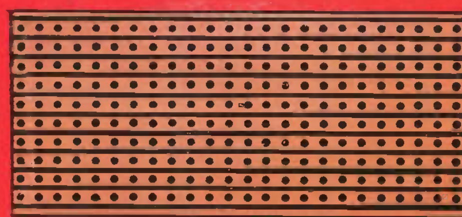
Easy to build projects for everyone

Everyday ELECTRONICS

OCT. 81
70p

* FREE *



AND INSIDE A CHOICE OF DESIGNS TO BUILD ON THIS STRIPBOARD

CAREER or PASTIME

START HERE

veroblot £1 SAVER SPECIAL OFFER

New Series TEACH-IN 82 part one

SUSTAIN UNIT

CAPACITANCE METER

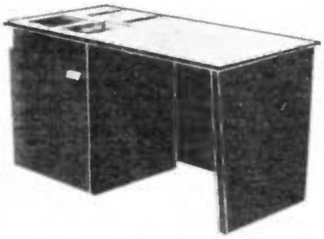
Australia $1·20 New Zealand $1·30 Malaysia $4·95 IR £1·00 (inc. V.A.T.)

NEW KITS THIS MONTH

COMBINATION SWITCH
Battery operated, would control solenoid lock or any electrical device up to 40 watts. Could be let into wall, virtually impossible to decode. Uses no power when in the off position. Complete kit £4.50.

A SECRET SWITCH
Can be hidden behind a panel, door, wallpaper, etc. etc. 2 reeds placed near enough to the surface to be magnetisable, the first reed closes a relay, the secondary contacts of which will light the lamp or whatever device is secretly controlled and it would also latch itself on. The second reed will unlatch the relay. Complete kit £1.95.

COMPUTER DESK



Size approx. 4'x 2' x 2'6" high. These were made for hard work, the top being formica covered. Suitable for housing instruments or for use as office desks. Beautifully made, these cost over £100 each, our price only £11.50 each, however, you must arrange to collect.

INSTRUMENT BOX WITH KEY

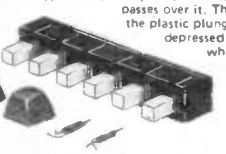
Very strongly made (ply-wood sides with hard-board top and bottom). This is black grained effect, vinyl covered, very pleasing appearance. Internal dimensions 12½" long, 4¼" wide, 6" deep. Ideal for carrying your multi range meter and small tools and for keeping them in a safe place. £2.30. Post paid if ordered with other goods, otherwise £1.00.

ROPE LIGHT

4 sets of coloured lamps in translucent plastic tube arranged to give the appearance of a running or travelling light. With variable speed control box, ideal for disco or shop window display. Complete, made up, ready to plug into mains. £36.00 + £2 post.

COMPUTER KEY SWITCHES (make your own keyboard)

These are for making up on a p.c.b. and consist of a vertical mounting computer type reed switch, which makes circuit when a magnet passes over it. The magnet is located in the plastic plunger which in turn is depressed by a push rod, to which the legended top is fixed. These are made up in banks of 6, price £2.30 per bank of 6 (including tops)



OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11.50 + £2.50 post.

GPO HIGH GAIN AMP/SIGNAL TRACER. In case measuring only 5⅛in x 3¾in x 1¾in is an extremely high gain (70dB) solid state amplifier designed for use as a signal tracer on GPO cables, etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An **absolute bargain** at only £1.85. Suitable 80ohm earpiece 69p.

MINI MONO AMP

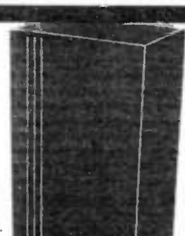
on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

12V FLUORESCENT LIGHTING

For camping — car repairing — emergeny lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer an inverter for 21" 13 watt miniature fluorescent tube. £3.45. (tube not supplied).

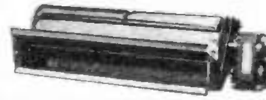
SUPER HI-FI SPEAKER CABINETS

Made for an expensive Hi-Fi outfit — will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.50 the pair.



TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.

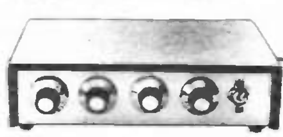


MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.

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 £14.95 in kit form or £19.95 assembled and tested.



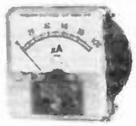
THIS MONTH'S SNIP

COMPUTER PRINTER FOR ONLY £4.95

Japanese made Epson 310 — has a self starting, brushless, transistorised d.c. motor to drive the print hammers, print drum — tape forward/reverse and paper feed.
Complete in module form with electronics including Printer Synchro Signal Amplifier & Printer Reset Signal Amplifier. Brand new and with technical and practical data. £4.95 post £1.25.
Data separately for £1.00.

EXTRACTOR FANS — Mains Voltage
Ex-computer, made by Woods of Colchester, ideal as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 rpm but quiet running. Choice of 2 sizes, 5" £5.50. 6" £6.50. post £1 per fan.

100uA PANEL METER



Japanese made (Shinohara Electrical) so very good quality, these have a full vision front, are approx. 2" square and come complete with mounting studs and nuts. A thoroughly reliable instrument usually retalled at over £4, offered at a snip price this month of £2.85 or 10 for £25.00.

12v MOTOR BY SMITHS

Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45.
Ditto, but double ended £4.25.

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: 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 at only £6.75 + 50p post and insurance.

FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30. (Not licenceable in the U.K.).

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit. (Not licenceable in the U.K.).

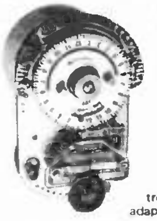
FM RECEIVER

Made up and working, complete with scale and pointer needs only a speaker, ideal for use with our surveillance transmitter or radio mike. £5.85.

CB RADIO —

Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller. Complete kit with case, speaker and instructions only £5.99.

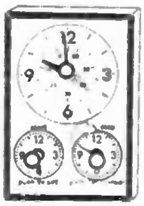
VENNER TIME SWITCH



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 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

STEREO HEADPHONES

Japanese made so very good quality. 8 ohm impedance, padded, terminating with standard ¼" jack-plug. £2.99 Post 60p.



TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. £2.50.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. 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. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

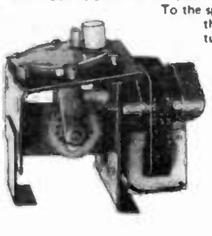
RADIO STETHOSCOPE
Easy to fault find — start at the arial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
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 £2.30

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

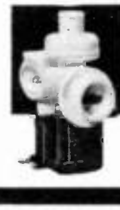
UNUSUAL MOTORISED PUMP

The motor is a normal ½" stack induction motor, mains operated. To the spindle is fitted a nylon worm drive, this considerably reduces speed and turns a nylon cog wheel to which is coupled a link operating a small bellows pump. The outlet and inlet to and from this pump are nylon pipes to which flexible tubing can be connected. Obviously, there will not be a big flow of air from this pump but quite considerable pressures can be developed. Price £4.60 + 50p.



SOLENOID AIR VALVE

made to work with the above pump. This mains operated valve will stop the flow of air or gas when mains is applied to it. 220v - 230v model — £3.45. 100v model — £2.30.



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Pak No.	Qty.*	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ⅛-½ watt Carbon Resistors	£1
SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm-2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects.
*Quantities approximate, count by weight.

"CAPABLE CAPACITOR PAKS"

Pak No.	Qty.*	Description	Price
SX16	250	Capacitors Mixed Types	£1
SX17	200	Ceramic Capacitors Miniature Mixed	£1
SX18	100	Mixed Ceramics 22pf-390pf	£1
SX19	100	Mixed Ceramics 470pf-.047uf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-100mfd.	£1
SX24	20	Tantalum Beads, mixed	£1

*Quantities approximate, count by weight.

AUDIO PLUGS, SOCKETS AND ACCESSORIES

25 pieces of Audio Plugs, Sockets and Connectors to include DIN 180°-240°, Inline 3-6 Pin, Speakers, Phono, Jack, Stereo and Mono, etc. etc. Valued at well over £3 normal. Order No. SX25. Our Price £1.50 per pak. Guaranteed to save you money.

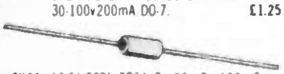
SX26	3 Prs. of 6 pin 240° DIN Plugs and Chassis Sockets	50p
SX27	1 x Right Angle Stereo Jack Plug 6.3mm plus matching metal chassis mounting socket.	30p
SX28	4 Phono plugs and 2 dual phono connectors.	30p
SX29	1 x 2.5mm Plug to 3.5mm Socket adaptor	20p
SX30	1 x 3.5mm Plug to 2.5mm Socket adaptor	20p
SX31	1 x 3.5mm Plug to Phono Socket adaptor	20p

SX32	1 x Standard Jack Plug to Phono Socket adaptor.	25p
SX33	1 x Toggle Switch SPST Miniature. 125v 10A	40p
SX34	1 x Toggle Switch SPDT Miniature. 125v 10A.	40p
SX35	1 x Rocker Switch SPDT Miniature. 240v 5A.	40p
SX36	1 x Right Angle Mono Jack Plug	15p
SX37	20 pieces, 1, 2 & 4mm plugs and sockets (Banana). Matching colours and sizes.	£1
SX50	10 Assorted Switches. Toggle, Slide, Rocker, Push button.	£1

Guarantee

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is. All these Sale items are in stock in quantity and we will despatch the same day as your order is received.

SX40	250 Silicon Diodes—Switching like 1N4148 DO-35. All good—uncoded. Worth double our price. 45v 75mA	£1.25
SX41	250 Silicon Diodes—General Purpose, like OA200/202, BAX13/16. Uncoded. 30-100v 200mA DO-7.	£1.25



SX44	10 5A SCR's TO64. 3 x 50v, 3 x 100v, 2 x 200v, 2 x 400v. Super value less than ½ price	£2
SX45	10 5A SCR's TO66. 2 x 50v, 2 x 100v, 4 x 200v, 2 x 400v. All coded. Brand new, a give away at...	£2

SEMICONDUCTORS FROM AROUND THE WORLD

100 A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices. **100**

Guaranteed Value over £10 at Normal Retail Price

yours for only **£4·00** Data etc. in every pak. Order No. SX56

£1 FREE PAK

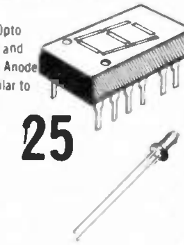
Get a £1 FREE PACK. Orders over £10 excluding VAT. Choose £1 Pack free (or 2 x 50p) add it to your order and save even more money. This offer only applies to this advertisement.

This offer only applies to this advertisement

BI-PAK'S OPTO BARGAIN OF THE YEAR!

Valued at over £10—Normal Retail—we offer you a pack of 25 Opto devices to include LED's Large and Small in Red, Green, Yellow and Clear. 7 Segment Displays both Common Cathode and Common Anode PLUS bubble type displays—like DL-33. Photo Transistors—similar to OCP71 Photo Detectors—like MEL11-12. This whole pack of 25 devices will cost you just

25 **£4·00** **25**



AND we guarantee your money back if you are not completely satisfied. FULL data etc included

Order No. SX57.

IC SOCKETS

The lowest price ever.

The more you buy the cheaper they come!

Pin.	10 off	50 off	100 off
8	75p	£3.00	£5
14	80p	£3.25	£5.50
16	80p	£3.25	£5.50
16*	80p	£3.25	£5.50

Quilled *

BARGAINS

SX42	20 small .125 Red LED's	£1
SX43	10 Rectangular Green LED's .2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New.	£1
SX47	4 Black Instrument Knobs—winged with pointer ¼" Standard screw. Fit size 29 x 20mm.	50p
SX48	5 Chrome knobs, standard push fit. 15mm.	50p
SX49	20 Assorted Slider Knobs. Black/Chrome, etc.	£1

MORE BARGAINS!

SX51	60 metres PVC covered Hook-up wire single and stranded. Mixed colours.	£1
SX58	25 Assorted TTL Gates 7400 Series. 7401-7460.	£1
SX59	10 Assorted flip Flops and MSI TTL	£1
SX60	20 Assorted Slider Potentiometers	£1
SX61	25 Assorted Potentiometers, Rotary, Dual, etc.	£1
SX62	40 Assorted Pre-Sets Hor/Vert etc.	£1

STILL MORE!

SLIDER POTENTIOMETERS

Plastic 40mm Travel Mono

SX63 5 x 470 ohms Lin	SX67 5 x 47k Lin
SX64 5 x 1k Lin	SX68 5 x 47k Log
SX65 5 x 22k Lin	SX69 5 x 100k Lin
SX66 5 x 22k Log	SX70 5 x 1 meg Lin

All at 50p per pack.

SX71	50 BC108 "Fallouts". Manufacturers out of spec on volts or gain. You test.	£1
SX72	A mixed bundle of Copper clad Board. Fibre glass and paper. Single and double sided. A fantastic bargain.	£1

SX52	6 Black Heatsink will fit TO-3 and TO-220. Ready drilled. Half price value.	£1
SX53	1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled. TO-3 Size 45mm squarex 20mm high.	40p
SX54	TO-66 size. 35mm x 30mm x 12mm.	35p
SX55	1 Heat Efficiency Power Finned Heatsink. 90mm x 80mm x 35mm High. Drilled to take up to 4 x TO-3 devices	£1.50 each

5 watt (RMS) Audio Amp

High Quality audio amplifier Module. Ideal for use in record players, tape recorders, stereo amps and cassette players, etc. Full data and back-up diagrams with each module.

Specification
● Power Output 5 watts RMS ● Load Impedance 8-16 ohms ● Frequency response 50Hz to 25 KHz—3db ● Sensitivity 70 mv for full output ● Input Impedance 50k ohms ● Size 85 x 64 x 30mm ● Total Harmonic distortion less than 5%

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You could not Build one for this price.

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There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, Bi-Pak's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

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SX38	100 Silicon NPN Transistors—all perfect. Coded mixed types with data and eqvt. sheet. No rejects. Real value.	£2.50
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MULLARD. ASZ 17 PNP.
Germ TO-3 Power Trans.

60 VCB 8A		Poss Replacement for
32 VCE 30W		AD130/131/140/149
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THE AX-210 IS OUT OF THIS WORLD

THE WORLDS MOST VERSATILE WATCH

CASIO AX-210
Multiple Display LCD Analogue/Digital

ANALOGUE display of time plus:
*Digital time display, 12 or 24 hour system.
*Digital date, month and year, plus day flag.
*Full month calendar display, current month.
*Full month calendar display, next month. Auto-calendar pre-programmed to the year 2029.

Dual time modes
*ANALOGUE display of local time plus digital second time zone, 12 or 24 hour system.

Alarm mode
*ANALOGUE time with digital "Alarm Set Time", 24 hour system, AM/PM and "alarm on" indicators.
*Buzzer for 20 seconds or select "Dixie Land", "Green Sleeves" or "My Darling Clementine".

Hourly time signal with 'Big Ben' type chimes at noon. Easily switched on or off.

RRP (34.95)
ONLY £29.95

Countdown alarm timer mode
*Amazing ANALOGUE display, plus digital countdown. Normal and net times from 1 to 60 minutes with automatic retrieval of pre-entered time.

Stopwatch mode
*ANALOGUE countup, with digital timing of net, lap and first and second place times from 1/100 second to 1 hour. Confirmation signal.

Easy setting of times and alarm with forward and backward stepping, and rapid run facility. Dims: 9.25 x 35 x 36mm approx. Mineral glass. Long life lithium battery. +/-15secs/month.

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100 METRE WATER RESISTANT WATCHES
WITH C/D ALARM AND STOPWATCH

W150	W150C	W100
£24.95*	£21.95*	£19.95

Time and auto calendar, alarm, hourly chimes, countdown alarm timer with repeat memory function, stopwatch. Time is always on display, regardless of mode. Stainless steel. (W100 Resin).

THESE SPACE INVADERS WILL ALARM YOU

CA90 (LEFT)
£19.95*

CA901 (RIGHT)
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Time and auto calendar, calculator, alarm, hourly chimes, stopwatch, dual time. DIGITAL SPACE INVADER GAME.

CASIO's MOST AMAZING WATCHES EVER

PROGRAMMABLE CALCULATORS

POWERFUL HIGH SPEED FX 702P COMPUTER USING BASIC LANGUAGE

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FX702P
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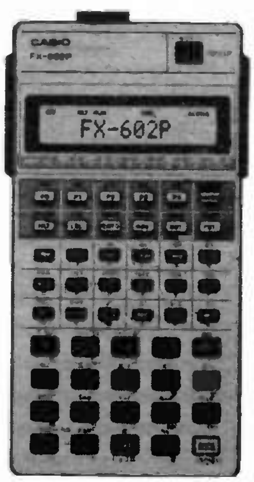

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Our new series *Teach-In 82* offers an easy way to understand the principles of electronic circuits and to gain practical experience with actual components through simple experiments in our 12-part course.

A SURE FOUNDATION

By happy chance this issue which includes a free piece of Veroboard ("stripboard") coincides with the 20th anniversary of its invention. Like many clever inventions, this one happened almost accidentally.

Veroboard was the brain child of a couple of electronic engineers who were designing machine tool control equipment in the factory of Vero Precision Engineering Ltd. Their success in making a few one-off "wiring boards" from copper clad plastics laminate was noted by someone on the management who had the foresight to realise its potential. So this "printed wiring board" was put into large scale production (a "natural" for the firm's milling capabilities) and marketed. The electronics industry took to the product as ideal for assembling circuits incorporating the new semiconductor devices, and constructors soon afterwards discovered its virtues and gave a further fillip to sales. Because of its success a separate company Vero Electronics was soon set up.

Those of us who had wrestled with transistors in the 'fifties, using makeshift methods and materials such as Paxolin, hardboard cut-offs and even cardboard as mounting bases for components, or tag strips designed for the valve era, seized on this new product with delight. It is no exaggeration to say today's thriving pastime of electronics has been built literally on Veroboard.

We congratulate the original inventors and the company managers whose bold step turned out to be no gamble.

TEN POPULAR DESIGNS

With newcomers to electronics particularly in mind, we include this month a fine selection of *Ten Popular Designs*, any one of which can be accommodated comfortably on the free piece of Veroboard. As anniversaries are in the air, we chose one design from each complete year of EVERYDAY ELECTRONICS. That makes us just ten, come next month.

FRED BENNETT

Our November issue will be published on Friday, October 16. See page 683 for details.

Everyday ELECTRONICS

VOL. 10 NO. 10 OCTOBER 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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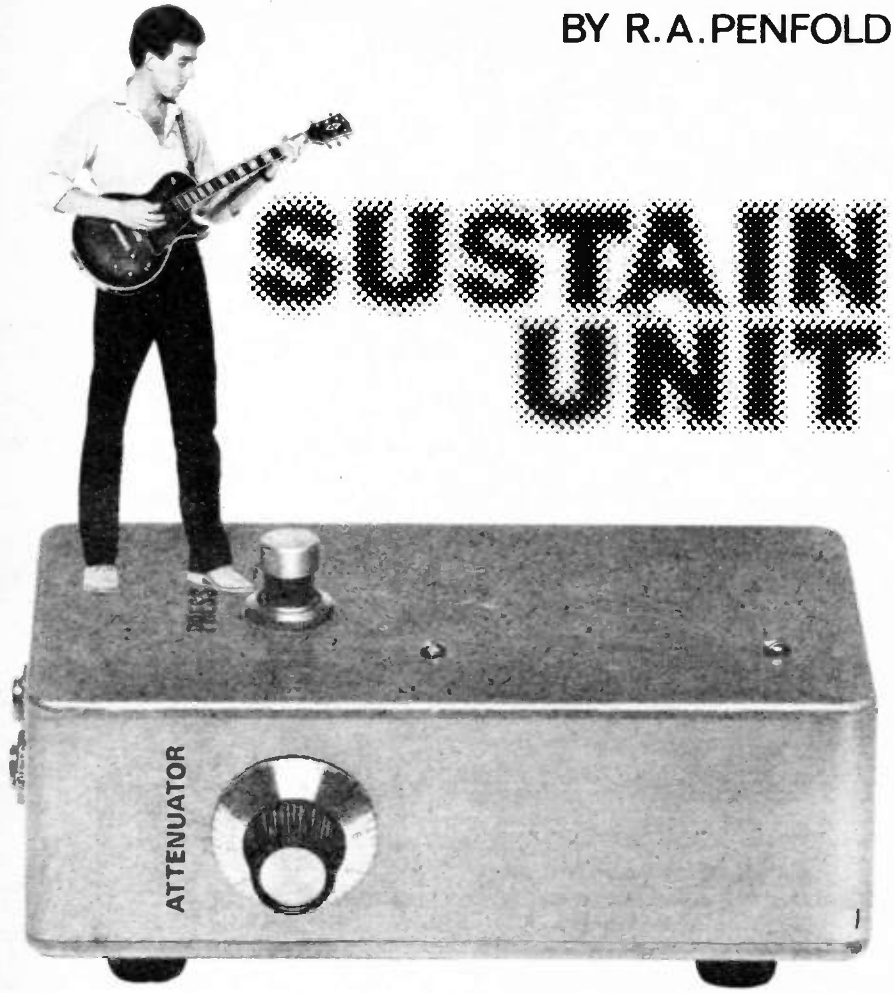
SEE PAGE 671



BY R. A. PENFOLD

SUSTAIN UNIT

SUSTAIN units are primarily intended for use with electric guitars, and as the name implies, devices of this type extend the maximum duration of the note from the instrument.

The output signal from a guitar normally has a high initial ampltude which quickly drops to a much lower level, and then steadily dies away to virtually nothing over a few seconds. A sustain unit boosts the signal as it dies away, giving an almost constant output amplitude and effectively increasing the maximum time for which a note can be sustained.

METHODS OF OPERATION

There are two reasonably simple ways of obtaining a sustain effect, the most simple one being to use a clipping circuit of the type outlined in the block diagram of Fig. 1(a). Here the input signal is first considerably amplified and then fed to a clipping circuit. The latter normally uses a couple of silicon diodes to clip the signal at about ±0·6V.

Thus the output amplitude is set at this level by the clipping action and is largely independent of the input level. In fact, however large the input level may be, the output will not rise above the clipping level.

It can fall *below* the clipping level if the input signal is inadequate, but the input amplifier is given a high enough gain to ensure that this does not happen until a few seconds after the commencement of a note.

DRAWBACKS

One major drawback to this system is that by clipping the signal it is considerably distorted. Strong harmonics of the fundamental note are produced, giving the same effect as a "Fuzz" unit. A low pass filter is therefore normally included at the output of the circuit in order to attenuate the harmonics that would otherwise give an undesired effect.

This does not completely solve the problem though, since strong intermodulation distortion is caused by the clipping, and this produces a very unpleasant sounding output if more than one note at a time is played. Most of the intermodulation distortion products will not be attenuated by the low filter as they are mainly in the same frequency range as the desired signals.

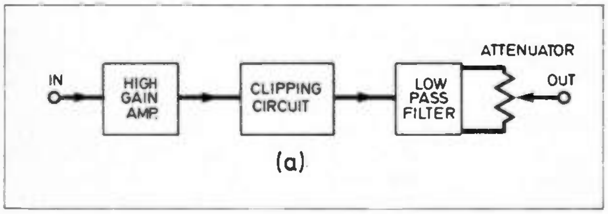
SECOND METHOD

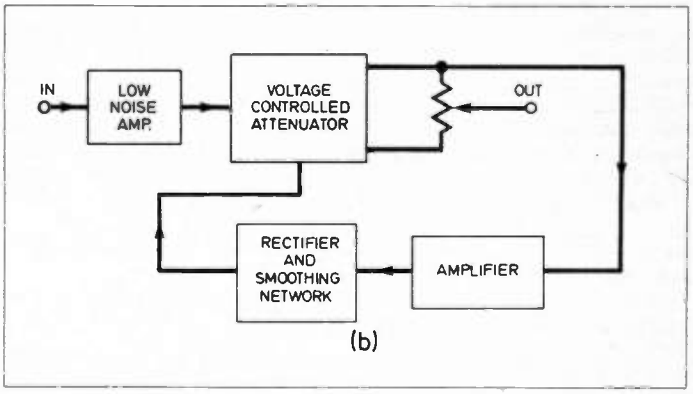
The second method, which is shown in the block diagram of Fig. 1(b), is slightly more complicated but is capable of much improved results. As before, the signal is first fed to an amplifier. It is then fed to a voltage controlled attenuator (v.c.a.), which is a circuit that reduces the amplitude of the input signal by an amount which depends upon the voltage fed to its control terminal.

In this type of circuit the v.c.a. gives little attenuation with only a small control voltage, and increasing attenuation as the control voltage is raised.

The control voltage is derived from the output of the v.c.a. by way of a rectifier and smoothing network, and a certain amount of additional amplification is also needed in order to obtain a sufficiently large control voltage.

Fig. 1 (below). Simple methods for obtaining sustain effect. (a) clipping circuit; (b) voltage controlled attenuator or compressor type of circuit.





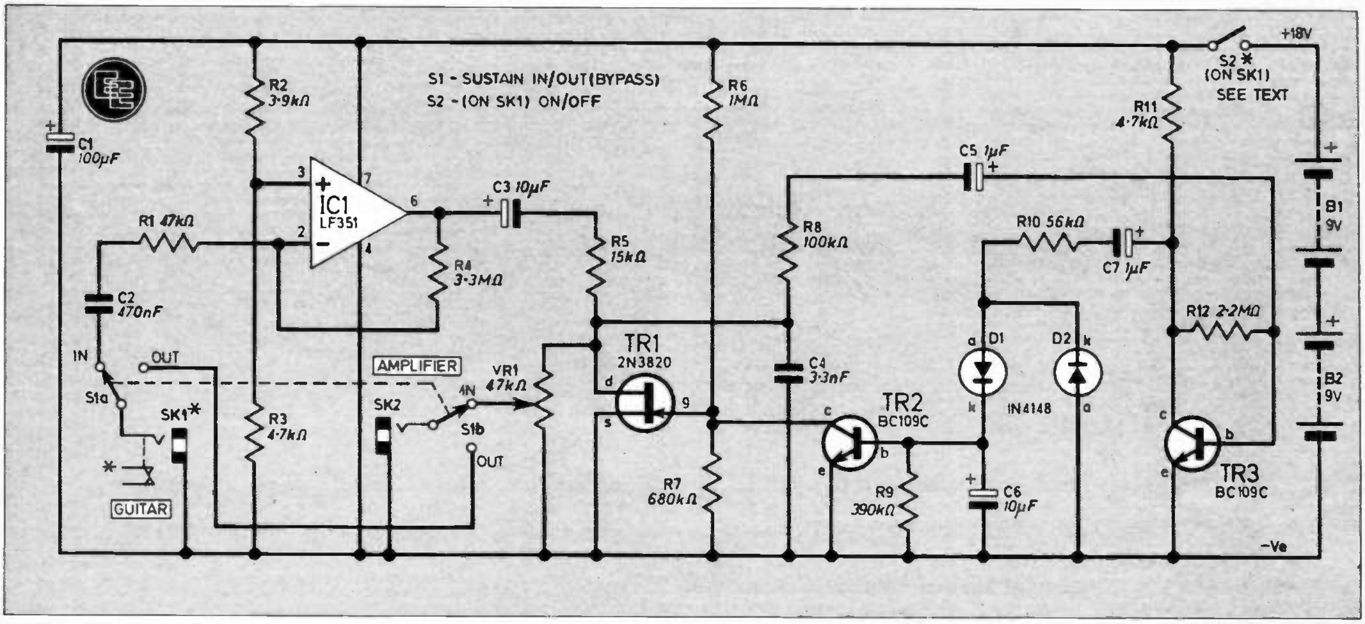


Fig. 2. The complete circuit diagram of the Sustain Unit.

Under quiescent condition or with only a very low input level there will be at most only a very small control voltage, and a greatly amplified signal appears at the output. At higher input levels a significant control voltage is produced, and the signal receives a lower level of amplification in consequence.

At still higher input signal amplitudes the control voltage is increased further, and little or no amplification is provided by the unit. This has the effect of holding the output signal at a certain level, provided the input is sufficiently strong to produce this output level. Raising the input above this minimum level causes the gain of the circuit to drop and results in very little increase in the output level.

This gives the required sustain effect because as the input level decays, the gain of the circuit increases so as to maintain the output level.

ATTACK AND DECAY TIMES

The attack and decay times of the smoothing circuit must be carefully chosen so that the unit will respond with suitable rapidity to changes in input amplitude, but not so rapidly that the waveform of the processed signal is altered and significant distortion is generated.

The unit will not properly respond to the transient at the beginning of each note as it is too brief, but this does not matter and is really of benefit as it maintains the guitars natural attack, which is lost when the clipping method is employed.

With either system a variable attenuator is included at the output so that the signal level from the unit can be adjusted to one which is comparable to the output from a guitar.

THE CIRCUIT

Fig. 2 shows the complete circuit diagram for the unit finally evolved, and this is of the second type, which is usually called a "compressor".

The input amplifier is based on operational amplifier IC1. R2 and R3 bias the non-inverting input to slightly more than half the supply voltage, and R4 biases the inverting input and output of the device to the same potential due to a negative feedback action. This bias voltage gives the circuit optimum unclipped peak to peak output voltage swing capability.

The voltage gain of the amplifier is determined by the ratio of R1 to R4, and is approximately equal to R4 divided by R1, or about 70 in other words. This gives sufficient sensitivity to produce a good sustain effect with any normal instrument.

It is essential for the input amplifier to have a low noise level as the circuit will produce maximum output from input levels below 1mV. A poor noise performance would result in low input levels being swamped in noise. IC1 provides a suitably high performance in this respect as it is a bifet type which has a low noise jfet input stage. The distortion performance is also very good, and these devices are ideal for critical audio applications.

VOLTAGE CONTROLLED ATTENUATOR

The v.c.a. is based on p-channel jfet TR1, and it is its drain to source resistance plus R5 that form the two elements of the attenuator. C3 couples the output from IC1 to the attenuator.

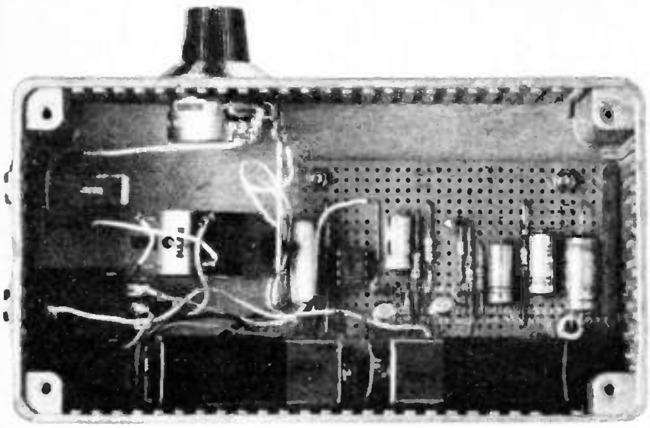
Under quiescent conditions R6 and R7 strongly reverse bias TR1 so that it is fully switched off and exhibits a drain to source resistance of typically about 1,000 megohms. It therefore causes no significant losses through R5, although output attenuator VR1 and other loads on the output do cause losses of a few dB. However, the circuit still exhibits a voltage gain of more than 50.

Some of the output signal is coupled by C5 to a common emitter amplifier which uses TR3 in a conventional configuration. The gain of the amplifier is far higher than is necessary, and so R8 is inserted in the signal path to reduce the gain to a more appropriate level. This resistor also boosts the input impedance of the stage and thus helps to reduce loading on the output.

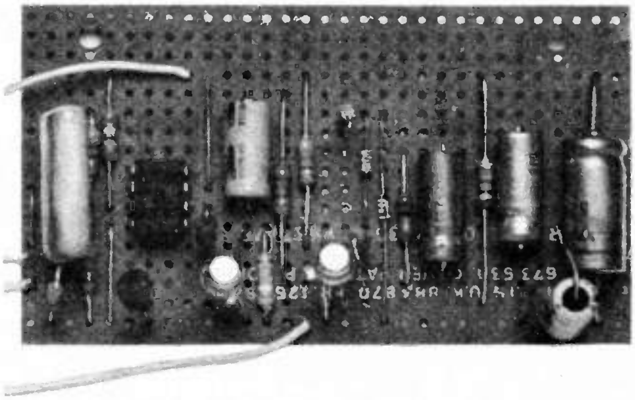
The output from TR3 is fed by C7 and R10 to the smoothing and rectifier circuitry which is comprised of D1, D2, C6 and R9.

If the input signal is sufficiently strong, the positive bias produced by the rectifier and smoothing circuit will be high enough to switch on TR2 to some extent. TR2 then reduces the bias on TR1, causing it to conduct more heavily and increasing the losses through R5. The stronger the input signal is made, the lower the bias voltage fed to TR1 and the greater the losses through R5. This gives the required stabilisation of the output signal amplitude.

C4 rolls-off the high frequency response of the circuit (above about 4 to 5kHz) under quiescent or low signal level conditions. This helps to give an improved signal-to-noise ratio



Layout of components within the case.



Completed circuit board removed from case.

under the conditions where any noise will be most noticeable.

C4 has little effect at medium and high input levels where the resistance of TR1 is quite low, and the shunting effect of C4 even at the highest audio frequencies is of far less significance.

BYPASS SWITCH

S1 can be used to bypass the circuit so that the sustain effect can be switched out when it is not required. S1 is a heavy duty push button type switch having a sequential action, so that it can be operated by foot.

S2 is the on/off switch, and on the prototype it is actually a make-contact on the input socket (SK1) so that the unit is automatically switched on when the guitar is plugged into it. This is quite common practice with effects units.

An 18 volt supply is needed in order to enable the unit to handle high input signal levels without clipping occuring, and this is provided by two small 9 volt batteries (PP3 size) connected in series. The unit only consumes about 5mA.

PERFORMANCE

The graph of Fig. 3 shows input voltage versus output voltage for the prototype. As can be seen from this, the compression commences at less than 1mV, and increasing the input to as much as 50mV or so causes only a marginal increase (about 15 per cent) in the output. At higher input levels TR1 saturates and the gain of the unit stays at approximately unity.

As the output from a guitar is only likely to reach a high enough level to saturate TR1 during the initial transient (if at all), when full compression is not necessary or achieved anyway, in practice the unit gives the desired effect with the initial attack followed by an almost constant output until the input signal decays to an insufficient level.

CONSTRUCTION starts here

HOUSING THE UNIT

Due to the high sensitivity of the unit it is advisable to use a metal case so that the circuitry is screened from sources of electrical interference. The case must also be very strong due to the manner in which the unit will be used. A diecast aluminium box measuring about 152 x 82 x 50mm makes an ideal housing for the project.

S1 is mounted on the top panel of the case, and this panel should be left clear of other controls, or sockets, which could otherwise cause confusion or get in the way when operating S1. Apart from this the physical layout of the unit is not critical.

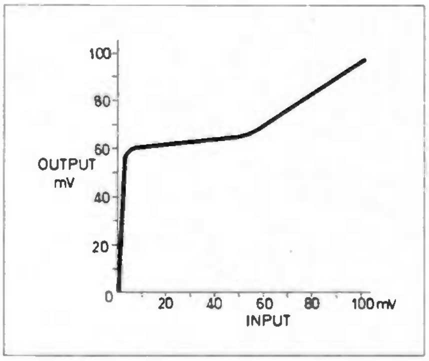


Fig. 3. Input voltage versus output voltage characteristic of the Sustain Unit.

CIRCUIT BOARD

The circuit is built on a piece of 0·1in matrix stripboard, size 31 holes by 17 strips. The component layout and the breaks needed in the copper strips on the underside of the panel are shown in Fig. 4. The two mounting holes are 3·3mm in diameter and accept either 6BA or M3 mounting bolts.

Before mounting the completed panel connect flying leads of sufficient lengths at the four appropriate points. Spacers must, of course, be used over the mounting bolts to hold the connections on the underside of the panel clear of the metal casing.

There is a small amount of point to point fashion wiring, and this is illustrated in Fig. 5. SK1 has d.p.d.t. contacts, but four tags are unused in this application as only a s.p.s.t. switch is required. One of the four spare tags is used as a convenient point to provide the interconnection between the two battery clips.

USING THE UNIT

Best results from the unit will probably be obtained with the volume control on the guitar set at maximum. VR1 is merely adjusted to give the same volume level with the unit switched in as when it is bypassed.

The unit provides a considerable increase in gain, and this could lead to problems with stray mechanical or magnetic feedback between the loudspeaker and pick-up if the latter is not a humbucking type. In such cases it is essential to ensure that the guitar is as far away from the loudspeaker as can be arranged, and if necessary the volume control on the guitar can be backed off slightly. ⌑

SUSTAIN UNIT

COMPONENTS

Resistors

R1	47k
R2	3·9k
R3	4·7k
R4	3·3M
R5	15k
R6	1M
R7	680k
R8	100k
R9	390k
R10	56k
R11	4·7k
R12	2·2M

All miniature ¼ watt ±5% (±10% over 1M)

See Shop Talk page 670

Potentiometer

VR1 47kΩ log. carbon

Capacitors

C1	100μF 25V elect.
C2	470nF type C280
C3	10μF 25V elect.
C4	3·3nF ceramic plate
C5	1μF 25V elect.
C6	10μF 25V elect.
C7	1μF 25V elect.

Semiconductors

IC1	LF351 f.e.t. input op-amp
TR1	2N3820 *n*-channel f.e.t.
TR2	BC109C silicon *npn*
TR3	BC109C silicon *npn*
D1	1N4148 small signal silicon diode
D2	1N4148 small signal silicon diode

Switches

S1	d.p.d.t. sequential heavy duty push button type
S2	Part of SK1

Sockets

SK1	Standard (6·3mm) jack socket with d.p.d.t. contacts
SK2	Standard (6·3mm) jack socket

Miscellaneous

Diecast aluminium box measuring about 152 × 82 × 50mm. 0·1in matrix stripboard. Control knob. Two PP3 size batteries and connectors to suit. Wire, solder.

COMPONENTS approximate cost £8·50

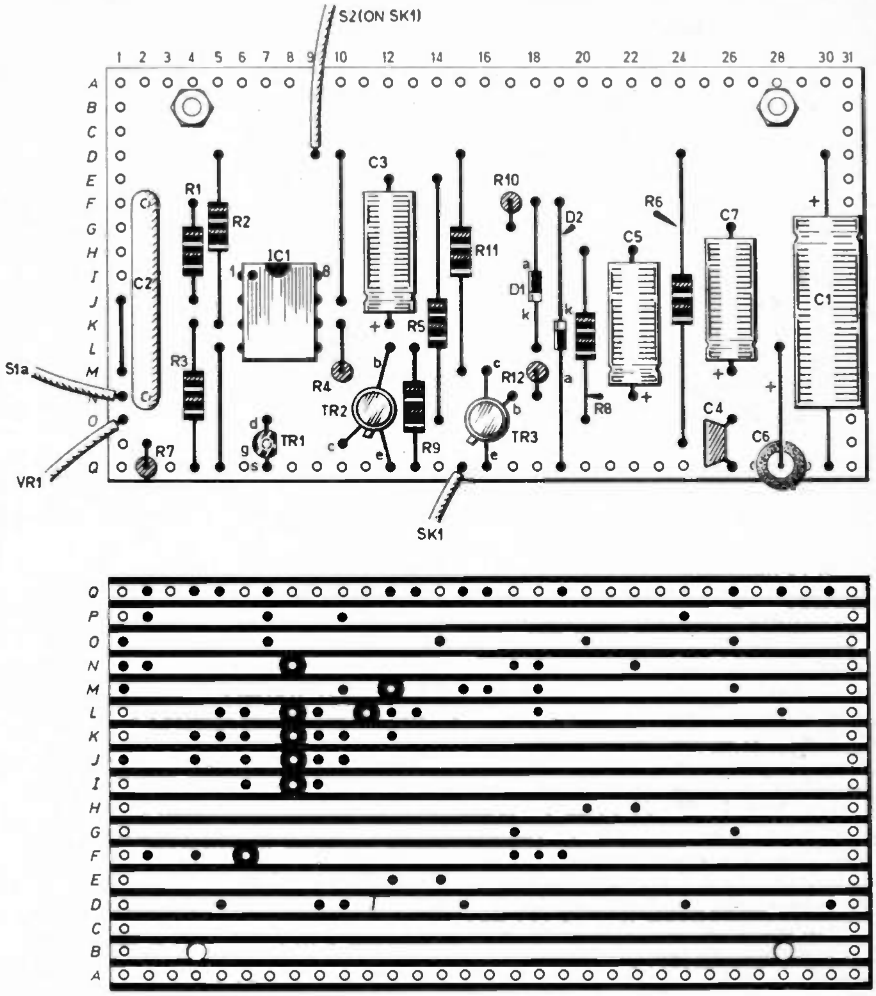


Fig. 4. Circuit board details, topside and underside.

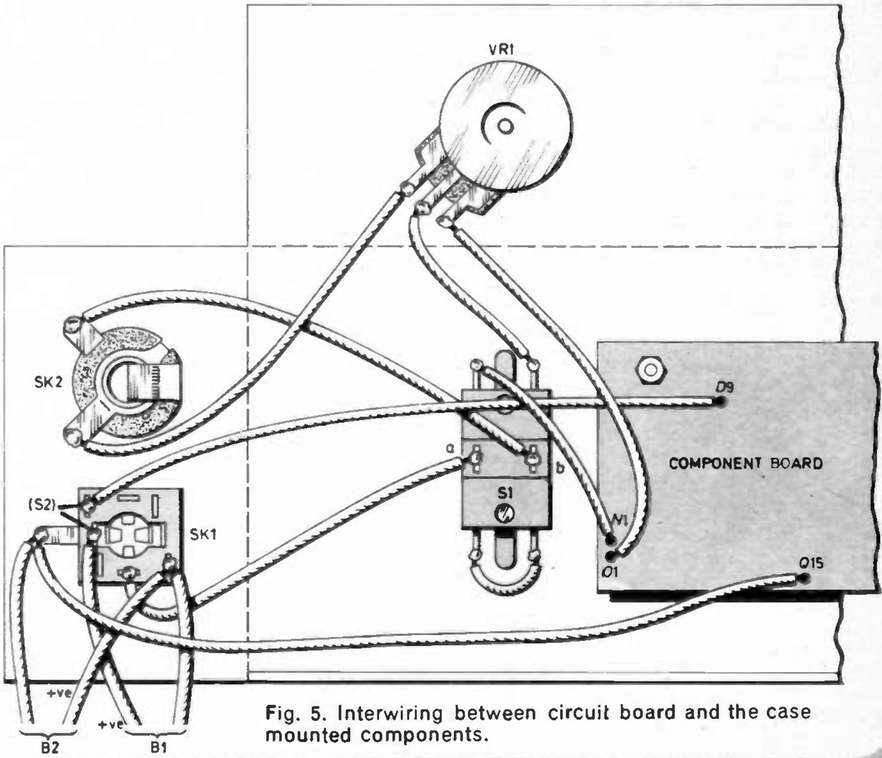
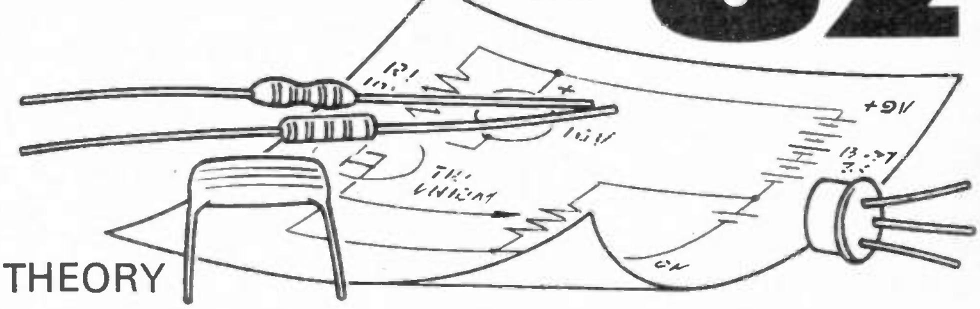


Fig. 5. Interwiring between circuit board and the case mounted components.

EE TEACH-IN 82

PART 1

BY O.N. BISHOP



A new 12-part series

BASIC ELECTRONIC THEORY WITH EXPERIMENTS

CONDUCTION IN MATERIALS AND DEVICES

Electronics is the study of devices in which electric charge is moved. The movement of charge is called conduction, so it makes sense to begin our course in electronics by studying this. We will then be ready to look next month at some of the devices in which charge is conducted.

ELECTRIC CHARGE

First of all we should ask "What is electric charge?" The surprising answer to this is that we do not really know what it is, in spite of the fact that it is a major factor in all our lives today.

We know that electrons and protons carry electric charge and that these charges are of two different kinds. We call them negative and positive, but the use of the word "negative" does not mean that electrons are lacking in charge when we say they carry negative charge.

Negative charge is just as real as positive charge. The two kinds of charge are simply opposites in the sense that one unit of positive charge (as carried by a proton) exactly cancels out one unit of negative charge (as carried by an electron). We will leave out of this discussion the fractions of unit charge carried by quarks and similar sub-atomic particles.

The only way we can tell that a particle is charged is when we can detect a force caused by the charge. The force between two similarly charged particles drives them apart. The force between two oppositely charged particles attracts them together.

The amount of charge on an electron is exceedingly small. For practical use we need a unit of charge much larger than this. Our unit is the **coulomb** (symbol C) which equals the charge on about six million million million electrons.

COMPONENTS required for experiments during the first 6-Parts of Teach-In 82. Complete kits of these (LIST 2) may be obtained from the retailers listed on page 670.

COMPONENTS approximate cost £10

Resistors

Quantity	*Value*
1	5·6Ω
1	39Ω
3	100Ω
2	180Ω
1	330Ω
2	470Ω
1	560Ω
1	1kΩ
1	1·5kΩ
2	4·7kΩ
2	10kΩ
1	22kΩ
1	100kΩ
1	150kΩ
1	220kΩ
1	270kΩ
1	470kΩ
1	1MΩ

All ¼W or ⅓W carbon types ± 5% tolerance. Types prepared for p.c.b.s. with short preformed leads are not suitable.
All leads on components to be between 0·5 and 0·8mm diameter to fit specified breadboard (Verobloc).

Capacitors

Quantity	*Value*
1	470pF—ceramic plate or disc
1	47nF—metallised polyester, Mullard C280, ITT PMT2R or similar.
2	10μF electrolytic
1	47μF electrolytic
2	220μF electrolytic

(Electrolytics: 16V types preferred, axial or radial leads. Short lead-out types are not suitable.)

All to be suitable for working at 12V. Very large types should not be obtained.

Semiconductors

Quantity	*Type*
1	VA1067S thermistor 150 kilohm @ 25°C
1	TIL100 infra-red photodiode
1	1N4148 small signal silicon diode
2	VN10KM VMOS power field-effect transistor
1	ORP12 light dependent resistor
2	ZTX300 silicon *npn* transistor
1	555 timer i.c. (8 pin d.i.l.)
1	CD4011 CMOS quad 2-input NAND gates
1	CD4027 CMOS dual J-K flip-flop
1	CD4070 CMOS quad 2-input exclusive-OR gates

Miscellaneous

Quantity	*Description*
1	**Verostrip**: 0·1 inch matrix 75 strips size 213 × 38mm (Vero 200-21086K)
1	**Crystal Microphone Insert**
1	**Toggle Switch**: standard size s.p.s.t.
1	**Rotary Switch** 1-pole, 6-way, break before make contacts
1	**Knob**: to fit rotary switch and match those in Minilab kit
20	**Terminal Pins** single-sided to fit Verostrip (Vero half-pin 200-21017B)
5m	**P.V.C. Covered Wire**: stranded 7/0·2mm: 1 metre of each of 5 different colours
1m	**Tinned Copper Wire**: 20 s.w.g.
	Hardware:
2	4BA bolt (25mm)
2	4BA shakeproof washer
6	4BA nut

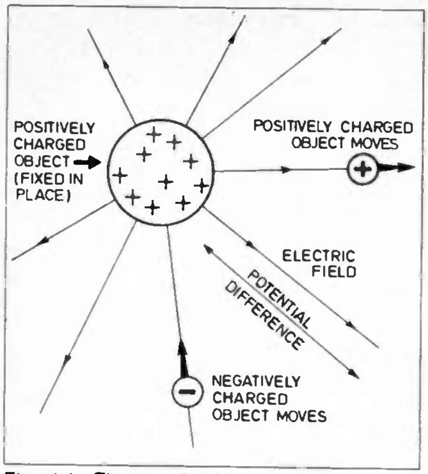


Fig. 1.1. Electric field around a charged object. Potential is high close to the object, but low at a distance.

CONDUCTION

If charge is to be carried from one place to another, there are three requirements:

(1) Charge carriers
(2) A medium in or through which the carriers can move
(3) An electric field to provide the force to make them move.

Electrons have already been mentioned as examples of charge carriers. These are the type we find most often in electronics, but there are other kinds, as we shall see later.

An electric field exists when there is a **potential difference** between one point and another. In Fig. 1.1 the charged object contains many particles which are positively charged. There is an electrical field around the object. Positively charged bodies are repelled by it, negatively charged objects are attracted by it.

If these charged objects are free to move, they will move. There will be movement of electric charge—which is what electronics is all about.

When we talk about the movement of charge we do not usually think of the amount of charge being moved. We think of the rate at which charge is moved. Our unit for rate of movement of charge is the **ampere**, (symbol A). A current of one ampere carries charge from one place to another at the rate of 1 coulomb per second.

The motion of charge causes a magnetic field, and an ammeter uses this effect to measure current.

The strength of an electric field is measured by the potential difference (p.d.) between two points in the field. Roughly speaking, the p.d. tells us how much energy is needed to move a charged object from one point in the field to the other. The unit for measuring p.d. is the **volt** (symbol, V).

Now that we have looked at some ideas on conduction, let us see how well different kinds of material can conduct by carrying out some simple experiments.

It is expected that the Minilab (see page 664) will take a little time to complete, but this should not prevent you from carrying out the experiments immediately. The only facilities we shall be using from the Minilab in the early experiments will be the battery supply, the meter and of course the Verobloc.

You can see from the experiment layouts, in Fig. 1.3 for example, that connections to the meter and battery are made via screw terminal blocks. Essentially this is all that is required, especially for the simple experiments. Even the terminal blocks may be dispensed with initially with the meter and battery leads "plugged" directly into the Verobloc.

The experimental layouts therefore are suitable for use with and without Minilab.

EXPERIMENT 1.1

How well do different materials conduct?

Look at the circuit diagram (Fig. 1.2) and how to set it out on the breadboard in Fig. 1.3. You are using the electric field produced by a 3V battery. In other words, the p.d. between the ends of wires *A* and *B* is 3V. The meter is included in the circuit to measure the current. A sensitive meter is used because the currents will be small.

When the needle is deflected fully to the right the current is 100μA. The symbol "μA" is read as "microampere", or "microamp" for short. A microampere is one millionth of an ampere.

The aim of this experiment is to measure the current that flows through different materials when a p.d. of 3V is applied. Use the two bare ends of wires *X* and *Y* as probes to touch against the different materials and devices listed below. Measure the current (if any), and keep a note of its value. Be ready to take the probes away quickly if the needle should swing beyond the right-hand end of the scale. Here are some tests to try:

(a) Hold one bare wire end *X* and *Y* in Fig. 1.3 in each hand, gripping its metal firmly. Measure the current *flowing through your body* (seen on the meter). Remember this point in future, and always hold the wire by its insulation. Remember this also when handling plugs—always hold

EXPERIMENT 1.1

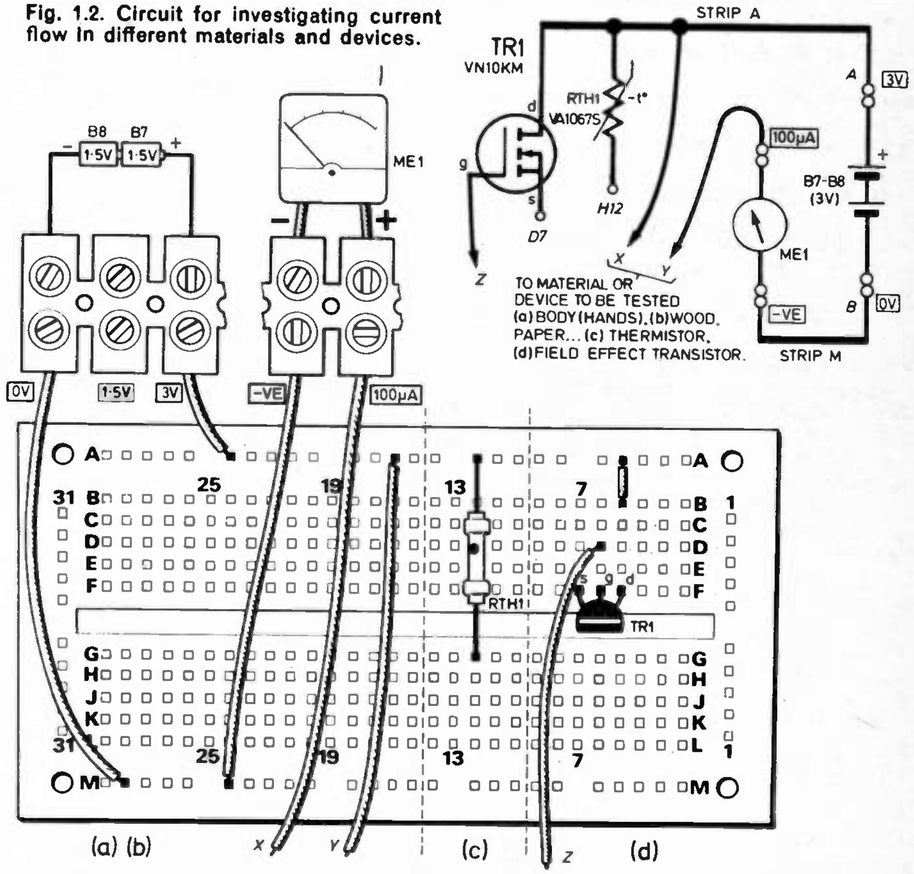


Fig. 1.2. Circuit for investigating current flow in different materials and devices.

Fig. 1.3. A suggested layout on the breadboard and wiring to meter and batteries for the circuit in Fig. 1.2.

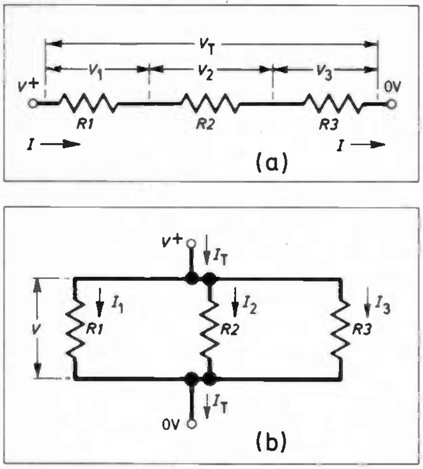


Fig. 1.6. Two ways of connecting resistors. In (a) they are said to be in series and in (b) they are connected in parallel.

OHM'S LAW

In the early 19th century a German physicist, George Ohm, did some experiments rather like the ones you have just done. He did not have semiconductors to work with, but he measured the current flowing through wires of various kinds. He summarised his results like this:

> "The current passing through a wire at constant temperature is proportional to the p.d. between its ends."

This has since become known as **Ohm's Law.** Nowadays we use this idea to define our unit for measuring resistance that a wire or other piece of material offers to the flow of electric current. We say that if the p.d. between two ends of a wire (or other material) is 1V and the current is 1A the resistance of the wire is 1 ohm (symbol, Ω).

We can write this as a formula which we shall use many times during this course:

$$V = IR$$

In this formula, V is the p.d., measured in volts; I is the current, measured in amperes; and R is the resistance, measured in ohms. We can write the formula in two other ways:

$$I = \frac{V}{R} \quad \text{and} \quad R = \frac{V}{I}$$

Given any two of the quantities, we can calculate the third.

COMBINING RESISTANCES

There are two ways in which resistances can be combined, in **series** and in **parallel.** Fig. 1.6 shows what these terms mean.

In Fig 1.6a the same current I passes through each resistance. So we can write:

$V_1 = IR1$ and $V_2 = IR2$ and $V_3 = IR3$

The total p.d. across all three resistances is:

$$V_T = V_1 + V_2 + V_3 = I(R1 + R2 + R3)$$

If the combined resistance of all three is R_T, then:

$$R_T = \frac{V_T}{I} = \frac{I(R1 + R2 + R3)}{I} = R1 + R2 + R3$$

In short, their combined resistance equals the sum of their separate resistances.

With resistances in parallel, there is the same p.d. across all three resistances, but different currents may flow through each. The total current is:

$$I_T = \frac{V}{R1} + \frac{V}{R2} + \frac{V}{R3} = V\left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right).$$

Their total resistance can be found from the formula:

$$\frac{1}{R_T} = \frac{I_T}{V} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

MEASURING P.D.

Given a known current and a known resistance we can calculate the p.d. across the resistance. We make use of this fact in electronics to measure p.d. by measuring current.

The meter in Minilab has resistors R1, R2 and R3 connected in series with it, see Fig. 1 on page 665. The resistance of the meter in the prototype is 4000Ω (4 kilohm, or 4kΩ), and the resistance of R1 is 100kΩ. Their combined resistance in series is 104kΩ, according to the formula above. If we connect a supply voltage, say V_1 to −VE and 10V to pass a current of 100μA through the meter and R1, the p.d. between the sockets is $V_1 = IR = 1000 \times 10^{-6} \times 104 \times 10^3 = 10{\cdot}4$V.

The factor 10^{-6} is used because current is in microamps ($1\mu A = 10^{-6}A$), and the factor 10^3 is used because the resistance is in kilohms ($1k\Omega = 10^3\Omega$).

EXPERIMENT 1.2

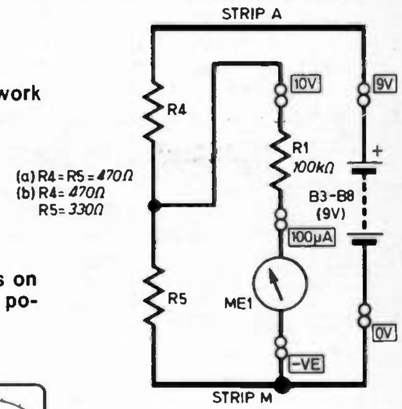


Fig. 1.8. A simple potential divider network composed of two resistors.

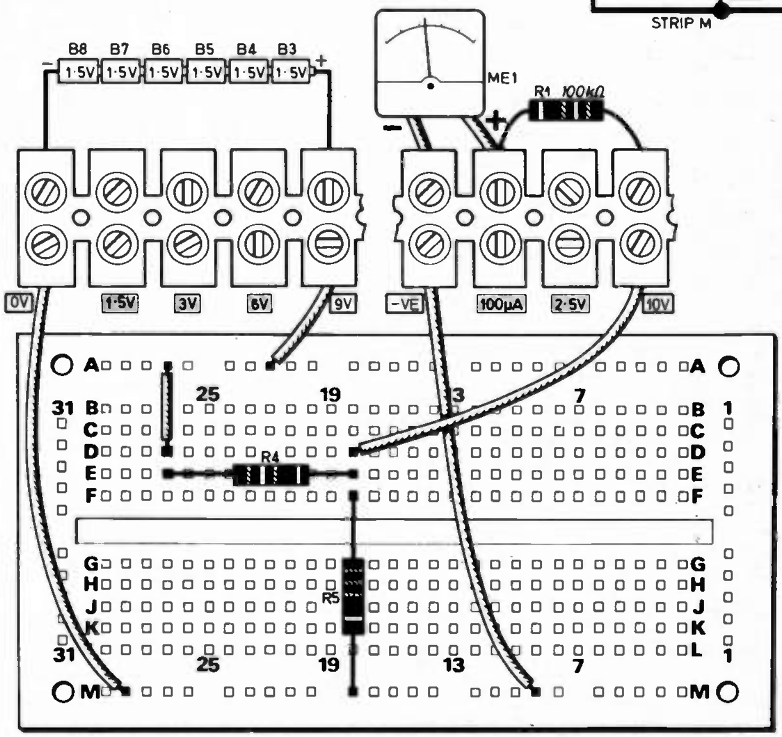


Fig. 1.9. The layout of the components on the breadboard to investigate the potential divider circuit of Fig. 1.8.

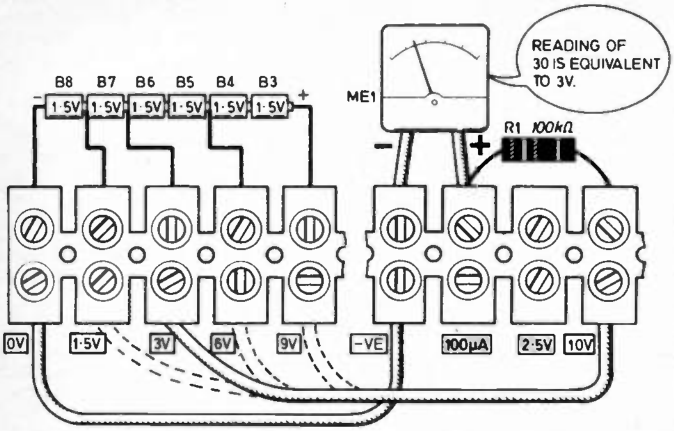


Fig. 1.7. Testing the meter connected as a 10 volt full scale voltmeter. The wire shown in 3V position should be placed in each of the positions: shown dotted.

The meter shows full scale deflection (f.s.d.) when the p.d. is 10·4V, which is close enough to 10V for our purposes.

The series resistor converts the microammeter to a voltmeter reading 10V f.s.d. Readings of other p.d.s are in proportion: when the needle points to "40", the p.d. is 4V.

To test the voltmeter, connect up as in Fig. 1.7 and put the meter 10V lead in to each of the battery terminal block positions in turn *except* 12v.

When we connect to −VE and 2·5V the meter is in series with R2 and R3. Their total resistance is 4kΩ+20kΩ+1kΩ=25kΩ. For a f.d.s. current of 100μA, the p.d. between sockets is

$V = 100\times10^{-6}\times25\times10^{3} = 2{\cdot}5V.$

This gives a 2·5V f.s.d. voltmeter, useful for measuring lower p.d.s. with greater accuracy.

EXPERIMENT 1.2

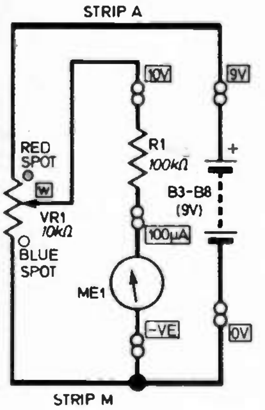


Fig. 1.10. Using a potentiometer instead of the two fixed value resistors in Fig. 1.8.

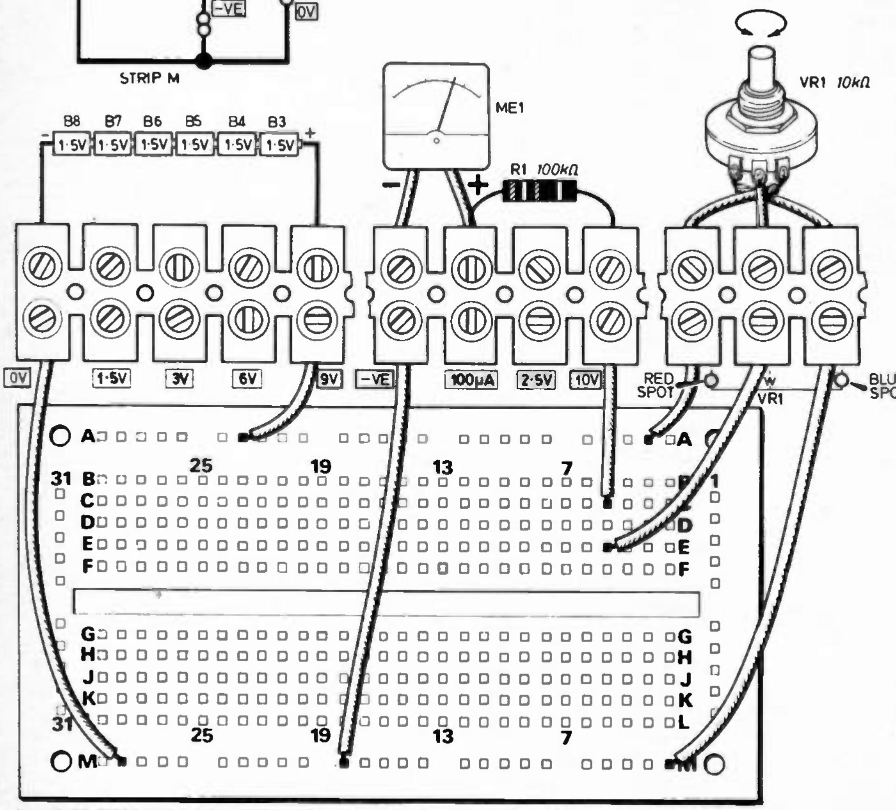


Fig. 1.11. Suggested layout of components for the circuit in Fig. 1.10.

POTENTIAL DIVIDER

If we require a p.d. which is less than any of the fixed p.d.s from the battery, we can use two resistors in series as shown in Fig. 1.8. If the p.d. across the two resistors is V_{IN}, the current is $I = V_{IN}/(R4+R5)$. The p.d. across the lower resistor is V_{OUT} and $I = V_{OUT}/R5$. Since I is the same for both equations:

$$\frac{V_{IN}}{R4+R5} = \frac{V_{OUT}}{R4}$$

giving:

$$V_{OUT} = \frac{V_{IN}\,R5}{R4+R5}$$

The network of resistors has divided the potential, so we call it a **potential divider**. The calculations assume that no current flows from the divider into the meter or into any other circuit that may be connected at the same point. In practice a small current does flow to the meter, so the actual p.d. across $R5$ is always a little less than the calculated value.

However, provided the outflowing current is small, we need not worry about this. In general, if the current leaving the junction of the resistors is less than one tenth of the current flowing through the network, we ignore its effects.

EXPERIMENT 1.2

To make and investigate a potential divider network

The circuit for this experiment is shown in Fig. 1.8 and the suggested layout on the breadboard in Fig. 1.9. The voltage across R5 can be read from the meter.

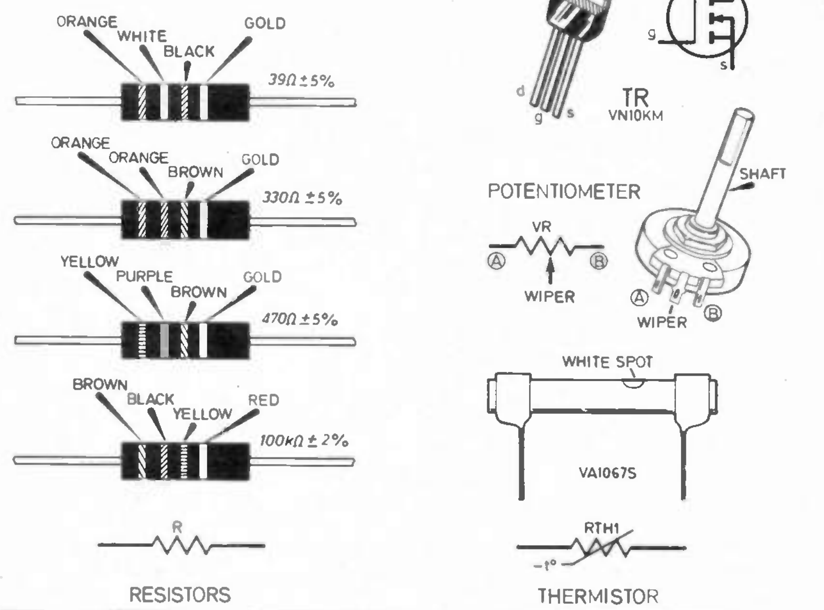
Measure the output p.d., using the meter. Does this agree with the result obtained by calculation? Try again with a 330Ω resistor in place of R4. Then make R4=470Ω and R5=330Ω and try again.

If we connect a variable resistor as in the circuit of Fig. 1.10, it acts like two resistors in series, with the wiper at their junction. The resistor becomes a potential divider which can be set to give *any* p.d. between 0V and V_{IN}. Investigate its action, using the layout shown in Fig. 1.11.

PRACTICE SPOT

In Experiment 1.1 you measured current through various materials and devices when the p.d. was 3V. Calculate the resistance of (a) your body, hand to hand; (b) the wet tissue; (c) the lamp; (d) the thermistor warm and cold; (e) the transistor warm and cold.

TEACH-IN 82
COMPONENTS IDENTIFIED



The components used in this month's experiments are shown above. Here we show a physical drawing of the component, its circuit symbol and its circuit reference.

There are four different resistor values required. The value of each is coded on the body in the form of a number of coloured rings. See page 697 for full account of resistor coding.

The transistor is a special type, a VMOS power field effect transistor. This must be connected exactly as shown in circuit diagram—otherwise the device may suffer damage.

The potentiometer can be considered as a resistor which can be tapped anywhere between its extremes. As the shaft is rotated clockwise, the wiper moves towards *B*.

The VA1067S rod thermistor is a heat sensitive resistor made of semiconductor material. May be connected in circuit either way round.

To be continued

QUESTION TIME

1.1. Which part of an atom carries negative charge?
1.2. What kind of force exists between two positively charged objects?
1.3. What is the practical unit of electrical charge?
1.4. Name three examples of charge carrier.
1.5. If a current of 2 amperes flows for 3 seconds, how much charge is carried?
1.6. Which kinds of material make the best conductors?
1.7. What does f.s.d. stand for?
1.8. The bands on a resistor are brown, red, orange. What is its resistance?
1.9. When a resistor has a p.d. of 3.4V across it, the current flowing through it is 5mA. What colours are the bands on the resistor?
1.10. If the potential divider of Fig. 1.8. has R1=150kΩ and R2=15Ω and V_{IN}=11V, what is V_{OUT}?

Answers in Part 2.

Ordering Components

Around this time of the year many new recruits are commencing the most fascinating of all hobbies, "Electronics", and it is my agreeable task to guide their faltering footsteps in the mysteries of purchasing components. This being the case I must ask my regular reader to bear with me, that is, unless he or she wishes to refresh his or her memory on these procedures.

You may be extremely lucky and have a little man round the corner who will attend to some of your requirements, but many of you will have to rely on Mail Order. Don't be dismayed by this, there are plenty of us dying to fulfil your needs and while I and my colleagues have always been eager to help you, the recession has put a keener edge on our performance. In other words it is a "Buyers Market".

I suggest your first move is to send for about four or five catalogues and then study them carefully. Make a list, showing who has the best selection of capacitors, resistors, etc., and so on. For example, dealer "A" might have the best selection of variable capacitors, and dealer "B" the largest selection of transistors, this will be a useful guide when ordering parts for a project. Let me say, at this point, never fail to read the *Shop Talk* page which gives invaluable information especially on the sources of supply of unusual components.

Let us assume you have reached the point where you have made your list of what you wish to buy. Most mail order companies supply order forms, always use them when provided. Paperwork is time consuming and costly and not many of us keep copies of your orders. Instead we ask you to return the original, in case of a query, so make sure you keep the order until you have checked that all the goods are there and as ordered.

Naturally, you are keen to start on your project and any delays are irritating but always remember your letter may take two or three days to reach us and even with a by return service you must allow another two days and most likely there will be an intervening weekend.

Many firms have a fixed postal charge which means you lose on the small parcels and gain on the big ones. Last, but most important of all, write your name and address clearly on your order.

Component Ratings

Probably the two most used building blocks in construction are resistors and capacitors, so a few words on these would not be out of place. The two factors you need to know with capacitors are the capacity given in either Picofarads (pF), Nanofarads (nF) or Microfarads (μF) and the voltage.

The designer usually states quite clearly the type he expects to be used, that is, ceramic, silver mica, polyester or electrolytic, but remember that with electrolytics the tolerance is usually +50 per cent and −20 per cent. As far as voltage goes, it is usually safe to go above the suggested one, but not below, remembering of course that as the voltage increases, so does the physical size!

The two factors given with resistors are wattage and tolerance but here we have a curious anomaly. It might be thought that the wattage is given to indicate the current passing through them, which in term means it must dissipate a certain number of watts, but when the value given is below one watt it is usually given as an indication of physical size; larger ratings and in some cases even smaller wattage types may be used.

As regards tolerance, these days most resistors are 5 per cent which is adequate for the majority of purposes.

EE MINILAB

For use with EE TEACH-IN 82 series

BY O.N.BISHOP

THE Minilab was designed to provide a portable electronic experimental deck for those who are starting to follow the *Teach-In 82* series beginning this month, see page 658. With the facilities provided by Minilab and the additional components listed on page 658, you will be able to undertake every experiment described in Parts 1 to 6 of this series.

When the series is over, Minilab will continue to be of great use to you. In fact it is a generally handy workplace for any electronics enthusiast, ranging from the beginner to one who has reached the stage of wanting to design and build his or her own circuits.

FEATURES

The general purpose circuitry within the basic Minilab is shown in Fig. 1 and provides the facilities listed below. All facilities are accessible through terminal strips TB1, TB2, TB3, mounted immediately behind the Work Panel.

Power Supply

With the younger and least experienced experimenters in mind we have decided that a battery is the safest and most convenient form of supply. The circuits to be built have low current requirements, for which a battery is perfectly adequate. There is also the great advantage that the Minilab is completely portable and can be used in any room, without need for a mains power socket.

The battery supply consists of eight dry cells, B1 to B8 providing a maximum voltage of 12 volts(V) d.c. It is tapped at several points to give 1·5V, 3V, 6V, 9V, as well as a balanced ±6V supply for operational amplifiers.

The batteries are housed in the case of Minilab, together with all the other facilities.

COMPONENTS

A complete kit of the components listed below may be ordered as LIST 1 from the retailers appearing on page 670.

Resistors
- R1 100kΩ
- R2 20kΩ } see text
- R3 1kΩ } see text
- All ¼W carbon or metal film ±2%

Potentiometers
- VR1 10kΩ carbon lin. law
- VR2 100kΩ carbon lin. law

Capacitor
- C1 500pF miniature variable capacitor, solid dielectric

Semiconductors
- D1, 2, 3 TIL209, TIL220 or similar red light emitting diodes with fixing clip/bush (3 off)

Switches
- S1, S2 push-to-make, release-to break miniature (2off)
- S3 push-to-break, release-to-make miniature
- S4 single-pole double-throw standard toggle

Miscellaneous
- ME1 100μA d.c. moving coil panel meter—see text
- LS1 8ohm moving coil loudspeaker, 45 to 80mm dia.
- B1-B8 HP2 1·5 volt cells (8 off)
- TB1-TB3 2-amp 12-way screw terminal blocks (3 off)

Verobloc solderless breadboard or similar—see text; battery holders to suit four HP2 type cells (2 off); control knobs, skirted with index line to fit VR1, VR2 and C1 (3 off); p.v.c. covered stranded wire, 7/0·2mm, 1 metre each of six different colours (6 metres); OBA solder tags (3 off)—only for in-line battery holders; 2A 12-way terminal block (for modules); materials for case, see CUTTING LIST on page 667.

Guidance only Approx cost £15 excl. batteries and case

Meter

A single low-cost microammeter ME1 is provided for measuring currents up to 100 microamps. The series resistors (R1, R2 and R3) allow it to be used to measure voltages up to 2·5V or 10V.

The values of the resistors, in particular R2 and R3, shown in the circuit diagram have been selected for use with a particular meter having an internal resistance of 4 kilohms. Teach-In 82 kit suppliers will be selecting resistor values to suit the meter supplied which may be other than 4 kilohm. This selection is only likely to affect the values of R2 and R3. It is possible that only a single resistor will be required and supplied.

By means of suitable shunt resistors it can also be used for measuring currents larger than 100 microamps. The way to use this meter will be fully explained during the series.

Light emitting diodes

Small lamps have many uses as visual indicators as will be explained during the series. The Minilab is equipped with three visual indicators in the form of light emitting diodes (l.e.d.s) D1, D2 and D3 mounted on the Control Panel. These are semiconductor devices which when excited by the application of a voltage, emit a red light.

Switches

There are four switches S1, S2, S3 and S4 having three different functions: S1 and S2 are push-to make, release to break button types; S3 is the inverse of the previous being push-to-break, release-to-make push button type; S4 is known as a single pole double-throw (s.p.d.t.) or single-pole two-way. Here the centre terminal makes with either of the other two depending on its position.

Potentiometers

There are two potentiometers VR1, VR2 having values of 10 kilohm and 100 kilohm respectively. These devices have three terminals. The extremes have a specially prepared carbon track between them forming a resistance in these instances of 10 kilohm and 100 kilohm. The centre terminal, known as the wiper is in contact with the track and its position along the track is determined by the angular position of its shaft. Variable resistors may be formed by using the wiper and one other terminal.

Variable Capacitor

A variable capacitor C1 having a capacitance suitable for radio tuning circuits is included.

The capacitance is a function of the fixed distance between, and overlap area of, two sets of parallel plates. Angular rotation of its shaft moves one set of plates relative to the other varying the overlap and thus its capacitance.

Loudspeaker

A miniature low power loudspeaker is fitted to the base of the Minilab for audio experiments. This transducer converts electrical signals to sound waves.

Modules

The Minilab described in this issue is the basic version. It will be noted that there are vacant spaces on the Control Panel. These are left ready to receive the controls and readout of three special modules, that are to be built into Minilab at a later date during the series. The circuits and the way the modules work will be described in the series as it progresses.

Each module is simple to construct and is a useful experimental and design tool. The three modules to be included are:

(a) a low-noise signal amplifier

(b) a square-wave oscillator which can be set to any one of four frequencies

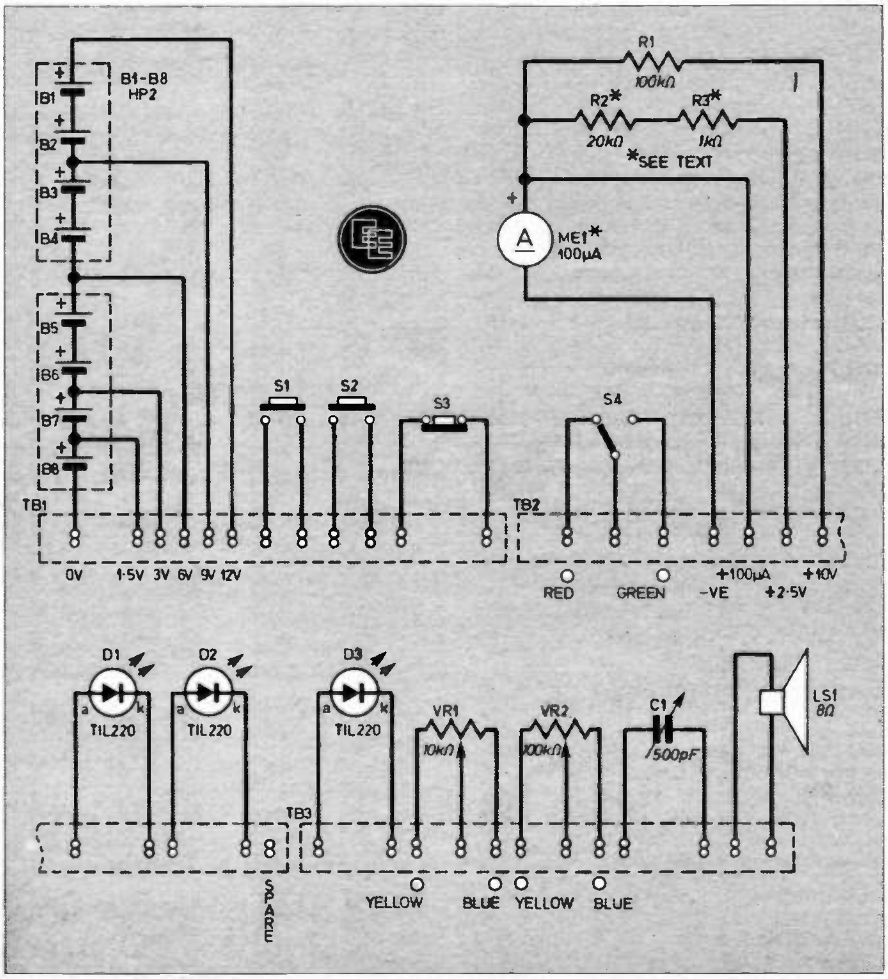
(c) a 7-segment l.e.d. display.

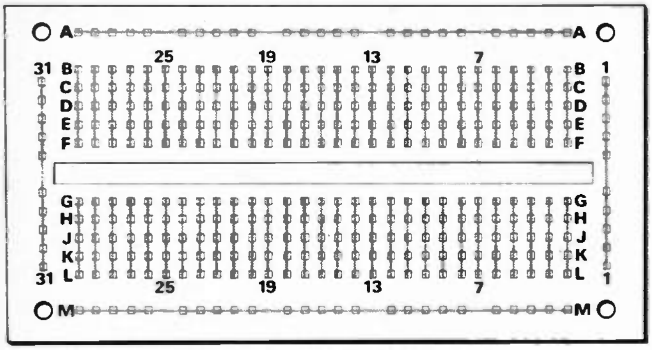
BREADBOARD

A "solderless breadboard" is used for interwiring the components according to the circuit diagram. It has a matrix of "sockets" arranged on a 0·1 inch grid and these are grouped (wired internally) to provide blocks of common sockets, in all 58 five-input sockets with four separate bus bars on the perimeter in the case of the Verobloc used here. The centre section sockets each allow up to five components to be interconnected at one point and should therefore be suitable for many circuits. This number can be extended by linking two or more groups as required.

The leads of the components and wires are simply pushed into the sockets to make a good electrical connection. This is an economical and quick way of wiring up components for experiments and project testing. When the experiment is completed, they can be quickly "unplugged" ready for re-use in other experiments.

Fig. 1. Circuit diagram of the basic Minilab.





How the contacts are interwired inside the Verobloc.

The breadboard is fitted to the Work Panel with double-sided adhesive tape. There is ample working space around the breadboard with plenty of room for mounting an additional board or boards should your enthusiasm take you in the direction of expansion.

The breadboard used in Teach-In 82 is the Verobloc, which is one of the smaller and least expensive of the 0·1 inch matrix boards. Should you already possess a different board of this type (for example EuroBread-Board or Protoboard) it can be used instead of the Verobloc.

Note that integrated circuits are to be used on several occasions during the series, so it is essential that whatever breadboard you install is capable of holding at least two 16-pin dual-in-line integrated circuits.

The Verobloc may be used as a "handle" to remove the Work Panel allowing access to the storage compartments.

CONSTRUCTION starts here

CASE

Details for constructing the Minilab case are shown in Fig. 2. Also contained on this page is the cutting list for all parts. All dimensions are in millimetres.

All parts should be cut to size according to this list and any rough edges arising from saw cuts rubbed smooth with glasspaper. Nails and woodworking adhesive, Resin W, were used for all fixings. The nails were later punched below the surface and filled in with Polyfilla and then sanded.

Fix the batten, control panel support and rear panel fixing to each frame side panel followed by the batten on the frame front member. When set, apply adhesive to the ends of the frame front member, frame divider and frame top member and secure each in position with nails using the base panel to keep the assembly square. When set, glue and nail the base in position, having previously made the array of holes to suit the loudspeaker. This can be followed by the horizontal rear panel support. The centre support can finally be glued in position to complete the case frame.

In the prototype the Work Panel and Control Panel were made up from 3mm plywood and covered with Formica. These may be painted or varnished if preferred.

The bare plywood panels, should be tried in position on the framework, and if necessary their dimensions modified to fit neatly in their final positions. A gap of about 4mm should exist between Control Panel lower edge and frame divider to allow the wires to pass from the terminal blocks to control panel components. A slightly oversized piece of plastic laminate can be glued to the panels using Evo-Stik or Thixo Fix and when set filed down to size.

Only the drilling of the rear and control panels remains. With the latter, use of a sheet of self adhesive paper or a number of self adhesive labels strategically placed are advised for marking out the positions of the holes on this panel. Besides providing protection to the surface during this operation, the paper will also reduce any likelihood of the drill bit slipping as drilling starts.

NOTES ON DRILLING

It is advisable to wait until you have the Minilab components to hand before drilling the holes in the Control Panel. The diameters of the holes shown are for the particular components at hand when building our Minilab. It is possible that you may obtain alternative types of component which may not be exactly the same size as specified. Do not be tempted to rearrange the layout on the Control Panel. Space has been left for the modules to be added later.

Panel mounted components for the modules will not be at hand until later in the series, but it is advised that the holes to accommodate these are made at the same time as the others, before any components are mounted.

We believe it will be safe to go ahead and drill the three uppermost right hand holes the same size as that you drill for S4. Also the hole between VR2 and C1 the same size as VR2 fixing hole.

The rectangular cut-out in the panel is to suit a particular 7-segment display that will be uniquely defined later in the series. It is in order therefore to cut this aperature to the size shown.

METER CUT-OUT

A large circular cutter will be required for making the meter cut-out, its diameter to accommodate the meter rear moulding. Alternatively a ring of small holes may be drilled side by side around the internal circumference of the cut-out and a small saw blade used to cut between adjacent holes and then filed smooth using a half-round file. A fret saw may also be used to make the cut-out.

Fixing hole positions can then be determined and made with the meter sitting in the cut-out.

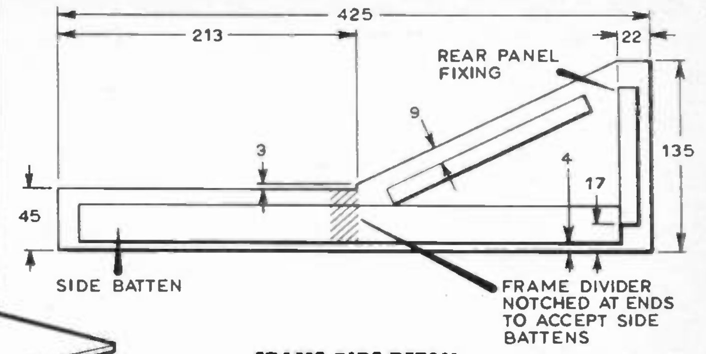
The rectangular cut-out is to accommodate a seven-segment display to be fitted later in the series and is easiest made by drilling two holes about 10mm diameter and then filing square. A file with an uncut edge is advised.

The two fixing holes for the variable capacitor should be marked and drilled using measurements taken from the capacitor supplied in your kit. Alternatively it can be glued using an adhesive such as Araldite.

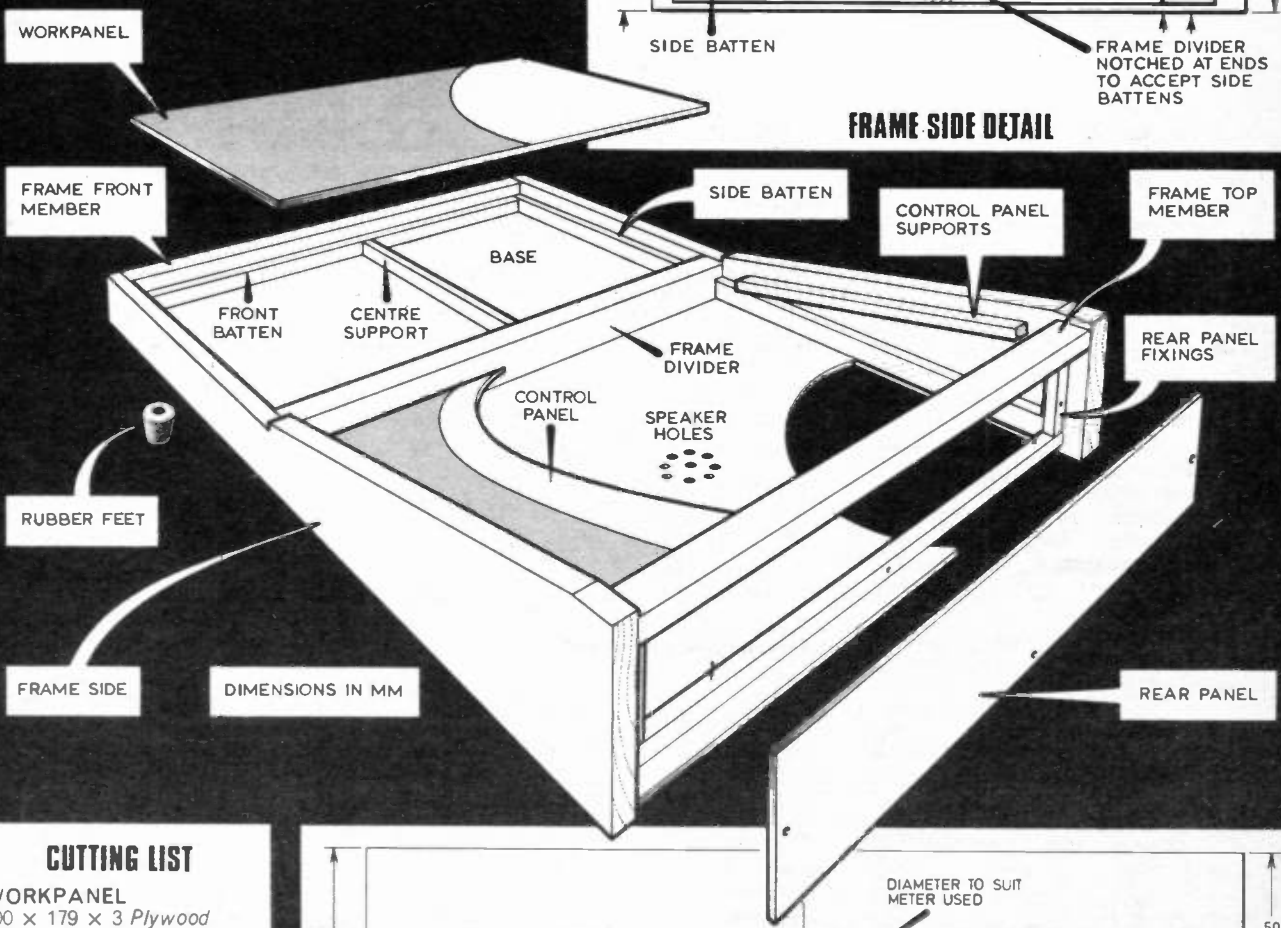
Finally countersink the four panel fixing holes.

EE MINILAB

CASE CONSTRUCTION FIG. 2

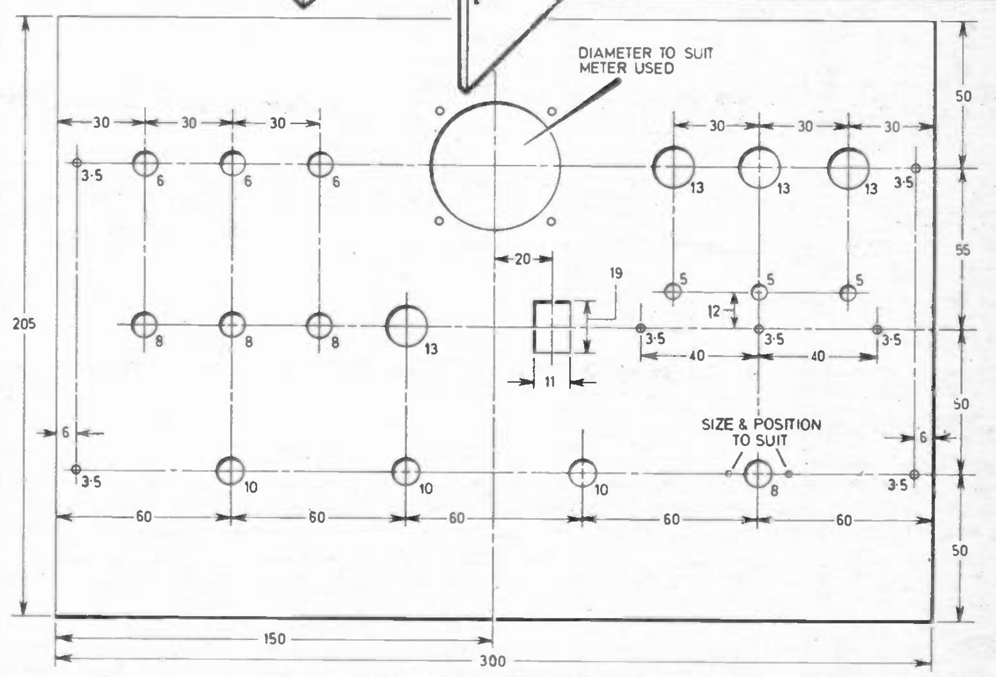


FRAME SIDE DETAIL



CUTTING LIST

WORKPANEL
300 × 179 × 3 *Plywood*
300 × 179 × 1 *Formica*
CONTROL PANEL
300 × 205 × 3 *Plywood*
300 × 205 × 1 *Formica*
FRAME SIDES
425 × 135 × 14 (2) *Softwood*
FRAME FRONT MEMBER
300 × 45 × 14 *Softwood*
FRAME TOP MEMBER
300 × 22 × 14 *Softwood*
FRAME DIVIDER
300 × 40 × 18 *Softwood*
SIDE BATTENS
389 × 35 × 8 (2) *Softwood*
FRONT BATTEN
284 × 35 3 *Softwood*
CENTRE SUPPORT
163 × 35 × 8 *Softwood*
REAR PANEL FIXINGS
101 × 13 × 13 (2) *Softwood*
300 × 13 × 13 *Softwood*
CONTROL PANEL SUPPORTS
165 × 13 × 13 (2) *Softwood*
BASE PANEL
397 × 300 × 3 *Plywood*
REAR PANEL
300 × 114 × 3 *Plywood*



CONTROL PANEL DETAIL

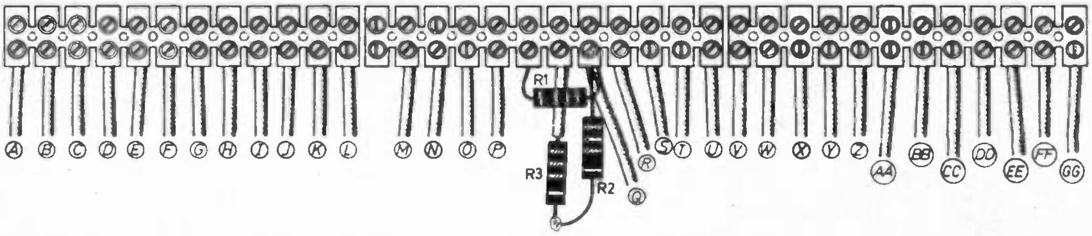


Fig. 3. Overhead view of screw terminal blocks showing wiring positions of leads from Control Panel mounted components. You can see the meter series resistors R1, R2 and R3 connected directly to the terminal block and secured by the terminal block screws. Solder R2 and R3 after they are secured to the block.

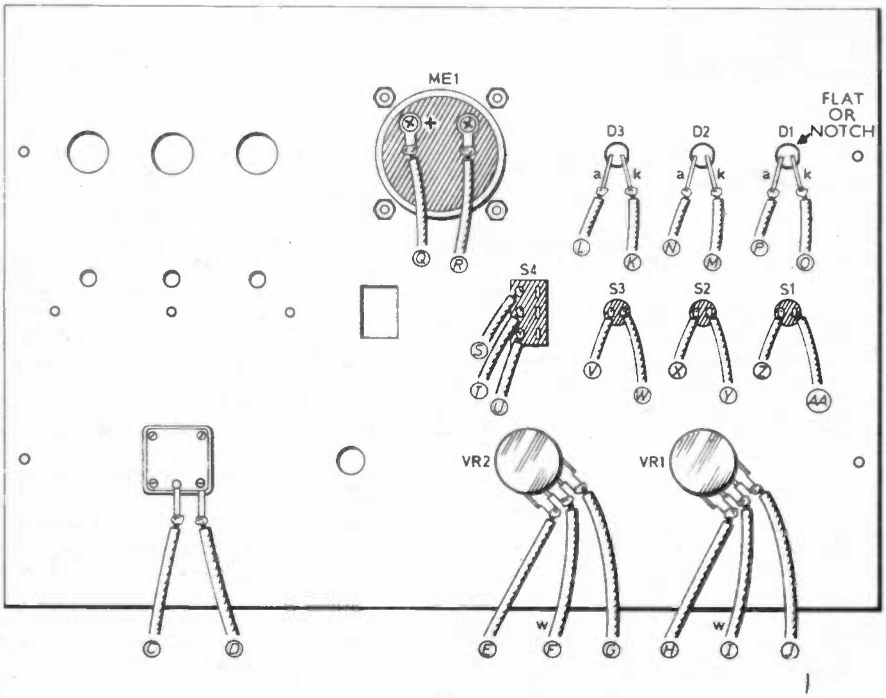


Fig. 4. Underside view of the Control Panel with all its components in place and wiring details to the terminal blocks. Connect *A* to *A*, *B* to *B* and so on.

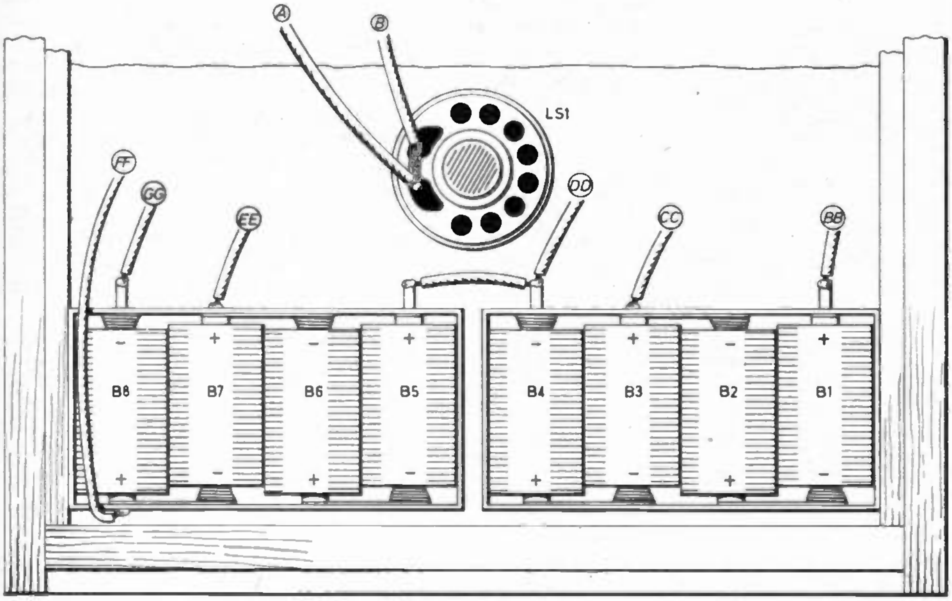


Fig. 5. Wiring details when using the lateral style battery holders showing connections to be made to the terminal block, see Fig. 3.

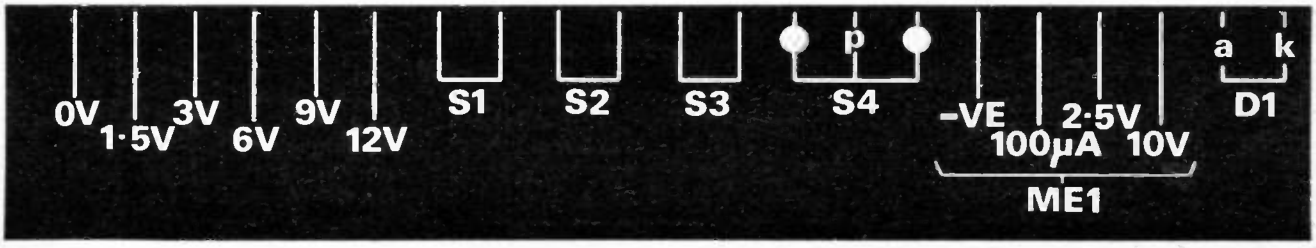
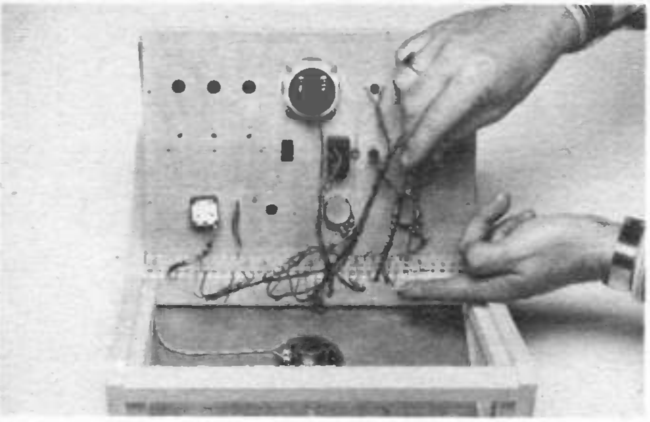


Fig. 7. Full-size label that may be cut out or copied and then glued on the Work Panel top edge to identify functions of terminal block positions.



Wiring to the terminal blocks with the Control Panel conveniently supported in an upright position.

lettering. The result with this method is seen in the photographs of our Minilab.

This is more easily done before mounting the components on the panel, but make allowance for protruding bushes, nuts and knobs which might cover the lettering when the items are in position. The lettering should be protected from wear by spraying with a clear lacquer such as Letracote.

For neater appearance, the underside of the control panel top edge was chamfered so that it fitted close up against the frame top member.

When this has been done, the fixing holes for this panel should be made in the panel supports using the Panel as a template.

The external framework can now be prepared and painted; gloss or varnish is considered more suitable than emulsion paint.

CONTROL PANEL LABELLING

It is recommended that all controls/indicators on the Control Panel are clearly labelled so that you know exactly which control to use during your experiments. This can be carried out with Letraset or similar rub-down

Embossed labelling tape (for example, Label-Mate) may be used instead, but this and other "panel type labels" are better added after the items are mounted.

The coloured spots on the Control Panel are intended to help identify the settings of S4, VR1 and VR2. The spots may be painted on or you can punch discs from coloured card and stick them in place.

COMPONENT ASSEMBLY

Depending on which battery holders you have, wire up according to Fig. 5 or Fig. 6. Connect long enough leads to these to reach the terminal block positions when holders are in place. The holders should touch the inside face of rear panel support. These may then be screwed or glued to the base panel. Do likewise with the speaker.

With reference to Fig. 4 mount all the components in place on the Control Panel. It may be necessary to recess the Control Panel underside at locations D1, D2 and D3 to properly fix the l.e.d. clips/bushes, and S1 S2, S3 to allow the fixing nut of these switches to be screwed on.

Connect sufficient lengths of wire to these components to comfortably reach the terminal blocks.

All terminal block positions are to be labelled on the Work Panel top side. A two-part label, actual size is provided in Fig. 7 and may be cut-out (or copied) and glued centrally on the Work Panel. With this done, the terminal blocks may be screwed to the frame divider to align with these.

With the Control Panel supported as seen in the photograph, all leads should be trimmed, insulation cut back and the stranded wire twisted and tinned (coated with solder). Referring now to Figs. 3 to 6, secure each of the leads, including battery and speaker, to their terminal block positions.

It is important to connect the meter and l.e.d.s the correct way round. The meter will be marked with a "+" and a "−" to correspond with "100μA" and "−VE" on the terminal block.

The two leads from an l.e.d. are polarity conscious being known as anode(a) and cathode(k).

Also pay attention to connections from VR1, VR2 and S4 to avoid confusion during experiments later on.

The wires to C1 should be as short as possible and be as far as possible from any other wires.

Once you have checked and double checked the wiring, the Control Panel may be screwed in place and the batteries inserted. Pay special attention to cell polarity when doing this, see Fig. 5 (or 6). The rear panel may now be screwed on to complete the unit.

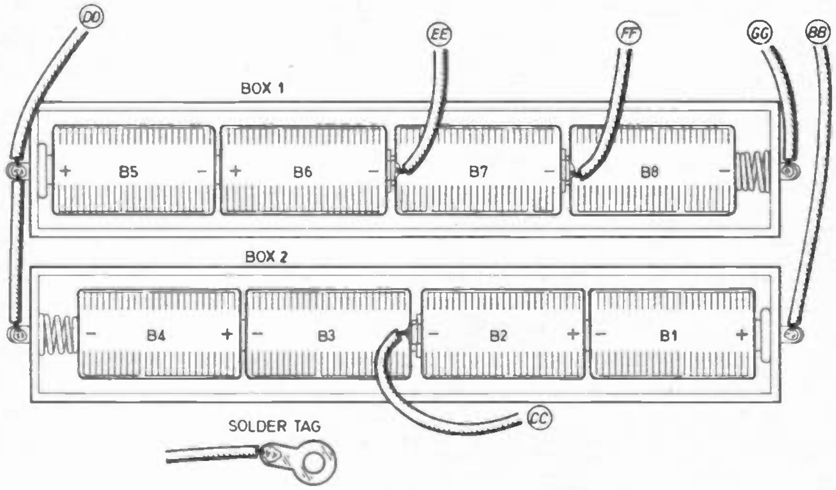
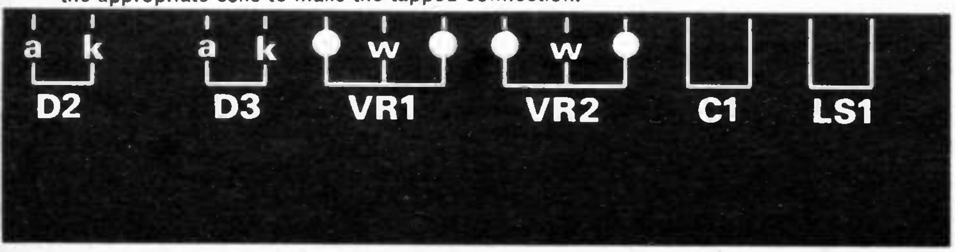


Fig. 6. Wiring of the alternative, in-line battery holders. With this type of holder, the tapping leads need to be fitted with a solder tag as shown. This is then pushed between the appropriate cells to make the tapped connection.



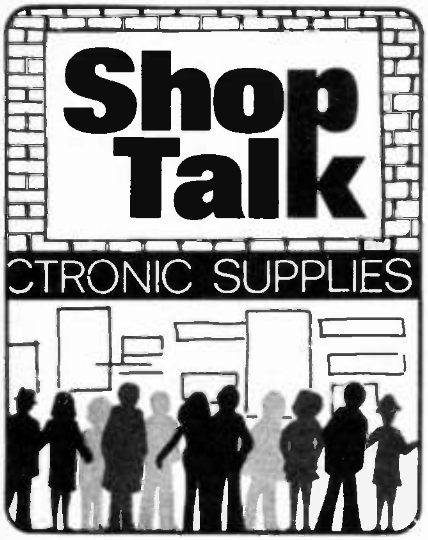
LEAD SET

A set of leads need to be made up to provide a means of interconnecting components on the breadboard and to the Control Panel components via the terminal blocks, see table below.

Quantity	Length (cm)
8	20
10	15
10	10
8	6
10	4

We recommend 7/0·2mm p.v.c. covered wire.

About 5mm of insulation should be stripped from each end, and the exposed strands twisted tightly together. Both ends should next be tinned to produce a suitable "plug" for inserting in the Verobloc "sockets". ⌑



By Dave Barrington

Special Offer

We strongly advise all our readers to take advantage of our Special Offer (see page 664) of a £1 off a Verobloc solderless breadboarding system module.

Apart from its use in the new Teach-In series, this Verobloc is suitable for most instant circuit experiments before being committed to a final "hardwired" version. Also it will repay for its self many times over in respect of damaged components through one cause and another.

Component Storage

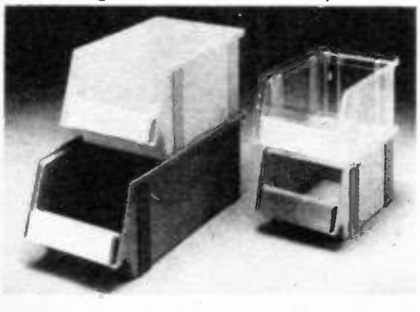
When considering items for the workshop one item that seems to be regularly overlooked is the component storage bin or rack. However, if we are to make serious attempts at keeping the work area "clutter free" then these are well worth the investment.

The price will, of course, vary according to whether you choose a single plastics or cardboard tray, or one of the multi-drawer cabinets available from most of our advertisers.

Available in three sizes and three colours, red, blue and yellow, the latest range of polypropylene storage bins from Link-Hampson are easily stackable and feature a corrugated inner base. The new base, it is claimed, makes it easier to pick up smaller components, such as glass diodes and transistors, from the bottom of the bins.

A moulded handle on the front of each "tray" has a slot for inserting an identification tab. Also, see-through bins are included in the range and have the advantage of displaying their contents at a glance.

Storage bins from Link-Hampson.



The largest of the polypropylene bins, 400mm × 156mm × 186mm deep, cost £2·05 and the medium size, 300mm × 156mm × 186mm deep, £1·65. The smallest bins, 250mm and 130mm × 149mm deep, cost 90p each.

The storage bins can be ordered direct or for addresses of nearest stockists write to Link-Hampson Ltd., Dept EE, 5 Bone Lane, Newbury, Berks.

Using their experience in providing document storage systems for banks, Bankers Box are now producing a range of fibreboard bins which make excellent low cost component storage trays.

This firm started by making document storage systems for banks, hence its name, but seeing possibilities in other fields it has applied its technical know how to broaden its range of products. The result is a flat-pack tray which folds into shape using no clips or staples. The folds are designed to provide plenty of strength and are grease resistant.

The bins come in seven sizes from 51mm wide by 102mm high by 305mm long up to 203mm × 102mm × 457mm. Available in packs of 10 the 102mm × 102mm × 305mm size usually retails at £3·75 per pack.

Further information can be obtained from Bankers Box, Dept EE, Doncaster Road, Kirk Sandall, Doncaster, DN3 1HT.

CONSTRUCTIONAL PROJECTS

Sustain Unit

Some of the components called for in the *Guitar Sustain* could cause readers buying problems.

First investigations reveal that it would appear only Watford and Electrovalue Electronics stock the 2N3820 field effect transistor (f.e.t.). The f.e.t. input op-amp type LF351 is stocked by Rapid, Watford, Maplin and Electrovalue.

Although the jack socket SK1 is listed as a standard type incorporating a double-pole double-throw switch this item is in very short supply. It does not appear in the Watford catalogue but we understand that they are able to supply this component.

Of course, there is no reason why a single-pole on/off toggle switch and a standard jack socket should not be used. The layout of components within the case will, of course, have to be altered.

Capacitance Meter

The multiturn cermet trimmer potentiometer (VR1) is available from most advertisers but check that it is of the correct physical dimensions for mounting on the circuit board. This component is fairly expensive and could be replaced by a standard skeleton miniature preset type of the same value.

However, for the sake of accuracy we recommend that readers use the components specified in the parts list.

EE Mini Lab and Teach-In '82

For those readers who will have to master the art of woodworking when tackling the *EE MiniLab*, there is no need for dispair as most of the components required for the first few experiments in the *Teach-In 82* series can be wired direct to the Verobloc "instant" circuit module.

A list of complete kit suppliers for the *EE MiniLab* (List 1) and components for the first six instalments of Teach-In 82 experiments (List 2) is set out in table below.

One of the reasons for the price variations (see relevent advertisements) is caused by component sourcing and the quality and type of the final selection of components used in making up the kits. This applies particularly to the meter, variable capacitor and battery holders.

Popular Designs

Most of the components called for in *Popular Designs* should be readily available from advertisers. We see that some of them offer an identical size piece of board in packs of five.

TEACH-IN 82 KIT SUPPLIERS

Supplier	LIST 1	LIST 2	LISTS 1 & 2
Bi-Pak *(p. 645)*	£15·65	£8·94	£23·00
Electrovalue *(p. 709)*	£16·56	£6·32	£21·79
Greenweld *(p. 699)*	£18·50	£8·10	£25·00
Magenta Electronics *(p. 700)*	£16·40	£9·34	£24·98
A. Marshall Ltd *(p. 696)*	£17·00	£12·50	£28·50
T. Powell *(p. 708)*	£19·75	£10·50	£26·50
T.K. Electronics *(p. 705)*	£19·50	£9·50	£27·50
Watford Electronics *(p. 641)*	£18·08	£9·33	£25·54

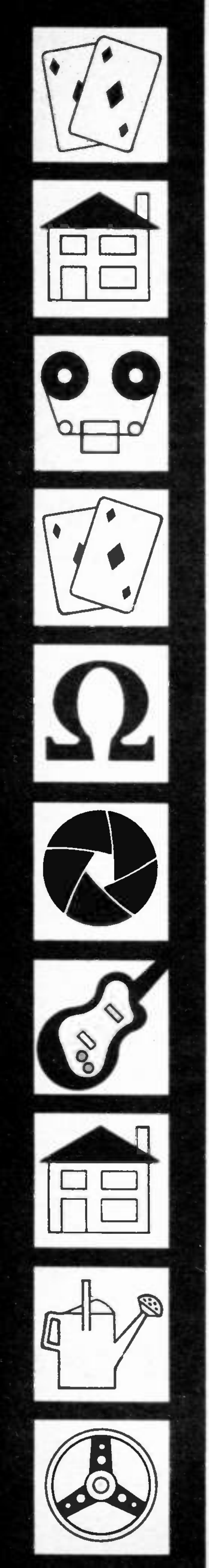
NOTE

(1) All prices are inclusive of VAT, postage and packing.

(2) If Vero coupon is enclosed deduct £1 from List 1 price quoted.

(3) Price quoted in last column applies only when Lists 1 and 2 are ordered *at the same time*. Deduct £1 from this price if Vero coupon is enclosed.

(4) For suppliers full address refer to page number following company name.



10 POPULAR DESIGNS

A COLLECTION of ten simple projects—comprising one from each volume of EVERYDAY ELECTRONICS 1971-1981. These have been selected to provide a wide range of subjects and fields of interest.

Any of these designs can be built on the piece of Veroboard (Stripboard) given with this issue.

CONTENTS

Newcomers to electronics should refer to page 682 for general information concerning construction of these projects.

POPULAR DESIGNS

SNAP INDICATOR

1971/2

In some games, such as snap and question games, it is necessary to know which person or team is first, If recognition of pairs or readiness to answer is declared by voice, it is not always clear who was first.

The device described here was built to avoid this difficulty. Its simple electronic circuit is arranged so that when one person has pressed a button, a later response by the opponent is blocked; and an indicator lamp shows who was first. The circuit automatically returns to its original condition when the push-buttons are released, and hence is ready for the next turn.

CIRCUIT OPERATION

Transistors TR1 and TR2 act as switches for LP1 and LP2 that are in the collector circuits of the transistors.

One push-button is operated by each player and S3 is the on/off switch. Normally S1 and S2 are open and the transistor bases are held off and no collector current flows.

If S1 is now pressed, connecting R1 to the base of TR1, this shifts TR1 into conduction so that the indicator lamp LP1 lights. Almost the whole supply voltage is dropped across LP1, so that the supply voltage between the negative line and TR1 collector, R3 junction is very small. If S2 is now closed, TR2 will not be turned on since its base will not be taken positive enough. Hence LP2 will not light.

Should S2 be closed first, LP2 lights and LP1 cannot be lit.

Push-buttons S1 and S2 are bell-pushes, suitably placed for each competitor. The button is pressed and held down, to show recognition of pairs or readiness to answer. LP1 and LP2 are low-consumption bulbs (0·06A 6V) which limit collector current to a low value.

When both pushes are released, the circuit returns to the normal condition.

COMPONENTS

Resistors

R1	5·6kΩ	R3	4·7kΩ
R2	4·7kΩ	R4	5·6kΩ

All ¼W ± 10% carbon

Transistors

TR1, TR2 2N2926 silicon *npn*

Lamps

LP1, LP2 0·06A 6V bulb and holder

Switches

S1, S2 S.P.S.T. push button (bell push)
S3 S.P.S.T. toggle (on/off)

Miscellaneous

B1 4·5V torch battery
Veroboard: 10 strips by 12 holes 0·1in. matrix
P.V.C. covered connecting wire (7 strand coloured)

ASSEMBLY

The complete unit is housed in a small box, ours was a wooden box made up for the job, but almost any small box will do. Holes are cut for the two indicator lamps (LP1 and LP2), the on/off switch, S3, and the wires to S1 and S2.

The wires used to connect the circuit to S1 and S2 are twin core mains or bell wire.

If a metal case is used it is a good idea to cover the metal area under the component board with insulation tape.

For team games, leads to S1 can run to two or more pushes connected in parallel, and leads to S2 similarly to the required number of pushes.

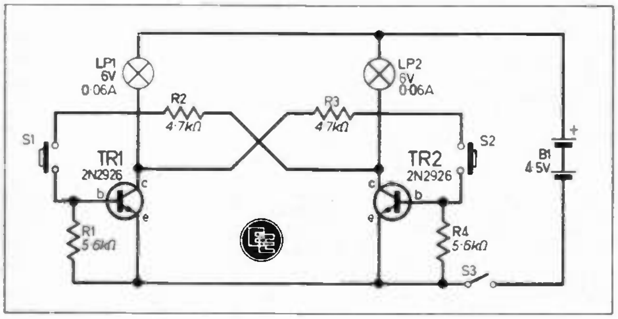


Fig. 1. Circuit diagram of the Snap Sequence Indicator.

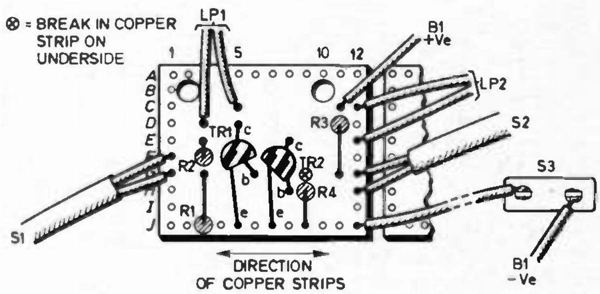


Fig. 2. Veroboard layout and wiring diagram.

POPULAR DESIGNS
DAMP LOCATOR
1973

THE device to be described is an inexpensive, simple, but effective, damp locator that will reveal damp in a variety of normally non electrically conducting materials such as stone, concrete, plaster, papers and textiles.

Since the device is intended to indicate a low level of dampness that is normally hard to determine by hand or eye, the use of a meter was not merited, and indeed by using an l.e.d. a fair portion of space and cost are saved.

CIRCUIT DETAILS

The two transistors, TR1 and TR2, are arranged in a configuration known as a Darlington pair. This arrangement has the property of providing extremely high gain—approximately equal to the multiplied gains of TR1 and TR2—with very high input impedance. Thus a small current flowing between TR1 base/emitter causes a very much larger current to flow between TR2 collector and emitter.

When the Damp Locator is placed upon a damp surface, a minute current is able to pass via that surface between the sensors. This small current provides the base bias for TR1 causing it to be in the conducting state and allows a larger current to pass through its collector and emitter to the base of TR2. This in turn allows TR2 to reach a state of conduction allowing a current to flow through the light emitting diode, D1, damp is indicated by the resultant glow.

In the absence of a conducting media between the sensors, the circuit draws negligible current from the battery, thus an on/off switch was not used on the prototype, the battery being removed during long periods of non use.

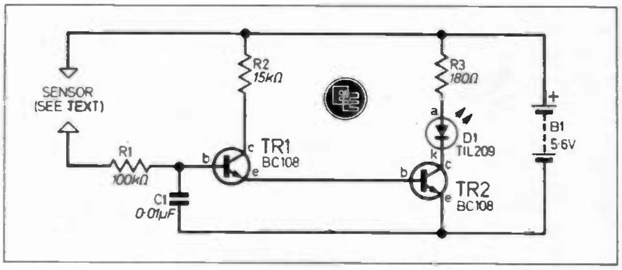


Fig. 1. The circuit diagram of the Damp Locator.

ASSEMBLY

The unit should be housed in a plastic box. A metal case is *NOT* suitable. The sensor is made from two parallel strips of 22 s.w.g. wire threaded through four holes drilled in the base of the box. The finished unit should appear to have a "railway track" running across the bottom outer surface of the case.

TEST

Carry out the following test. Hold the battery flying leads on the battery and touch the sensor lead (from *B*4) on the positive terminal of the battery. The diode should glow brightly. If this does not happen re-check and rectify.

COMPONENTS

Resistors
R1 100kΩ R3 180Ω
R2 15kΩ ¼ watt ± 10% carbon

Capacitors
C1 0·01µF sub-miniature type

Semiconductors
TR1, TR2 BC108 or similar silicon *npn*
D1 TIL209 or similar light emitting diode

Miscellaneous
B1 5·6 volt Mercury type PX-23
Veroboard 10 strips 12 holes 0·1in. matrix; small transparent plastic box; 22 s.w.g. tinned copper wire. Connecting wire.

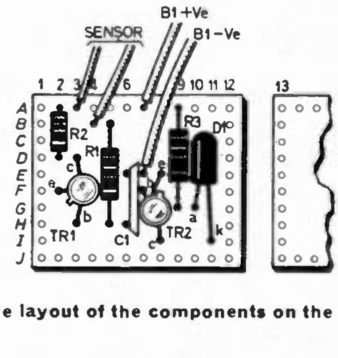


Fig. 2. The layout of the components on the Veroboard.

POPULAR DESIGNS

TAPE NOISE LIMITER

1974

INEXPENSIVE portable cassette tape recorders are extremely popular, but they usually have only a rather limited output power, driving a small internal loudspeaker, and the noise level is rather high.

The noise level cannot be entirely overcome, but a worthwhile improvement can be made by connecting the unit described in this article between the output of the recorder and the amplifier input.

CIRCUIT DESCRIPTION

Resistors R1 and R2 form a potential divider across the supply, and produce a low voltage supply for the field effect transistor, TR1. With only a small supply potential such as this, the d-s connections of the f.e.t. act as a simple resistor. With the gate terminal tied to earth via R4, its resistance is very low, at about 100 ohms, or even less.

Resistor R3, together with the d-s resistance of TR1, R5, and C3, forms an attenuator. The main complication is C3, as its reactance (its resistance to a.c.) varies with frequency. It has a reactance of approximately 50 kilohms at 100Hz, but of only approximately 500 ohms at 10kHz.

This means that the attenuation factor of the circuit changes with frequency. If one calculates the attenuation factor of the circuit at 100Hz, and 1kHz, it will be found to be a little over one, which is barely noticeable.

If it is calculated for 10kHz, it will be found to be almost exactly three, which is of course considerable, and will increase still further at high frequencies. This gives the required treble cut.

Some of the input signal is fed via C4, VR1, C6, and R6, to the base of TR2. This is a high gain common emitter amplifier, and the amplified signal is fed from TR2 collector, via C8 and R9, to a voltage doubling rectifier circuit, D1, D2, and C7. The resultant negative d.c. bias is fed to the gate of TR1.

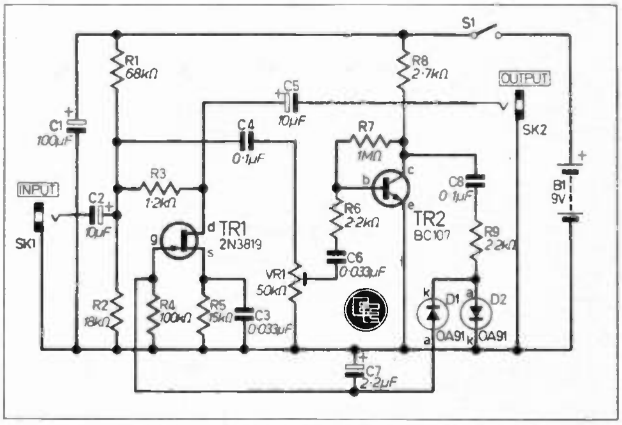


Fig. 1. Circuit diagram of the Tape Noise Limiter.

On low level signals, this bias voltage will have little or no effect, but on strong signals it will be large enough to cause the resistance of TR1 to be greatly increased, to as much as a few megohms. Components C3 and R5 are virtually switched out of circuit, and the treble cut is thus removed.

The tape hiss is less noticeable in the presence of high frequencies, than in the presence of low or middle frequencies; C4, C6, and C8 are given rather low values, so that the circuit responds more readily to high frequencies.

ASSEMBLY

Solder all the flying leads to the board; the leads should be about 70mm long insulated wire. The board should now be mounted in a suitable case by means of two 12mm long 6BA nuts and bolts. Finally, wire up the flying leads to the case-mounted components.

ADJUSTMENT AND USE

The "tape" or "radio" input of most amplifiers or record players has a fairly high input impedance (50 to 100 kilohms), and should be used. The unit can be used with amplifiers having fairly low input impedances (5 to 10 kilohms).

Potentiometer VR1 adjusts the level at which the treble cut is removed. Experiment a little using various settings. If this is set too high, tape hiss will be heard on low level signals.

COMPONENTS

Resistors

R1 68kΩ	R4 100kΩ	R7 1MΩ
R2 18kΩ	R5 15kΩ	R8 2·7kΩ
R3 1·2kΩ	R6 2·2kΩ	R9 2·2kΩ

All ¼ watt carbon + 10%

Potentiometer

VR1 50kΩ sub-miniature preset, horizontal

Capacitors

C1 100µF elect. 10V	C5 10µF elect. 10V
C2 10µF elect. 10V	C6 0·033µF
C3 0·033µF	C7 2·2µF elect. 10V
C4 0·1µF	C8 0·1µF

Semiconductors

TR1 2N3819 *n* channel f.e.t.
TR2 BC107 silicon *npn*
D1, D2 OA91 (2 off)

Miscellaneous

B1 PP3 9V battery
SK1, 2 3·5mm Jack socket (2 off)
S1 s.p.s.t. rotary switch
Veroboard: 0·1in. matrix; battery clips for PP3; aluminium case 135 × 70 × 40mm with removeable lid; control knob.

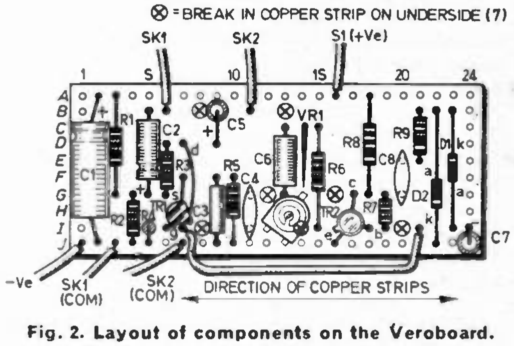


Fig. 2. Layout of components on the Veroboard.

POPULAR DESIGNS

HEADS & TAILS GAME

1975

THIS simple little novelty device demonstrates how it is possible to electronically simulate the tossing of a coin.

The circuit is arranged so that it is purely a matter of chance whether the heads or tails lamp is illuminated when the push button is pressed, the circuit thus providing the same effect as tossing a coin.

CIRCUIT OPERATION

The two indicator lamps are two light emitting diodes (l.e.d.s), D1 and D2. These are protected against passing excessive currents by the series resistors R1 and R4. Diode D1 is illuminated when TR1 is turned on, and D2 will be illuminated when TR2 is turned on.

If VR1 is ignored for the time being, when the push button switch, S1, is depressed, the positive supply will be connected to the circuit. The transistors will obviously both begin to turn on, TR1 receiving its base bias current via R4, D2, and R3, and TR2 receiving its base current via R1, D1, and R2.

It is, however, not possible for both transistors to turn hard on at the same time, as if TR1 is turned hard on, only a fraction of a volt will appear at its collector, and TR2 cannot receive the necessary bias current to turn hard on. If TR2 turns hard on then the same is true for TR1.

What happens when the supply is connected is that both transistors begin to turn on, but due partially to chance, and partially to a slight unbalance in the resistor values, transistor gains, etc. of each half of the circuit, one will begin to turn on faster than the other. In doing so it tends to starve the other transistor of base current as its own collector swings towards earth potential.

On the other hand this enables it to obtain a heavy base current from the collector of the other transistor, as this has its collector still at virtually the full supply potential. This regenerative action results in one transistor being biased to saturation, and the other being cut off. Obviously only only of the lamps will light up.

COMPONENTS

Resistors

R1	470Ω	R3	82kΩ
R2	82kΩ	R4	470Ω

All ¼W carbon ± 5%

Potentiometer

VR1 1kΩ horizontal skeleton preset

Semiconductors

TR1, TR2 BC109 silicon *npn*
D1, D2 TIL209 or similar l.e.d. with holder

Miscellaneous

S1 push-to-make, release-to-break push-button switch
B1 9V PP3 with connector
Veroboard: 0·1 inch matrix size 10 strips by 24 holes; case.

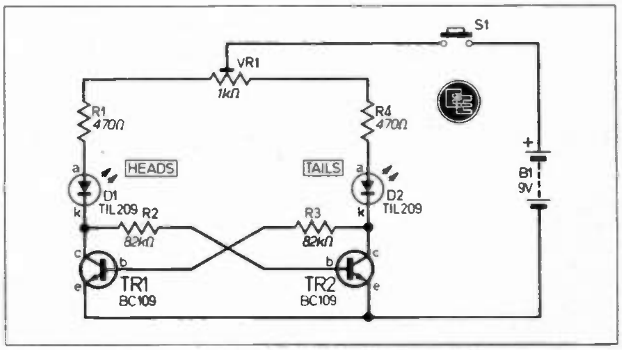


Fig. 1. The circuit diagram of the Heads & Tails Game.

VR1, compensates for the component tolerances by supplying a higher supply voltage to one or other side of the circuit, and is adjusted by trial and error.

ASSEMBLY

Connect up the l.e.d.s and S1 using approx. 75mm lengths of thin insulated wire. Make quite sure that the l.e.d.s are connected with the correct polarity.

The front panel of a suitable case should next be drilled to take S1 and the diodes. Switch S1 is mounted in the centre of the panel, and the l.e.d.s are mounted to the right of this, one above the other.

ADJUSTMENT

Start with the slider of VR1 at a central position and then press S1 a number of times (25 or more). It will probably be found that one lamp lights up much more often than the other. If D1 lights up more frequently, then VR1 should be adjusted slightly in an anticlockwise direction to compensate for this. If D2 lights up more frequently, then VR1 needs to be adjusted slightly in a clockwise direction.

Repeat this procedure until the circuit is properly balanced with each lamp lighting up approximately the same number of times.

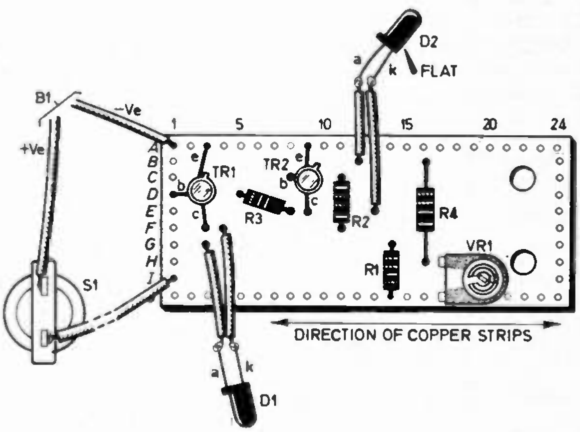


Fig. 2. Stripboard component layout.

POPULAR DESIGNS

CONTINUITY TESTER

1976

WHEN building and servicing electronic equipment, there are numerous occasions when some form of electrical continuity tester is required. It may be when tracing out the wiring around a complicated array of switches, or perhaps something more everyday such as checking for a break in a mains cable; sorting out the contacts of a wavechange switch; or checking a fuse which one suspects has blown.

The very simple tester described here produces an audible tone to indicate continuity. The unit is very simple to construct and is also quite inexpensive as few components are used.

COMPONENTS

Resistor
R1 6·8kΩ ± 10% ¼W carbon
Capacitor
C1 0·22μF polyester type C280
Transistor
TR1 TIS43 unijunction transistor
Miscellaneous
LS1 25 to 80 Ω speaker
B1 9V PP3 battery
Veroboard 0·1in matrix; 10 strips × 11 holes; aluminium box; test leads and prods; speaker fret; PP3 battery connector.

CIRCUIT OPERATION

The circuit consists of a relaxation oscillator, feeding a miniature speaker.

A unijunction transistor, TR1 forms the active component in the oscillator. Unijunction transistors have little in common with ordinary bipolar transistors except that they are also three terminal devices. The terminals are named differently though, being called base 1 (b1), base 2 (b2) and emitter (e).

With no voltage present at the emitter, the base 1 and base 2 terminals have a resistance of about three to 10 kilohms across them. Therefore, when the test prods are short-circuited, a current of about a couple of milliamps will flow through the loudspeaker via the unijunction.

This does not, of course, take into account that C1 will have charged to the supply potential within a fraction of a second of the battery being connected and so there is about 9V at the emitter of TR1.

If more than about half the supply potential is present at this terminal the emitter input impedance (which is otherwise extremely high) suddenly falls to a very low level and the base 1 to base 2 resistance of the device falls to about half its previous level.

Thus, at the instant the test prods are touched together, C1 discharges into the emitter of TR1 and a pulse of current is fed to the loudspeaker via the b1, b2 terminals of TR1.

Once C1 has largely discharged, TR1 operates as previously described until C1 is charged via R1 to the trigger voltage once again. Then C1 will again discharge and another pulse of current will be fed to the loudspeaker. This will continue in rapid succession causing a continuous tone to be emitted from the loudspeaker as long as the test prods are connected together.

If a resistance of more than a few hundred ohms is present between the two test prods, TR1 will cease to function and no audio tone will be generated,

ASSEMBLY

Virtually any small case can be used to house the unit, the minimum suitable size being about 100×70 ×25mm.

CONCLUSION

When using the unit it should be borne in mind that if the circuit under test has a resistance of perhaps as much as several hundred ohms the unit will still produce an audio tone even though there is not true continuity. This is not a major drawback however as, if the resistance between the prods is more than just a few ohms, the volume of the tone drops and the type of note changes noticeably.

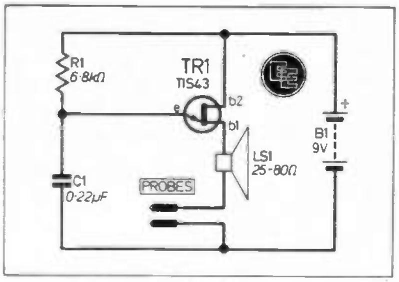


Fig. 1. The complete circuit diagram of the Continuity Tester.

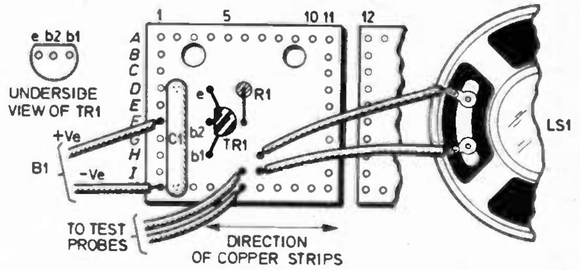


Fig. 2. Layout of components on Veroboard and complete wiring details.

POPULAR DESIGNS

PHOTO FLASH SLAVE

1977

THERE now seems to be a very wide range of electronic aids available to photographers, and most such aids appear to be fairly complex devices. Although a photo-flash slave unit is probably the most simple of these devices it is nevertheless one of the most useful.

A flash slave unit triggers a secondary flashgun when it receives a pulse of light from the main flashgun.

CIRCUIT OPERATION

A thyristor is a unilateral device, and it will therefore only function properly if it is fed with a voltage of the correct polarity. In order to avoid any problems here, a bridge rectifier consisting of D2 to D5 has been added in series with the flash lead, and this provides a signal of the correct polarity to the thyristor (CSR1) regardless of which way round the flash lead is connected.

Resistors R2, R3, and diode D1 form a simple Zener shunt regulator, and these limit the voltage which can be fed to the gate of CSR1 via the photo-Darlington amplifier TR1. Capacitor C1 is needed in order to provide the current required to trigger CSR1.

While C1 charges up it is receiving a current of only a few microamps for about one second. When the light from the main flashgun is received by the photocell (TR1), it's normally very high resistance falls to a level of only about a few hundred ohms. This happens extremely quickly, and as a result C1 almost instantaneously discharges through TR1 and into the gate of CSR1. Because the charge on C1 is released so rapidly, the discharge current is many times greater than the charge current. It is thus sufficient to switch on CSR1 which then places a low impedance path across the flash lead and so fires the flashgun.

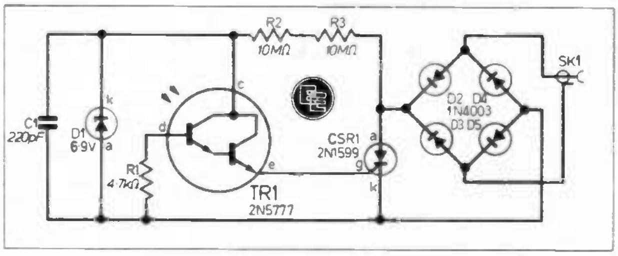


Fig. 1. Complete circuit diagram of the Photoflash Slave Unit.

COMPONENTS

Resistors
R1 4·7kΩ R2 10MΩ R3 10MΩ
All resistors are carbon ¼W ± 10%

Capacitors
C1 220nF polyester

Semiconductors

TR1	2N5777 photo darlington *npn*
CSR1	2N1599 200V 1A invristor or equivalent
D1	BZY88C6V8 6·8V 400m W Zener
D2-D5	IN4003 rectifier (4 off)

Miscellaneous
SK1 extension lead for flash gun
Small transparent plastic case, 50mm × 40mm × 25mm; stripboard 0·1 inch matrix 10 strips × 12 holes; small rubber grommet; solder.

After the flashgun has gone off the current through CSR1 falls to virtually zero and this component switches off. The circuit is then ready to start a fresh cycle when the flashgun is recharged again.

ASSEMBLY

The unit should be housed in a small transparent plastic case.

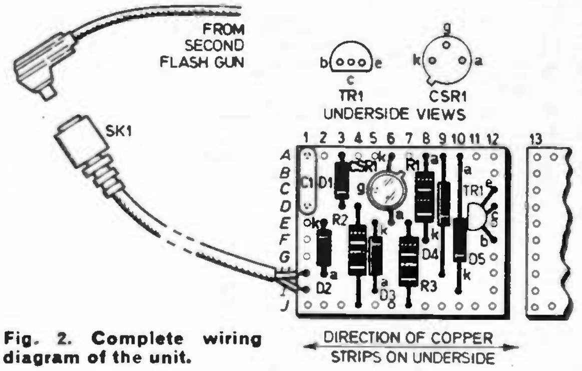


Fig. 2. Complete wiring diagram of the unit.

POPULAR DESIGNS
FUZZ BOX
1978

THE POP musician is being constantly bombarded with new and improved musical effects units, but still polling high in the popularity charts is the "old" Fuzz Box.

CIRCUIT DESCRIPTION

Input to the unit is at SK1 a stereo jack socket wired to complete the d.c. power circuit when the input jack is inserted. The signal then passes to the op-amp via d.c. blocking capacitor C1. Resistor R1 sets the input impedance at 100 kilohms which should suit most guitars and electronic organs.

The gain of the sustain 741 op-amp is controlled by feedback and is equal to: (VR1 + R2 + R3)/R2. With specified values gain is from 6 to 92, depending on the setting of VR1. However, all output signals are limited to 600mV peak by the effect of D1, D2 in the feedback chain. VR1 setting controls the rise time of the signals towards the diode clipping level and thus the high order harmonic content in the signal which determines the depth of fuzz.

The resulting signal from the op-amp is reduced in amplitude by the potential divide action of R6 and R7, giving an attenuation factor of approximately four. Thus the maximum output signal via C3 available for inputting to an amplifier is about 150mV. This level will be maintained during the period of clipping (fuzz) and will then decay naturally to zero.

The 741 requires a split supply and this is derived by the potential divide action of R4 and R5 producing +4·5 volts with respect to the op-amp reference line which is decoupled by C2.

A foot-switch S1 is incorporated to allow the unit to be readily by-passed when desired.

ASSEMBLY

The assembled stripboard, Fig. 2 was mounted horizontally in a die-cast aluminium box.

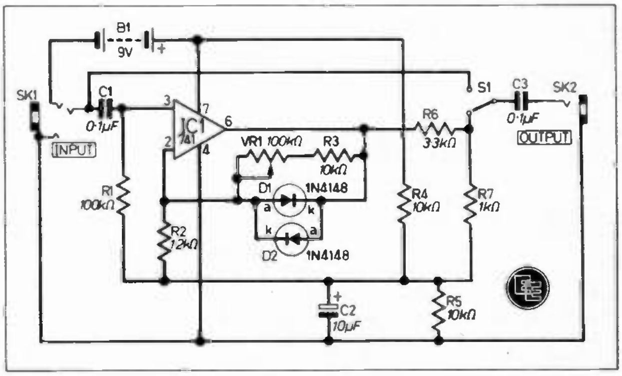


Fig. 1. The complete circuit diagram of the Fuzz Box.

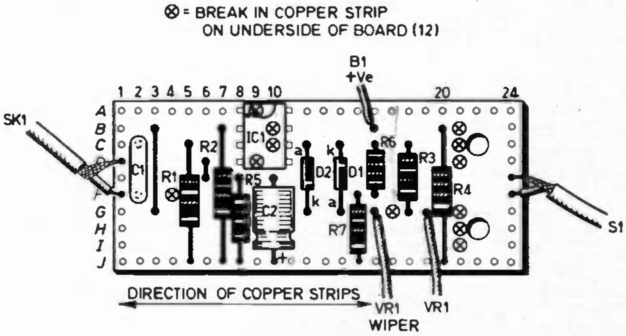


Fig. 2. Layout of components on the stripboard.

Attach the flying leads including the battery connector, Fig. 3, and then proceed with drilling the case.

Screened lead should be used for input and output connections.

A much harsher fuzz can be produced by connecting a 1 kilohm resistor across SK2, signal to earth.

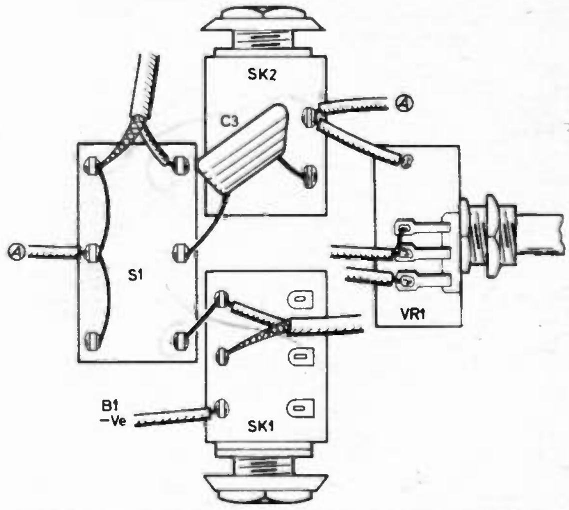


Fig. 3. Interwiring details. To be fitted in a metal box.

COMPONENTS

Resistors

R1	100kΩ	R4	10kΩ	R6	3·3kΩ
R2	1·2kΩ	R5	10kΩ	R7	1kΩ
R3	10kΩ	All ¼ watt carbon film ± 10%			

Capacitors
- C1, C3 0·1μF plastic or ceramic
- C2 10μF 6V elect.

Semiconductors
- IC1 741 operational amplifier 8 pin d.i.l.
- D1, D2 1N4148 or similar silicon diode

Miscellaneous
- SK1 standard stereo jack socket
- SK2 standard jack socket
- S1 s.p.d.t. successional action foot-switch
- B1 9V PP3
- VR1 100 kilohm carbon lin.

Stripboard: 0·1 inch matrix 13 strips × 21 holes; PP3 battery clip; aluminium diecast box; knob for VR1; connecting wire.

OPTO ALARM

THIS simple single-transistor circuit is designed to sound a miniature audible warning device when light falls on to a photocell. The photocell is normally mounted in a dark room and the alarm is triggered when either the room lights are switched on or possibly when light from an intruder's torch falls directly on to the photocell.

CIRCUIT DESCRIPTION

The photocell PCC1 is an ORP12 light-dependent resistor which is located in the room to be protected, and is connected by means of PL1 and SK1. Together with R1, PCC1 forms a potential divider: the voltage at the junction of R1 and PCC1 varies with the amount of light striking the l.d.r.

In absolute darkness the resistance of an ORP12 is at least 10 megohms, and so the voltage at the junction of R1/PCC1 is very nearly that of the supply rail, 9V. Transistor TR1 is therefore firmly switched off as its base is not biased.

When light falls on PCC1, its resistance drops (albeit relatively slowly) and this causes TR1 to switch on. A triggering pulse is therefore delivered to the gate of CSR1 and this component conducts. The audible warning device (WD1) will therefore sound.

The thyristor will now remain in this low impedance state even if the triggering signal is removed. The only way to reset CSR1 and mute the alarm is to switch off the power supply. Resistor R5 will ensure that a minimum holding current is flowing in the anode-cathode circuit of the triggered thyristor, and so preventing any undesirable resetting.

ASSEMBLY

The prototype was built into an ABS "Bimbox" type 4003. This measures approximately 85×55×35mm and has an aluminium front panel.

There should be no problems with the construction of the circuit; Fig. 2 illustrates the recommended arrangement of components.

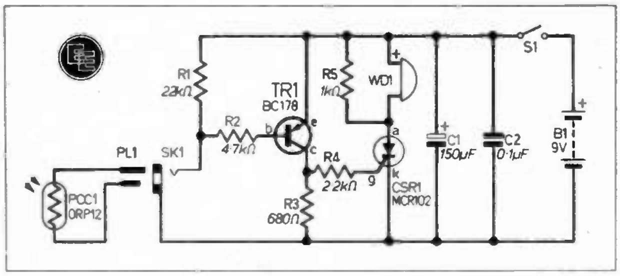


Fig. 1. The circuit diagram of the Opto Alarm.

COMPONENTS

Resistors
R1 22kΩ R3 680Ω R5 1kΩ
R2 4·7kΩ R4 2·2kΩ
All ¼W carbon ± 5%

Capacitors
C1 150μF16V elect.
C2 0·1μF polyester C280 or similar

Semiconductors
TR1 BC178 silicon *pnp*
CSR1 MCR102 thyristor rated 30V 0·8A or at least 9V 100mA
PCC1 ORP12 or similar light dependent resistor

Miscellaneous
SK1 3·5mm jack socket (2 off)
PL1 3·5mm jack plug
WD1 miniature 9V audible warning device
Stripboard: 0·1 inch matrix, 10 strips × 24 holes; case BIM 4003 or similar; twin-core flex; stranded connecting wire; 6BA fixings including 5mm spacers; 9 volt battery and connector; on/off switch.

All interconnections between the component board and front panel can be completed with stranded flexible hook-up wire.

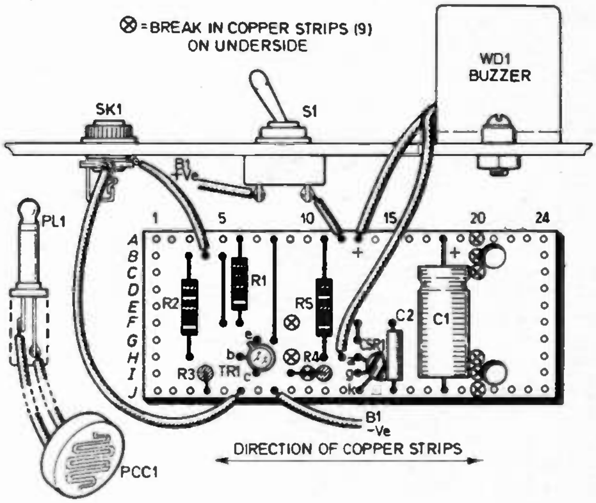


Fig. 2. The layout of the components on the topside of the stripboard

SOIL MOISTURE UNIT

1980

THIS device has partly a novelty value, but also definitely does give some indication of when the soil that it is measuring is "wet" or "dry". It may therefore help to give more consistent and successful results, assisting those who don't have much luck with potted plants.

CIRCUIT DESCRIPTION

Most of the work is done by IC1, a cheap and readily available 741C op-amp.

The variable resistor VR1, is wired between the supply lines and its wiper is connected to the inverting input. The setting of VR1 therefore determines the voltage at pin 2, and this can be altered from +9V to 0V.

At the non-inverting input we have the same sort of thing. The two probes, when inserted into soil, in effect form a resistor. The value of this "resistor" is dependent upon the moisture within the soil: the more moisture there is, the lower the value of this resistance.

Assuming that VR1 is at mid-position, when the soil is wet, we can say that the voltage at pin 3 will be lower than at pin 2. Therefore the output of IC1 is low. Current can therefore flow through R2 and D1, and "sink" into the output pin causing the green l.e.d. to light up. This is labelled WET.

Similarly with dry soil, the high resistance of the soil ensures that pin 3 is at a greater voltage than pin 2. The output pin therefore swings high, and it allows current to flow through the red l.e.d. D2 and R3 to 0V lighting up this l.e.d. This is labelled DRY.

ASSEMBLY

A Bimbox type BIM2002/12 houses the unit. This handy-sized box measures 100×50×25mm.

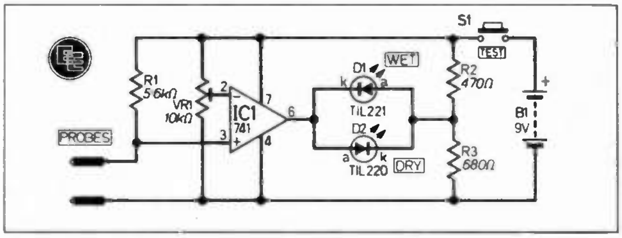


Fig. 1. Circuit diagram of the Soil Moisture Unit.

Any other plastic case can be used.

The two probes are made of 4BA threaded brass rod about 120mm long. Connections to the probes are made by solder tags placed under the mounting nuts within the case.

The two light-emitting diodes can be secured in position with either an appropriately-coloured lens-clip or a standard plastic fixing clip.

SETTING UP

With construction completed, set VR1 to approximately midway, connect up a battery and press S1. The red l.e.d. should glow. Bend the two probes together at their tips so that they short together: the red lamp should extinguish and the green l.e.d. illuminate.

If this happens the unit is ready to use. Set VR1 to give the desired switchover point of the two indicators. Here it may prove useful if you have some small containers of soil available. The individual samples should have various levels of water content, ranging from dry to saturated. It should then be possible to eventually adjust VR1 until a desired sensitivity is obtained.

COMPONENTS

Resistors
R1 5·6kΩ R2 470Ω R3 680Ω
All ¼W carbon ± 5%.

Semiconductors
IC1 741C 8-pin d.i.l. operational amplifier
D1 TIL221 0·2 inch green l.e.d.
D2 TIL220 0·2 inch red l.e.d.

Miscellaneous
VR1 10kΩ miniature horizontal skeleton preset
S1 single-pole push-to-make, release-to-break
B1 9V type PP3

0·1 inch matrix stripboard; 10 strips by 24 holes; case, 100 × 50 × 25mm, Bimbox BIM2002/12 or similar; battery connector; 4BA fittings, threaded brass rod for probes; 8 pin d.i.l. socket; connecting wire; mounting clips for D1 and D2.

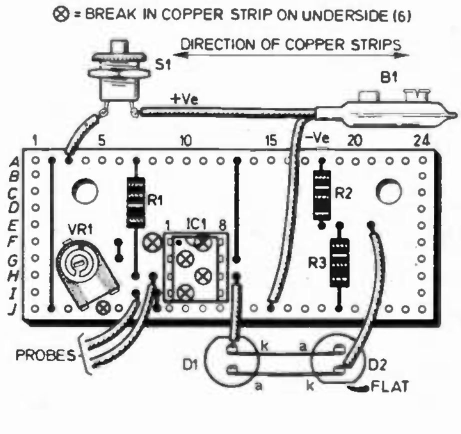


Fig. 2. Stripboard layout and interwiring diagram.

ICE ALARM

THIS Ice Alarm warns the driver when possible conditions exist for the formation of black ice. It does this by monitoring the temperature outside the car. When this drops to about two or three degrees Celsius, slightly above freezing, the unit flashes a warning lamp on the dashboard.

CIRCUIT

The heart of the unit is IC1, a CMOS multivibrator which has been wired up as a gated astable. This means that the device oscillates only when pin 5 is high, otherwise it is inoperative.

Along with R1 and VR1, the thermistor forms a potential divider, the output of which is connected to the base of TR1.

If TR1 is on, pin 5 is high and so the i.c. oscillates freely. If the transistor is off, however, the reset pin is grounded through R2 and so the i.c. is disabled.

As the temperature of RTH1 decreases towards 0°C, its resistance will increase and the voltage at TR1 base will be reduced. Eventually a point is reached where the base terminal is 1·2V less than the emitter and so TR1 must turn on. Pin 5 of IC1 goes high, permitting it to oscillate normally; pin 11 then presents a square wave signal to TR2 and this causes the indicator lamp to flash.

Note that the lamp is normally fully alight to show that the Ice Alarm is on, but it flashes when RTH1 detects a low temperature.

Connections for the power feed and thermistor are taken by flying leads from the stripboard, through the case to a four-way screw terminal block mounted outside the case.

COMPONENTS

Resistors
R1 82kΩ R3 470kΩ R4 680Ω
R2 22kΩ All ¼W carbon 10%

Capacitors
C1 0·1μF tantalum bead 35V
C2 0·22μF polyester C280

Semiconductors
IC1 CD4047 CMOS mono/astable multivibrator
TR1 MPSA65 *pnp* silicon Darlington
TR2 BFY50 *npn* silicon

Miscellaneous
VR1 47kΩ miniature horizontal preset potentiometer
RTH1 VA1066S negative coefficient rod thermistor
LP1 14V 40mA integral type MA lamp (amber)
S1 push-on, push-off single pole switch
Case, 110 × 60 × 30mm, Bimbox type 2003/13 or similar; stripboard, 0·1 inch pitch, 10 strips × 24 holes; 14 pin d.i.l. socket for IC1; four-way screw terminal block; piece of tagstrip for mounting RTH1; twin core flex, mounting hardware for circuit board; lamp holder for LP1.

INSTALLATION

Ascertain whether the car chassis is positive or negative earth and connect this to the positive or negative terminal on the terminal block. The other supply wire should come from an ignition-controlled circuit (possibly at the fusebox), so that the Ice Alarm is not inadvertently left switched on when the ignition is switched off.

The position of the thermistor module may be rather a trial and error affair. The unit is obviously not waterproof and so it must not be exposed to spray or road filth. Furthermore it needs to be placed away from the car's exhaust system and cooling system—parts which get hot during normal operation.

Final positioning must vary from car to car. A suggestion is behind (i.e. inside) the front bumper.

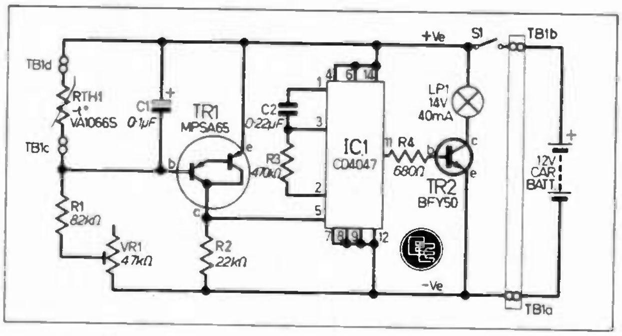


Fig. 1. Full circuit diagram of the Ice Alarm.

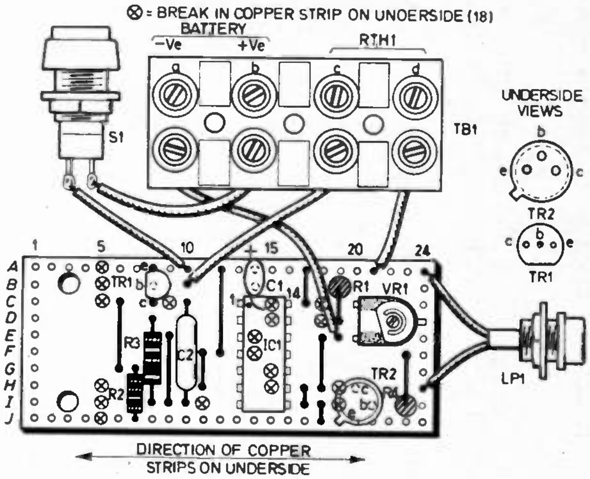


Fig. 2. Circuit board layout and component inter-wiring. Note that the thermistor RTH1 is not shown in this diagram but is connected to the terminal block via a long cable and located at some remote location.

CONSTRUCTION GUIDE

1 Any one of these **Popular Designs** can be built on a piece of stripboard (Veroboard) measuring $1\frac{1}{16}$in by $2\frac{3}{8}$ in, or 10 strips by 24 holes, such as the piece of board given free with this issue. Further boards of this size can be obtained from retailers advertising in this magazine.

2 Before attempting to build one of these **Popular Designs,** read carefully the article and study the circuit diagram and the component layout diagram. Note the method of coding the strips (letters) and holes (numbers) of the stripboard. This helps positive identification of connection points on the board. See Fig. 1.

3 Make any required breaks in the copper strips as indicated in the diagrams. This operation is performed using a twist drill (hand held); or with the aid of a special tool which can be purchased. See Fig. 2.

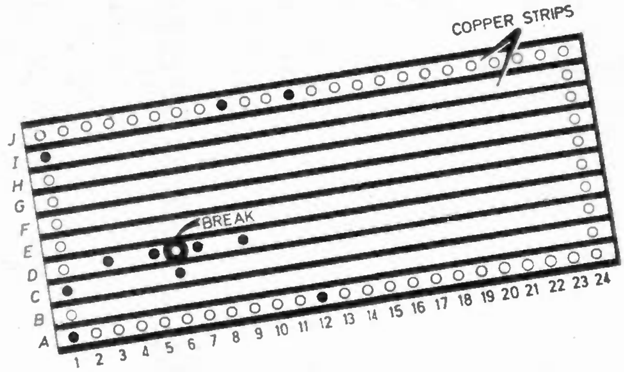


Fig.1

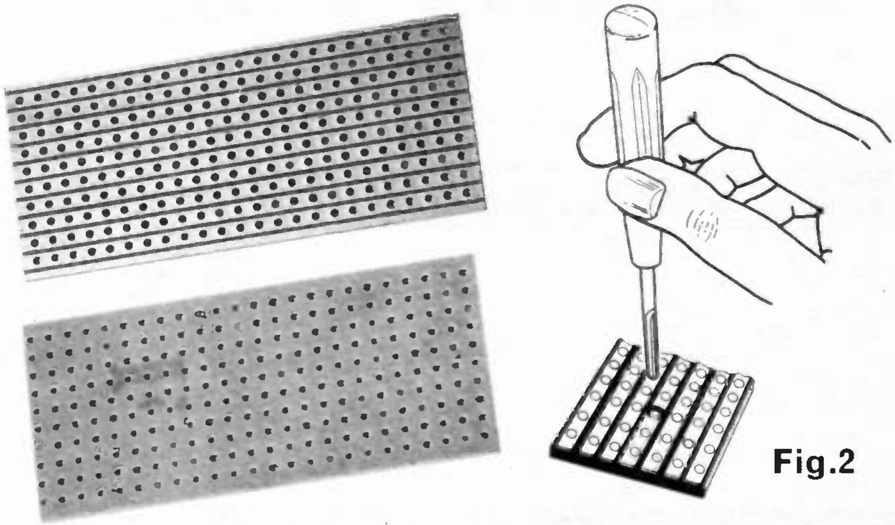


Fig.2

4 Solder in position the resistors, capacitors and semiconductors. Carefully check the identity of the semiconductor lead out wires, also the polarity of electrolytic capacitors, before placing in position. It is advisable to use a heatsink when soldering semiconductor leads. I.C. sockets are recommended for the mounting of these devices.

5 Any other components such as potentiometers and switches that are mounted externally to the stripboard should be connected to the appropriate points on the stripboard as indicated. Use insulated (preferably flexible) wire of sufficient length to suit the mounting arrangements and general assembly of the complete unit.

6 Note any special recommendations regarding the housing of the project, and the fixing arrangements for the stripboard within the case. Where a plastic (non-conductive) case is specified do NOT use a metal one.

SIMPLE INFRA RED REMOTE CONTROL

Pulsed beam gives high efficiency and strong peak output using a single l.e.d. Receiver uses a special i.r. photodiode that does not respond to visible light. The receiver energises a relay which can be used for switching electrically operated apparatus. The i.r. remote control could also be applied as a burglar alarm.

LOUDHAILER

A self-contained electronic megaphone unit built around an LM380N audio i.c. and designed to feed either a small conventional loudspeaker or a horn speaker. The output power of 1W is adequate for many applications and enables the unit to operate for long periods from small batteries.

TRANSISTOR IGNITION

This solid state replacement for the conventional car ignition system will improve m.p.g., extend spark plug life, minimise points wear and reduce demands on starter motor and battery.

NOVEMBER 1981 ISSUE
ON SALE FRIDAY, OCTOBER 16

EXPERIMENTAL CRYSTAL SET

A fascinating starter project for beginners of all ages. Easy to build and inexpensive in parts. Home-made coils cover medium and short waves.

Everyday News

ELECTRONICS AND MICROELECTRONICS

RADIO ELECTRONICS FOR SCHOOLS

With a new school term just starting it's a bumper month for the hard pressed physics teacher who, due to lack of qualified electronics teachers, is the one person invariably "press-ganged" into running the school's electronics classes.

Not to worry! Hard on the heels of our new beginners *Teach-In 82* series comes news that, under the School Radio banner, the BBC Radio 4 will be starting on September 22 a sound plus vision series for the teaching of electronics in secondary schools, including practical work. With our new series and the radio broadcasts, this should keep the pupils happy and relieve some of the pressure from the teacher.

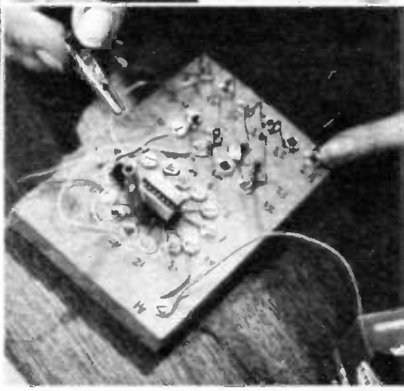
The arrival of this more ambitious project from BBC School Radio entitled *Electronics and Microelectronics* is aimed at the 14 to 16 year olds and is designed to introduce some of the developments which have taken place in the last ten years.

The series consists of ten programmes and are accompanied by five Radiovision film strips. Also complete pupils' kits of component parts incorporating three transistors, two integrated circuits and a special softwood base (which take woodscrews for non-soldering experiments) are available. It is claimed that each kit is suitable for 3 or 4 pupils and costs £7·95.

Full details of how to obtain the kit and the filmstrips (which cost £5·70 each) are included in a 24-page Teacher's Notes booklet. These notes which contain master copies of pupils' worksheets, are available Free from "Electronics and Microelectronics" BBC School Radio, 1 Portland Place, London W1A 1AA, on receipt of a A4 self-addressed envelope stamped at 20p.

In collaboration with this BBC School Radio project BP Educational Service is producing a teachers handbook entitled *Microelectronics: Practical Approaches for Schools and Colleges.* The book is meant to complement the radio series by offering detailed guidance on choosing equipment and projects which demonstrate practical circuits.

The book, price £2·75, is available from BP Educational Service, PO Box 9, Wetherby, West Yorkshire LS23 7EH.



Electronics and Microelectronics is produced by Arthur Vialls. The series can be heard on Radio 4 VHF on Tuesdays, at 2.20-2.40 p.m., starting September 22.

MAPLIN ROADSHOW

At the end of September '81 Maplin are taking the Atari personal computers and their new Matinee Organ to five cities in the UK. This is a golden opportunity for mail order customers or anyone for that matter to actually see and handle these popular products and ask questions on the spot.

A warm welcome (between 6 pm and 10 pm) awaits anyone wishing to enjoy a pleasant informal evening which is completely free, so make a note of the following dates in your diary:

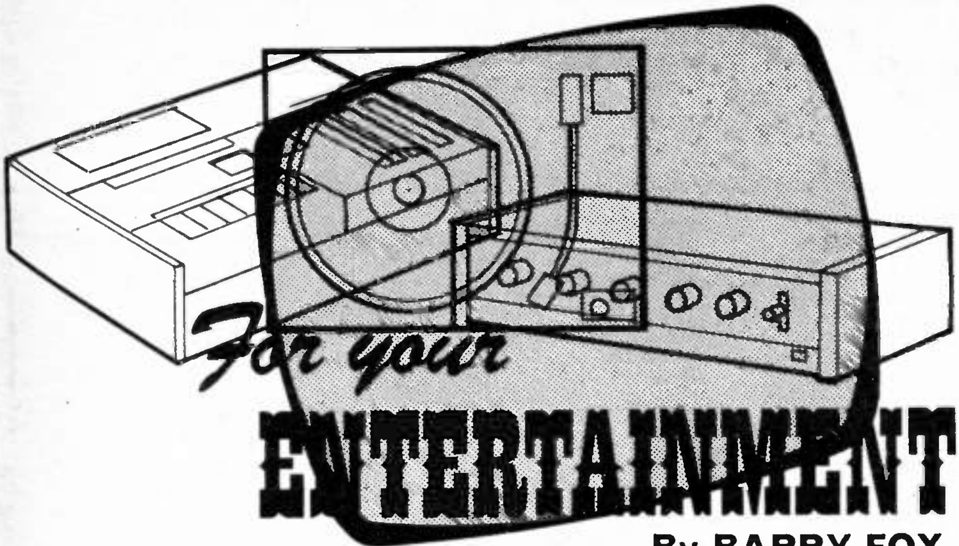
Newcastle upon Tyne, *Friday, September 25,* at the Grainger Room, Newcastle Centre Hotel, New Bridge Street, Newcastle upon Tyne.

Edinburgh, *Saturday, September 26,* at the Rosebery Room, Grosvenor Centre Hotel, Grosvenor Street, Edinburgh.

Manchester, *Sunday, September 27,* at the Ullswater Room, Portland Hotel, 3 Portland Street, Piccadilly Gardens, Manchester.

Birmingham, *Monday, September 28,* at the Malvern Suite, Birmingham Centre Hotel, New Street, Birmingham.

Norwich, *Tuesday, September 29,* at the Riverside Suite, Hotel Nelson, Prince of Wales Road, Norwich.



For your ENTERTAINMENT

By BARRY FOX

Talking Memories

A radio receiver and a television set which took the art of speech synthesis and recognition a stage further was demonstrated by Toshiba at a recent trade show. Although the prototypes are not in themselves to be taken too seriously they provide a useful pointer to the future.

The radio receiver is a fairly conventional hi fi unit, but it can be operated under voice control. Although interesting this, in itself, isn't new. Last year Toshiba was showing a television set that operated under voice control. You tell it to switch on, switch off and change channels. The new receiver is important because it can memorise, and mimic, up to ten phrases, each of two seconds in length.

To "teach" the receiver to do what you want, you speak command phrases into a microphone while microprocessor and memory chip store a digital coding of the words and dialect. Each stored phrase is then delegated to a switched function of the receiver.

For instance if you speak the phrase "BBC Radio 4", the microprocessor and memory store the sound of your voice saying those words. If you delegate that stored command to switch to the frequency for BBC Radio 4, then whenever you subsequently shout "BBC Radio 4" at the receiver it will recognise the command and switch to the appropriate frequency.

The breakthrough is in storage *capacity*. Ten phrases of two seconds each is a 20 second speech store. And as well as recognising the memorised phrases, the receiver can also speak them out as a check on what is memorised.

This points to the imminence of much larger solid state speech stores, programmable by the user. Imagine for instance a telephone answering machine on which the master message is recorded on a solid state memory, rather than a clumsy endless tape loop.

Talking TV

The other Toshiba development is a TV set which talks to the viewer. This is a digitally stored voice which is pre-programmed to speak appropriate phrases at user-selected times. For instance a timer will switch the TV on in the morning with an alarm call and a spoken "Good morning" at any chosen time.

At night the set will switch itself off at a pre-appointed hour with a "Now I'll fade out—have a goodnight's sleep". If you turn the volume up too loud the solid state voice (in the prototype a very female voice) advises you to "remember the neighbours, lower the volume".

An ultrasonic ranging device (not photoelectric as wrongly reported elsewhere) senses if anyone in the room is too close to the set. The voice then warns "Watch from a distance, for your eyes' sake".

The ultrasonic sensor also detects when everyone has either left the room, or moved out of range of the set. "Now I'll fade out", says the synthesised voice and the set switches itself off.

Chatter Box

It now looks as if we shall get legal CB radio on 27MHz f.m. any day now.

If recent experience in both Germany and Austria is anything to go by, it will rapidly become a craze, but a short-lived craze. The sad truth is that CB—even on f.m.—only "works" while the system is illegal and its use is restricted to those who are prepared to risk breaking the law. As soon as the system becomes legal, the electronics industry floods the market with cheap sets and these are heavily advertised. The number of CB users increases dramatically and very soon no one can get a word in edgeways over the air.

Journalists from Germany and Austria have told me that the airwaves there are now so cluttered with CB shouting that useful communication is impossible.

Pacemaker

When King Khaled visited London in the early summer of 1981, there was much publicity given for his heart ailment and the need for constant communication with his private surgeon in the USA. The word went round Fleet Street that King Khaled wore a miniature transmitter which provided a direct link with a machine in an American hospital continually monitoring his heart beat.

It was rumoured that King Khaled's personal transmitter beamed signals up to a satellite, from where they were beamed down again to the hospital. "Money can buy anything these days", said the political correspondents, "Nonsense" said the science correspondents," satellite transmitters are too big to hide in your clothes."

We'll probably never know whether King Khaled was or was not hooked up to a heart monitoring machine in America, but it was certainly technically possible, despite what the science correspondents told their editors. The clue is to be found in an erudite article published in *The Radio and Electronic Engineer*, official journal of the IERE (Institution of Electronic and Radio Engineers). The article, titled "Manpack Satellite Communications Earth Station" was by coincidence published at almost exactly the same time as King Khaled visited the UK.

Manpack Station

To cut a long, technical story short the Royal Signals and Radar Establishment in Worcestershire has now built a prototype ground station for satellite communication which can be carried as a military back-pack. Normally satellite linked gound stations are either permanent, with large dish aerials secured to the ground, or are mounted on a lorry. This is because the dish for such a ground station is around 2 metres in diameter and the transmitter is of between 30 and 60 watts power needing either a mains or generator supply to drive it.

The RSRE manpack station is just 45cm × 45cm × 20cm in size, weight 17 kilos and draws only 30 watts of power from a battery. The aerial dish is built into the case and measures only 45cm in diameter. The system transmits either low quality analogue speech or a 50 baud telegraph signal.

Although the unit is small enough for one man to carry around on his back, it isn't used as a mobile back-pack. To transmit, the unit is dumped onto the ground and aligned with a sky satellite using its built-in compass and signal strength meter.

It would have been perfectly possible for for King Khaled to wear a radio microphone, of the type now routinely used by performers in TV studios, strapped close to his heart. This radio mic would transmit heart beat signals over a short distance to a back pack satellite earth station in constant contact with the American heart hospital.

As I said we've no idea whether or not King Khaled actually used such a system, but it was certainly dangerous for Fleet Street science correspondents to dismiss the idea out of hand. But then, my experience of Fleet Street science correspondents is that some of them are remarkably naive about up-to-date science.

RADIO WORLD

By Pat Hawker, G3VA

Armchair travellers

Whether or not one believes wholeheartedly in the modern cult of amateur radio "DXpeditions"—the setting up of stations on islands from which there is little or no regular operation—there is no doubt that two-way contacts, even brief ones, with out-of-the-way places still provides an operator with a real sense of achievement, no matter how illogical this may be. Then again, compact h.f. transceivers allow holiday-makers and tourists to set up stations from hotel rooms in, for example, the smaller European countries such as Monaco, Liechtenstein, Andorra, Aland Islands and the like—and then be sure of plenty of contacts.

In Europe there are indeed very few places from which amateur operation does not take place; only Albania remains reluctant to permit either the indigenous population or tourists to use amateur radio "rigs" in that very private country.

The poor early summer this year seems to have made holiday operation more popular than ever. My own log shows that Liechenstein is proving a popular venue for German amateurs; a Dutch amateur with one of the small 10 watt transceivers has been telling me of the pleasures (and the mosquitoes) of the Northern Italian lakes while sitting on the terrace outside his holiday villa and a Greek amateur, normally located in Athens, has been praising the sunny beaches of Rhodes.

Several Finnish amateurs have crossed over to Aland Islands in the Baltic and, as usual, I have been receiving strong signals from the Royal Navy Amateur Radio Society's station on *HMS Belfast* in the Pool of London with the special callsign GB4RW to mark the Royal Wedding.

Ascension Island

The recent contact that gave me the most pleasure was with Dave, ZD8DM on Ascension Island, a thousand miles off the coast of Africa in the Southern Atlantic. A tiny island that had always previously eluded my calls, although back in 1967 I was lucky enough to make a fascinating 8000 mile trip to Ascension on what was possibly the one and only press visit in the island's history.

This was at the time of the opening of the first Cable & Wireless 42ft satellite communications terminal built on the island by the Marconi Company as part of the NASA *Apollo* network for the moon landings. Small though it is, Ascension supports more aerials to the acre than almost anywhere else on Earth.

Ascension, a tiny volcanic dot in the vast South Atlantic, has no indigenous population but it supports changing communities of Britons, Americans and contract-workers from "neighbouring" St Helena, some 800 miles away.

The island, in fact, is a remarkable mixture of the old and the new. Space and missile tracking stations (at that time it was near the end of the main American missile testing range), a large BBC overseas relay base with numbers of 250kW h.f. transmitters, a long-established Cable & Wireless telegraph cable station linking South America to Europe (and more recently on the route of the South African telephone cable) with a mass of glittering brass telegraph instruments, local medium-wave broadcasting stations and other futuristic electronics co-exist with vast colonies of wideawake terns and enormous green turtles.

While on the island I spoke over the satellite circuit to an American amateur in the NASA base in Maine—and many of the BBC and C&W staff who spend just a few years on this remote island are attracted there by the chance to operate with the rare ZD8 prefix. The American community also often includes a few radio amateurs.

Defence and H.F. Radio

It is becoming increasing clear that there has been a real revival of interest in h.f. radio communications systems among British and NATO Defence planners. According to a recent article by C. R. M. Noonan in the Marconi journal "Communication & Broadcasting", the NATO countries are currently planning to spend over £100 million on such long-established communications techniques as relatively low-speed radio-teleprinters, unprocessed analogue speech (ssb) and hand Morse.

It is recognised that this picture does not conform to the now accepted image of modern radio communications and may even seem "old hat" when compared to wideband, high-speed data and multichannel digitally-encrypted links for speech. But h.f. is seen as having a number of special, almost unique, advantages while there is a growing belief that communications based on space satellites are vulnerable to enemy action. It is also accepted that with hand Morse operating one can continue to pass traffic in conditions which would defeat other systems.

There is also, it would appear, an increasing concern with the possible effects of the electromagnetic pulse (e.m.p.) that would follow a nuclear explosion in the upper atmosphere. It has been suggested that a single explosion, about 300 miles above the Earth's surface, could put out of action solidstate radio and electronic control equipment (including computers) over much of a continent unless more effective ways of "hardening" equipment are adopted.

For this reason we may see a revival not only of h.f. but also of miniature valves in place of the much more e.m.p.-vulnerable solidstate devices. There is some evidence that this course is already being followed in the USSR.

Television Makes News

This year's NAB and Montreaux television equipment exhibitions foreshadowed further significant developments in the field of electronic news gathering (the use of electronic rather than film cameras in news reporting). At both exhibitions were shown the first integrated colour-camera/video-recorder equipments, including a prototype unit based on a single-tube colour camera.

The "Hawkeye" unit developed jointly by RCA and Matsushita ("Panasonic") uses ½-inch tape cassettes similar in size to the VHS-format domestic VTRs and providing 20 minutes of broadcast recording time on each cassette. The single-tube Sony prototype unit is based on a new high-speed Saticon Trinicon form of pick-up tube and promises to eliminate many of the problems inherent in the accurate registration of the usual colour cameras which have three pick-up tubes; it should also reduce battery consumption which is still a problem with many of the lightweight cameras taking 25 to 35 watts.

With integrated camera/recorders, the electronic news man could be virtually as "action ready" when he arrives on the scene as the traditional film cameraman with no interconnection plugs, sockets and cables to worry about. But it may be some time yet before we see such equipment suitable for use in the European 625-line system rather than the American 525-line standard.

Trip Wires

One problem for television broadcasters that seems to be on the increase in Europe is that of aircraft flying into the high television transmitting masts or the guy wires which surround them.

A 1000ft mast in Luxembourg was snapped in two recently with fatalities both in the plane and among the technical staff at the transmitting station when an aircraft flew into it. In the UK a light aircraft from France recently crashed with fatal consequences when it hit the guy wires of the Dover television mast.

A few years ago an American fighter aircraft hit one of the guy wires of the Caldbeck television mast in Cumbria and sliced off part of its wing. The military plane must have been very sturdily built, the pilot managed to fly it a couple of hundred miles back to its base.

Poor Horace

I suppose that in some ways it was rather sad that Horace, the BBC's sub-titling computer found it so difficult to cope "live" with the Royal Wedding commentary—but it added a touch of light relief and Horace deserves an Equity card as the year's best up-and-coming comedian.

It was a worthy try and I am sure that there must have been many hard-of-hearing viewers who benefited from the open sub-titling and who found Horace not only funny but also of tremendous help.

INTRODUCTION TO LOGIC

PART 6 BY J. CROWTHER

THE "AND" GATE

The AND gate is equivalent to relays (switches) in series, see Fig. 6.1.

An output will be obtained if *A* AND *B* are energised, that is if *A* AND *B* are at logic 1.

Boolean Equation

$AB=S$ for two inputs
$ABC=S$ for three inputs

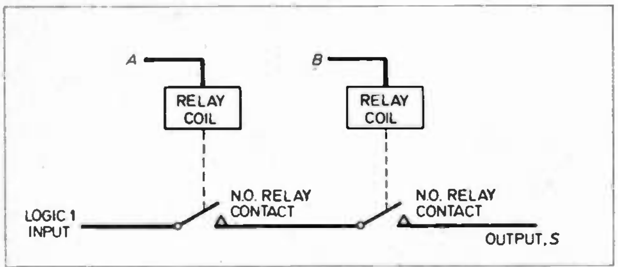


Fig. 6.1. A 2-input AND gate made up using relays.

Symbols

A number of different symbols are currently in use for representing logic gates; Fig. 6.2. shows most commonly found AND symbols. Types shown in (a) in each "symbol" diagram are those used in E.E.

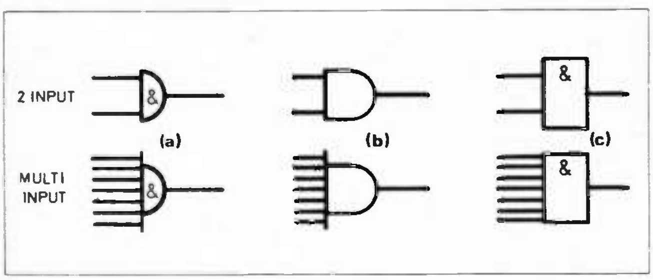


Fig. 6.2. Three different ways of representing AND gates in a circuit.

Truth Tables

In order to see at a glance what combination of inputs give an output, **Truth Tables** for a particular gate or circuit are constructed.

Truth Table for a Two Input "AND" Gate

inputs *A*	*B*	output $AB=S$
0	0	0
0	1	0
1	0	0
1	1	1

The more inputs a gate has, the more complicated the truth table becomes. For example, if a gate has ten inputs the number of possible combinations of the inputs will be 1,024. In order to be certain that none of the possible combinations have been omitted the following procedure is useful:

The number of possible combinations is given by the formula: Number of combinations $=2^n$ where n is the number of inputs.

Once the number of combinations has been established, allow this number of lines, and number them in binary, starting at 0.

example

To construct a Truth Table for a three input "AND" gate.

Since there are three inputs the number of combinations are:

$$2^3=8$$

Now draw eight rows and number them in binary, from 0 to 7 as shown.

	Inputs *A*	*B*	*C*	Outputs $ABC=S$
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	0
4	1	0	0	0
5	1	1	0	0
6	1	1	0	0
7	1	1	1	1

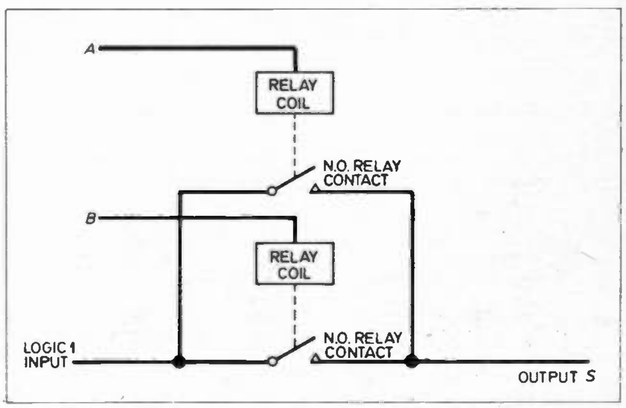


Fig. 6.3. Making up a 2-input OR gate from two relays connected in parallel.

THE "OR" GATE

The OR gate is equivalent to relays (switches), in parallel. See Fig. 6.3.

Boolean Equation

$A+B=S$ For two inputs
$A+B+C=S$ For three inputs

Symbols

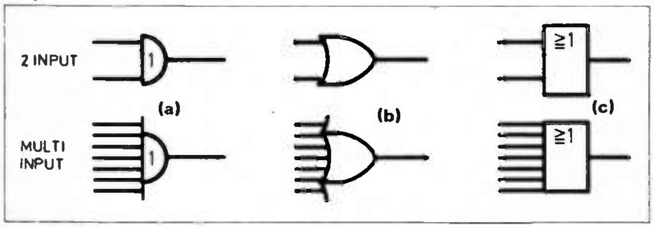


Fig. 6.4. Three different ways of representing OR gates in a circuit.

Truth Tables

Two Inputs

Inputs A	Inputs B	Output $A+B=S$
0	0	0
0	1	1
1	0	1
1	1	1

Three Inputs

Inputs A	Inputs B	Inputs C	Output $A+B+C=S$
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

THE "NOT" OR "INVERTER" GATE

The NOT or INVERTER gate is the special case of one input only, and it turns logic 0 into logic 1 and vice-versa.

Therefore it turns A into $\overline{A}$, and $\overline{A}$ into A.

In other words we get an output if there is no input, so it is equivalent to a normally closed relay or switch.

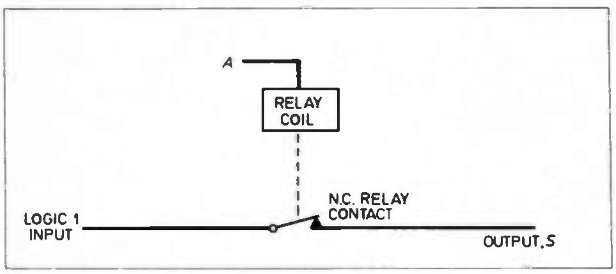


Fig. 6.5. Shows how a relay may be used to realise a NOT (or INVERT) function.

Truth Table

Inputs A	Output $\overline{A}=S$
0	1
1	0

Boolean Equation

$\overline{A}=S$

Symbols

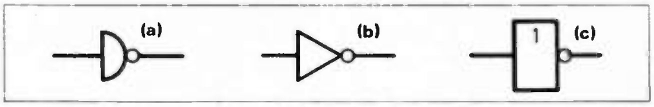


Fig. 6.6. Some symbols seen in use for representing a NOT gate in a circuit.

THE "NAND" GATE

NAND means "NOT AND", that is there is no output if AND B are both at logic 1.

Boolean Equation

Since AB means A AND B, and a bar means NOT, it follows that:

$\overline{AB}$ means NOT A AND B.

The Boolean equations for a "NAND" gate are:

$\overline{AB}=S$ for two inputs
$\overline{ABC}=S$ for three inputs

If we apply Demorgan's Theorem to $\overline{AB}$ we get $\overline{A}+\overline{B}=S$ This represents two normally closed switches or relays in parallel. Therefore a NAND gate is equivalent to Fig. 6.7.

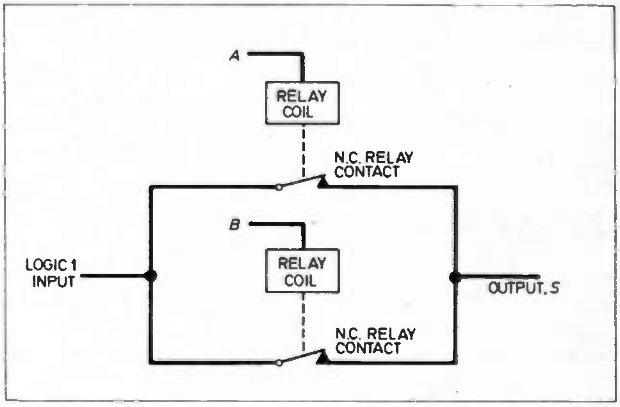


Fig. 6.7. A 2-input NAND function may be realised by using two relays (with normally closed contacts) in parallel.

Truth Tables

Two Inputs

Inputs A	Inputs B	Output $\overline{AB}=S$
0	0	1
0	1	1
1	0	1
1	1	0

Three Inputs

Inputs A	Inputs B	Inputs C	Output $\overline{ABC}=S$
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

By comparing the "NAND" truth table with that for the "AND" gate we will see that it is the inverse, in other words it is an "AND" gate followed by a "NOT" gate, and the symbols show this.

Symbols

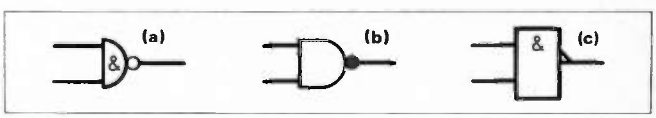


Fig. 6.8. Common symbols for representing NAND gates.

TO BE CONTINUED

CAPACITANCE METER

BY J.R.W.BARNES

It is inevitable that at some stage most constructors will be faced by an unmarked or suspect capacitor. How do you measure capacitance? Most multimeters don't have capacitance ranges, the traditional L.C.R. bridge is expensive and difficult to use. Surely a direct reading capacitance meter could be designed. As is the first step in any design, the desired specifications were chosen.

(1) The ability to measure most capacitors encountered in electronics excluding electrolytics.
Useful measurements can be made with the prototype of capacitors between 50pF and 1μF.

(2) A linear scale is very desirable.

(3) An accuracy of around 3 to 5 per cent can be obtained depending on the calibration standard (see later).

(4) The decision to make the unit mains powered was taken because, unlike a multimeter, a capacitance meter has few uses outside a workshop.

CIRCUIT

The full circuit of the Capacitance Meter is shown in Fig. 1.

To ease explanation and promote understanding the circuit can be split into four sections: pulse generator, monostable multivibrator, meter circuit and power supply.

The pulse generator is based on a unijunction relaxation oscillator. C1 charges through R10 and VR1 until the voltage across C1 equals the supply voltage multiplied by the intrinsic stand-off ratio of the unijunction, approximately equal to 7V. The capacitor is then discharged through the emitter/base 1 junction of the unijunction transistor TR1 resulting in positive pulse across R12. This turn TR2 on, reducing the voltage at pin 2 of IC1 below $\frac{1}{3}$ Vcc, and so triggering the monostable. VR1 is the calibration control; it controls the frequency with which the monostable is triggered.

TIMING RESISTOR

The widely used 555 i.c. was selected for the monostable primarily for its ability to handle wider variation of components in its timing circuit. Upon application of a trigger pulse, the unknown capacitor connected to SK1 and SK2 is charged through the timing resistor (one from R1 to R9 as selected by the range switch S1a). When the voltage across the capacitor reaches $\frac{2}{3}V_{CC}$ the capacitor is discharged. For the duration of the timing cycle the output pin 3 on IC1 goes high, this period being equal to $1{\cdot}1\,R_tC$ (where R_t is one from R1 to R9).

When the output is high D1 conducts allowing C3 to charge through R15. The voltage across C3 is indicated on the meter ME1. The deflection

COMPONENTS

Resistors

R1	10MΩ	R6	33kΩ
R2	3·3MΩ	R7	10kΩ
R3	1MΩ	R8	3·3kΩ
R4	330kΩ	R9	1kΩ
R5	100kΩ		

All ½W metal oxide ± 2%
(e.g. Electrosil type TR5)

R10	10kΩ
R11	220Ω
R12	220Ω
R13	2·2kΩ
R14	2·2kΩ
R15	10kΩ

All ¼W carbon

See Shop Talk page 670

Potentiometer

VR1 1MΩ ⅜in square multiturn cermet trimmer

Capacitors

C1	10nF polyester, axial
C2	100nF ceramic disc
C3	100μF 16V elect., axial
C4	100μF 25V elect., axial
C5	10nF ceramic disc

Semiconductors

D1-3	1N4148 small signal silicon diode (3 off)
TR1	2N2646 unijunction transistor
TR2	2N3904 silicon *npn*
IC1	NE555 timer i.c.
IC2	μA7812 regulator 12V 1A

Miscellaneous

ME1	meter 500μA (SEW type MR65P)
SK1	insulated screw terminal, black
SK2	insulated screw terminal, red
S1	miniature Maka switch assembly and two 12-way 1-pole wafers
T1	mains transformer: 12-0-12V 100mA secondary

Stripboard 32 holes by 23 strips 0·1in matrix. Case 100 × 100 × 150mm. Miniature tag board 9 way. 6BA nuts (8 off) and bolts (4 off). Veropins. Three core mains lead. Knob, skirted with index mark. Grommet for mains lead.

Approx. cost Guidance only **£16** excluding case

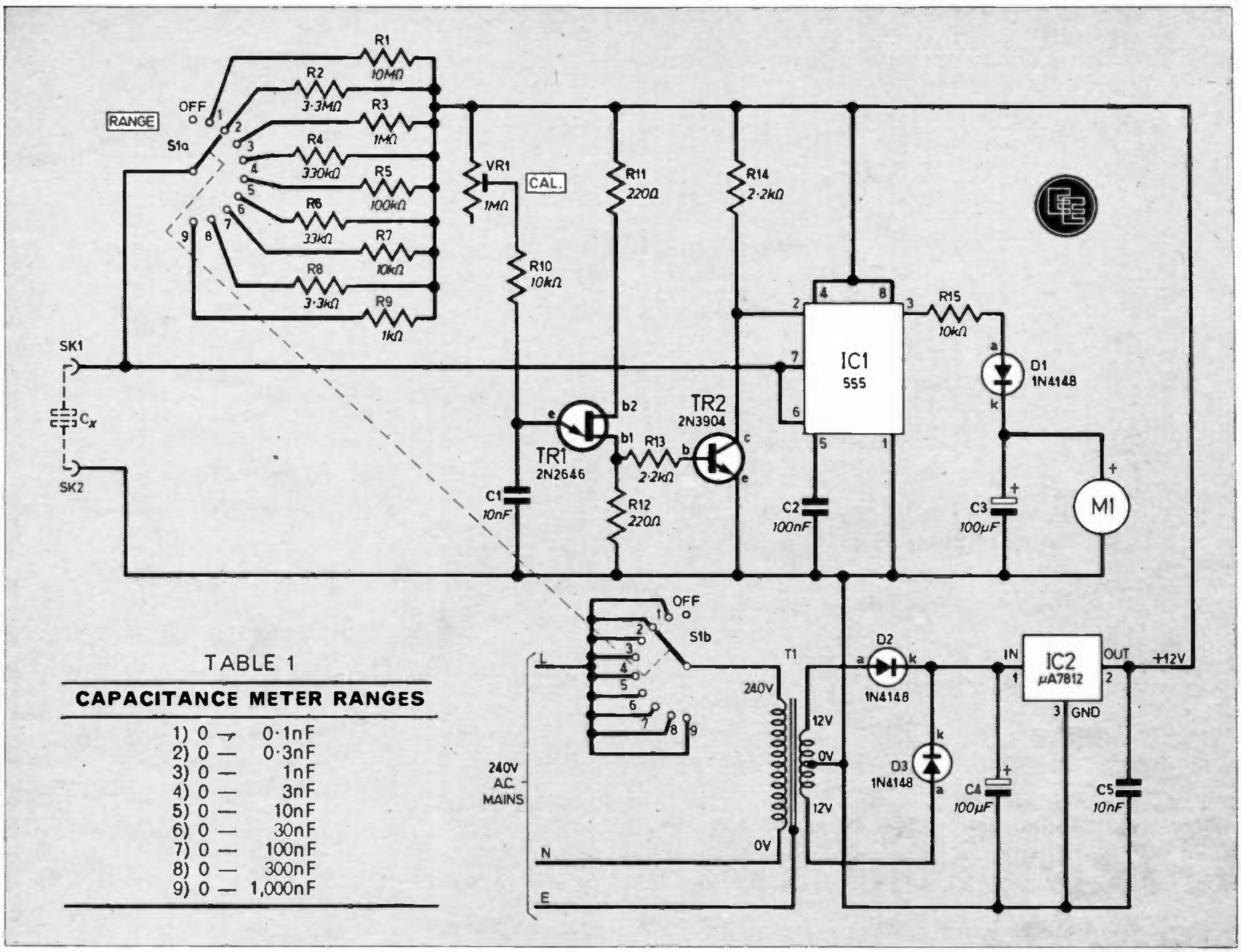


TABLE 1

CAPACITANCE METER RANGES

1) 0 —	0·1nF
2) 0 —	0·3nF
3) 0 —	1nF
4) 0 —	3nF
5) 0 —	10nF
6) 0 —	30nF
7) 0 —	100nF
8) 0 —	300nF
9) 0 —	1,000nF

Fig. 1. Circuit diagram of the Capacitance Meter.

of the meter is proportional to the value of the unknown capacitor.

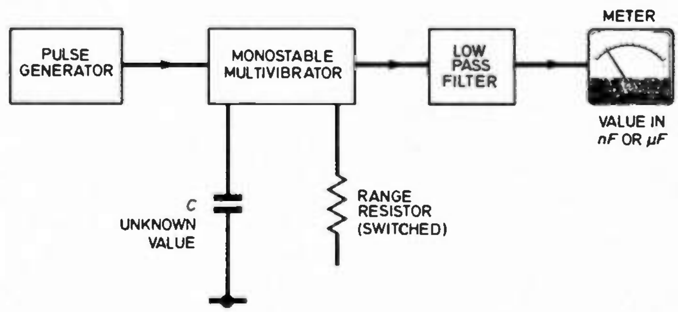
The power supply consists of T1, D2, D3 and C4 providing raw d.c. and IC2 providing a regulated 12V.

CONSTRUCTION starts here

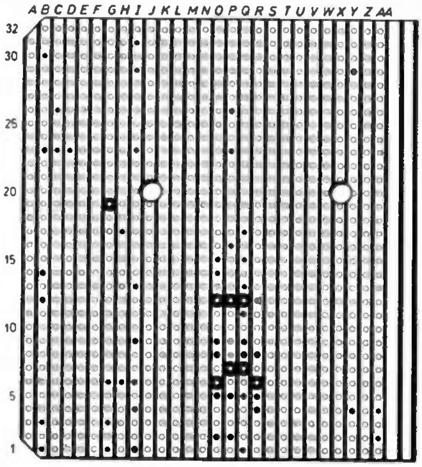
LAYOUT IMPORTANT

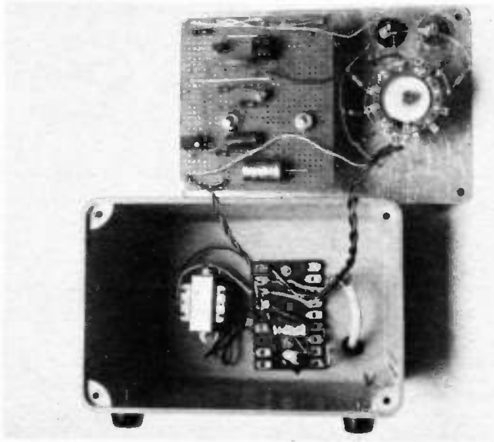
Begin construction with the stripboard; the layout given was carefully designed to minimise stray capacitance, and should be strictly adhered to. The stray capacitance shows up as residual reading of around 30pF on the lowest two ranges. This however poses no problems, it is simply subtracted from the measured reading.

HOW IT WORKS



The unknown capacitor along with the resistor selected by the range switch form the timing elements in a monostable multivibrator, the length of the output pulse being proportional to the unknown capacitor. The monostable is triggered at regular intervals by the pulse generator built around the unijunction transistor. The output of the monostable is fed to a low pass filter to produce a voltage proportional to the unknown capacitor. This voltage is displayed on the meter.





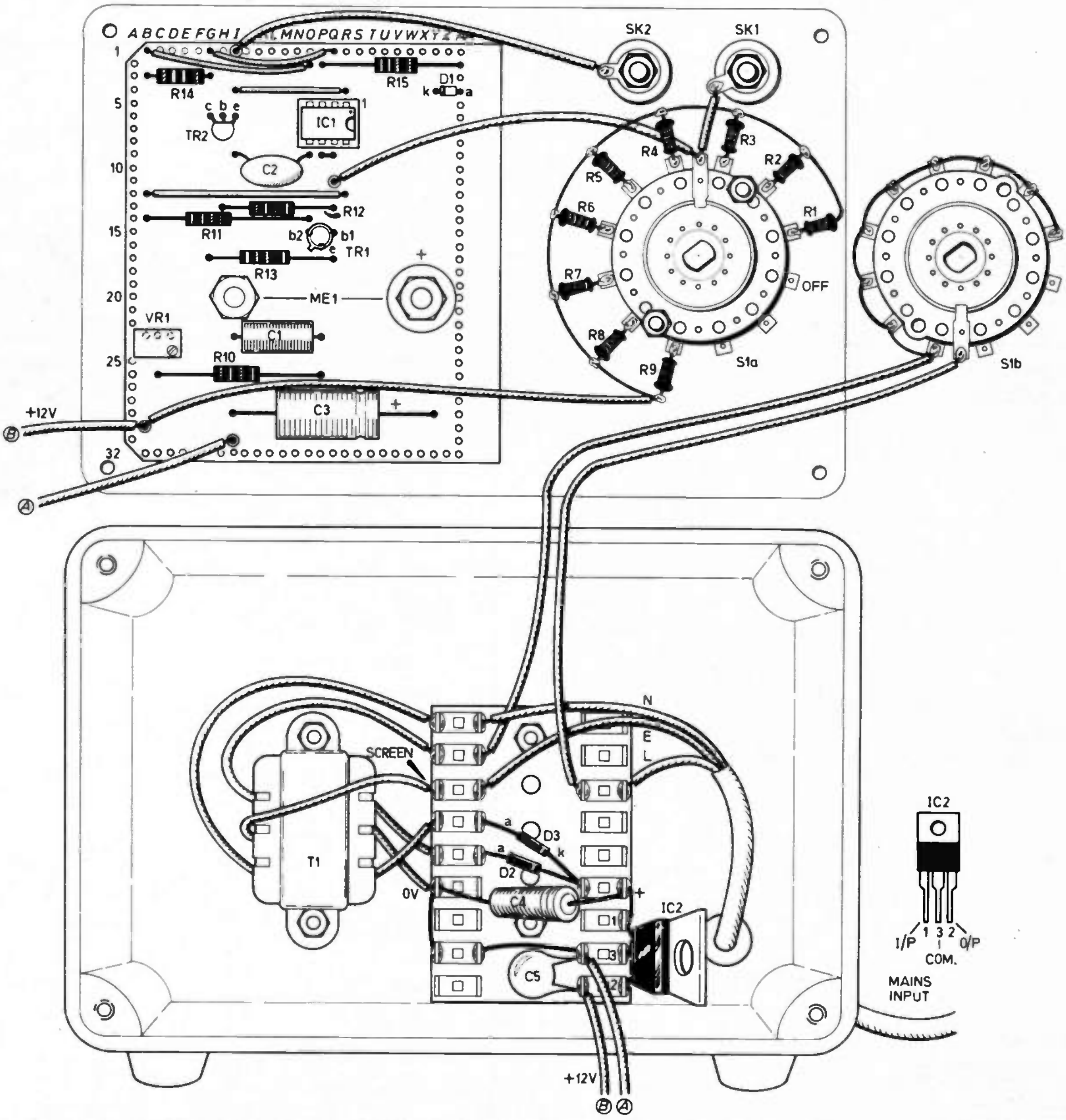


Fig. 2. Constructional details of the Capacitance Meter. The front panel has been lifted clear of the case to expose all components and wiring. At the top is an underside view of the stripboard with details of breaks in copper strips and drilling for meter terminals.

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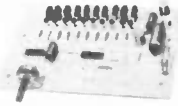

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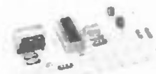

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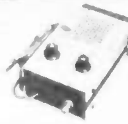

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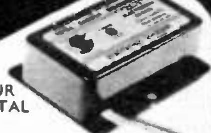
ELECTRONIC IGNITION SAVES PETROL



More and more new cars use electronic ignition to give the best performance and economy. Bring YOUR CAR up to top specification by fitting the latest TOTAL ENERGY DISCHARGE electronic system.

TOTAL ENERGY DISCHARGE gives all the advantages of the best capacitive discharge ignitions;

★ **Peak Performance**—higher output voltage.
★ **Improved Economy**—consistent high ignition performance.
★ **Better Starting**—full spark power even with low battery.
★ **Accurate Timing**—prevents contact wear without 'contactless' errors.
★ **Smooth Performance**—immune to contact bounce effects.

PLUS

SUPER HIGH POWER SPARK—3½ times the energy of ordinary C.D. systems.

OPTIMUM SPARK DURATION—to get the very best performance and economy with today's lean carburettor settings.

DESIGNED IN RELIABILITY—with the 'ultimate insurance' of a change-over switch to revert instantly to standard ignition.

TECHNICAL DETAILS

HIGH EFFICIENCY INVERTER. A high-power, high efficiency, regulated inverter provides a 400-volt energy source—powerful enough to store twice the energy of other designs and regulated to provide full output even with the battery down to 4 volts.

SUPERB DISCHARGE CIRCUIT. A brand new technique prevents energy being reflected back to the storage capacitor, giving 3½ times the spark energy and 3 times the spark duration of ordinary C.D. systems, generating a spark powerful enough to cause rapid ignition of even the weakest fuel mixtures without the ignition delay associated with lower power 'long burn' inductive systems. In addition this circuit maintains the correct output polarity, thereby preventing unnecessary stress on the H.T. system.

SOPHISTICATED TRIGGER CIRCUIT. This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level—just sufficient to keep the contacts clean.

IN MONEY-SAVING KIT FORM at £14.85
ALSO MOTORCYCLE TWIN OUTPUT KIT £22.94 Plus £1 U.K. P.&P.

All you need is a small soldering iron and a few basic tools — everything else is supplied with easy-to-follow instructions.

FITS ALL 6/12 volt NEGATIVE EARTH vehicles

ELECTRONIZE DESIGN
Magnus Road, Wilnecote, Tamworth. B77 5BY
Phone (0827) 281000

VISA

The normal practice of cutting the board to size, drilling the large holes for the meter terminals and breaking the strips, should be followed. Then insert the Veropins, i.c. socket and wire links. The resistors and capacitors are then added. Finally the diodes and transistors can be soldered in place. Take care to ensure the diode, integrated circuit and the electrolytic capacitor are the right way round. A drawing of the stripboard is shown in Fig. 2.

The prototype used a Sew panel meter type MR65P. If a different meter is used the position of the mounting holes may need adjusting; simply move the mounting hole and the positive ends of both C3 and D1 accordingly.

Mount the range switch, two screw terminals and the meter onto the front panel.

WIRING THE SWITCH

The wiring details of the range switch are shown in Fig. 2. Care should be taken to avoid over heating the range resistors R1—R9 as this will change their values and subsequently effect the calibration.

Mount the main circuit board onto rear of meter and secure with nuts on the terminal screws.

The power supply was built on a small piece of tag board as shown in Fig. 2. Construction is straight forward, just take care to observe the polarity of the diodes and the electrolytic capacitor.

Solder the mains lead to the power supply board then feed this lead through the grommet hole at the rear of the case.

Complete all the interwiring between the range switch, test terminals, main circuit board and power supply board as shown in Fig. 2.

The tag board is mounted together with the transformer on the rear panel of the case, with 6BA nuts and bolts.

Place the front panel assembly in position and secure to the case with four screws.

FRONT PANEL

The large hole for the meter is best made by drilling a series of smaller holes and filing the resultant hole. Alternatively an "Abrafile" may be used.

CALIBRATION

In order to calibrate the instrument a "standard" capacitor is required. It is best to use a standard of either 0·01µF or 0·1µF preferably 1 per cent tolerance. Simply connect the capacitor using short leads to the terminals, select the appropriate range and adjust VR1 for full scale deflection. This single process calibrates all the ranges.

The meter scale should be linearly divided into ten, with five subdivisions between each. The main divisions should be marked 0 to 10 at the top of the scale. The bottom edge of the scale should be marked at the appropriate points "0", "0·5", "1", "1·5", "2", "2·5" and "3".

This will facilitate readings to be made on all the nine ranges. See Table 1 for range coverage. The values have been specified in nanofarads throughout, though in practise µFs would be often used, certainly for the larger values. Table 2 provides at a glance conversion from nanofarads and picofarads to microfarads.

USING THE CAPACITANCE METER

When measuring capacitors take them out of the circuit by disconnecting one lead. This is most important because any parallel components will effect the reading. It is also advisable to discharge any capacitor before measurement as any stored charge could damage the instrument.

TABLE 2

CAPACITANCE UNIT CONVERSION
Each line indicates equivalents

nanofarad (10^{-9}F)	picofarad (10^{-12}F)	microfarad (10^{-6}F)
0·1nF	100pF	0·0001µF
0·3nF	300pF	0·0003µF
1nF	1,000pF	0·001µF
3nF	3,000pF	0·003µF
10nF	10,000pF	0·01µF
30nF	30,000pF	0·03µF
100nF	100,000pF	0·1µF
300nF	300,000pF	0·3µF
1,000nF	1,000,000pF	1µF

OTHER APPLICATION—BROKEN CABLE

An ohmmeter will tell you if a cable is broken, a capacitance meter will tell you where.

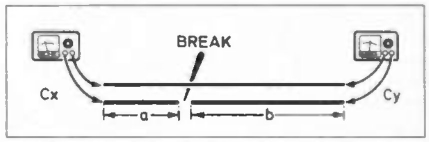


Fig. 3. Locating the break in a cable.

Measure the capacitance between the two wires or the core and the screen at both ends. The ratio of the two capacitances is also the ratio of the length from the break. In the diagram Fig. 6 $\frac{C_x}{C_Y} = \frac{a}{b}$.

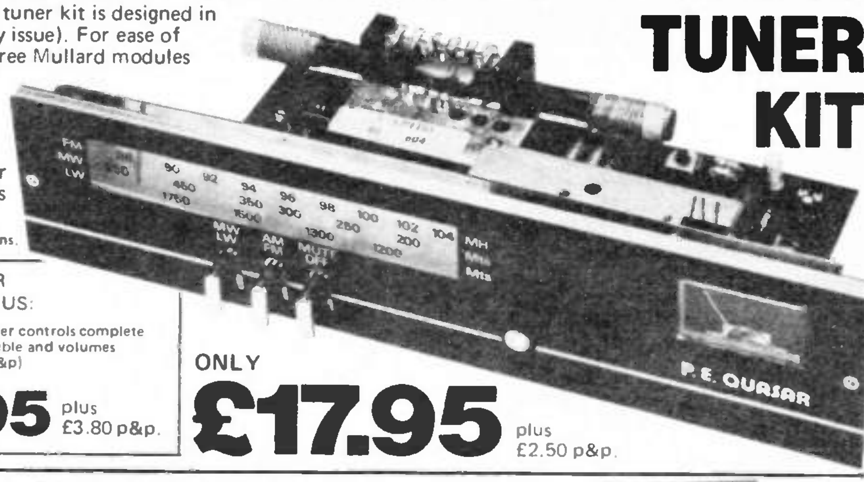
JACK PLUG & FAMILY...

BY DOUG BAKER

NEW PRACTICAL ELECTRONICS - STEREO TUNER KIT

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10½"x 2½" approx. Complete with diagrams and instructions.



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- Mullard LP1183 built preamp. suitable for magnetic/ceramic and auxiliary Inputs (usually £1.95 + 70p p&p)
- Matching power supply kit with transformer (usually £3.00 + £1.95 p&p)
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes (usually £1.70 + 80p p&p)

£21.95 plus £3.80 p&p.

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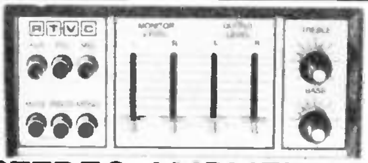


STEREO AMPLIFIER KIT

- Featuring latest SGS/ATES TDA 2006 10 watt output IC's with In-built thermal and short circuit protection.
- Mullard Stereo Preamplifier Module.
- Attractive black vinyl finish cabinet, 9"x8¾"x3¾" (approx)
- 10+10 Stereo converts to a 20 watt Disco amplifier.

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amp assembly kit and mains power supply. Also features 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia with matching knobs and contrasting cabinet. Instructions available, price 50p. Supplied FREE with the kit.

£14.95 Plus £2.90 p&p.

SPECIFICATIONS: Suitable for 4 to 8 ohm speakers.

Frequency response	40Hz - 20KHz.
Input sensitivity	P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls	Bass ±12db @ 60Hz Treble ±12db @ 10KHz
Distortion	0.1% typically @ 8 watts
Mains supply	220 - 250 volts 50Hz.

STEREO MAGNETIC PRE-AMP CONVERSION KIT
Includes FREE Magnetic cartridge with diamond styli.
All components including p.c.b. to convert your ceramic Input on the 10+10 to magnetic.
Only available with 10+10 amp. **£2.00** includes p&p.

8" SPEAKER KIT Two 8" twin cone domestic speakers. £4.75 per stereo pair plus £1.70 p&p. when purchased with amplifier. Available separately £6.75 plus £1.70 p&p.

PRACTICAL ELECTRONICS CAR RADIO KIT SERIES II

2 WAVE BAND MW -- LW

- Easy to build
- 5 push button tuning
- Modern design
- 6 watt output
- Ready etched and punched PCB
- Incorporates suppression circuits.

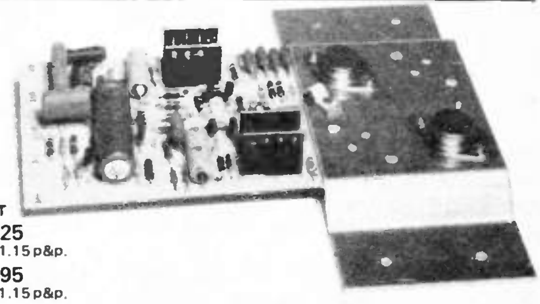
All the electronic components to build the radio, you supply only the wire and the solder, featured in Practical Electronics March issue. Features: pre-set tuning with 5 push button options, black illuminated tuning scale. The P.E. Traveller has a 6 watt output neg. ground and incorporates an integrated circuit output stage, a Mullard IF Module LP1181 ceramic filter type pre-aligned and assembled, and a Bird pre-aligned push button tuning unit.

£10.50 Plus £2.00 p&p.

Suitable stainless steel fully rettactable aerial (locking) and speaker (6"x4" app.) available as a kit complete. **£1.95**/pack. Plus £1.15 p&p.

HIGH POWER AMPLIFIER MODULES

READY BUILT OR IN KIT FORM



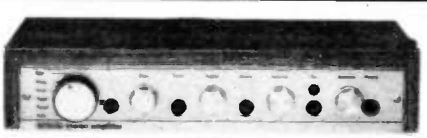
	KIT	BUILT
125 WATT MODEL	£10.50 Plus £1.15 p&p	£14.25 Plus £1.15 p&p.
200 WATT MODEL	£14.95 Plus £1.15 p&p	£18.95 Plus £1.15 p&p.

SPECIFICATIONS:	125 W Model	200 W Model
Max. output power (RMS)	125 watts	200 watts
Operating voltage (DC)	50 - 80 max.	70 - 95 max.
Loads	4 - 16 ohms	4 - 16 ohms
Frequency response measured @ 100 watts	25Hz - 20KHz	25Hz - 20KHz
Sensitivity for 100 watts	400mV @ 47K	40mV @ 47K
Typical T.H.D. @ 50 watts, 4 ohms	0.1%	0.1%
Dimensions (both models)	205 x 90 and 190 x 36mm.	

The P.E. power amp kit is a module for high power applications — disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC Board Is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES:

Suitable LS coupling electrolytic for 125W model	£1.00 plus 25p p&p.
Suitable LS coupling electrolytic for 200W model	£1.25 plus 25p p&p.
Suitable mains power supply unit for 125W model	£7.50 plus £3.15 p&p.
Suitable Twin transformer power supply for 200W model	£13.95 plus £4.00 p&p.



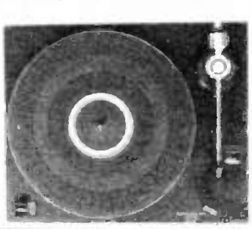
30+30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet, silver finished rotary controls and pushbuttons with matching fascia, mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30+30 watts RMS, 60+60 watts peak. For use with 4 to 8 ohm speakers.
Size 14¾"x10" approx.
BUILT AND TESTED.

£32.90 Plus £3.80 p&p.

PHILIPS BELT DRIVE RECORD PLAYER DECK GC037 (Size: 15¼"x 12¾" approx.)

HiFi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge



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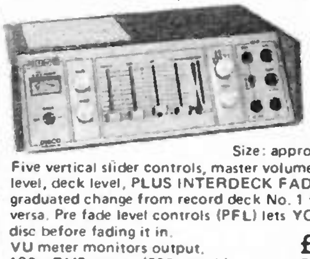
50 WATT Six individually mixed inputs for two pick ups (Cer. or Mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic and aux inputs. Size: 13¼"x6½"x3¾" app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

£39.95 Plus £3.70 p&p.



100 WATT

Brushed Aluminium fascia and rotary controls.
Size: approx. 14"x4"x10¼".
Five vertical slider controls, master volume, tape level, mic level, deck level, PLUS INTERDECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PFL) lets YOU hear the next disc before fading it in.
VU meter monitors output.
100w RMS output (200w peak).

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SQUARE one FOR BEGINNERS

This regular feature provides an easy guide to circuit components and materials and the techniques involved in building electronic projects.

THIS month we look at resistors. These are the most commonplace of components.

Resistors fall into the following classes:
(*a*) fixed value
(*b*) variable (potentiometers).

FIXED VALUE RESISTORS

Some fixed value resistors are wire wound. These are only used for certain special applications.

The most frequently used fixed value resistors are small tubular components with lead out wires emerging from either end. There are four principal types: **carbon composition, carbon film, metal film** and **metal oxide**. All of these are available in a very wide range of resistance values —expressed in ohms (Ω)—from 10 ohm to 1 megohm and even higher.

The generally available "preferred" values are 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms, and decadal multiples of these.

For example: **10**, 100, 1,000, 10,000, 100,000, 1,000,000 ohms.

39, 390, 3,900, 39,000, 390,000, 3,900,000 ohms. These are expressed in more practical terms as 39Ω, 390Ω, 3·9kΩ, 39kΩ, 390kΩ, 3·9MΩ.

It will be seen that k (kilo) means 10^3 and M (mega) means 10^6.

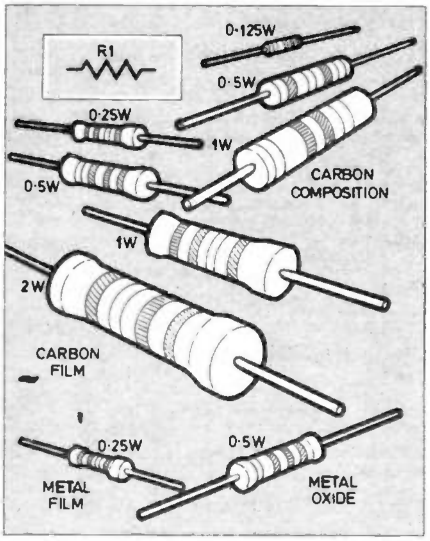
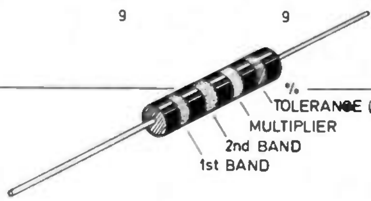


Fig. 1. Fixed value resistors. Shown here are carbon composition, carbon film and metal oxide resistors of typical wattage ratings. All are drawn to scale and are actual size. The circuit symbol for a fixed value resistor is also shown.

RESISTOR COLOUR CODE

Band (ring) Colour	BAND 1 (1st Figure)	2 (2nd Figure)	3 (Multiplier)	4 (Tolerance %)
BLACK	0	0	–	–
BROWN	1	1	10	1
RED	2	2	100	2
ORANGE	3	3	1,000	3
YELLOW	4	4	10,000	4
GREEN	5	5	100,000	–
BLUE	6	6	1,000,000	–
VIOLET	7	7	10,000,000	–
GREY	8	8	100,000,000	–
WHITE	9	9	1,000,000,000	–
GOLD			0·1	5
SILVER			0·01	10



Examples:

①

BAND	COLOUR		
1	RED	2	
2	VIOLET	7	
3	YELLOW	x 10,000	= 270,000 OHMS OR 270kΩ
4	GOLD	±5%	±5% TOLERANCE

②

BAND	COLOUR	
1	ORANGE	
2	ORANGE	
3	RED	= 3·3kΩ

ABSENCE OF BAND 4 = ±20% TOLERANCE

COLOUR CODE

The resistance value is indicated by coloured bands on the body of the resistor. This colour code is explained in the illustration.

It is an excellent idea for beginners to obtain an assortment of resistors and practise working out the code.

WATTAGE

The physical size of these fixed value resistors determines the power they can safely carry, without over heating with possible degradation of rated ohmic value. Power (volts × amps) is expressed in watts (W).

The forementioned values are available in the following wattage ratings.
Carbon composition: 0·125W, 0·5W, 1W
Carbon film: 0·25W, 0·5W, 1W, 2W
Metal film: 0·25W
Metal Oxide: 0·5W

EAGER TO START?
If you are handy with a lightweight soldering iron, try one of our Popular Designs. Read the notes on page 682.
How to Solder will be the subject of next month's Square One.

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OA202	16p	AC141	38p	MPSA65	39p
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W06	47p	AC176	37p	TIP31A	52p
Z5J	£2·92	BC182	11p	TIP32A	63p
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IN4005	6p	BC183	11p	TIP34A	99p
IN4148	5p	BC184	11p	TIP121	£1·12
IN5404	16p	BC184L	11p	TIP2955	69p
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LM381N	£1·98	4020	£1·20
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LM1830	£2·32	4522	£1·79
		40174	£1·50

¼W CARBON FILM RESISTORS
E12 SERIES. 1R-10M .... 1½p each
MIN. HORIZ. PRESETS. 100R-4M7 12p each
MIDGET POTS. LINEAR. 47OR-4M7 37p each
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10nF; 15nF; 22nF; 33nF; 47nF 7p each. 68nF; 100nF 8p. 150nF; 220nF 12p. 330nF 15p. 470nF 20p. 680nF 28p. 1µF 33p. 1·5µF 49p. 2·2µF 65p.

ELECTROLYTIC CAPACITORS
AXIAL Leads: 1µF/16V 11p; 1µF/63V, 1µF/100V 12p; 2·2µF/63V, 3·3µF/63V, 4·7µF/63V 12p; 10µF/16V 11p; 10µF/25V, 10µF/63V 12p; 22µF/10V, 22µF/25V 12p; 22µF/63V 15p; 33µF/40V, 47µF/25V 12p; 47µF/40V 15p; 47µF/63V 18p; 100µF/16V 12p; 100µF/25V 15p; 100µF/40V 18p; 100µF/63V 29p; 220µF/10V 15p; 220µF/25V 19p; 470µF/16V 29p; 470µF/25V 36p; 470µF/40v 55p; 680µF/16V 32p; 1000µF/10v 30p; 1000µF/16V 33p; 1000µF/25V 48p; 1000µF/40V 58p; 1000µF/63V 79p; 2200µF/10V 39p; 2200µF/25V 84p; 2200µF/63V £1·10.

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BPX25 .... £2·24
2N5777 .... 60p
ORP12 .... 99p
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LEDS WITH CLIPS
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F.M. AERIAL 49p
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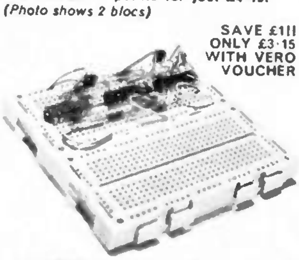

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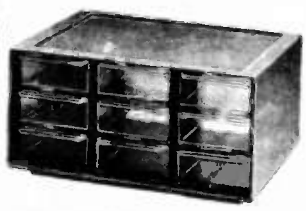

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In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

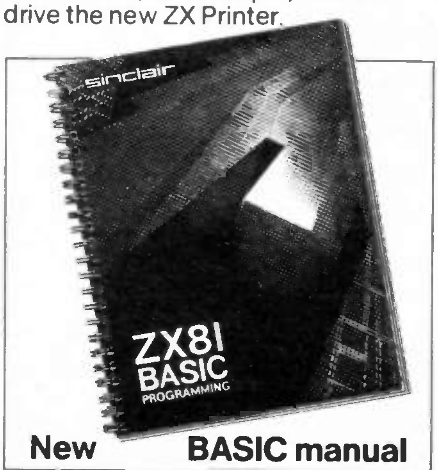
Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability

With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.



New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
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- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
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- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

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You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

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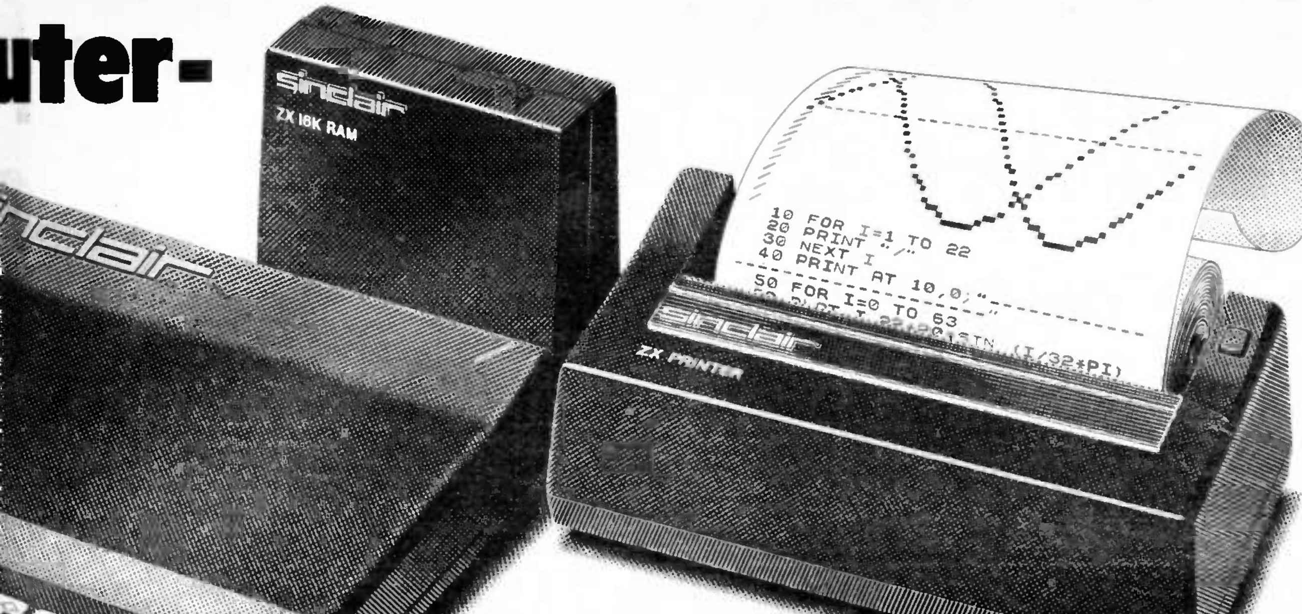

Available now- the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings–particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

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To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY. **Order**

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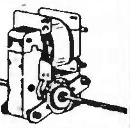

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