-MIN MICROPHONE

Size only 3/8" × 3/8" × 3/16" so small enough for a bugging device, ex-hearing aids but guaranteed. Price **£1·50.**

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversations to be picked up with FM radio. Can be made in a matchbox—all electronic parts and circuit **£2·00.**

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6·50.**

DP.DT TOGGLE SWITCH

Normal size, normal fixing bright plated toggle and fixing nuts—by NSF, 3 amp 250v price **40p** each. **£35** per 100.

PLEASE NOTE: The "+" sign after the amount shows the amount V.A.T. The postage, if quoted, is based upon the amount the article costs to send if it forms part of a larger parcel. Should your order be less than £10·00 however, please send an additional 50p. BARCLAYCARD & ACCESS WELCOMED. Phone 01-688 1833.

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Simply ahead . .

I.L.P's PROVEN RANGE OF HIGH

Chosen in more countries throughout the world than any other U.K. make

- **FIVE POWER AMPLIFIERS EACH ENCAPSULATED WITHIN LARGE HEATSINK.**
- **PRE-AMP/ACTIVE TONE CONTROL MODULE COMPATIBLE WITH ALL I.L.P. AMPS AND POWER SUPPLIES.**
- **SEVEN MATCHING POWER SUPPLY UNITS (FOUR WITH TOROIDAL TRANSFORMERS).**
- **EASY ASSEMBLY DESIGNS WITH WELL PRESENTED INSTRUCTIONS.**

I.L.P. constructional modules are different. Whereas most others come with components neatly arranged on open P.C.Bs with little else, I.L.P. modules are encapsulated within totally adequate heatsinks and need no extra components to complete them. As a result, I.L.P. power amplifiers, pre-amp and matching power supply units are infinitely more rugged, impervious to working in extremes of temperature and can be easily positioned to requirement. No additional metal work is needed to take away heat, connections are minimal and utterly simple. Circuitry, workmanship and performance are of the highest standards, equal to the demands of loudspeakers, pick-ups, tuners, digital signals etc. even more exacting than those of today, making amplifier systems less than the best completely inadequate. Now study the tested and guaranteed specs. for I.L.P. That is why more people in more countries prefer these British designed and made modules.

Why toroidal?

Toroidally wound transformers are more compact than their conventionally laminated equivalents, being only half as high and heavy. Their circular profile ensures greater operating efficiency and as such are particularly valuable in heavy duty applications. We have our own production section for winding and making toroidal transformers enabling us to offer this much sought-after type at competitive prices. Four of the larger models in our range of power supply units are now supplied with this type.

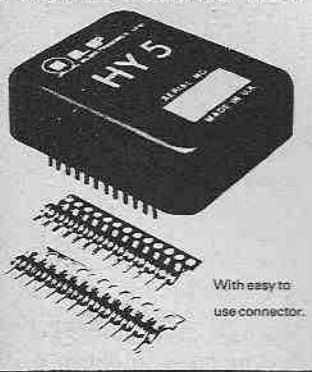
PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS IN ELECTRONIC MODULAR DESIGN

AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS

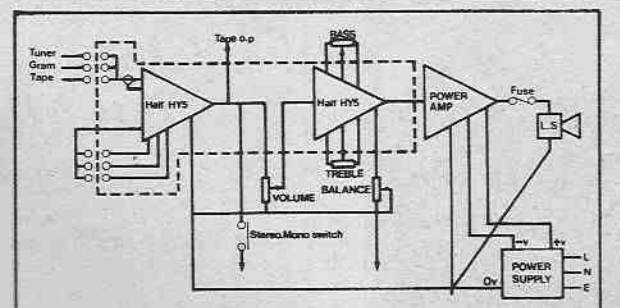
and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER



With easy to use connector.

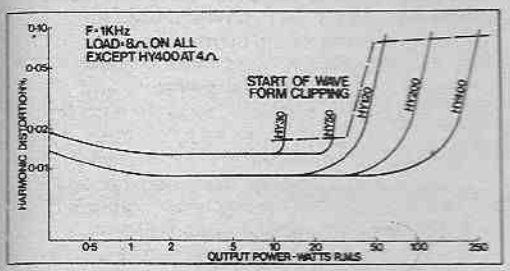


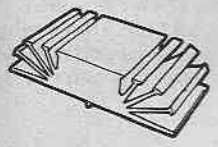
VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume – 10K Ω log.
Bass/Treble – 100K Ω linear. Balance – 5K Ω linear.

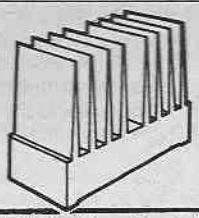
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS



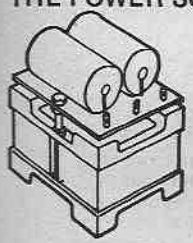




Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15

Load impedance – all models 4 - 16 Ω
Input sensitivity – all models 500 mV
Input impedance – all models 100K Ω
Frequency response – all models 10Hz-45KHz –3dB

THE POWER SUPPLY UNITS *(Laminated and Toroidal)*



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

PSU 30 ±15V at 100ma to drive up to five HY5 pre-amps **£4.50** + £0.68 VAT
PSU 36 for 1 or 2 HY30's **£8.10** + £1.22 VAT
PSU 50 for 1 or 2 HY50's **£8.10** + £1.22 VAT
PSU 60 (Toroidal) for one HY120 **£9.75** + £1.46 VAT
PSU 70 with toroidal transformer for 1 or 2 HY120's **£13.61** + £2.04 VAT
PSU 90 with toroidal transformer for 1 HY200 **£13.61** + £2.04 VAT
PSU180 with toroidal transformer for 1 HY400 or 2 x HY200 **£23.02** + £3.45 VAT

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BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE –see below

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HOW TO ORDER, USING FREEPOST SYSTEM

Simply fill in order coupon with payment or credit card instructions. *Post to address as below but do not stamp envelope – we pay postage on all letters sent to us by readers of this journal.*

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FREEPOST 1 **Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP.**
Telephone (0227) 54778 **Telex 965780**

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Signature. . . . . .

NewBear Components

Microcomputing IC's

MC6800	£6·75
MC6802	£8·50
MC6809	£20·60
MC6821	£4·63
MC6850	£4·99
MC6810AP	£3·61
MC6840	£9·42
Z80 CPU 2·5Mhz	£8·99
Z80 PIO 2·5Mhz	£7·99
Z80CTC 2·5Mhz	£7·99
Z80A P10 4Mhz	£10·00
Z80A CPU 4MHz	£13·99
Z80A CTC 4Mhz	£10·00
SC/MP II	£8·88
INS8154N	£8·18
8080A	£6·00
6502	£9·90
6522	£7·90
6532	£12·56
6551	£10·79

Memories

4116 (16K Dynamic)	£6·99
2102-1*	£0·85
2102L-1*	£0·99
2112	£2·25
2114	£6·99
2708	£6·99
2716 INTEL	£21·50

SHARP

MZ80K ..... from £520·00

ACORN

6502 Based Micro Kit	£65·00
PSU	£5·00
V.D.U. Kit	£88·00
8K RAM Kit	£95·00

ZEN

Editor/Assembler for Z80

Formats avialable:-

standard
Nascom. 1
TRS.80 ..... £14·50

77-68 The low cost 6800 Micro now upgradable to 6809

77-68 CPU Board Kit	£35·00
77-68 4K RAM Board Kit	£55·00
77-68 MON.1. Board Kit	£37·50
77-68 V.D.U. Board Kit	£42·50
77-68 MON.2 Board Kit	£47·50
77-68 EPROM Board Kit	£21·50
77-68 PI0 Board Kit	£40·00
77-68 32K Dynaram Kit (with 16K Supplied)	£75·50

Disc Interface & 6809 boards available send for free system description.

TERMS:.

50p Postage and packing. Official orders (Min. £10). Access and Barclaycard welcome. Please add 15% VAT to all prices.

Send for catalogue and booklist.

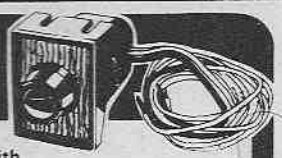
Mail order & Callers:—40, Bartholomew Street, Newbury, Berkshire. Tel: (0635) 30505

Callers only:—220-222, Stockport Road, Cheadle Heath, Stockport. Tel. 061 491 2290

Newbear Components is a division of Newbear Computing Store Limited.

VARI WIPE

WIPER DELAY CONTROL



The Vari Wipe provides intermittent operation of the windscreen wipers with adjustable control to delay each wipe between 3 and 60 seconds. Set the control to suit the conditions to clear light drizzle, fog, snow, sleet or spray. Easily fitted to British, Continental & Japanese cars with 12 volt self park wipers. Complete kit contains all components, including timer chip, PCB, case, mounting panel, wire, etc., with full instructions.

VARI WIPE KIT £6.75 inc. P & P
ASSEMBLED £9.25 inc. P & P
or send large s.a.e. for details

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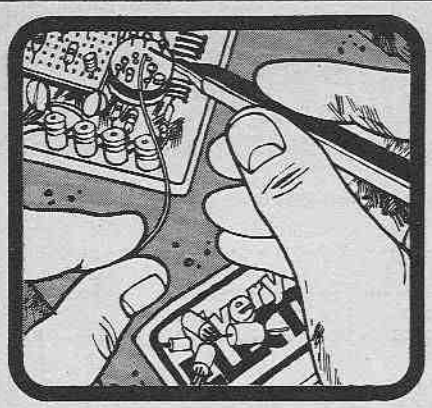

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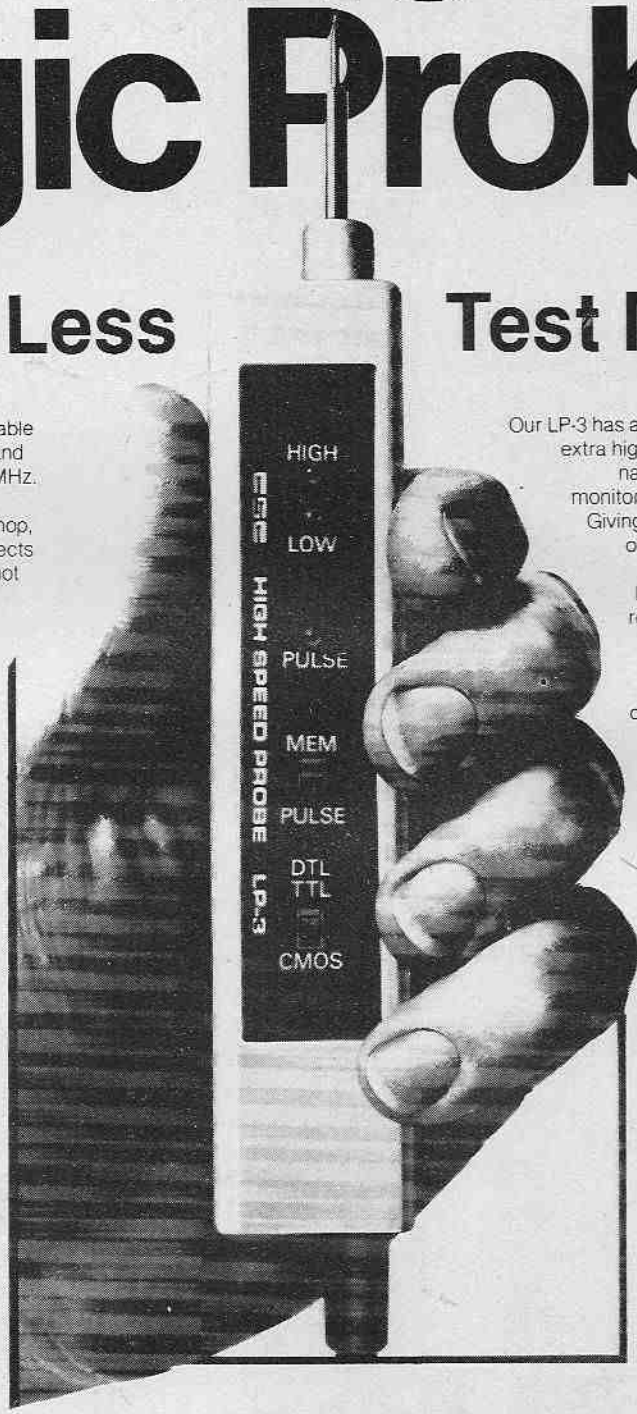

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