Australia 95c New Zealand 95c South Africa 90c Malaysia $2.75

PRACTICAL ELECTRONICS

JULY 1979 50p

STROBOSCOPE

SPECIAL OFFER! DOLOMITI MULTIMETER

Also: Switched Tone Treble Boost

PRACTICAL ELECTRONICS

VOLUME 15 No. 7 JULY 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

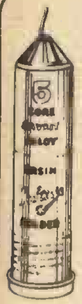
OUR AUGUST ISSUE WILL BE ON SALE FRIDAY, 13 JULY 1979
(for details of contents see page 63)

ERSIN
Multicore
5 CORE SOLDER

Handy size reels and dispensers

of the world's finest cored solder to do a professional job at home

SAVBIT



handy solder dispenser

Contains 2.3 metres approx. of 1.22mm Ersin Multicore Savbit Solder. Savbit increases life of copper bits by 10 times.

Size 5 65p inc. VAT

For soldering fine joints

Two more dispensers to simplify those smaller jobs. PC115 provides 6.4 metres approx. of 0.71mm solder for fine wires, small components and printed circuits.

78p inc. VAT

Or size 19A for kit wiring or radio and TV repairs. 2.1 metres approx. of 1.22 mm solder.

Size 19A 69p inc. VAT

Ersin Multicore Solder contains 5 cores of non-corrosive flux that instantly cleans heavily oxidised surfaces and makes fast, reliable soldering easy. No extra flux is required.

handy size reels of

SAVBIT, 40/60, 60/40 and ALU-SOL *solder alloys*

These latest Multicore solder reels are ideal for the toolbox. Popular specifications cover all general and electrical applications, plus a major advance in soldering aluminium. Ask for a free copy of 'Hints on Soldering' containing clear instructions to make every job easy.

Ref.	Alloy	Diam. (mm)	Length metres approx.	Use	Price inc. VAT
Size 3	40/60 Tin/Lead	1.6	10.0	For economical general purpose repairs and electrical joints.	£2.81
Size 4	ALU-SOL	1.6	8.5	For aluminium repairs. Also solders aluminium to copper, brass etc.	£2.81
Size 10	60/40 Tin/Lead	0.7	39.6	For fine wires, small components and printed circuits.	£2.81
Size 12	SAVBIT	1.2	13.7	For radio, TV and similar work. Increases copper-bit life tenfold.	£2.81

Sole U.K. Sales Concessionaires
Bib Hi-Fi Accessories Limited,
Kelsey House, Wood Lane End
Hemel Hempstead, Herts. HP2 4RQ

Prices shown are recommended retail inc VAT. From electrical and hardware shops. In difficulty send direct, plus 20p P & P. Prices and specifications subject to change without notice.

SOLDERING FLUX PASTES

'ERSIN' A non-corrosive, rosin based flux for general and electrical soldering in conjunction with 'Ersin' Multicore solders.

Ref RF10 52p inc. VAT

'ARAX' For general metal joining in conjunction with 'Arax' Multicore solders.

Ref AF14 52p inc. VAT

BIB WIRE STRIPPER and CUTTER

Fitted with unique 8-gauge selector and handle locking device. Sprung for automatic opening. Strips flex and cable in seconds.

Model 8B £1.21 inc. VAT
Pat. No. 144913

EMERGENCY SOLDER

Self-fluxing, tin/lead solder tape that melts with a match. For electrical and non-electrical applications.

Size ES36 48p inc. VAT

MULTICORE DESOLDERING WICK

Absorbs solder instantly from tags, printed circuits, etc. Only needs 40-50 watt soldering iron. Quick and easy to use. Non-corrosive. **Size AB10** **£1.14** inc. VAT

ECONOPAK

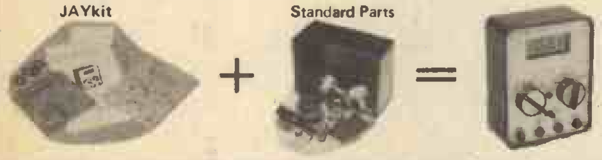
A reel of 1.2mm 'Ersin' Multicore solder for general electrical use.

Size 13A £2.61 inc. VAT

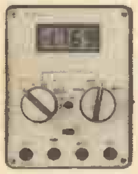
A reel of 3mm 'Arax' Multicore solder for general non electrical use.

Size 16A £2.61 inc. VAT

JAYkit + Standard Parts =



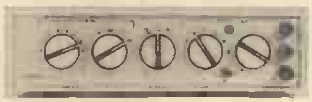
DM-2



DIGITAL MULTIMETER

- ★ DC Volts .... 1mV to 1000V
  AC Volts .... 1V to 500V
  DC Current .... 0.1mA to 0.2A
  Resistance .... 1Ω to 20MΩ
- ★ 3½ digit LCD
- ★ Battery Test Point
- ★ Auto Polarity & Zero
- ★ 1% accuracy (DC volts)
- ★ Designed around Intersil 7106 IC
- ★ Total cost around £30 (incl. case)

FG-1a



FUNCTION GENERATOR

- ★ 30mV to 10V pk-pk
- ★ 1Hz to 100kHz
- ★ DC coupled
- ★ Sine, Square & Triangle
- ★ Separate TTL output
- ★ Designed around Intersil 8038 IC
- ★ Total cost around £25 (incl. case)

Provided in a JAYkit is a Printed Circuit Board, a punched and lettered Front Panel, a Circuit Diagram and Instruction Sheet and a comprehensive and up to date Component List showing suppliers and current prices. Difficult pieces of hardware such as screws, washers etc. are supplied with the kit.

Jayen Developments, 21 Gladeside, Bar Hill, Cambridge CB3 8DY

To: JAYEN Developments
21 Gladeside, Bar Hill
Cambridge CB3 8DY
Tel: (0954) 80285

Please send:
☐ DM-2 @ £4.85
☐ FG-1a @ £4.50
(Incl. VAT and P&P)

Name ____________________

Address ____________________

Money to be refunded if the kit is returned within 10 days.

PE7

JAYkits

ELECTROVALUE

Your leading direct suppliers for

RESISTORS

Carbon Film ●

½ watt 1 to 10	E24 values (E12 over 1M)	ea. 2p
⅓ watt 47 to 4M7	E12 values	ea. 2p
¾ watt 47 to 10	E24 values	ea. 2p
1 watt 4.7 to 10M	E12 values	ea. 5p

Metal Oxide ●

½ watt Electrosil TR5 10 to 1M	2% E24 values	ea. 5p

Metal Film

0.4 watt Mullard MR25 5.1 to 300K	2% E24	ea. 5p

Wirewound

1 watt 0.22 to 3.9	E12 values	ea. 15p
2.5 watt 1 to 1K	E12 values (vitreous)	ea. 26p
3 watt 1 to 10K	E12 values	ea. 16p
7 watt 1 to 10K	E12 values	ea. 16p

THERMISTORS ●

Discs – VA1039 500 **19p**. VA1040 130. VA1100 15 **19p**. VA1104 15-25 **59p**.

Plate and Bead (vacuum) types also available from **22p** to **£4.80** each.

Buying from **Electrovalue** can cost you even less when purchased together with other items from our Catalogue 9 (See pages 85/86 and discounts scheme). You will find practically everything you want in our Catalogue at good prices backed by good service – so start buying the Electrovalue way today.

V.A.T. Add **8%** to all prices quoted here except those marked ● which carry 12½%. Prices subject to alteration without prior notice.

Discounts non-allowable on Barclaycard or Access.

● **We pay postage.** In U.K. on cw orders list value £5 and over. If under add 27p handling charge.

● **We give discounts** On cw orders only 5% on list value £10 or more. 10% on orders list value £25 or more.

● **We stabilise prices** By keeping to our printed price lists which appear, but three or four times a year.

● **We guarantee** All products brand new, clean and to makers specs. No seconds, no surplus.

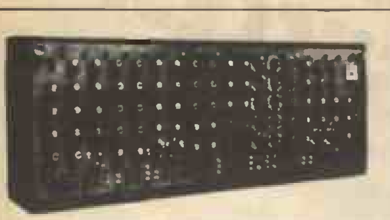
● **WE WILL SEND YOUR OUR 100 PAGE CATALOGUE NO. 9 FREE ON REQUEST**

Write, phone or call for your copy together with latest price list.

ELECTROVALUE LTD

Dept. PE7, 24 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.
Phone Egham 3603. Telex 264475
Northern Branch (Personal shoppers only), 680 Burnage Lane, Burnage, Manchester M19 1NA.
Phone (061) 432 4945.

KITS FOR SYNTHESISERS, SOUND EFFECTS



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

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

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

PHONOSONICS

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

P.E. MINISONIC Mk. 2 SYNTHESISER

A portable mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, mixer, power supply.

Set of basic component kits (excl. KBD R's and tuning pots – see list for options available).	from £61·00
Set of printed circuit boards	£8·99

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

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

FORMANT SYNTHESISER (Elektor 1977/78)

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

128-NOTE TUNE-PROGRAMMABLE SEQUENCER (P.E. Nov/Dec 77)

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

Main Circuit (Nov) excl. sw's (KIT 76-1)	£18·03
Power Supply (KIT 76-3)	£4·72
Trigger Inverter and Alt. Output (KIT 76-2)	£1·15
LED Counter (KIT 76-4)	£2·10
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2·61
PCB for KITS 76-2 & 4 (PCB 76B)	£2·54

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

The new keyboard string-instrument synthesiser.

Basic component sets:

Power Supply (KIT 77-1)	£8·77
Tone Generator (KIT 77-2)	£14·66
Diode Gates (KIT 77-3)	£18·81
Chorus Generator (KIT 77-4)	£19·08
Voicing System (KIT 77-5)	£7·38

Printed Circuit Boards:

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

Fuller details of kits & PCBs are in our lists.

P.E. JOANNA PLUS ORGAN VOICING

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

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

GUITAR EFFECTS PEDAL (P.E. July 75)

Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches	£7·69
Alternative component set with panel switches	£5·05
Printed circuit board	£1·43

ELEKTOR ELECTRONIC PIANO (Elektor Sept 78)

A touch-sensitive, multiple-voicing 5 octave piano using the latest integrated-circuit techniques for the keying and envelope shaping and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos. Details in our lists.

DIGITAL REVERBERATION UNIT (Elektor May 78)

A very advanced unit using sophisticated i.c. techniques instead of mechanical spring-lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main component set (KIT 78-1)	£45·45
Extension component set (KIT 78-2)	£43·36
PCB for Kit 78-1 (PCB 78A)	£2·86
PCB for Kit 78-2 (PCB 78B)	£1·06

ANALOGUE REVERBERATION UNIT (Elektor Oct 78)

Using i.c.s instead of spring-lines, the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main component set (KIT 83-1)	£26·18
Additional Delay Set (KIT 83-2)	£18·25
PCB (as published) to hold both above kits (PCB 9973)	£4·31

RESONANCE FILTER (Elektor Oct 78)

This filter module has been designed to allow a synthesiser to produce a more realistic simulation of natural musical instruments.

Basic component set (KIT 82-1)	£15·10
PCB (as published) (PCB 9951)	£3·29

SYNTHESISER EXTERNAL INPUT INTERFACE (P.E. Oct 78)

This unit allows external inputs, such as guitars, microphones etc. to be processed by the circuits within a synthesiser.

Basic component set (incl PCB) (KIT 81-1)	£2·94

GUITAR MULTIPROCESSOR (P.E. Dec/Feb 78)

An extremely versatile sound processing unit capable of producing, for example, Flanging, Vibrato, Reverb, Fuzz and Tremolo as well as other fascinating sounds. May be used with most electronic instruments. Details in our lists.

RHYTHM GENERATOR KITS

Several available – details in our lists.

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

A modified and extended version of the circuit published.

Component set and PCB	£4·52

GUITAR SUSTAIN (P.E. Oct 77)

Maintains the natural attack whilst extending note duration.

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

WIND AND RAIN UNIT

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

Component set (incl. PCB)	£4·26

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)

Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot	£7·58
Component set using dual rotary pot	£6·89
Printed circuit board	£1·62

FUZZ UNIT

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

Component set (incl. PCB)	£2·05

TREMOLO UNIT

Based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·94

TREBLE BOOST UNIT (P.E. Apr. 76)

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB)	£2·51

WAVEFORM CONVERTER

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

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

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

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

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

RING MODULATOR (P.E. Jan. 75)

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

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

NOISE GENERATOR (P.E. Jan. 75)

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

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

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

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

Component set (incl. PCB)	£4·77

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

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

Component set (incl. PCB)	£6·68

TRANSIENT GENERATOR (P.E. Apr. 77)

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

Component set	£4·87
Printed circuit board	£1·82

SOPHISTICATED PHASING AND VIBRATO UNIT

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

Component set	£17·38
Printed circuit board	£2·33

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£3·20

PHASING CONTROL UNIT (P.E. Oct. 74)

For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB)	£4·74

WAH-WAH UNIT (P.E. Apr. 76)

The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB)	£3·63

AUTOWAH UNIT (P.E. Mar. 77)

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

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

VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows.

Component set (incl. PCB)	£3·97

10% DISCOUNT VOUCHER (PE 74)

TERMS: Goods in current adverts & lists over £50 goods value (excl P&P & VAT). Correctly costed, C.W.O., U.K. orders only. This voucher must accompany order. Valid until end of month on cover of P.E.

ADD: POST & HANDLING
U.K. orders – Keyboards add £2·00 each plus VAT. Other goods: under £15 add 25p plus VAT, over £15 add 50p plus VAT. Recommended: optional insurance against postal mishaps, add 50p for cover up to £50, £1·00 for £100 cover, etc. pro-rata.
N.B. Eire, C.I., B.F.P.O. and other countries are subject to higher export postage rates.

ADD 12½% VAT
(or current rate if changed). Must be added to full total of goods, discount, post & handling, on all U.K. orders. Does not apply to Exports.

EXPORT ORDERS ARE WELCOME but to avoid delay we advise you to see our list for postage rates. All payments must be cash-with-order, in Sterling by International Money Order or through an English Bank. To obtain list – Europe send 20p, other countries send 50p.

PHONOSONICS · DEPT PE74 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH TERMS: C.W.O., MAIL ORDER OR COLLECTION BY APPOINTMENT (TEL 01-302 6184)

AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list: Europe—send 20p: other countries—send 50p.

KIMBER-ALLEN KEYBOARDS AND CONTACTS

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

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

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

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 48½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with most contacts (thus eliminating much interwiring) are available. Details in our lists.

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

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

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

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

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)
A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set	£24·05*
Printed circuit board	£3·03*

*This kit & PCB are at 8% VAT (all others are 12½%)

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

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

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4·58

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

Basic component set	£18·19
Printed circuit board	£3·45

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Components set (incl. PCB)	£3·95
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6·59
Audio Amplifier Module Type PC7	£7·75

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
Details in lists.

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

NEW PCB SERVICE

PCBS FOR ALL NEW P.E. & E.E. PROJECTS FOR WHICH PCB LAYOUTS HAVE BEEN PUBLISHED AND FOR WHICH FULL COPYRIGHT CLEARANCE IS AVAILABLE.

LIMITED QUANTITIES ONLY FOR AN EXPERIMENTAL PERIOD.

LET US KNOW YOUR NEEOS AND WE WILL AOVISE YOU OF AVAILABILITY AND PRICES.

INTEGRATED CIRCUITS

301	8-pin DIL	48p
318	8-pin DIL	220p
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	TO5	87p
723	14-pin DIL	51p
726	TO5	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	17½p
4011	14-pin DIL	17½p
4024	14-pin DIL	46½p
4069	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16721/6		188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	150p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

TRANSISTORS

AC128	32p
AC176	28p
BC107	13p
BC108	13p
BC109	15p
BC109C	16p
BC177	18p
BC184	11p
BC187	18p
BC204	10p
BC209C	13p
BC213	11p

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

PHONOSONICS

TRAIN FOR SUCCESS

in Radio, Television & Electronics

ICS have helped thousands of ambitious people to move up into higher paid more secure jobs in the field of electronics – now it can be your turn. Whether you are a newcomer to the field or already working in the industry, ICS can provide you with the specialised training so essential to success.

Personal Tuition and Guaranteed Success

The expert and personal guidance by fully qualified tutors, backed by the ICS guarantee of tuition until successful, is the key to our outstanding record in the technical training field. You study at the time and pace that suits you best and in your own home. In the words of one of our many successful students: "Since starting my course, my salary has trebled and I am expecting a further increase when my course is completed."

City and Guilds Certificates

Excellent job prospects await those who hold one of these recognised certificates. ICS can coach you for:
Telecommunications Technicians
Radio, T.V. Electronics Technicians
Technical Communications
Radio Servicing Theory
Radio Amateurs
Electrical Installation Work
Also MPT Radio Communications Certificate

Diploma Courses

Colour T.V. Servicing
Electronic Engineering & Maintenance
Computer Engineering and Programming
Radio, T.V. and Audio, Engineering & Servicing
Electrical engineering, Installations & Contracting

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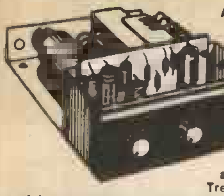
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8–15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. AC 200/250V.

PRICE £18·00 P. & P. £1·20.

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An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp.). Input 1, 15mV into 47k. Input 2, 15mV into 47k (suitable for use with mic. or guitar etc.). Input 3, 200mV into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240 volts. Size approx. 12½in. wide × 5in high × 7½in deep.

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200/240V Mains operated Solid State F.M. A.M. Stereo Tuner. Covering M.W. A.M. 540–1605KHz V.H.F. F.M. 88–108MHz.
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A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up. 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p + S.A.E. (Free with parts). All parts sold separately. ONLY £18·00 P. & P. £1·40. Also available ready built and tested £22·00 P. & P. £1·40.

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Overall size 12in wide × 8in deep × 2½in high.
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AMPLIFIER KIT (Magnetic input components 33p extra)	£14·50 P. & P. 80p
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A solid state stereo amplifier chassis, with an output of 3–4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in, short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel. Size approx. 9½in × 2½in × 1in max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only £10·00 + 50p P & P. Mains transformer with an output of 17V a.c. at 500mA can be supplied at £2·00 + 40p P. & P. If required. Full connection details supplied.

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SIZE 2" · 3" · ½" ready built. Pre-aligned and tested for 9·16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6·00 plus 20p P. & P. Stereo beacon light if required 40p extra.

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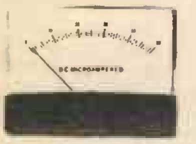

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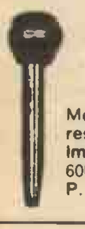

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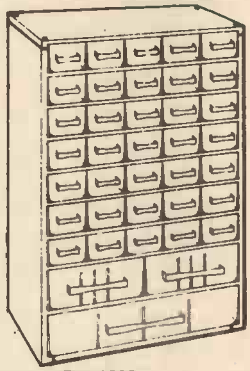

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M2

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M6

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SOL M7

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METAC ★ PRICE

M8

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M9

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List Price £130.00

METAC PRICE

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M10

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M11

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M12

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M13

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M14

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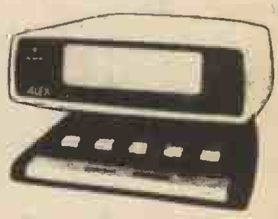
M15

DIGITAL LED CLOCK



Automatic brightness control. Weekend alarm cancel.

Features and Specification: Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on-off control. Display flashing for power loss indicator. Repeatable 9-minute snooze. Automatic brightness control. Weekend alarm cancel.

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M16

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123	6.6m Coiled Guitar Lead Mono Jack plug to Mono Jack plug BLACK	£1.69
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	84p
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	84p
126	5 pin DIN plug to Tinned open end. Length 1.5m	84p
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1.46
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	90p
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.18
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	77p
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5. Length 1.5m	93p
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1.10
133	5 pin DIN plug to 2 phono plugs. Connected pins 3 & 5. Length 1.5m	84p
134	5 pin DIN plug to 2 phono sockets. Connected pins 3 & 5. Length 23cm	77p
135	5 pin DIN socket to 2 phono plugs. Connected pins 3 & 5. Length 23cm	77p
136	Coiled stereo headphone extension lead Black. Length 6m	£1.97
178	AC mains lead for calculators etc.	51p

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157	6in	4¾in	1¾in	£1.40
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161	4in	2¼in	1½in	67p
162	5¼in	4in	1½in	76p
163	4in	2½in	2in	69p
164	3in	2in	1in	48p
165	7in	5in	2½in	£1.12
166	8in	6in	3in	£1.43
167	6in	4in	2in	93p

NUTS AND BOLTS

BA BOLTS – packs of BA threaded cadmium plated screws slotted cheese head. Supplies in multiples of 50

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½in 0BA	840	81p	¼in 4BA	847	27p
1in 2BA	842	70p	1in 6BA	848	43p
½in 2BA	843	48p	½in 6BA	849	22p
¼in 2BA	844	56p	¼in 6BA	850	27p
1in 4BA	845	47p			

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Type	No.	Price	Type	No.	Price
0BA	855	77p	4BA	857	32p
2BA	856	51p	6BA	858	25p

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Type	No.	Price	Type	No.	Price
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250mA	612	5p	1.5A	616	6p	4A	620	10p
550mA	613	5p	2A	617	5p	5A	621	5p
800mA	614	8p	2.5A	618	6p			

ANTI-SURGE 20mm

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250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

All 8p each

QUICK-BLOW 1¼ in.

Type	No.	Type	No.	Type	No.
250mA	831	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

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2025	MT150-0-12V 0-12V RMS	£1.80

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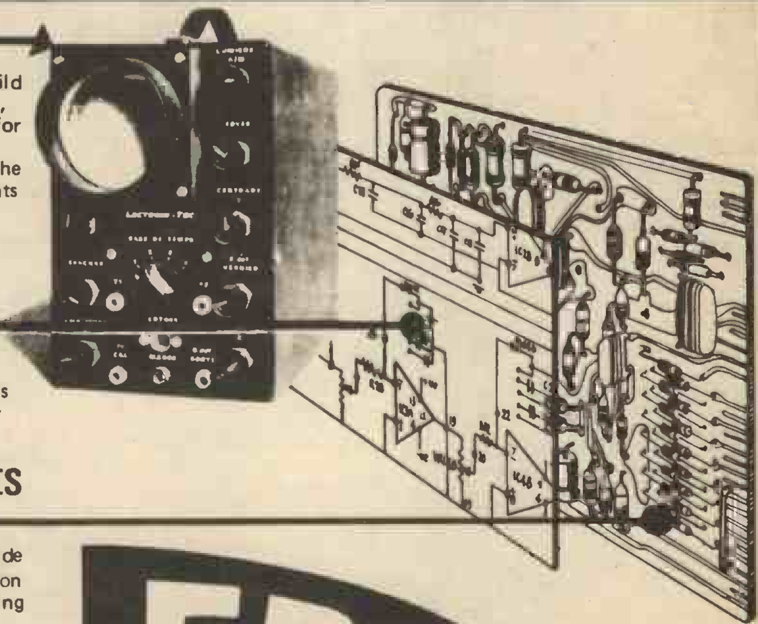

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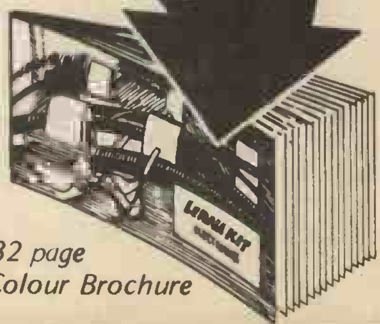

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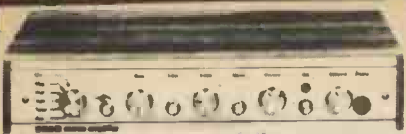

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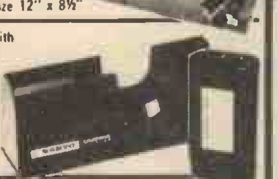

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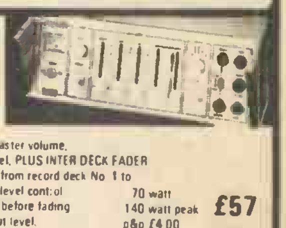

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PE VOLUME 15 No. 7 JULY 1979

AFFORDABLE—JUSTIFIABLE?

"THE AGE of affordable personal computing has finally arrived", so runs the slogan of one American supplier and, if you were paying their price and earning an American salary then it quite definitely has. However, most of us have to pay the same figures in £'s rather than $'s, making the products about twice the price and, of course, most people in the UK do not earn — in relative terms — the salaries paid across the pond.

So, has "the age . . . arrived" in the UK, well of course it depends on what you can afford! It also depends on the justification behind buying a home computer and that is still, and probably will continue to be, uppermost in the minds of many potential consumers (or their wives). Can you justify the expense? Will the computer be worth the £200 plus in time saved? Will it enable you to manage your money — if you have any left — so much more efficiently that it will pay for itself inside a couple of years? Can you use it to control your heating, hot water, burglar alarm, to wake you up with a cup of tea and help with the cooking? The answer to all these questions and to many more similar ones is, probably, not yet.

Why then does anyone other than the small business man buy a personal computer? The answer in 9 out of 10 cases is because computing is a hobby. It must be the fastest growing hobby in this country, probably in the world. It is probably one hobby which "outsiders" totally fail to understand, to them a computer must be justifed on the terms above, no doubt one day soon it will be, but at present it is used for the interest, entertainment, education and to tax the logical dexterity of the individual.

OUR SYSTEM

Most hobbyists, having bought a system quickly find out what they really need and many find that they have purchased, what turns out to be the wrong system for their needs. With this and the growing interest in computing of our readers in mind (a small survey at last year's Breadboard showed more than 35% of you listed microprocessors and allied technology as your basic interest — a greater percentage interest than in any other area of electronics) we have reviewed a different system each month for four months and will continue in this way.

Having got to grips with many systems we now have an excellent understanding of what most people require in a hobby computer and how they need it to expand to meet their developing requirements. That knowledge has been used in deciding to publish our own single board computer of which you will find more information on page 63. While other systems, developed in this country and sold in small numbers, have been limited by the lack of peripherals or lack of interest and development of software, we feel that we have overcome these problems by making our computer compatible with all Ohio Scientific Superboard accessories etc.

We believe that Compukit UK101 will be a significant step nearer "the age of affordable personal computing" in the U.K.

We also expect next month's issue to be in great demand and since distribution problems are by no means unknown at the present time, we urge you to place an order with your newsagent to ensure your copy. We believe our single board computer is in a class of its own when price and performance are compared.

Mike Kenward

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Sound Triggered FLASH

R.A. PENFOLD

WITH the aid of this sound triggered flash unit it is possible to take numerous interesting and unusual action photographs which probably could not be obtained by other means. The circuit is really just a form of sound activated switch, but it has a very fast operating speed so that it can, for example, be triggered by the sound from a balloon as it bursts, causing the flashgun to fire and take a photograph to freeze the balloon mid-burst.

Units of this type are usually only designed to provide instant triggering of the flash, and this makes it difficult to obtain pictures of shortly after the triggering event has taken place. Such photographs are often the most spectacular and interesting.

Previous experience with this type of equipment has shown that it is possible to obtain a specific delay by positioning the microphone away from the object to be photographed, the time taken for the sound to reach the microphone (due to the distance between the microphone and the object) determining the delay. Drawbacks of this system are that it can easily lead to frequent accidental triggering due to the necessary use of a high sensitivity. Also, only a fairly short maximum delay can normally be obtained, and it may not be practical at all if the event to be photographed only produces a low sound level.

Despite the slight increase in cost and complexity, it was thought to be well worthwhile incorporating a variable delay facility into the present design. The unit can be set for nominal delays of 0·5, 1, 2, 5, and 10ms, or for instant operation. However, the delay times can easily be varied to suit individual requirements, and the unit can be modified for a continuously variable delay if desired.

THE CIRCUIT

The block diagram of Fig. 1 shows the basic arrangement employed in the circuit. A low impedance dynamic (cassette recorder) type microphone is used as the transducer, and this feeds a common base amplifier stage which provides a suitably low matching input impedance. Low impedance dynamic microphones have very low output signal levels, usually less than a millivolt, and so a further stage of amplification is needed in order to boost the signal to a reasonable level.

This amplified signal is used to trigger a monostable multivibrator, and it is the length of the pulse produced by this circuit which determines the delay given by the unit. For instant operation the timing capacitor is switched out of circuit so that there is no significant delay through the monostable, although like every other part of the circuit, it obviously has a finite operating speed and there is still a very small delay.

The flash must be triggered on the falling edge of the monostable output waveform, and so the output from this circuit is fed to the input of a second negative edge triggered monostable. When triggered, this produces a brief (1ms.) output pulse which triggers a thyristor and fires the flashgun.

The full circuit diagram of the Sound Triggered Flash Unit is shown in Fig. 2.

Transistor TR1 is used as a fairly conventional common base amplifier with the microphone connecting directly into its input (emitter) circuit. This results in a small d.c. current flow through the microphone, but this is of no practical consequence.

In the interest of avoiding premature triggering it is advisable to use a sensitivity only marginally higher than is absolutely necessary. VR1 is therefore used as a simple volume control type sensitivity adjuster at the output of the preamplifier.

Transistor TR2 is used as the basis of the common emitter amplifier stage, and VR2 is adjusted to bias TR2s collector to a little more than one third of the supply voltage.

The output of TR2 is direct coupled to the input of the first monostable which is based on an NE555 i.c. This will be triggered when a signal from the microphone causes the voltage at TR2 collector to fall below one third of the supply potential. S1a selects one of five timing resistors, and these provide the five delay times.

For *instant* operation the lowest value timing resistor (R10) is left in circuit by S1a, and S1b switches the timing capacitor, C5, out of circuit. The unit, in effect, simply

INSTANT **STRIKE A LIGHT!** 10ms DELAY

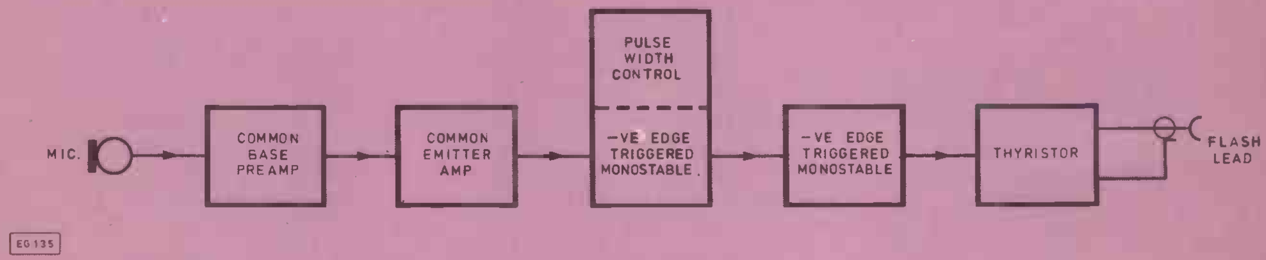


Fig. 1. Block diagram

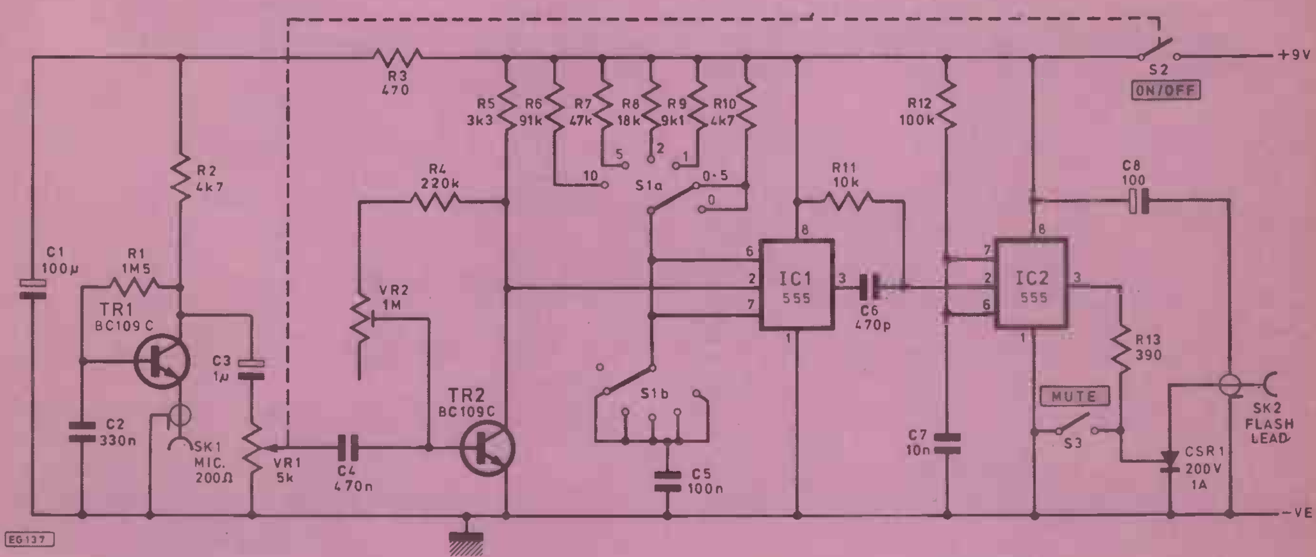


Fig. 2. Full circuit diagram

SOUND TRIGGER

WITH

VARIABLE DELAY

couples the signal at TR2 collector through to the second monostable circuit.

The latter is a second NE555 based circuit using IC2. The input of the second monostable must be high under quiescent conditions or the output will assume the high quiescent state, and switch on CSR1 via current limiting resistor R13. R11 holds the input in the high quiescent state and capacitive coupling is used to the normally low output of IC1.

Timing components R12 and C7 produce a nominal output pulse length of just over 1ms., but the pulse must merely be long enough to reliably trigger the thyristor and the pulse length of the second monostable is otherwise of no importance.

Switch S3 can be used to short circuit the gate of CSR1 to the negative supply rail and thus prevent the flashgun from being triggered by the unit. This is a very useful feature in practice which can help to avoid spurious triggering while preparing to take a photograph, but is not an essential part of the unit. S2 is the ordinary on/off switch and can be ganged with VR1.

Current consumption of the unit is about 18mA from a 9 volt (PP3 of PP6) battery.

CONSTRUCTION

It is advisable to house the project in a metal case earthed to the negative supply rail, so that the circuit is screened from stray pick-up which could cause spurious triggering of the flashgun.

The small components are assembled on a 0·1in. matrix stripboard having 17 strips by 41 holes using the layout illustrated in Fig. 3, except R6 to R10, which are mounted on the tags of S1. This and all the other point to point wiring is detailed in Fig. 4. The unit has a high overall level of gain and care to avoid earth loops must be taken if the wiring is altered in some way.

Sockets to suit the plugs fitted to flashguns are available from a few sources, but it will probably be more convenient to connect the unit to the flashgun via a flash extension cable. This has the plug (which would normally fit into the camera's flash socket) removed, so that the lead can be threaded through a hole in the rear of the case and connected to the component panel.

It is essential that the flash-lead is connected with the correct polarity if the unit is to function. Normally the black lead or outer braiding is the negative lead, and the white one is the positive lead. This may not always be the case though, and if necessary, trial and error can be used to find the correct polarity.

Note that many cassette type dynamic microphones have provision for a remote on/off control facility, and are fitted with a combined 3·5/2·5mm jack plug. Either the plug can be changed for an ordinary single type, or a 2·5mm socket can be fitted to the unit to accommodate the unused part of the plug, as on the prototype.

USING THE UNIT

With VR2 adjusted for maximum resistance (set fully anticlockwise) the unit will probably work, but with very low sensitivity. Adjusting VR2 for decreased resistance will increase sensitivity, up to the point where the collector voltage of TR2 becomes virtually equal to the trigger voltage of IC1. The unit may then fail to operate, or having triggered once it will latch and fail to operate subsequently. VR2 should be very slightly backed off from this setting.

The steps involved when taking a photograph are listed below. It is suprisingly easy to make an error in this procedure which will ruin the photograph, and it is a good idea to make a few "dummy runs" before actually attempting some exposures.

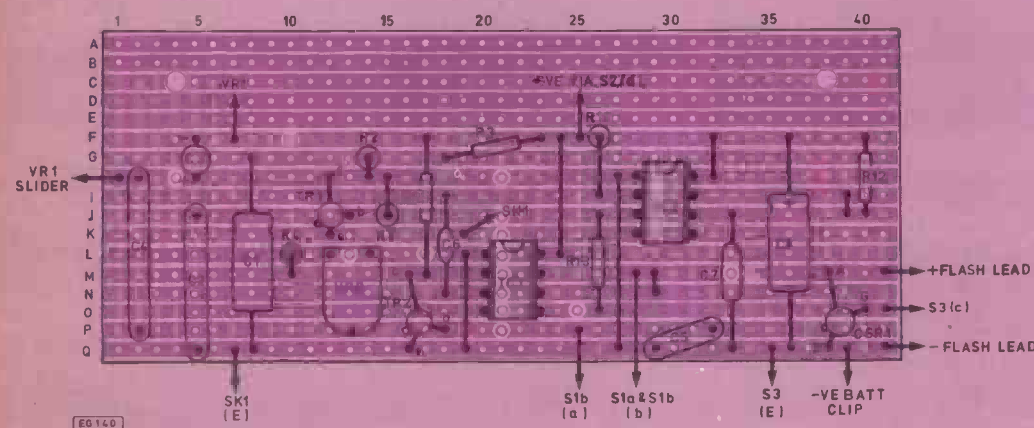
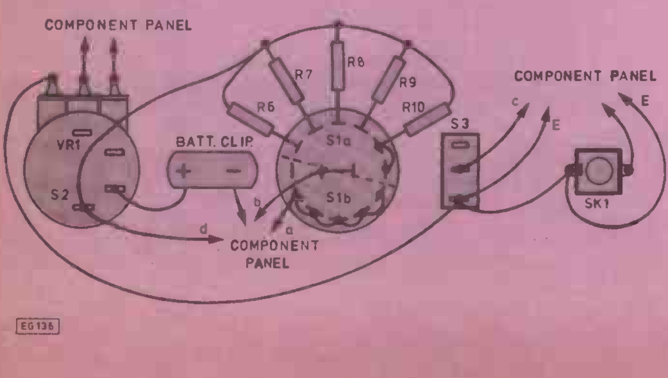
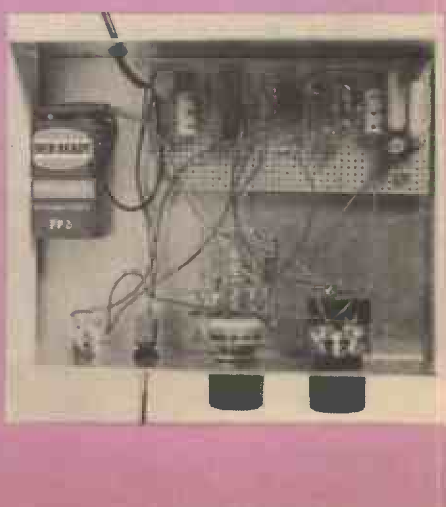


Fig. 3. Stripboard layout of Sound Triggered Flash

Fig. 4. Front panel wiring





COMPONENTS . . .

Resistors

R1	1M5
R2, R10	4k7 (2 off)
R3	470
R4	220k
R5	3k3
R6	91k
R7	47k
R8	18k
R9	9k1
R11	10k
R12	100k
R13	390

Potentiometers

VR1	5k log + switch (S2)
VR2	1M preset

Capacitors

C1, C8	100µ/10V (2 off)
C2	330n (C280)
C3	1µ/10V
C4	470n (C280)
C5	100n mylar 10%
C6	470p ceramic plate
C7	10n (C280)

Semiconductors

IC1, IC2	555 timer (2 off)
TR1, TR2	BC109C (2 off)
CSR1	Any 200V (p.i.v.) 1A (TO5 case)

Switches

S1	2-pole 6-way rotary
S3	1-pole 1-way toggle

Miscellaneous

Metal instrument case approx. 152 × 114 × 50mm
SK1, 3·5mm jack socket
2·5mm jack socket (see text)
Flash extension lead or flash socket (SK2)
Stripboard (0·1in. matrix)
PP3 battery and connector studs
Two control knobs
Wire, solder etc.

(a) Set up the subject, flashgun, microphone, and camera, and adjust the camera's controls for correct focus, etc.

(b) Close the mute switch, turn the unit on, and advance the sensitivity control to the appropriate point (a little experimentation with the unit will show how far the control must be advanced in order to give reliable triggering for various types of shot).

(c) Check that the flashgun is fully charged ready to fire, and that S1 is set for the required delay.

(d) Switch off the light, open the camera's shutter (using the B setting), open the mute switch, and activate the subject so as to fire the flash and take the picture.

(e) Close the shutter before switching on the light, and close the mute switch.

It is not necessary for there to be total darkness when the main lighting is switched off, but there should obviously be a minimal light level and the shutter should be opened for no longer than is absolutely necessary. Where flying objects that represent a hazard to the photographer or camera are to be photographed, adequate safety precautions should be taken, such as eye protection.

Water cascades from a plastic container shot by an airgun. Non-gimmick applications might include "snapping" nocturnal wildlife, or "freezing" extensometer experiments at the breaking-point

Electronic flashguns usually have a flash duration of less than 1ms and will freeze most action. A computer flashgun used close to the subject or an adjustable flash duration type can produce very much more brief flashes which will freeze virtually any action.

DELAY TIME

All the delays provided by the unit as described here are fairly short, but it is an easy matter to obtain longer delays if desired, by altering the timing resistor values. The delay time in ms. is approximately equal to 0·11R where R is the value of the timing resistor in kilohms (20MΩ max.).

If a continuously variable delay is preferred, S1 can be replaced by a SPST switch so that C5 (and the delay) can be switched out, and the timing resistance can consist of a variable resistor and a 1k resistor in series. The value of the potentiometer is chosen to give the maximum delay that is required. ★

Market Place

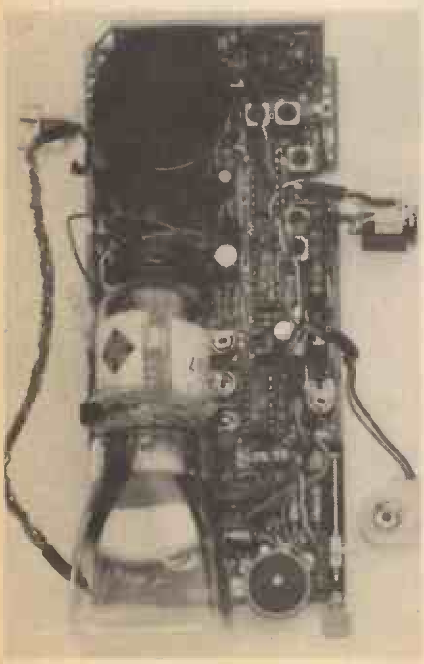
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

MICROVISION

As you might expect, it's not very big, the screen is only 2in. across the diagonal. The case is 3½ × 2¼ × 7in. Weight 21oz. including batteries (4 × 1·5V manganese alkaline).

Surprisingly, a fair picture was receivable inside the P.E. office building. In fact the Microvision did not appreciate a very strong signal from our boosted rooftop aerial. The dislike of being connected to permanent aerials was noticed by several testers of the set. This did not matter too much as the Microvision's own telescopic aerial proved sensitive enough in most reasonably open places. In one countryside test area, however, it failed to tune in anything in one house but in another, a level half mile away, reception was excellent. UHF reception can be like that.



One point to consider if thinking of buying one of these marvels of the micro age is, how mobile do you hope to be with it? Directional sensitivity of the aerial (in tests around Poole) was such that although undoubtedly portable, even pocketable, the Microvision could not be used easily "on the move". Once set down and directionally tuned, reception was OK.

Now to the question of what you see on a screen so small. While the set was under test the Miss England contest was on. Head and shoulders shots of the girls showed their facial beauty adequately. But a full length line up of the seven girls selected for the final vote showed them so small as to render them unstimulating. On another channel a two person interview was under way. Again, head and shoulders shots were OK but over shoulder two shots were getting visually dull. A football match could be followed but the players' numbers were only just readable.

So, given that technically the Microvision is an eye opener, the important consideration is, how much might you see of your particular televisual interest?

Microvision sells for around £100, with these accessories—a soft carrying case, shoulder strap, earphone, screen hood. An optional accessory pack contains a mains adaptor, external aerial connector, external 12V d.c. battery connector.

Sinclair Radionics Ltd., St. Ives, Cambs. PE17 4HJ. (0480 64646).

TWEETERS TO THE TRADE

Mullard have announced *to the trade* new 1in. dome tweeter loudspeakers. They have a frequency range of 2kHz to 22kHz, high sensitivity and low distortion.

The tweeters have a non-exposed paper dome, and a diffuser within the cover. Horn loading of the dome gives high on-axis sensitivity. The minimum recommended crossover frequency is 2kHz at which the power handling capacity is 50W measured at the input to the filter (6W at the tweeter). At 4kHz, power handling rises to 70W (8W at the tweeter). The operating power (sound pressure level of 96dB at 1m) is 2W. The tweeters, which have a ceramic magnet system, are available with 8Ω and 15Ω impedances.

Trade enquiries to Mullard Ltd., Mullard House, Torrington Place, London WC1E 7HD. (01-580 6633).

MACROVISION

One of the main problems with large screen television has been the low efficiency of the screen resulting in the need to sit in darkened conditions for viewing. The new VS500 television from Mitsubishi has a 50in high-efficiency aluminium coated screen which is both angled and concave, concentrating the light and allowing the screen to be viewed in full daylight.

The unit has a pull down front panel on which is fitted a precisely located optical mirror. This mirror reflects the image onto the screen in three primary colours from three separate picture tubes and lenses which are mounted in the consul. The lenses are factory set and require no adjustment by the user.

Remote control of on/off, colour contrast and volume is available as well as normal channel access. On changing channels visual confirmation of the programme selection is flashed onto the corner of the screen for a short period as well as a permanent l.e.d. indicator on the consul of the unit lighting up.

Although the unit is of primary interest to schools, colleges, hotels, conference centres and clubs, the manufacturers also expect large sales in the domestic market where the £3,500 price tag which includes VAT should make it a must for *every* home?

Mitsubishi Electric (UK) Ltd., Otterspool Way, Watford, Herts. WD2 8LD. (0923 40566).

JVC VIDEO SYSTEM

The Video Home System (VHS) which was developed mainly by JVC is the basic system used by many of the major Japanese companies (i.e. JVC, Akai, Hitachi, National Panasonic, Mitsubishi and Sharp). Now JVC have taken their VHS design into the portable market with the HR4100 cassette recorder.

This new unit is fully compatible with all VHS recorders, weighs only 9·3kg (4·2lbs) complete with a cassette, battery pack and RF converter. Also available for use with the HR4100 is a new colour video camera (GC4100) and a separate TV41 tuner-timer which when linked to the HR4100 will provide exactly the same basic recording and playback facilities as deck type VHS units.

The price of the HR4100 is £799·92, the GC4100 is £934·20 and the TV41 is £240·75 (all prices include VAT).

JVC (UK) Limited, Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 7AF (01-450 2621).

SINCLAIR DFM

The latest instrument to be announced by Sinclair is a digital frequency meter.

The PFM 200 has an 8 digit l.e.d. display with an adjustable accumulation period which gives high resolution from low audio frequencies right up to VHF, without the need for range changing. The guaranteed range is 20Hz to 200 MHz with frequency resolution down to 0·1Hz.

Other applications include, transmitter, audio, digital and RF circuit checking and on video equipment applications include monitoring scanning frequencies and video bandwidths.

The unit is powered from a 9V battery and is supplied complete with test leads and prods, protective wallet and operators manual. Optional extras include a.c. adaptors for 117V, 220V or 240V, de-luxe padded carrying case with lead storage compartment and a connector pack comprising BNC, co-ax, DIN and phono adaptors, plus telescopic aerial for direct signal pick-up from nearby transmitter.

The PFM 200 is priced at £49·80 plus VAT. **Sinclair Radionics Limited, London Road, St. Ives, Huntingdon, Cambs, PE17 4HJ (0480 64646).**

MINIATURE REED RELAY

Despite a body size of only 28·1mm × 7·5mm, the Erg AXM1 high reliability reed relay can switch inductive loads of up to 20W. Two versions of this axial leaded, miniature component are available: Form A-s.p.s.t. (normally open), and Form C-s.p.d.t. (changeover). Operational life at full inductive load switching rating is >1 million operations. At low levels, switching life is extended to >100 million operations.

A 10W version in the range offers coil options of 5, 12, or 24V d.c. The Form A standard version has a switching voltage capability of 200V d.c. or a.c. peak at 0·5A (resistive load).

Optional extras include external magnetic shielding and ruggedised mounting clip. Prices from £1·08 (100 rate), delivery usually from stock.

Erg Industrial Corp. Ltd., Luton Road, Dunstable, Beds LU5 4LJ. (0582 62241).

NEW SCOPE

Scopex Instruments have introduced a new dual trace oscilloscope to succeed their 4D10A range. The 4D10B retains the accuracy (± 3 per cent) and the d.c.–10MHz bandwidth of its predecessor, but has an enhanced specification made possible by the incorporation of CMOS technology.

In the XY mode Channel "A" is switched into the horizontal deflection system giving fully matched sensitivities for both X and Y axes over the entire 10mV to 50V/cm range. When used in the conventional mode, the vertical amplifiers are complemented by a 16 range timebase of 1µs to 100ms/cm.

Priced at around £188 (ex. VAT) the 4D10B is available from **Scopex Sales, Pixmore Avenue, Letchworth, Herts. SG6 1JJ.**

PROTECTING THE INQUISITIVE

Shuttered 13A sockets, manufactured to British Standards, are apparently safe from young prying fingers, but when a three-year-old is inquisitive enough to use a knitting needle to operate the shutter opening mechanism in the earth hole, then perhaps there is a need for extra protection.

Eighteen months ago two worried fathers got together and designed a simple socket cover and showed it to The Boots Company who were sufficiently impressed to market it under their own brand name.

The designers claim that the covers can not be opened by young hands.

As well as protection of the very young the covers are also used where it is important that the supply is not interrupted. On switched sockets the covers do also prevent access to the switch.

The manufacturers, Cima Products, are now producing twin socket covers retailing at around £1·25, single socket covers are around 75p.

Cima Products, 62 Queen Square, Bristol 1. Tel. (0272 28831).

STROBOSCOPE

G. BROWN Ph.D.

FOR the dynamic study of rotating and oscillating mechanical systems, the strobe light is invaluable. It plays a role equivalent to the cathode-ray oscilloscope in electronics, and the principle of both instruments is the same. In the oscilloscope, a periodic input signal is observed for a time corresponding to the sweep of the timebase and at a frequency equal to, or a sub-multiple of, that of the input signal. Similarly, the strobe light illuminates a rotating or oscillating system with very short flashes at a frequency equal to, or a sub-multiple of, that of the system. To the observer, the moving system appears stationary. Unlike the oscilloscope, the strobe light is most often used at a frequency very slightly different from that of the system under investigation, so that the system appears to move very slowly.

A simple, robust and accurate strobe light is described, which operates over the frequency range 22–360Hz with a pulse length variable up to about 400µS. The use of the instrument is described, and details are given for the construction of strobe discs for any combination of rotational and flash frequencies.

CIRCUIT DESCRIPTION

Fig. 1 shows the complete circuit diagram of the strobe light, and illustrates the simplicity of the system.

The master oscillator is an astable multivibrator using two of the four NAND gates of the CD4011AE connected as inverters. If pins 5 and 6 are at logic "0" (zero volts), then pins 4, 1 and 2 must be at logic "1" (15 volts) with pin 3 at logic "0". Capacitor C1 thus charges through VR1 and R2 until the voltage at point X rises to about 7·5 volts, causing the inverter IC1a to change state. IC1b changes state also, and C1 now discharges, producing the second half of the cycle.

CMOS data books usually quote the formula $T = 1{\cdot}41RC$ for calculating the period, T, of this circuit where, in this case, $R = VR1 + R2$ and $C = C1$. However, the author has never succeeded in verifying this relation experimentally, and instead has used the modified equation:

$$T = 1{\cdot}96RC + 7{\cdot}98 \times 10^{-4} \text{ seconds,} \qquad (1)$$

which has been determined empirically in the circuit of Fig. 1 by the method of linear regression.

Consideration of the form of equation (1) shows that the frequency variation for large values of R is much less than that at small values of R. In other words, if R is to be a calibrated potentiometer, the frequency scale would be very cramped at the high frequency end. This difficulty is partly overcome by using a potentiometer, VR1, having a logarithmic law. The calibration is still slightly compressed towards the upper frequency end, but not drastically so. The fixed resistor, R2, is used to set the high frequency limit of the oscillator.

The pulse generator is formed by the two remaining gates of the CD4011AE, again connected as inverters. The incoming square-wave from pin 3 is differentiated by C2, R3 and VR2, and the resulting spikes have their negative components removed by D1 to protect the input to IC1c. This inverter produces short pulses to logic "0", the lengths of which are equal to the widths of the input spikes measured at half their maximum amplitude. This can be understood by referring to Fig. 2(a). A positive voltage step is applied at the input: because the capacitor cannot change its charge instantly, the fast-rising step is faithfully reproduced at the inverter input, and the output is thus a voltage step from "1" to "0". As soon as the input step is complete, the capacitor begins to charge up through R and the input voltage to the inverter begins to fall. When this falls to about half of its initial value,

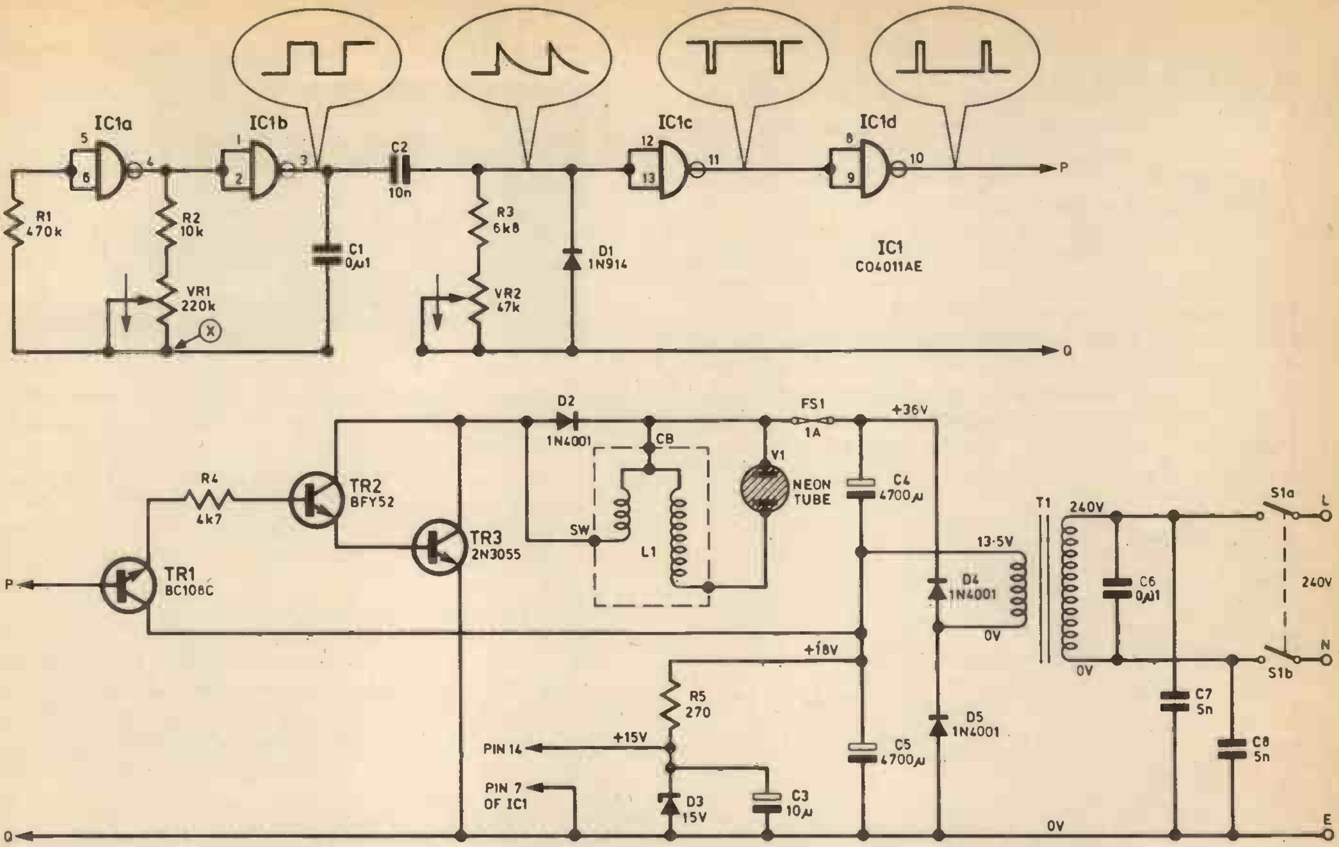


Fig. 1. Circuit of Stroboscope. The arrows on the potentiometers indicate clockwise rotation

the inverter changes state and the output returns to "1".

Mathematically, the decay curve of the spike, shown in detail in Fig. 2(b), is described by

$$v = Ve^{-t/RC}, \quad (2)$$

where e = 2·718, V is the voltage step, and v is the instantaneous voltage after t seconds. Given that the inverter will change state at V/2, this defines a pulse length, t_p, and the equation becomes

$$V/2 = Ve^{-t_p/RC}. \quad (3)$$

Rearranging gives

$$e^{t_p/RC} = 2. \quad (4)$$

Taking natural logarithms of both sides:

$$t_p = RC.\log_e 2, \ldots\ldots (5)$$

$$\text{i.e., } t_p = 0{\cdot}693RC \text{ seconds.} \quad (6)$$

A glance at Fig. 1 shows that the maximum pulse length corresponds to a resistance R = 53·8 kilohms and the minimum pulse length to a resistance R = 6·8 kilohms. C is 10 nanofarad and the extreme values of t_p are:

Maximum t_p = 0·373 milliseconds for R = 53·8 kilohms
Minimum t_p = 0·047 milliseconds for R = 6·8 kilohms

VR2 can, if required, be calibrated by linear interpolation from these extremes.

The pulses are inverted by IC1d and are used to turn on the transistors in the neon drive circuit.

NEON DRIVE CIRCUIT

The neon tube used is the high-intensity type designed for ignition timing applications, and it requires some 3 kilovolts to strike the discharge. This voltage is derived from a standard car ignition coil having a primary resistance of 3·19 ohms and designed for a 12 volt system. Although the cost of a new ignition coil can be between £6 and £9, a brief visit to a breaker's yard or second-hand shop can secure a working coil for a few pence only!

In this circuit, the coil is energised by the Darlington pair TR2 and TR3 operating as a switch, these transistors being turned on by a current pulse from TR1. The duration of the flash of light from the neon tube is governed by the length of the pulse from the CMOS circuitry. This is made as short as possible to avoid producing blurred images of high-speed movement.

When TR3 switches off, there is a large back-e.m.f. across the primary of the coil which, if ignored, would prolong the flash and increase the dissipation in TR3. To prevent this, the diode D2 is connected across the primary to short-circuit the back-e.m.f.

POWER SUPPLY

The power supply may appear unconventional at first sight, but it is a simple voltage-doubler arrangement which operates in the following way. During one half-cycle, D4 charges up C4 to 18 volts; during the next half-cycle, D5 charges up C5 to 18 volts. Because C4 and C5 are in series, the maximum voltage is +36 volts, with a second supply at +18 volts.

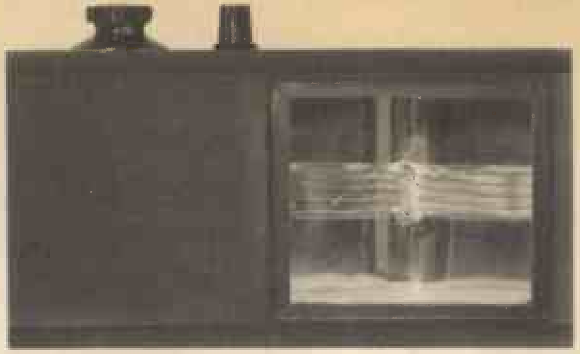
The reason for using a 36 volt line for the coil supply is explained in the next section. The 18 volt supply feeds TR1 and a simple Zener diode stabiliser for the 15 volt CMOS supply. C6, C7 and C8 act as a suppressor to limit mains-borne interference.

SPECIAL POINTS

Ignition coils are very robust—they have to be in order to operate successfully in the automobile environment: some ballasted types dissipate about 80 per cent more power than normal during starting; a capacitive discharge ignition system charges up a 0·5 microfarad capacitor to about 500 volts and then discharges it across the 12 volt coil primary.

In this strobe light, the coil is being treated very gently, although the use of a 36 volt line to energise the coil may raise a few eyebrows! It will be shown that all is quite normal, however.

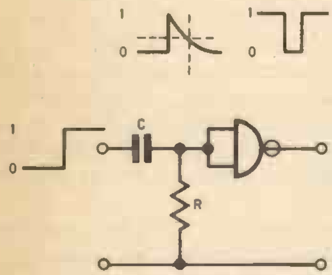
It is often difficult for the amateur constructor to measure the parameters of a pulse circuit such as this, operating at a low duty cycle. The use of a reactive load complicates the issue even more, so this article concludes with calculations of circuit parameters, and proves that the coil is not being over-run by the 36 volt supply. While the instrument can be set up with an ordinary multimeter capable of measuring d.c. up to 1 ampere, calibration is not quite as straightforward. Three methods of calibration are described in the Appendix, one requiring no test equipment other than a record-player turntable and a strobe disc, the construction of which is described later.



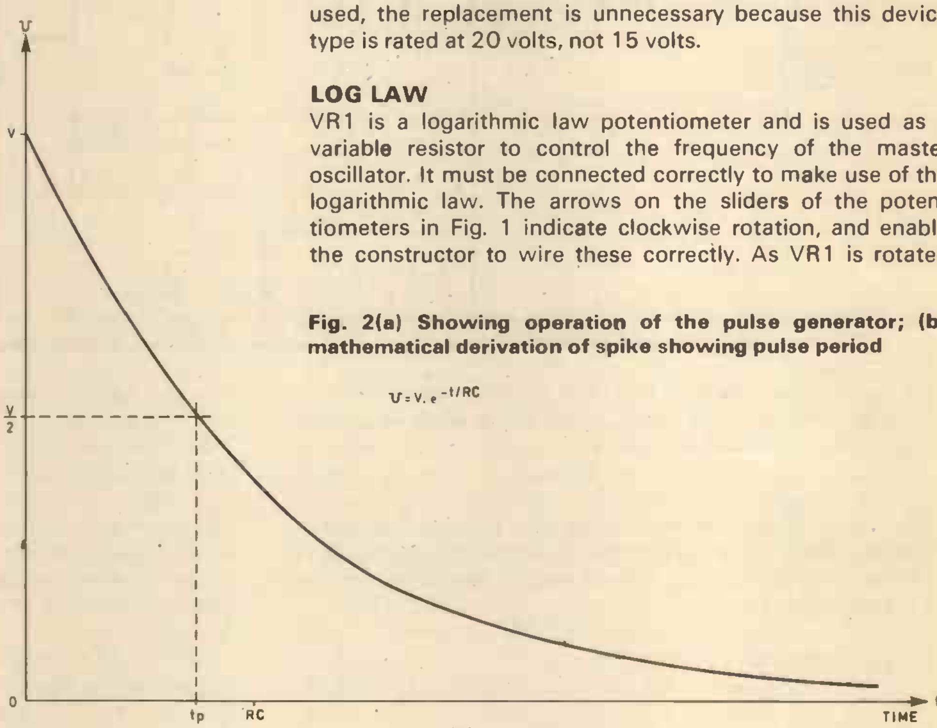
the handling of the integrated circuit, but normal CMOS handling precautions should still be taken. The power supply should be tested first, together with the 15 volt supply for the CD4011AE. If more than 15 volts are present on pin 14 of the d.i.l. socket, the Zener diode should be replaced by one giving slightly less than 15 volts. If a CD4011BE is used, the replacement is unnecessary because this device type is rated at 20 volts, not 15 volts.

LOG LAW

VR1 is a logarithmic law potentiometer and is used as a variable resistor to control the frequency of the master oscillator. It must be connected correctly to make use of the logarithmic law. The arrows on the sliders of the potentiometers in Fig. 1 indicate clockwise rotation, and enable the constructor to wire these correctly. As VR1 is rotated



(a)



(b)

Fig. 2(a) Showing operation of the pulse generator; (b) mathematical derivation of spike showing pulse period

The voltage induced in the secondary of the ignition coil is proportional to the rate of change of current in the primary. Under normal circumstances, a mechanical switch (the contact-breaker) provides the current steps from a low-resistance source (the car battery). Using a power transistor as an electronic switch is the major limitation in producing a high e.h.t. The switching time is relatively slow and, with a supply of 12 volts, the e.h.t. is not high enough to strike the neon discharge, i.e., it must be less than 3 kilovolts. However, it is roughly true to say that the switching time is independent of the supply voltage, so that if the supply voltage is trebled, so is the *rate* of rise of primary current, and thus the e.h.t. is trebled also. Using a 36 volt supply produces a peak e.h.t. of about 4 kilovolts. *Such voltages could prove dangerous and proper care should be taken if taking measurements.*

CONSTRUCTION AND SETTING UP

Layout of the components is shown in Fig. 4. Fig. 5 gives board assembly. Using a 14-pin d.i.l. socket will minimise

clockwise, the frequency decreases; as VR2 is rotated clockwise, the pulse length increases.

It is important to ensure that the 2N3055 transistor is being driven fully on by each pulse. If this check is not made, it may be found that this transistor runs very hot and that the e.h.t. is low. Put a multimeter (1 ampere d.c. range) in series with the coil primary and record the current at any frequency setting but at the maximum pulse width. Replace R4 by a 2·7 kilohm resistor and record the current again. If there is no change, the original value of R4 is correct. If the current is higher in the second case, increase R4 from 2·7 kilohms until the current begins to fall. The correct value is the highest resistance that will give the maximum current. This adjustment is necessary to compensate for the gain spreads of TR2 and TR3.

Although the voltages used in this circuit are relatively low, due respect must be paid to the e.h.t. on the neon tube. A simple, flat, parabolic mirror can be made from polished metal to direct the light, and a glass or Perspex front cover protects the fragile neon tube.

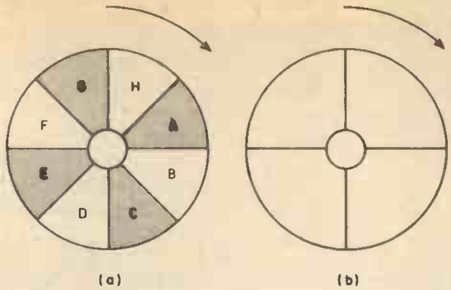


Fig. 3. Basic Strobe disc with alternate black and white sectors; (a) is the ideal form (b) simplified form

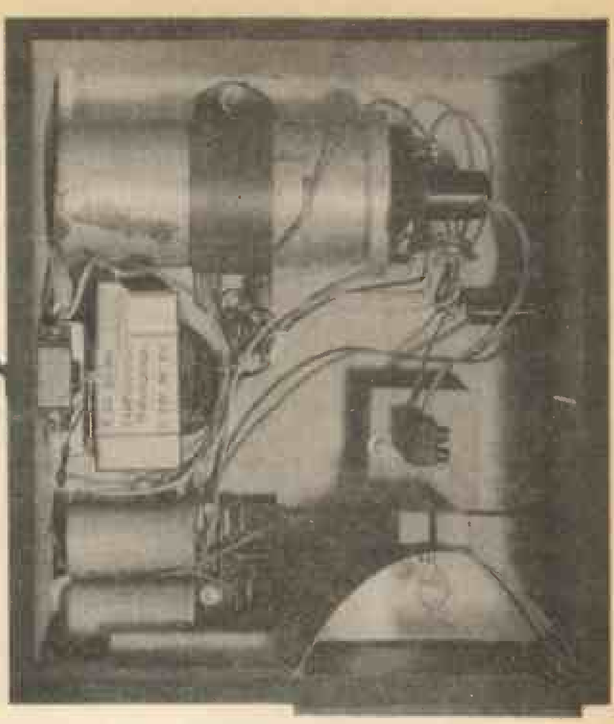
USES

Uses of the strobe can be enumerated as:

1. Almost any rotating system can be studied in motion using the strobe light. Any irregularity of motion is instantly revealed.
2. The speed of rotation of a system can be measured directly with the strobe light, subject to the precautions mentioned later governing multiple-order solutions to equation (10). If the speed of rotation is inconveniently slow, a stroboscope can be used on the system to enable a much higher pulse frequency to be used.
3. Vibrating systems, too, are interesting to study: a very common system which can be very spectacular when strobed is the loudspeaker cone. Excessive excursions are easily visible, and the loading effect of various waddings in a bass enclosure can be simply judged.
4. The use for which this strobe was originally designed was the study of a suspected defective claw action in an 8mm cine camera. A flash frequency of 16 hertz was used initially, but this was too slow to be observed comfortably. Instead, an integral multiple of 16 hertz was used: this produced a multiple image of the claw, which was much easier to study.
5. There is an unlimited number of uses for the strobe light, but as an example of the capability of the instrument, it was used to illuminate an electric power drill, the chuck of which was rotating at 3,600 r.p.m. With a flash frequency of 60 hertz and a narrow pulse width, the engravings on the chuck appeared indistinguishable from those on the stationary chuck!

CONSTRUCTION OF A STROBE DISC

Fig. 3 shows a basic strobe disc, a circular card with alternate black and white sectors. (a) is the ideal form, having equal black and white sectors; (b) is a simplified form which can be used successfully with the strobe light because of its



very short pulse duration. The artistic effort involved in (b) is considerably less, however! The strobe disc is attached to a rotating system and, if illuminated by a strobe light, will appear stationary if the speed of rotation bears a simple relationship to the strobe frequency. (If the strobe disc is intended for subsequent use under a.c. mains light, the type shown in Fig. 3(a) must be made.) To calculate the number of black lines (or sectors) required, the following procedure is very simple.

Suppose the strobe frequency is f hertz, that the strobe disc rotates at n revolutions per second and that there are p black lines (sectors) on the strobe disc.

Time between consecutive flashes = 1/f seconds. In 1/f seconds there are n/f revolutions and np/f black lines (sectors) pass a given point in this time.

To obtain a stationary display, sector A must exactly replace sector C in 1/f seconds; in other words, one black line (sector) must pass a fixed point in 1/f seconds.

$$\text{i.e.,} \quad \frac{np}{f} = 1 \text{ for a stationary display.} \qquad (7)$$

Therefore the number of black lines or sectors, p, is given by

$$p = \frac{f}{n} \qquad (8)$$

The strobe disc used in the Appendix for calibration purposes is designed to appear stationary on a $33\frac{1}{3}$ r.p.m. turntable viewed under 50 hertz mains lighting. This will now be used as an example to calculate p.

A trap for the unwary is immediately revealed in deciding what value of f to use as a.c. mains light has a flicker component of 100 hertz (one peak and one trough per cycle producing *two* equivalent light peaks), so this is the value of f to use.

f = 100 hertz and n = $33\frac{1}{3}/60$ = 100/180 revolutions per second.

$$p = 100 \times \frac{180}{100} = 180 \text{ black lines or sectors.}$$

Many people will have such a strobe disc already, but for those who have not, and to whom the artistic effort involved seems daunting, most record shops will be able to provide one.

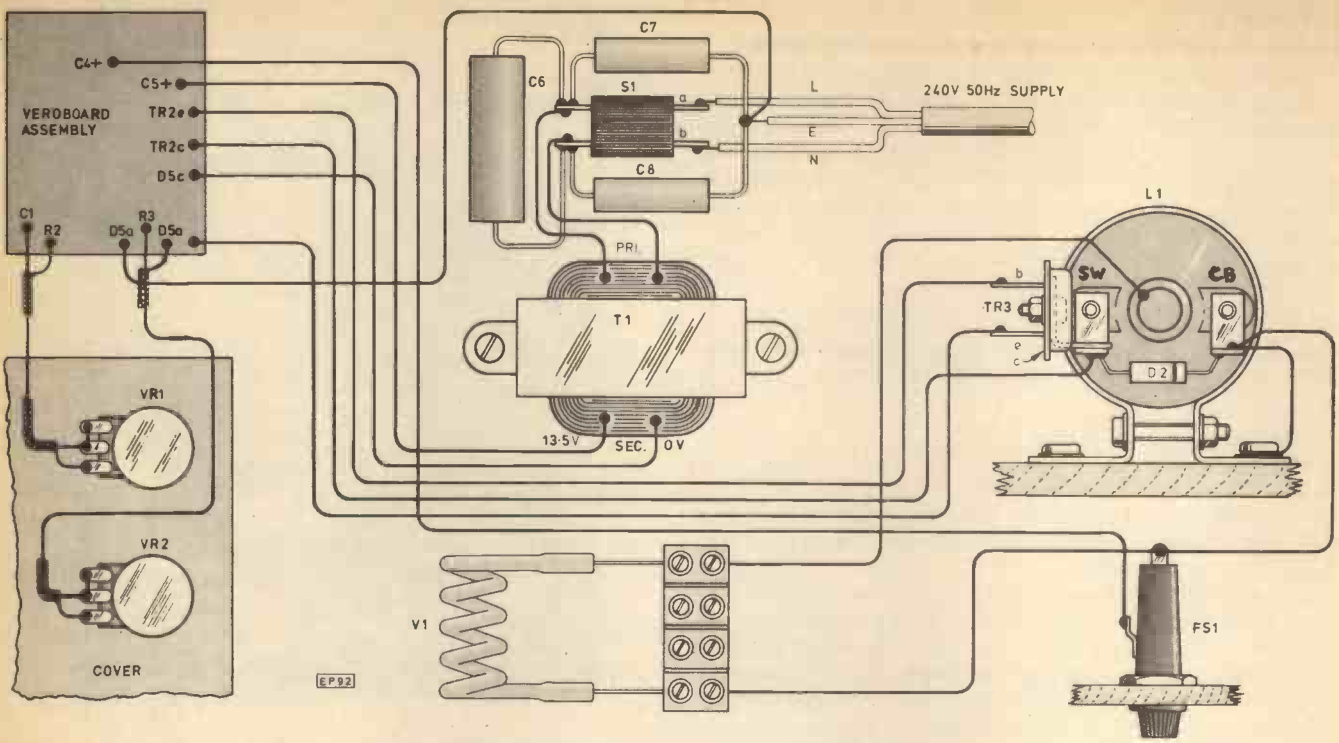


Fig. 4. Component layout and connections to Veroboard

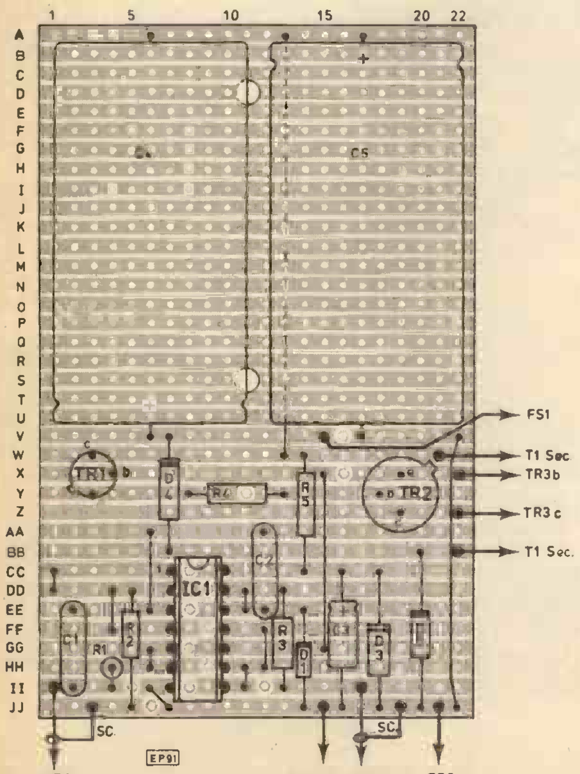
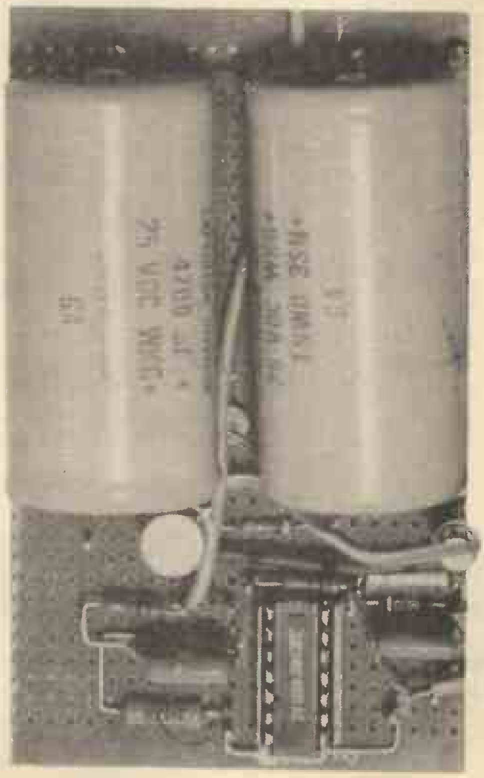


Fig. 5. Veroboard layout



APPENDIX

Measurement of peak current and power dissipation

The only item necessary for these measurements is a non-inductive resistor. Copper wire, having a resistance of less than one ohm, is folded back on itself so that the two ends are together and is wound in this configuration on any convenient former. The resistance is measured by averaging a series of voltage and current readings. The current must not be so large that it heats the wire, as it is the "cold" resistance which is required. It is then soldered in series with the coil primary.

Resistance of non-inductive resistor = 0·73 ohms
Resistance of coil primary = 3·19 ohms = R
Peak voltage across non-inductive resistor = 3·30 volts (measured on oscilloscope)

$$\text{Peak current} = I = \frac{3{\cdot}30}{0{\cdot}73} = 4{\cdot}52 \text{ amps during a pulse.}$$

Peak power dissipated in coil $= I^2R$
= 65·2 watts during a pulse.
Peak current through 2N3055 = 4·52 amps.

Collector-emitter saturation voltage (from tables)
= 1·1 volts at 4 amps

Peak power dissipated in 2N3055
= 4·52 x 1·1
= 5·0 watts during a pulse.

COMPONENTS . . .

Resistors

R1	470 k
R2	10 k
R3	6k8
R4	4k7
R5	270

Capacitors

C1	0µ1, polyester
C2	10n, polyester
C3	10µ, 25V elect.
C4, 5	4,700µ, 25V elect
C6	0µ1, 1,000V
C7, 8	5n, 1,000V

Potentiometers

VR1	220k, logarithmic
VR2	47k, linear

Semiconductors

IC1	CD4011AE
TR1	BC108C
TR2	BFY52
TR3	2N3055
D1	1N914
D2	1N4001
D3	BZY88 C15V Zener
D4, 5	1N4001

Miscellaneous

L1	Car ignition coil, 12V type, 3·19 ohms primary resistance.
V1	Neon flash tube (type FT3, Service Trading Co.).
FS1	1A fuse with holder.
T1	Mains transformer. Secondary 13·5V (or 15V) r.m.s., 2A.
S1	Double pole mains switch.

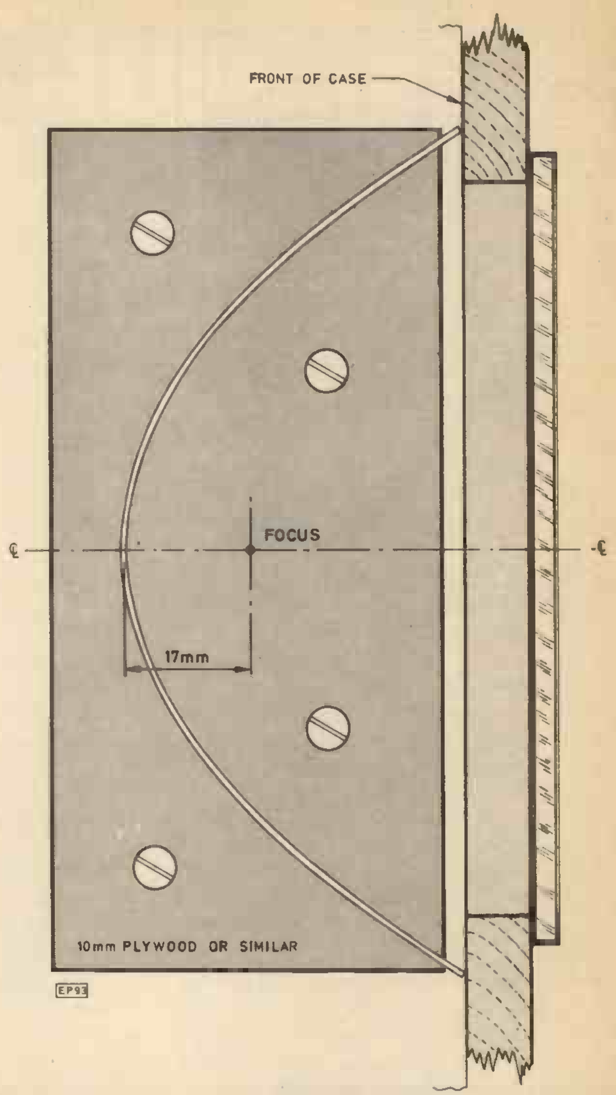


Fig. 6. Template for forming plywood parabolic profile in which reflector is placed. The lid has similarly shaped pieces attached

The average dissipations and current are derived from the peak figures by multiplying by the duty cycle. Obviously this is variable, so the maximum figure is used, corresponding to the highest frequency and the maximum pulse length.

From equation (1), minimum period $= 2{\cdot}76 \times 10^{-3}$ seconds
From earlier calculation, maximum pulse length $= 3{\cdot}73 \times 10^{-4}$ seconds

$$\text{Maximum duty cycle} = \frac{3{\cdot}73 \times 10^{-4}}{2{\cdot}76 \times 10^{-3}} = 0{\cdot}135.$$

Maximum average current = 4·52 x 0·135 = 0·61 amps
Maximum average coil dissipation = 65·2 x 0·135 = 8·8 watts
Maximum average 2N3055 dissipation = 5·0 x 0·135 = 0·68 watts

These figures show how conservative the ratings really are, and why the power transistor does not require a heat sink. It runs barely warm at maximum dissipation: under normal conditions of use, the maximum duty cycle is only required in the very brightest ambient lighting conditions.

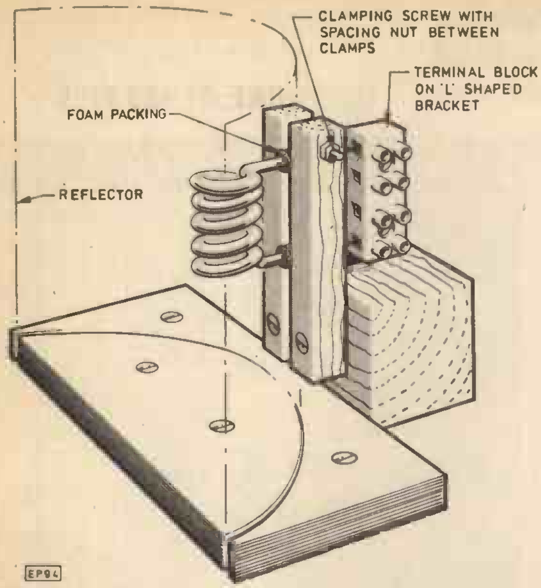


Fig. 7. Showing neon fixing. The centre of the helix forms the reflector focus

Table 1
A list of the calibration frequencies in hertz

Turntable speed (r.p.m.)	**33⅓**	**45**	**78**
Order (eqn. 10)			
1	100·0	135·0	234·0
2	50·0	67·5	117·0
3	33·3	45·0	78·0
4	25·0	33·8	58·5
5	—	27·0	46·8
6	—	—	39·0
7	—	—	33·4
8	—	—	29·3
9	—	—	26·0
10	—	—	23·4

Calibration of the strobe light

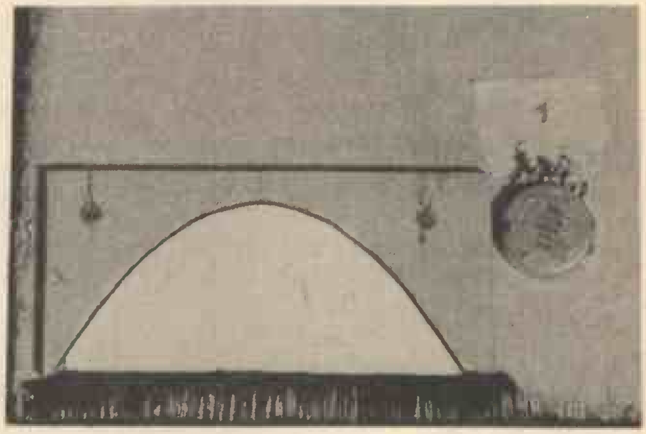
Three methods of frequency calibration are given here so that all constructors can calibrate their instrument, whatever test equipment they possess.

1. *Using a frequency counter.* This method is trivial when such an instrument is available. A rectangular 15 volt pulse is present at pin 10 of IC1. Some frequency counters do not perform well when counting narrow pulses, so a second measurement may be worthwhile on the 50 : 50 square wave on pin 3 of IC1.

2. *Using an oscilloscope.* Lock the timebase externally to the 50 hertz mains frequency, and set the sweep duration to 40 milliseconds. The timebase will now be running at 25 hertz. With the master oscillator of the strobe at minimum frequency, feed the signal from pin 3 of IC1 into the Y-amplifier and slowly increase the strobe frequency. The first stationary waveform obtained should be one cycle of a square wave. The frequency control can now be marked 25 hertz. Increase the frequency until the next stationary waveform appears. There should now be two cycles on the trace. Mark this point 50 hertz. Proceed in this manner, marking the points 75, 100, 125, 150, 175 hertz, and so on. The strobe is now calibrated.

3. *Using a strobe disc.* This method requires no apparatus other than the turntable of a record player and a strobe disc for $33\frac{1}{3}$ r.p.m., described earlier. The calibration is just as accurate as that obtained in method 2; the only drawback is that the calibrated spot frequencies are rather strange values and not the regular series produced by the oscilloscope method. Nevertheless, to be able to calibrate a scientific instrument without recourse to any standard measuring instrument is quite a rarity, and will be appreciated by many constructors.

With the strobe disc on the turntable rotating at $33\frac{1}{3}$ r.p.m., switch on the strobe light at maximum frequency and adjust the pulse length to give a comfortable level of illumination. Reduce the frequency slowly, while watching the strobe disc, until a stationary display is seen. Mark this position of VR1 100 hertz, the design frequency of the stroboscope. Reduce the frequency further until another stationary display is seen: mark this position 50 hertz. Repeat twice more, marking out 33·3 hertz and 25 hertz.



Parabolic groove in lid to take top of reflector

There are several stationary displays because the rigorous solution to equation (7) is

$$\frac{np}{f} = 1, 2, 3, \ldots\ldots \qquad (9)$$

This can be seen by reference to Fig. 3(a). The first order solution corresponds to sector A replacing sector C in 1/f seconds. The second order solution corresponds to sector G replacing sector C in 1/f seconds, and so on. Because f is the only variable in this experiment, the frequencies for stationary displays are given by the formula

$$f = \frac{np}{1, 2, 3, \ldots.} \text{ hertz,} \qquad (10)$$

hence the four calibration points above. Two further series of calibration points can be provided by running the turntable at 45 and 78 r.p.m. with the same stroboscope. A full list of calibration frequencies is given in Table 1.

A fourth method of calibration, which the author found surprisingly successful, is to use equation (1) together with the logarithmic law of VR1 to produce a theoretical frequency scale for VR1. However, anyone attracted by this method should first derive his own form of equation (1), because the linear regression method absorbs any deviation of C1 from 0·1 microfarads into the "constant" term, 1·96.

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7403	.15•	.19•	7453	.16•	—	74141	.76•	—	74194	1.21•	—
7404	.16•	.21•	7454	—•	.19•	74145	.75•	1.05•	74195	1.01•	1.05•
7405	.16•	.21•	7455	—•	.19•	74147	1.59•	—	74196	1.18•	1.05•
7406	.26•	—	7460	.16•	—	74148	1.32•	—	74197	1.18•	1.05•
7407	.26•	—	7470	.27•	—	74150	1.02•	—	74198	1.81•	—
7408	.17•	.19•	7472	.23•	—	74151	.67•	.88•	74199	1.81•	—
7409	.17•	.19•	7473	.28•	.29•	74153	.67•	.48•	74221	—	.99•
7410	.15•	.19•	7474	.28•	.29•	74154	1.21•	1.25•	74240	—	2.25•
7411	.25•	.19•	7475	.44•	.43•	74155	.67•	.78•	74241	—	2.25•
7412	.18•	.19•	7476	.30•	.29•	74156	.67	.78•	74242	—	2.25•
7413	.27•	.40•	7478	—	.29•	74157	.67•	.55•	74243	—	2.25•
7414	.71•	.79•	7482	.73•	—	74158	—	.58•	74247	—	.95
7415	—•	.19•	7483	—	.75•	74160	1.21•	.99•	74248	—	.95•
7416	.25•	—	7485	1.18•	.88•	74161	1.21•	.65•	74249	—	.95•
7417	.34•	—	7486	.25•	.29•	74162	1.21•	1.25•	74251	—	.83•
7420	.16•	.19•	7489	2.60•	—	74163	1.21•	.65•	74253	—	.99•
7421	—•	.19•	7490	.34•	.62•	74164	1.02•	1.15•	74257	—	.99
7422	—•	.19•	7491	.73•	1.05•	74165	—	.78•	74258	—	.99
7423	.25•	—	7492	.46•	.75•	74166	1.02•	—	74259	—	1.50•
7425	.25•	—	7493	.34•	.65•	74168	—	1.85•	74266	—	.35•
7426	.25•	.19•	7495	.54•	.88•	74169	—	1.85•	74273	—	2.25•
7427	.39•	.19•	7496	.67•	1.26•	74170	1.85•	1.65•	74279	—	.48•
7428	.38•	.19•	74107	.27•	.35•	74173	1.41•	.88•	74283	—	.99•
7430	.16•	.19•	74109	.44•	.35•	74174	1.01•	1.05•	74290	—	.83•
7432	.25•	.25•	74112	—	.35•	74175	.81•	1.05•	74293	—	.83•
7433	—•	.19•	74113	—	.35•	74176	1.01•	—	74295	—	1.05•
7437	.25•	.25•	74114	—	.35•	74177	1.01•	—	74298	—	1.25•
7438	.25•	.25•	74121	.27•	—	74180	1.01•	—	74365	—	.51•
7440	.17•	.19•	74122	.50•	.75•	74181	2.21•	2.99•	74366	—	.51•
7441	.70•	—	74123	.60•	.78•	74182	.81•	—	74367	—	.61•
7442	.50•	.55•	74124	—	1.25•	74184	1.81•	—	74368	—	.51•
7445	.60•	—	74125	.51•	.39•	74185	1.62•	—	74386	—	.39•
7446	.60•	—	74126	.51•	.39•	74188	2.97•	—	74670	—	1.85•
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4009	.54•	4068	.21•
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4011	.18•	4070	.21•
4012	.18•	4071	.21•
4013	.48•	4072	.21•
4014	.92•	4077	.21•
4015	.92•	4081	.21•
4016	.43•	4082	.21•
4017	.81•	4085	.92•
4018	.92•	4086	.92•
4019	.56•	4093	.81•
4020	.92•	4099	1.81•
4021	.92•	4502	.92•
4022	.92•	4508	2.46•
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4024	.65•	4511	.95•
4025	.18•	4514	2.70•
4026	1.84•	4515	2.70•
4027	.51•	4516	1.07•
4028	.70•	4517	4.10•
4029	1.18•	4518	.95•
4030	.56•	4521	2.54•
4032	1.08•	4522	1.89•
4034	1.89•	4526	1.89•
4035	1.06•	4528	.92•
4040	.92•	4534	7.12•
4042	.70•	4536	3.74•
4043	.81•	4543	1.62•
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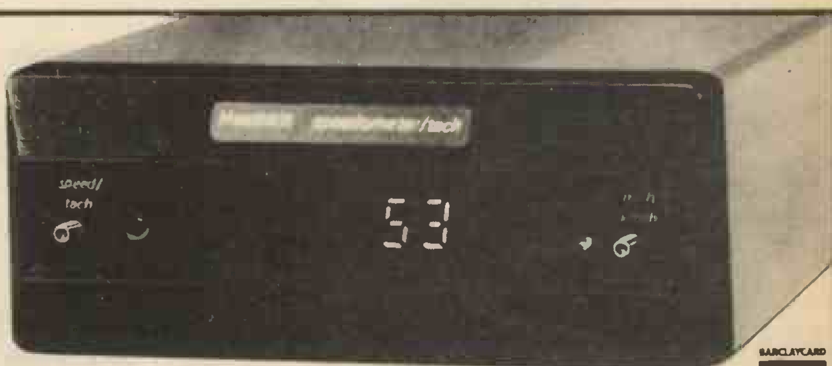

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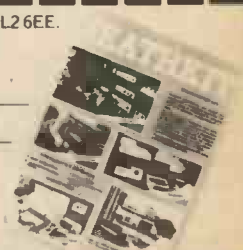

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IEA/Electrex—February 25–29, 1980. National Exhibition Centre, Birmingham. Details: Industrial and Trade Fairs Ltd. Tel: 021-705 6707.
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ADVANCED CTV CHASSIS—THE TX9

In developing the TX9 single board chassis, Ferguson (Thorn Group) believes it has achieved a major breakthrough in colour television technology.

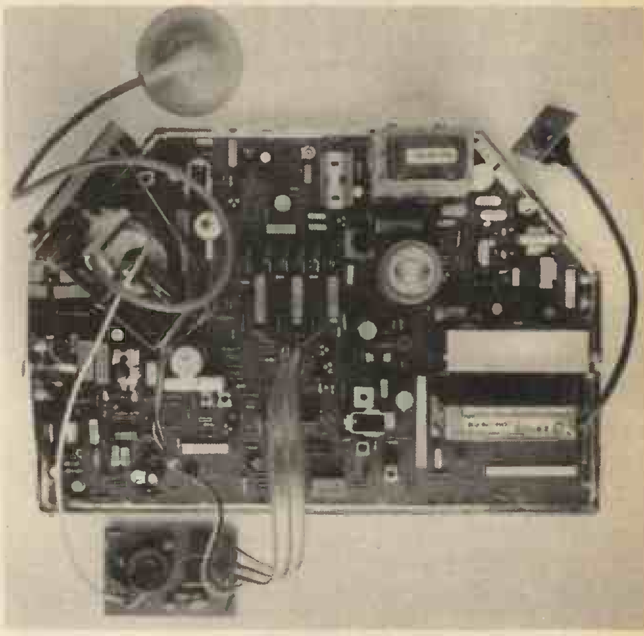
The chassis will drive a new range of 14, 16, 18 and 20in. screen sizes without the need for any component or electrical changes.

The five circuit elements which contribute most in reducing component count consist of a tiny surface acoustic wave filter which replaces most of the conventional i.f. coils; a luma chroma processor single chip which alone amplifies and decodes picture control and colour information; an e.h.t. diode split transformer acting for horizontal output, focus and e.h.t. rectification; an integrated field time base i.c. and an efficient, compact thyristor p.s.u.

Designed from the outset to be assembled automatically, the TX9 chassis is made up with 70 per cent of its components tested, inserted, and tested again on board. This ensures a reliability and subsequent high performance, which is further endorsed by the considerable reduction in preset adjustments required.

Servicing the TX9 will inevitably result in savings since component replacements are common across a range of receivers meaning that less money need be tied up in spares.

The first television featuring this chassis in a new series (which will replace the 9000 family) is the 14in. model 3755 portable which is expected to be released to the trade in September, 1979. No price has yet been fixed.

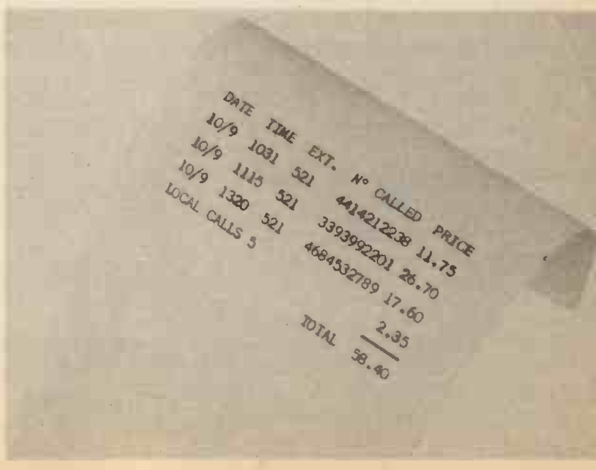


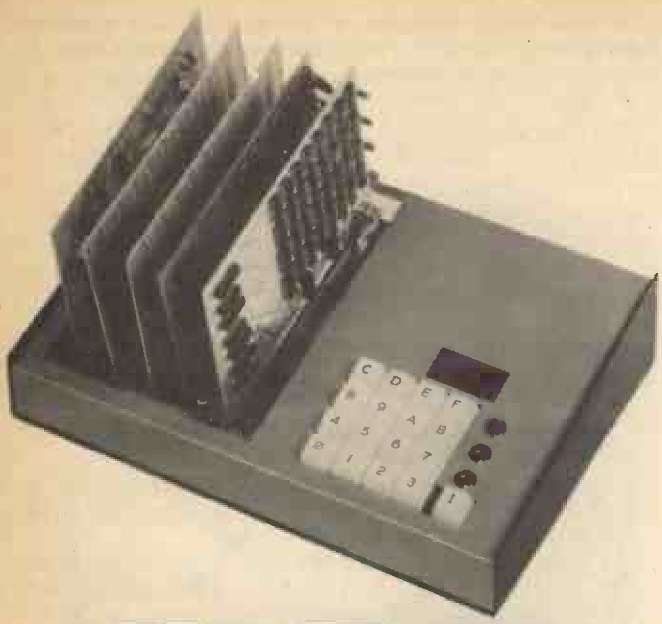
TELEPHONES 1984 STYLE

A French company called Norex produce a telephone accounting system which has now arrived in this country via Rack Data Ltd. of Bourne End, Bucks. It's a case of "watch out!" on those personal telephone calls made at work, because this system is the answer to a prayer for companies who suffer from indiscriminate or excessively liberal use of telephones by employees. On the other hand, if you like ringing up your aunt in Australia at the company's expense, it could be the end of the road. The system can monitor details of every call on every extension. The picture below says it all!

The "Teleprintex" comprises a CPU which can be connected to any PABX telephone; it is self-testing, and in the event of a failure can indicate the location of the fault by printout. The printer documents recorded data on up to 15,000 telephone calls from a floppy disc, at the request of a separate keyboard unit.

A system costing £6,500 can support 20 lines and 128 extensions.





ELF II REVIEW

A.A. BERK B.Sc. Ph.D.

The Cosmac Elf, from Netronics R & D Ltd, has been one of the most popular and fast-selling small systems produced for the hobbyist in the U.S.A. It is based around the RCA 1802 MPU which has some remarkable features. H.L. Audio (advertising in this issue) are marketing the machine in this country and they kindly lent one to our contributor for review.

THE exciting feature of this system is its modularity. This implies at least two important advantages. Firstly, the buyer can start with a very basic, and hence cheap, system and slowly build it up as interest and financial outlay permit. Secondly such a system is usually more expandable, fundamentally, than a one-board computer. Both of these advantages are most admirably inherent in the Elf, and while there are disadvantages described below, these two points should be borne in mind throughout.

I shall describe the various parts and levels of the machine in the order they would normally be purchased.

An interface to the *P.E. VDU* is also described.

BASIC MACHINE

This consists of a double-sided, plated-through p.c.b. of excellent quality in every way, containing a hexadecimal key-pad, five spaces for expansion sockets, the MPU, clock and support logic plus four other switches labelled: I, RUN, LOAD and M/P.

The 1802 is an 8-bit processor with sixteen 16-bit, two 8-bit, four 4-bit and three single-bit internal registers. Any of the 16-bit registers (R(1), ... , R(F)) may be used as the Program Counter to tell the MPU where to find the next instruction. In addition to holding addresses during the execution of a program, each R-register may be regarded as two separate 8-bit registers, thereby providing, on-chip, 32 bytes of scratchpad RAM, selectable by unique machine-code instructions.

Referring to the 1802-architecture diagram, R(0).1 denotes the high byte of register R(0) and R(0).0 the low byte, and similarly for the other registers. The diagram shows all the other registers provided with the number, in brackets, of bits in each.

D (8 bits) is the most important of these and is a pretty typical accumulator through which all logical and arithmetic commands must be routed as well as all load and store instructions. Operations such as "LOAD", "STORE", "ADD" etc automatically refer to D and may not be used directly for the R-registers. This creates the restriction, for instance, that R-registers must be loaded with data (or even cleared) by loading D first and then one half of R, followed by D again and the other half.

The greatest restriction is the lack of ability to call subroutines by an 1802 instruction code. This does not restrict the power fundamentally, but makes it harder to perform the same activity. Despite such restrictions (as well as having only one accumulator) the 1802 is very rich in conditional branch and skip instructions and includes some branches which depend upon the state of a set of external flag lines ($\overline{EF1}$, . . . , $\overline{EF4}$). These may be set by any external hardware from simple switches to the complex workings of one's kitchen appliances.

There is an I/O flip-flop (QFF) whose state may be set and checked by machine code instructions and is connected to a l.e.d. on the Cosmac Elf. It is this line which is used for the serial communications such as cassette. The 1802 is perfectly fitted for hardware control purposes and it is surely in this area that its best use is realised. There are so few pins left after the above is taken care of, that the 16 Address-Bus bits have to be multiplexed onto 8 address lines and must be latched at the appropriate time by external devices to address more than 256 bytes of addressable memory. Such latching gives the usual 64K maximum memory addressing.

Direct Memory Access (DMA) and interrupts are very well catered for on the 1802 and are used to their maximum advantage by the Elf system. The hex keyboard uses this structure as follows.

Each time a byte (2 hex digits) is to be loaded into the

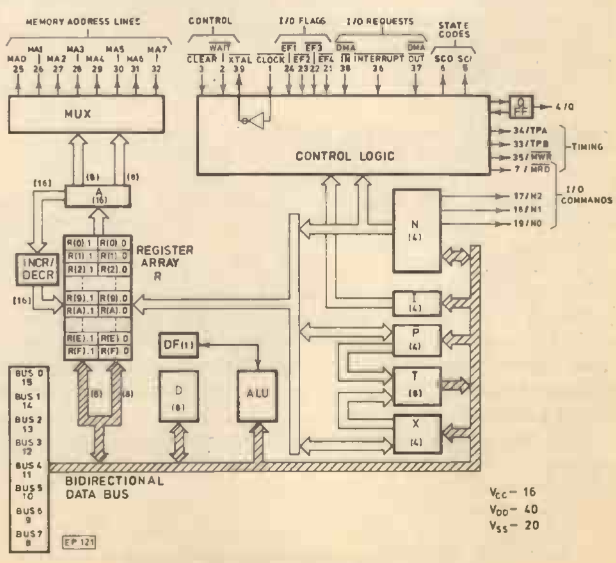


Fig. 1. 1802 architecture diagram

machine, the appropriate two hex keys are pressed, one after the other, followed by the I (input) button. The two key-pressings are latched into two 4-bit buffers, and if more than two key-strokes are made, only the final two strokes are remembered, allowing the user to change his mind before I is pressed.

Pressing I causes a DMA request to pass the latched byte into whichever address the machine is set up to access at that instant (stored in R(0)) and causes the 2 hex characters to be displayed on the 7-segment l.e.d. displays.

In order to load a program into any computing machine, the correct address block must be accessed (location by location) as the program is fed in, and a Program Counter set-up with the start-address of that block. This will force execution of the program "from the top". This procedure is technically termed "loading" and is normally performed on a computer by some resident program—which has to remain in ROM to prevent its demise upon switch-off—and is termed a Loader.

It is provision of such firmware for a machine which causes many of the headaches associated with system design. Does one provide a very low-cost and simple firmware monitor, of which the user will tire very easily, or a complex, sophisticated and expensive program which influences and demands a great deal of the hardware design of the entire system?

The interesting point about the 1802 is that there is a simple loader on the chip itself and this is used by the basic Elf board. It has no ROM, only RAM (256 bytes).

Access to the loader- which only loads sequentially in memory from address location 0000 is created by a pulse on the $\overline{\text{LOAD}}$ input to the MPU provided by the load switch next to the keyboard. Also included on the chip is the ability to run the program thus loaded.

The only other switch provided is a memory protect switch (M/P), which protects RAM from being overwritten and is used during viewing of the information loaded into the memory block based at 0000 without destroying it. M/P is part of the Elf's keyboard and display circuit and is not a part of the 1802's structure. In this way, also, any other program block in memory may be executed—from a hardware control routine to a BASIC interpreter—simply by loading into 0000 the instruction CO (a jump command), followed by the address of the start of that program block. This is exactly how the expansions to the basic system—right up to BASIC and beyond—are implemented.

TV CHIP

The other feature of the basic board is the 1861 chip, which is a TV Controller and may be used to display on a TV, the bit patterns (as short black and white lines) stored in a block of 256 bytes of memory. Letters and characters may be displayed on the screen by placing the right 1s and 0s in a block of memory. In this way, the 1861 claims to provide a video "graphics" interface to the computer and, while going part of the way, it is rather cumbersome and crude and provides characters too large, and too slowly, to be of more than educational use. However, the TINY BASIC language, described later, does use this aspect of the Elf for its output and gives an excellent introduction to BASIC in general.

As a consequence of the simple nature of the TV chip, the bandwidth necessary for its display, through a u.h.f. modulator, is quite restricted. It was thus found that the cheaper version of the ASTEC modulator provided an excellent output to the TV's aerial socket, even when working on +5V. The power supply on the basic board is set up to accept a.c. or a raw +8V d.c. supply and H-L Audio sell an excellent p.s.u. which will deliver +8V plus all the other voltages needed for the various expansions available. The regulator and smoothing circuit of the basic p.c.b. provides power for the basic board itself plus one of the expansion connectors—other expansion boards must have their own regulators and smoothing capacitors, as on any well-designed motherboard system.

In order to fully appreciate and use the 1802 machine code, a book is very important—Tom Pittman's "A Short Course In Programming" is an excellent example and is available through H-L Audio.

The basic board provides the first-time buyer—perhaps having little or no technical background—with an excellent introduction to everything from basic soldering to the full complexity of machine-code programming. However, it is very restricted and fiddly to program and one very soon needs to access parts of memory randomly with the ability to store on and load from cassette. This takes the user to the next level of the machine.

GIANT BOARD

As mentioned above, one of the five expansion sockets is fed from the basic board's regulated +5V supply—this is the far left socket which allows one to plug in Netronics' Giant Board.

I would certainly say that the full potential of the machine cannot be appreciated without having expanded at least to this level, and many may decide to go no further.

Included in the board is, first and foremost, a 256 byte block of ROM containing a system monitor which is stated to occupy the memory locations F000 →FOFF. In fact, only the upper 4 bits and the lower 8 bits of the 16 address-bus bits are demultiplexed off for decoding and the monitor is thus resident as *copies* in sixteen pages of memory and may be contacted in blocks starting at any of the following addresses: F000, F100—FF00. The Giant Board also contains the all-important cassette interface. Other components of the Giant Board are as follows.

One 8-bit parallel input port is provided into which an ASCII keyboard fits for the use of BASIC.

One 8-bit parallel output port is provided for user-configuration as well as a set of 14 lines used to communicate with I/O devices via dedicated machine-code instructions within the 1802. This lends further weight to the argument that the system is excellently fitted for hardware control applications.

An RS232C interface and a 20mA loop are also included, and these interfaces, of course, need supplies in addition to the standard +5V provided.

The System Monitor allows the user six commands for program development and cassette storage. To place the machine in a mode whereby the System Monitor has control, the user must perform the following actions.

Run, Load and M/P must be set *off*—this is a system reset normally given by a reset button on other machines. Load is then set *on* which begins the 1802's loader function at the address 0000. A jump instruction (CO) is then typed, followed by the Input button. CO appears on the display and the 1802 is ready to load address 0001. In this address is loaded the upper byte of the start address of the monitor (FO, normally, though F1, F2 etc, will do), then the lower byte (00) and Load is set *off*. This little block of 3 bytes is a small program in itself and is executed by setting Run on. It causes a jump to the system monitor which then waits for one of its six commands:—00, 01, 02, 03, 04, 05. They have the following meanings—

00 followed by an address will run a program starting at that address.

01 plus an address allows examination of the contents of that address and pressing "I", repeatedly, displays the subsequent locations' contents.

02 is similar but allows modification of contents-for loading and editing programs etc.

03 and 04 allow cassette writing and reading of programs.

05 gives the facility for searching memory for a given byte.

It is at this point that one has a real computer at ones disposal. Each time a command has been used, the Run switch is turned *off* and then back *on* and the same jump is executed to the Monitor.

To execute any program, either a jump from 0000 or the 00 command in the monitor can be used.

The cassette interface was found to be very fast—it timed at around 1200 baud and will write or read a 1K block of memory in around 8 seconds. This speed is essential for the Elf as all its software expansions are provided on tape and would be very cumbersome on a slow interface.

4K RAM

To run any of the software expansions such as BASIC, Elfbug (a machine-code monitor using the TV interface) etc, or to write larger, more complex programs, more memory is essential. There are two main ways to expand the memory. The "do-it-yourself" man could buy one of the prototype boards, which plug into the expansion sockets and wire up his own memory. He would need some address decoding to make it sit in the correct place in the main memory map of the machine, some latches to demultiplex off the upper byte of the address and an on-board +5V regulator.

However, standard 4K memory boards, using 2102s, are available with latches, address decoding, regulator and jumpers to allow the user to choose their memory positions.

One such board of 4K RAM is necessary for BASIC and very useful for Elfbug, which is described below.

The main limitation of the basic l.e.d. display is that full addresses plus contents cannot be displayed. Elfbug uses the TV interface to display a block of 24 locations, plus addresses, which may be modified on the screen. The hex characters are very large and extremely readable. Elfbug also allows the registers to be displayed, execution of a program and the setting of breakpoints.

The monitor itself takes up $\frac{3}{4}$K of storage but requires 416 bytes workspace, in addition, to run the TV interface. It is loaded from cassette and is fully relocatable-though its position in relation to user-workspace is critical.

BASIC

The TINY BASIC interpreter available is described below and requires a minimum of 4K RAM normally configured to lie from address 0000.

The space taken up by the interpreter is from 0000 to 0F3F and includes the video display buffer (contents of the TV screen at any instant), various flags and 26 variable contents (variables are capital letters only from A to Z). This, then, is a RAM based BASIC and may not reside in ROM or EPROM.

In addition to 4K RAM, an ASCII keyboard is required and is available to plug directly into the Giant Board—H-L Audio's Power Supply Unit is fitted out to supply the requirements of this keyboard.

With the original 256 bytes of RAM on the basic board (which is relocated above the 4K RAM), the user has 384 bytes available for BASIC programs—quite adequate for many simple routines.

The BASIC is an integer version allowing calculations in the range −32768 to +32767 and has no scientific functions or exponentiation: +, −, X and ÷ are all that are provided.

PEEK and POKE exist, as does a call to a machine-code routine via the USR function. No FOR – – – NEXT statement is provided which is a great restriction; and, of course, no strings or arrays.

PRINT, IF – – – – THEN, GOTO, LET (which is optional), INPUT, GOSUB, SAVE and LOAD (for cassettes), etc. are included and will provide an excellent introduction to this high level language.

In order to gain the most from the language, Tom Pittman has written an excellent book "Introduction To Programming In TINY BASIC" and is essential for the beginner.

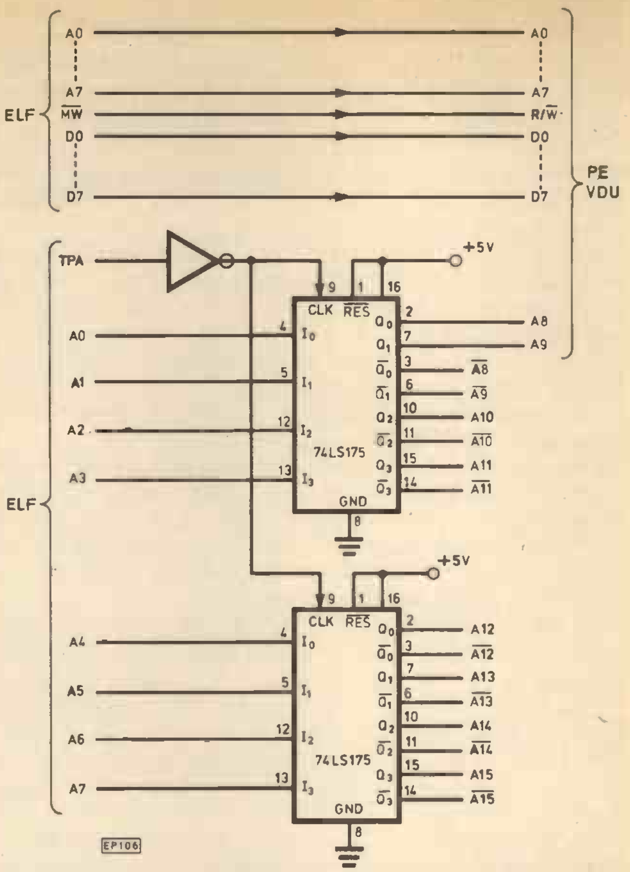


Fig. 2. Simple interface

The ASCII keyboard used with the BASIC is of good quality and when mounted in a cabinet looks pleasant and handles very professionally. The photograph shows the complete system mounted in the available cabinets which, with their blue IBM colours, look most attractive.

The BASIC ASCII characters, as displayed on the TV via the 1861 TV chip, are, in some cases, a little difficult to read at first—very few of these large letters can be fitted on the screen comfortably and hence only a small portion of one's program is available for viewing. However, the display is adequate and will provide an excellent start into the field of computing.

As usual with American machines, the TV frame frequency is 60Hz and, though the majority of UK TVs have the flexibility to adapt, I had trouble with a Philips TV which had no adjustment for frame hold or line hold.

PE VDU INTERFACE

In order to circumvent the problems of the video interface, or to provide a powerful addition to the machine, a more professional VDU may be added. The asynchronous VDUs on the market which communicate via a RS232 interface are quite appropriate at this point but a cheaper, and more flexible, alternative is to use the memory mapped PE VDU. The interface is quite simple and provides a 1K block of RAM for display on a TV screen. See Fig. 2.

The VDU requires 10 address lines (A0, . . ,A9), a read/write line (R/$\overline{W}$), two select lines ($\overline{ENABLE}$ and $\overline{VDU\ SELECT}$) and eight data lines (D0, ... , D7). The data lines are connected straight through and R/$\overline{W}$ is taken from $\overline{MW}$ on the Elf. A0, . . , A7 are also connected straight through, while the upper address lines (A8 and A9) and the address decoding have to come from latches as shown in the diagram. Here, two 74LS175s are used to demultiplex off A8, . . , A15 as well as

(Above) Elf II with 16K RAM on board, professional ASCII keyboard and power supply

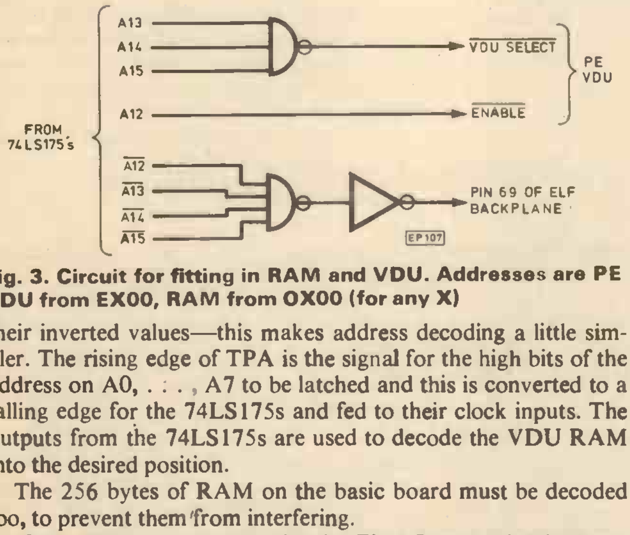


Fig. 3. Circuit for fitting in RAM and VDU. Addresses are PE VDU from EX00, RAM from 0X00 (for any X)

their inverted values—this makes address decoding a little simpler. The rising edge of TPA is the signal for the high bits of the address on A0, . . . , A7 to be latched and this is converted to a falling edge for the 74LS175s and fed to their clock inputs. The outputs from the 74LS175s are used to decode the VDU RAM into the desired position.

The 256 bytes of RAM on the basic board must be decoded too, to prevent them from interfering.

If the VDU is to be used with the Giant Board only, the diode CR4 on the Giant Board should be lifted to free the 256 bytes of RAM for external decoding. Pin 69 of the backplane of the motherboard is then the enable (active high) for this block of RAM.

FX00 (for X anything) is the enable address for the Monitor and there is a large variety of circuitry which will fit the RAM and VDU in without conflict. One is suggested in Fig. 3.

Here, 0s on A12, . . , A15 give 1s on $\overline{A12}$, . . . , $\overline{A15}$ and hence enable a four-input NAND gate to give a zero which is inverted to enable the RAM block. This is addressed, therefore, from 0X00 (any X). The VDU is enabled by A13, A14, A15 high and A12 low—giving EX00 as base address.

This circuit should provide enough information for any adaptations to be made for the addition of further Elf family devices, such as 4K RAM boards; and, at the same time, provides all 16 address lines for any other use.

Fitting the *PE VDU* into the system will add greatly to the potential of the machine—perhaps someone will have a go at adapting the TINY BASIC to run via the VDU instead of through the 1861 chip.

DOCUMENTATION

Each board and expansion has its own details and manual included and each hardware addition has carefully written constructional details of a very adequate nature. The documentation with the software tapes, I found excellent, though, perhaps, for the absolute beginner, should be supplemented by one of the books, as mentioned above.

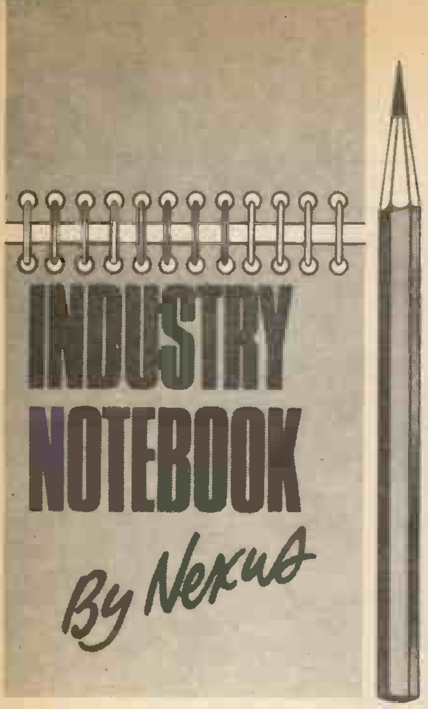
The hardware, I feel, is rather inadequately described. The absolute beginner would find it difficult to learn very much about hardware from the circuit diagrams included in the manual—the knowledgeable hobbyist will, of course, have little trouble, if used in company with the 1802 design data and some CMOS data books.

CONCLUSION

This kit, rather than forming a sophisticated personal computer, is ideal for the person who wishes to start without a large outlay, but wants to keep the options open for expansion. It is also excellent for anyone wishing to evaluate the 1802 for dedicated control purposes—though to write a long control program, an assembler would be very useful.

This last is, apparently, on its way, along with an assembler and a new video display board. All in all, most compatible with the tradition of expandability set up by the basic Elf. ★

The PE VDU is available solely from Technomatic, 17 Burnley Rd, London NW10.



Awareness

Last month I reported that schools and universities in France were to receive 10,000 microcomputers and teacher training in their use to help ease the young into the MPU era. Now the Americans have launched their Basic Computer Literacy Programme. Under this scheme the U.S. Federal Government will buy up to half a dozen microcomputers for any schoool class at any level of education.

In the U.K., computers in schools are not a new innovation. I recall that in the early 1960s Elliott Automation was encouraging their use in education but of course not on the gigantic scale now thought to be necessary. Today the Science Research Council has been addressing itself to the new challenge and has published a report "Proposed New Initiatives in Computing and Computer Applications". Half a dozen five-year projects are envisaged which include school and undergraduate training as well as post-graduate training and research.

Although our educational budgets are still under strain, cash should be found for improving microelectronics literacy in our schools. If the young are provided with awareness of the benefits of the new technology fear will be dispelled and attitudes will change.

At adult level there are so many 'awareness' programmes that it is hard to keep up with them. Apart from the Government-sponsored programmes hardly a week passes without a conference, seminar or computer "workshop" or "teach-in" being organised.

Intel Anniversary

Ten years ago most industry observers were beginning to believe that the semiconductor industry would shrink in number of companies down to three or four huge volume suppliers and perhaps a handful of specialised companies on the fringe of the industry which could survive on relatively small quantities of more unusual devices. After all, no other type of business had such high commercial risks or needed so much capital investment. Many companies of real substance had moved into the semiconductor business with high expectations only to withdraw later in a spirit of humiliation and sadly depleted bank balances.

So when, in 1969, a small break-away group founded Intel there seemed little hope of success. In fact net income for the first two years was a loss of nearly $3 million. Then revenue started to come in, first at a trickle and later, apart from a dip in 1975, at a sharp upward rate. This was achieved on the founding philosophy of the necessity of a new company having a unique product and the investment power of contemporary big timers.

Intel celebrated their 10th birthday with 11,000 employees generating $400 million turnover. This year $40 million is being spent on R & D. Intel also has a policy of constant replacement with up to date production equipment, investment this year being $120 million. That these policies are paying off is evidenced by the fact that IBM is now Intel's largest customer with orders of $25 million.

The business has been built on solid state memories and the MPU. Longest running line was the type 1103 RAM, now honourably retired after a production run of 35 million units. In the last recorded twelve month period Intel shipped a fantastic total of 200 billion bits of memory. Co-founder Dr. Robert Noyce certainly deserves the Faraday Medal which he was awarded on a recent trip to London.

Recognition

British semiconductor manufacturers seldom get adequate recognition even when they do well. Plessey, for example, has come in for a lot of criticism lately so it is only fair to record that their new remote control chips, a bipolar transmitter and MOS receiver, have already attracted an order for 500,000 sets from a European TV manufacturer. And, as they cost 30 per cent less than the cheapest competitive set of chips, there is a growing interest from toy companies who see a modestly priced remote control (without wires) as a good future prospect.

Let's cast our minds back to 1975 when Racal-Dana (then Racal Instruments) introduced in September of that year the 99 Series of counter/timer and frequency meters with the sales tag "Simply Light Years Ahead". The centre piece of all the instruments in the range was a Racal-designed chip containing some 5,000 components fabricated by Ferranti in the CDI process.

Now Racal has launched a successor range, the 9900 Series, of 13 instruments with an overall frequency range from d.c. to 3GHz. Specifications are improved, they are simpler to use, digital readouts are larger and clearer and styling has become more international. But the chip is the same.

John Ceresa, Racal-Dana's managing director told me that there is still nothing to beat the Ferranti-built CDI chip for this application. There are 10,000 of them in the 99 Series in use throughout the world, some of them with well over three years' hard service, with not a single case of chip failure. So all the models in the 9900 Series will carry a lifetime guarantee on the chip and you can't ask for better than that.

Madley

It seems unlikely that a modest little name like Madley will ever have the same aura as Goonhilly, at least to old-timers who remember the thrill of the first TV transmissions via satellite in the early 1960s. The original Goonhilly I earth terminal is still there and working but now supplemented by Goonhilly II, III and IV with still the intention of another four dishes on the site.

Meantime Madley, near Hereford, has come on stream to handle traffic through the Indian Ocean Satellite. A second dish has already been contracted for and is due for service next year and Madley III should come in 1981, with IV, V and VI to follow.

Prime contractor to the Post Office was Marconi Communications Systems whose share of the work was £6 million out of the £10 million so far invested in the Madley site.

An interesting sidelight on inflation is that a three-minute telephone call to Australia in 1930 then cost £6, equivalent to £84 today. Now you can directly dial to Australia via Madley at a rate of £3·15 for three minutes, less than 5/- in 1930 money.

And if the commonly accepted yardstick that a nation's prosperity is in direct proportion to its population of telephones and general communications capability is still correct, then the U.K. surely cannot be in decline.

Exports

Despite hard times good products still sell well. Five years ago Racal-Milgo in data communications had a full-year turnover of £6 million. In a recent 4-week trading period the company took £6·3 million worth of orders of which 40 per cent were for export. The record month was entirely at the U.K. end of the business and does not include the business in the same period achieved by the Miami, Florida, company which is also Racal-owned.

Redifon, in the flight simulator business, has clocked up £37 million of business in the past year from overseas buyers in the U.S.A., Germany, Japan and the Middle East.

But BSR, whose enormous output of record players goes 70 per cent to North America, could be hit by the relative weakness of the U.S. dollar against the pound sterling. Even so, BSR inched up sales to North America last year by 5 per cent and had a total turnover of just under £160 million.

News Briefs

CASUAL COMPUTERS

NOW open in London's Tottenham Court Road, is The Byte Shop, whose Gants Hill address may already be familiar to computer users. Demonstrations and over the counter sales of personal and business computers are the theme. Casual "lunchtime" visits by London's business men and the general public are expected, and experienced staff will be on hand to put the machines through their paces. Systems will range in price from a few hundred pounds to around £15,000.

GLASS KEYBOARD

WHEN personnel who are not totally familiar with computerised equipment, are confronted with rows of switches or a keyboard, they very often "can't see for looking", and a typical situation brought down to the home computer level could be this:

The VDU says: *Further instructions? Key Y for yes, Key N for no.*

The user's eyes and "prodding" finger then scan frantically up and down the keyboard in an attempt to find those keys. Wouldn't it be more convenient to have a keyboard with rows of buttons which have nothing written on them? And then suddenly, in the situation described above, two keys become labelled with illuminated letters; one as Y and the other as N. Or even better, one as YES and the other as NO. With Digilux by Marconi Radar Systems, you can do just this. Software alone allocates key functions, and the VDU screen labels them!

The Digilux *keyboard*, or anything like it, is usually to be found on home computers for a long time, but at a high level of sophistication there are self evident advantages. The transparent panel uses 8 vertical and 4 horizontal light beams covering the lower half of the screen.

The 400mm Digilux *touch sensitive panel* uses 64 horizontal and 64 vertical light beams spaced 6mm apart, so that a finger placed anywhere on the screen will interrupt at least one beam in each axis. When two beams in any one direction are blocked, decoding assumes that the finger is at the centre of the two, giving an effective resolution of 3mm. The generated 14-digit binary code identifying the touch position, is used to produce an electronic video-marker, with which the finger can be manoeuvred to obtain coincidence with the target. As the photograph shows, this system can be quicker at addressing an image on a screen, than requesting from a conventional keyboard.

BAEC

ONCE upon a time there was a local electronics hobby group with a membership of twenty or so. By May 1966 things were going well and the group decided to spread their wings, and the hobby, by adopting a constitution, electing a committee, and renaming the group *The British Amateur Electronics Club*. Followed up by a newsletter proper, and publicity in the electronics magazines, the group subsequently became international.

The aim of the organisation is simple. It is to help hobbyists avoid pitfalls and bugs in their pursuit of constructing, often sophisticated, electronic equipment. The Newsletter contains letters to the editor of this nature, and generally promotes cross-pollination of ideas, exchanges and sales of related items. Reviews of the various electronics magazines and their projects are included, from which we at P.E. do not escape. A Members List also enables members to discover BAEC "brothers" who might live in the locality.

There is a Beginners Section, run by Bill Stilling, a technical library operated by Robert McBride, and, of course, a number of local groups. Lapel badges are obtainable, and BAEC labels. Use of these labels on orders to many of the suppliers found advertising in electronics magazines, will give the member concessionary prices.

The Chairman and Editor of BAEC is Mr. C. Bogod, Dickens, 26 Forrest Road, Penarth, Glam. Annual subscription is £3·50 for UK members, and £4·50 for overseas (surface post), which, to avoid bank commission should be paid in sterling. Address subscriptions to the Treasurer, Mr. R. G. Voisey, 7 Twyn-y-Fedwen, Whitchurch, Cardiff.

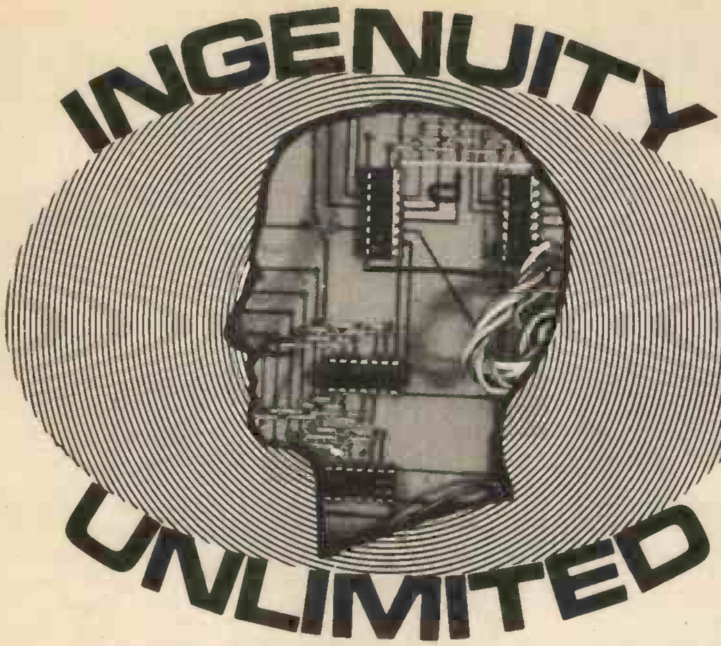
FINANCE FOR INNOVATION

THE NATIONAL Research Development Corporation (NRDC) has published a new brochure called *Finance for Innovation* which describes the various kinds of finance offered by the NRDC.

The brochure explains three forms of finance: Joint venture finance, recirculating loans, and equity and loan capital.

NRDC was set up in 1949 to promote the exploitation and development of new technology, with amounts invested being as small as £5,000, and as large as £5m. The word "exploitation" is included deliberately because the joint venture finance can apply not only to development work, but tooling up for production. The NRDC also claim to have in-house technical and patent expertise which is not generally available from other sources of finance.

A video marker follows the operator's finger across the screen, to assist referencing of the target

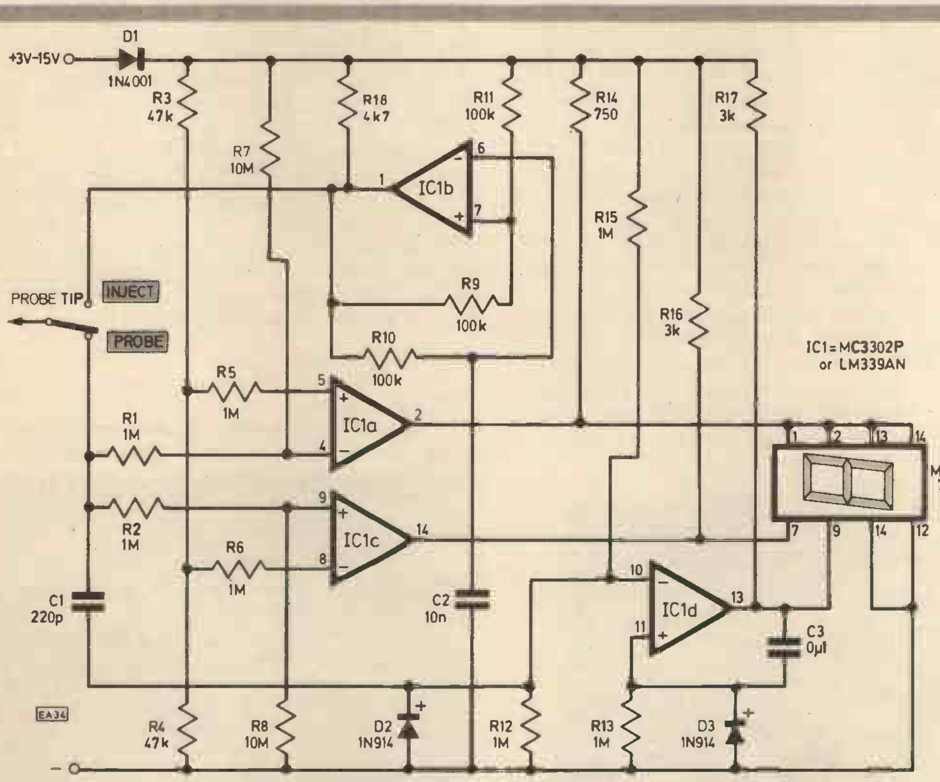


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.



LOGIC PROBE INJECTOR

THE circuit employs a low power quad comparator feeding a common cathode seven segment l.e.d. display. The display is mounted horizontally, so that the figure eight is on its side. A partially functional unit may be used since two of the segments are not fused.

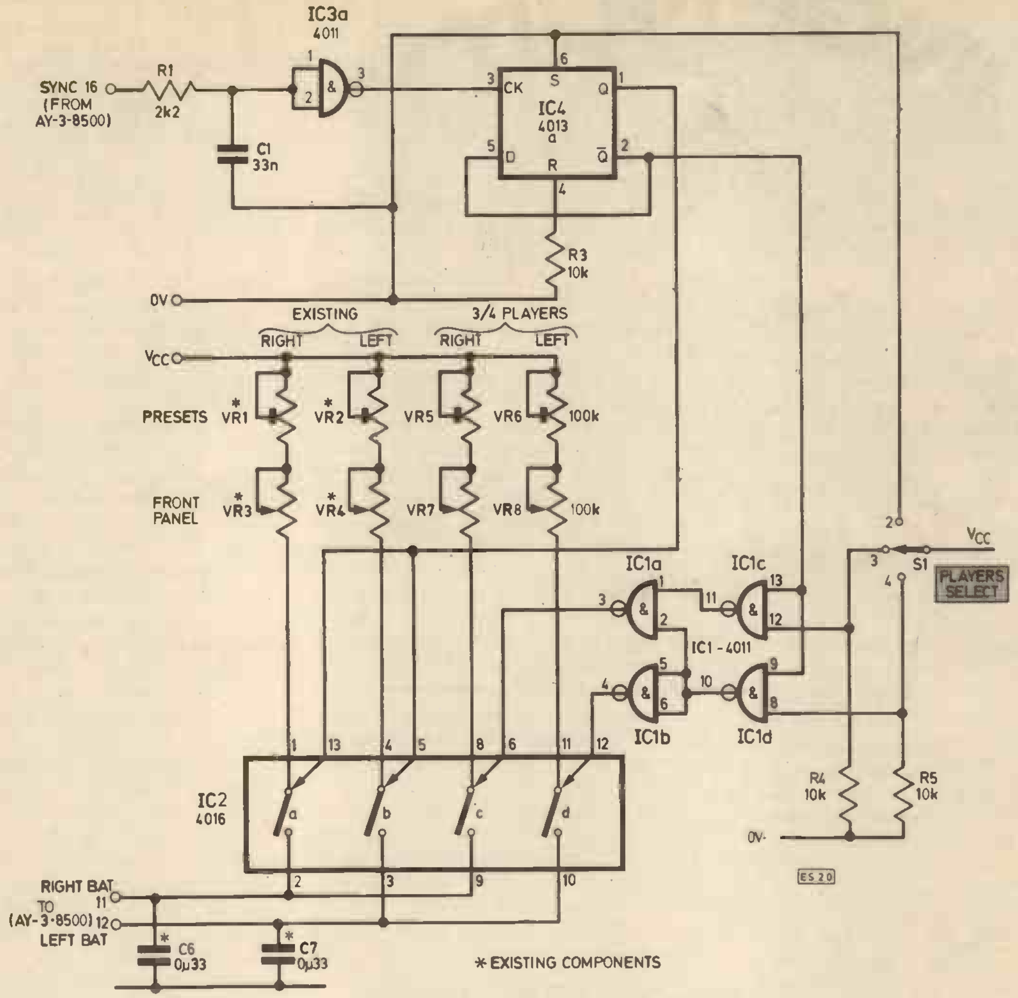
IC1a compares the input voltage with a reference voltage of $\frac{1}{2}V_{cc}$. If input is at logic 0 level, a 0 lights on the right of the display. Similarly, IC1c lights a 1 if a logic 1 is detected. A negative pulse is stretched by IC1d and lights the decimal point. If the input is floating, the display is blanked.

S1 selects either the "Logic Probe" or "Signal Inject" modes. IC1b is connected as a square-wave generator, and oscillates at around 1kHz. Rise and fall times are around 100nS.

The supply current, which is virtually independent of the state of the l.e.d. is around 9mA at 5V, to 25mA at 15V. The probe may be used with both CMOS and TTL since it has an input current of around 2µA, and a sink current from the injector of 16mA.

The supply voltage may range from 3V and 15V.

D. P. Akerman,
Coventry.



MODIFICATION FOR THE PE SPORTSCENTRE

THE circuit shown extends the PE Sportscentre game for use by 2, 3 or 4 players. The 3 player option gives 2 players on one side against one player on the other. The 4 player option gives two players on each side.

The basic AY-3-8500 chip only has two player inputs. This is extended to four by using the 4016 multiplexer chip to switch the four players bat inputs in pairs on alternate TV frames.

Sync pulses from pin 16 on the games chip are integrated by R1, C1 and IC3a to separate out the frame sync pulses. These clock the D type flip flop IC4a in the 3 and 4 player mode. The Q output is connected to a, b control inputs of the 4016 multiplexer chip IC2. When Q is high, pin 11 of the game chip is therefore connected to VR3, and pin 12 to VR4.

The $\overline{Q}$ output is gated by IC1, hence the c control input on the 4016 (for 3 players) and the c, d control inputs (four players) go high when $\overline{Q}$ goes high. Pin 11 of the games chip is now connected to VR1 and pin 12 to VR8.

The right hand bat input is thus controlled by VR3 and VR7 on alternate frames and the left bat by VR4 and VR8. The coincidence logic in the chip for detecting "bat and ball" does not notice this multiplexing of the bat signal. VR3, VR7 are thus the right team; VR4, VR8 are the left team.

In the two player option the D type flip flop is permanently set, and the a, b gates in IC2 are permanently made. The bats are then controlled solely by VR3, VR4.

The 3,4 player modification works best on the tennis. On the football and squash games the court becomes a bit cluttered.

E. A. Parr,
Carluke,
Lanarkshire.

Semiconductor UPDATE...

FEATURING : ICL 8063 HA 5195 BB 212

R. W. Coles

TEAM WORK

When you need to put together a power amplifier, for a hi-fi application or even to drive a d.c. motor in a servo system, there are quite a few different ways of setting about the job. You could be lucky enough to find an integrated power amplifier with an adequate specification so that your problem is solved in a very simple way. Generally speaking, complete monolithic power amplifiers can handle most jobs up to about 10W, but watch those THD specs at the higher power levels!

If you need a lot more than 10W, you will need to consider a discrete transistor design with a couple of 2N3055's or some other power-pair in a push-pull configuration. You will find it better to jack up the supply voltage to 60V or so for the 50W applications, and a centre tapped supply makes life easier. The pre-amplifier and driver circuits may be a bit of a headache unless you use an existing design, but suppose you want to go it alone, wouldn't it be possible to use a couple of 741 op-amps in the pre-amp and driver stages? After all, getting 741's to do what you want is easy, isn't it? Unfortunately you soon find out that there is a "credibility gap" between the puny 24V swing at 5mA or so which the op-amp can supply, and the tens of milliamps at 60V which the "power-pair" may require. You can add a couple of intermediate driver transistors of course, but then the problem of protecting the power devices against short circuits and the dreaded "second-breakdown" rears its ugly head. Oh well, didn't P.E. publish a pretty good power amp circuit back in April '75, or was it '76 . . .?

If resigning yourself to someone else's design goes against the grain you can now fill the "credibility gap" with a new device from the electronic equivalent of the 7th Cavalry, Intersil. The **ICL 8063** is a sixteen pin d.i.l. package which contains a complete driver and protection circuit system which can be put between, say, a 741 and a pair of power transistors. You can build the '8063 into all kinds of power amplifier designs, 50W hi-fi systems, 1A servo-motor drivers, beefy function generators, and so on. It's up to you. With the '8063 you don't have to accept someone else's integrated public address chip, or someone else's discrete design, you can now get into the power design scene yourself, *without* being a specialist!

To see what this chip can do, take a look at the example circuit reproduced here. This is a complete audio hi-fi amplifier delivering 50W r.m.s. using the '8063 in combination with a couple of 741's and a 2N3055/2N3791 power pair. That's teamwork.!

FASTEST THING ON FOURTEEN LEGS

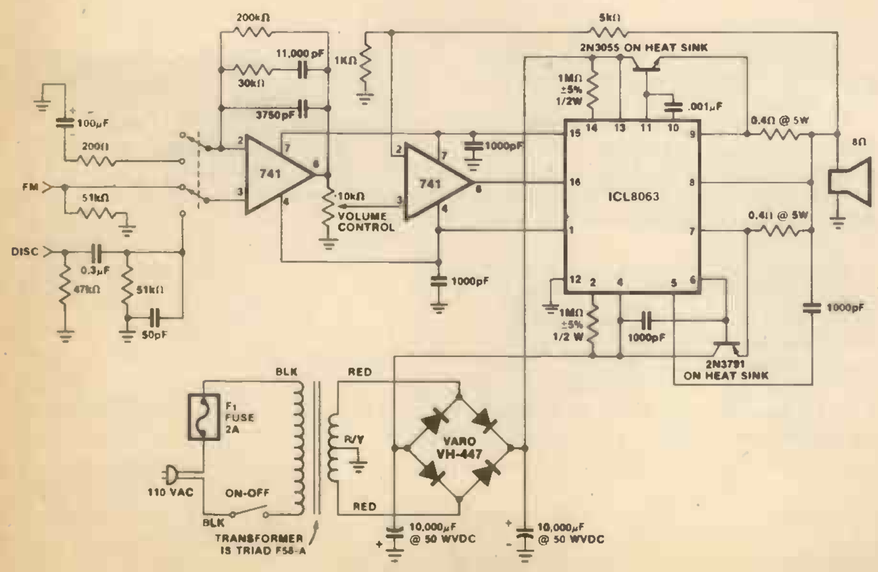
Don't get me wrong, 741's are great, but with a bandwidth that starts to droop alarmingly from 20kHz or so (in most applications) it's hardly the stuff of which great oscilloscope Y amplifiers are made—now is it? If you like the ease of use, accurate gain setting, and precise d.c. performance of op-amps like the 741, but need just a teeny-weeny bit more bandwidth—try the Harris **HA 5195.**

This incredible new monolithic op-amp has a gain-bandwidth product of 150MHz (yes, *MHz*) and it slews at an amazing 200V per microsecond to provide an 11 ns pulse response risetime which rivals TTL for speed. Down at d.c. it's almost as good as a 741 with a 20K voltage gain (open loop) and an input offset voltage of 5·0mV or so. The full power bandwidth (200 ohm load, plus and minus 5V swing) is 6·5MHz, which makes this chip the fastest monolithic op-amp around.

I always dreamed about building an oscilloscope using i.c.s throughout, and some readers may remember my Digiscope using a matrix of 80 l.e.d.s as a display screen, which was my first attempt at this. I spent ages searching for a simple but fast Y amplifier chip which could work at d.c., and eventually settled for an R.C.A. device which managed a bandwidth of almost 2MHz. I thought that was pretty slick at the time but the HA 5195 could probably manage more than 10MHz in a similar application so if anyone would like to build a "Son of Digiscope . . ." "We have the technology—we can rebuild it!"

HANDY-CAP

Remember those beautiful air-spaced 500pF tuning capacitors (condensers, actually!) which we used to use for tuning in Radio Luxembourg or the Home Service? Well, I'm showing my age again I suppose, but when you had one of *those* at the other end of the dial-cord, you really knew what "radio" was all about. These days you would use a device like the **BB 212** variable capacitance double diode and some cissy pot. The BB 212 seems to do all that those aluminium marvels used to do, only it goes in a boring, plastic, TO92 transistor package. You can swing its capacitance from 20 to 500pF, and you probably won't need beehive trimmers or padders to match the two halves because they're pretty well matched by Mullard. You don't need dial-cord of course, or flywheels or anti-backlash couplings, just a d.c. voltage which you can shift between 0 and 9V. There is one thing though, you won't be able to tune in the Home Service, or the Light Programme; you'll have to settle for Radio 1. Serves you right!



Microprocessor Evaluation System

Part 3

D.S.COUTTS

WE have now reached the point where we can start programming, but first a few preliminary notes might be useful.

NUMBER SYSTEMS

Each digit in the binary system can take the value of Ø or 1 with the least significant digit on the right. To convert decimal 46 to binary, divide the number continually by 2 as shown in Fig. 3.1 together with the binary to decimal conversion.

2	46	
2	23	Ø (Least Significant Bit)
2	11	1
2	5	1
2	2	1
2	1	Ø
	Ø	1 (Most Significant Bit)

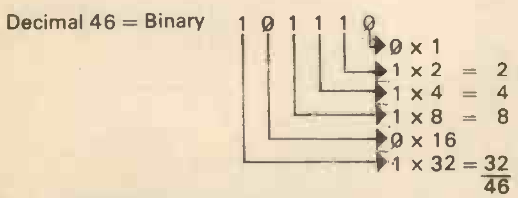


Fig. 3.1. Binary and decimal conversions

The front panel l.e.d.s on the CP1610 can display 0000000000000000 to binary 1111111111111111.

That is decimal Ø to decimal 65535.

OCTAL NUMBERS

Binary numbers are very clumsy to work with when they are large and so the octal system is often used. The binary number is divided into groups of 3 digits from the right. As 3 binary digits can give values from Ø to 7 there is no 8 or 9 in the octal system. For example:

DECIMAL	46	becomes	BINARY	1Ø1	11Ø	
			or OCTAL	5	6	
DECIMAL	125	becomes	BINARY	ØØ1	111	1Ø1
			or OCTAL	1	7	5

and the front panel l.e.d.s on the 1610 can display Octal Ø to Octal 177777.

Table 1 shows the values from Ø to 17 in decimal, binary and octal.

DECIMAL	BINARY	OCTAL
0	00000	0
1	00001	1
2	00010	2
3	00011	3
4	00100	4
5	00101	5
6	00110	6
7	00111	7
8	01000	10
9	01001	11
10	01010	12
11	01011	13
12	01100	14
13	01101	15
14	01110	16
15	01111	17
16	10000	20
17	10001	21

TABLE 1

Programs will be written in octal and with leading zeros omitted unless stated.

RUNNING PROGRAMS

When writing a program into memory that program will contain instructions for the processor, and data for the processor to work on with addresses to tell the machine where to put the results, etc. As the information is all stored in memory as binary numbers how does the machine differentiate between instructions, data and addresses? The answer is the program must be written in such a manner that the information in memory is accessed in the correct order. In Fig. 3.2 there is a simplified block diagram of the processor. At the top we have the memory sitting between addresses Ø to 377. This holds our program. Next we have the control unit. This accepts instructions from the program and controls the operation of the Arith/Logic Unit (ALU). Next we have the 8 registers: Ø, 1, 2 and 3 are general purpose, being used for computation, address pointers, etc. Registers 4 and 5 are also general purpose but have an automatic increment feature. Register 6 is the Stack Pointer (SP). This register points to an address space in memory where return addresses are stored when subroutines are used. Register 7 is the all important Program Counter (PC) which points to the next address in memory from which we will obtain data.

FLOWCHARTS

When writing programs it is useful to construct a flowchart first. Flowcharts are a means of representing programs in simplified form using standard graphical symbols. This allows you to follow your program through and check that the various jumps go to the correct places.

Rather than explain what direct and indirect addressing and immediate data, etc., mean here, it is probably more instructive to look at a few flowcharts and programs with notes. We are more interested in making the machine do something than memorising a dictionary of terms.

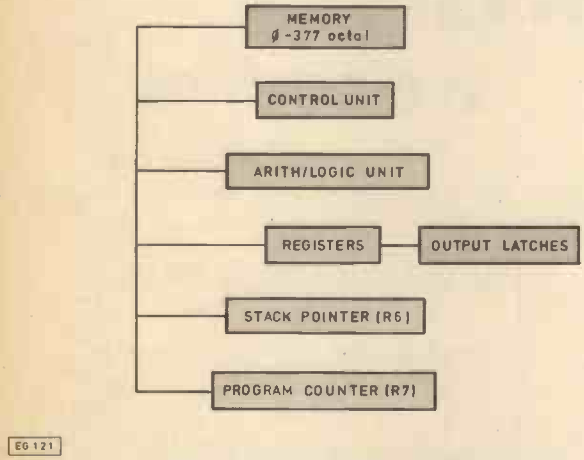


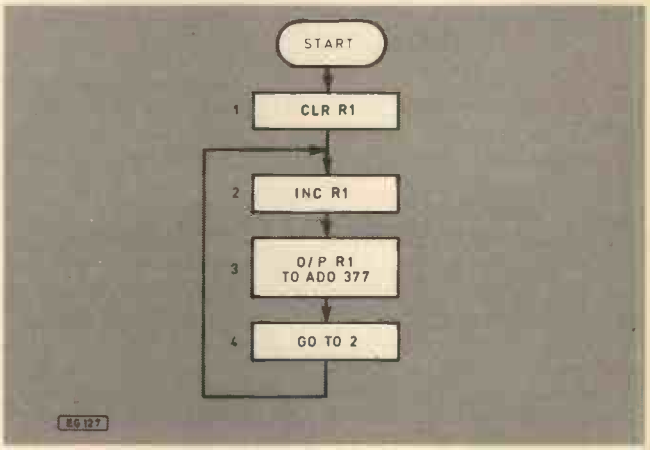
Fig. 3.2. Simplified block diagram of the processor

PROGRAM 1

This program increments register 1 and outputs it to the l.e.d.s. The flowchart and listing for the program are shown in Fig. 3.3. It starts at box 1 which says clear register 1. After that the contents of register 1 are output to the output latches and l.e.d.s by storing it in memory address 377, the first l.e.d. lights up. From box 3 we go to box 4. This box contains a jump instruction telling us to go to box 2 again. R1 is again incremented and output to the l.e.d.s.

The program will loop around boxes 2, 3 and 4 until it is stopped by putting the load/run switch back to load.

The last operation in the program was to enter Ø into address 376, therefore the address latches are pointing to address 376. When the load run switch is put to run, the first thing the processor does is to load the data from address 376 (in this case Ø) into the program counter. This tells the machine where the next item of information is located. The processor now loads the contents of address Ø into the control unit. This word must be an instruction as the machine has been told only where to fetch the information from (ADD Ø) but has not been told to do anything yet. The word in address Ø tells the machine to clear register 1. The machine increments the PC and clears R1. The PC is now pointing to address 1 in memory. As the first operation is completed the word in location 1 must again be an instruction. This is loaded into the control unit, the PC is incremented and R1 is cleared. The PC is now pointing to address 2 and as the last operation has been completed the word in location 2 must be another instruction. The word from location 2 is loaded into the control unit and the PC is incremented to point to location 3. The word in location 2 tells the machine to output the contents of register 1 but the machine has not yet been told where to send it. The word in location 3 must therefore be an address. This word is loaded into the processor and written into the address latch so that address 377 is now pointed to by the address latch and the data in R1 is written into address 377 (the output latches). Meanwhile the PC has been incremented again and now points to location 4 which must be another instruction as the previous operation has been completed. Locations 4, 5 and 6 contain 3 words telling the Control Unit to make a jump back to location 1 forming a program loop. The PC will increment to point to location 5 then to location 6 and finally it will be set to point to location 1. The instruction in location 1 is loaded into the Control Unit and the PC is incremented to point to location 2 and R1 is again incremented. We go round this loop until we stop the machine. The instructions in locations Ø and 1 are one word instructions. Locations 2 and 3 contain a 2-word instruction using Direct Addressing, i.e. the address immediately follows the instruction in memory. Locations 4, 5 and 6 contain a 3-word instruction



ADD	DATA	OPERATION	INSTRUCTION CYCLES
Ø	711	CLR R1	6
1	11	INC R1	6 } *
2	11Ø1	OUTPUT R1	11 } *
3	377	TO 377	
4	4	JUMP	
5	14ØØ	TO	12 } *
6	1	ADD 1	
376	Ø	ST ADD	

* 29 INSTRUCTION CYCLES

1 INST CYCLE = 4 MICROSECONDS

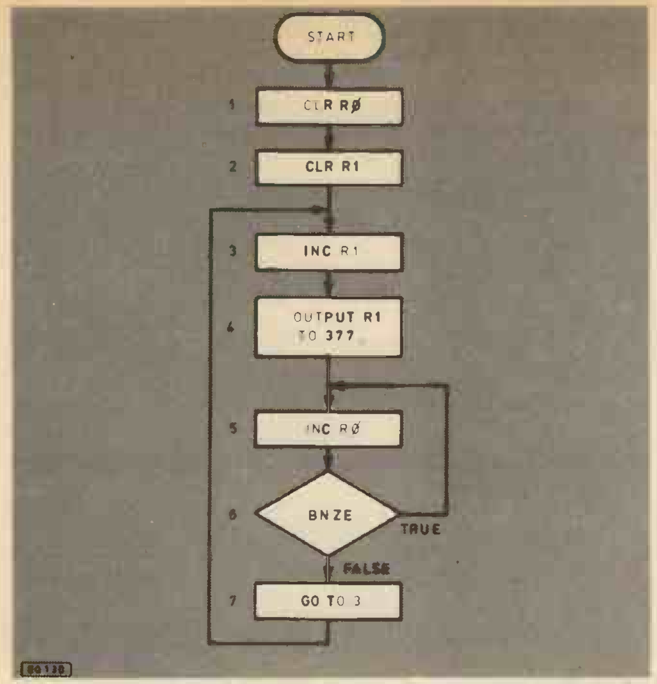
Fig. 3.3. Flowchart and listing for program 1

again using Direct Addressing. The loops formed by locations 1 to 6 takes 29 instruction cycles or 116 microseconds, therefore, R1 and the l.e.d.s are incremented once every 116 microseconds.

PROGRAM 2

The Flowchart and listing for program 2 are shown in Fig. 3.4.

In this program after R1 is output, register RØ is incremented and tested to check that it is not zero. As it has been previously cleared to zero and then incremented, the register does not contain zero, and we leave box 6 by the TRUE exit and go to box 5. The program keeps incrementing RØ and testing it. Eventually RØ will be filled with 16 ones and next time we increment it, it will go to all zeros. When this happens box 6 is left by the FALSE exit to box 7. Box 7 loops to box 3, where R1 is incremented and the loop is repeated again. When box 6 is executed, if the test is TRUE the box takes 9 machine cycles to execute, and if the test is FALSE the box takes 7 machine cycles to execute. This is because a TRUE result requires a branch back to the previous box, whereas a FALSE result allows the program to go straight on to box 7. As boxes 5 and 6 are executed 65536 times, this takes (65536 x 15) − 2 = (983040 − 2) x 4µs = 3·932152 microseconds. Boxes 3, 4 and 7 are executed once each time R1 is incremented, therefore, R1 in-



ADD	DATA	OPERATION	INSTRUCTION CYCLES
0	700	CLR RØ	6
1	711	CLR R1	6
2	11	INCR R1	6
3	1101	O/P R1	11
4	377	TO ADD 377	
5	10	INCR RØ	6
6	1054	BNZE	7/9
7	2	BACK 2	
10	4	JUMP	12
11	1400	TO	
12	2	ADD 2	
376	0	ST ADD	

Fig. 3.4. Flowchart and listing for program 2

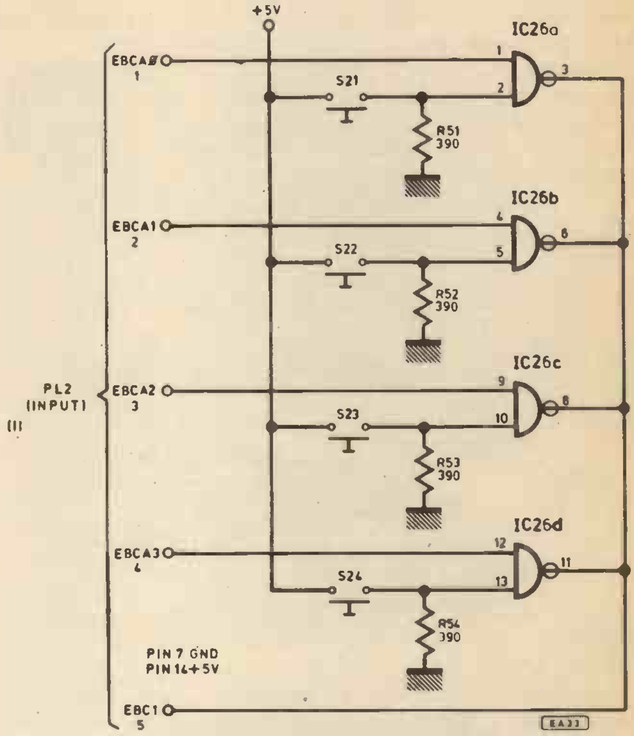


Fig. 3.5b. Circuit diagram of input unit

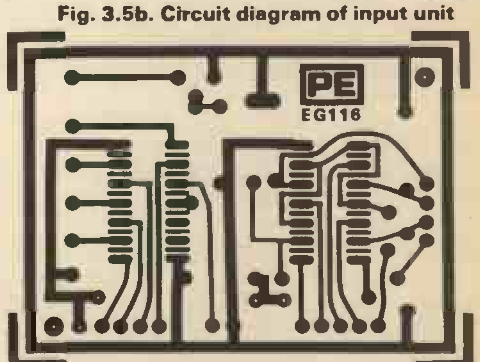


Fig. 3.6. Design for p.c.b.

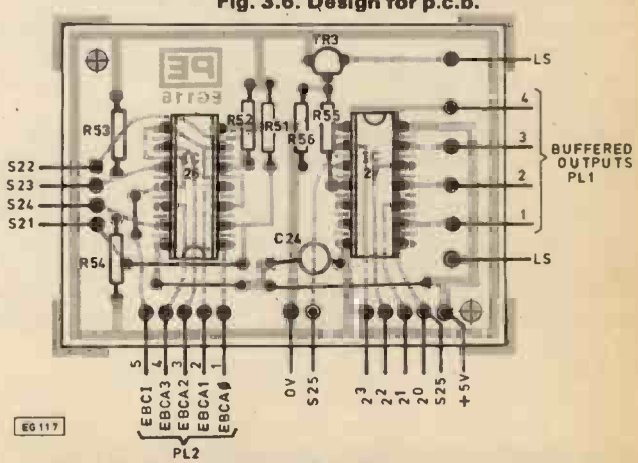


Fig. 3.7. Component overlay of the input-output unit

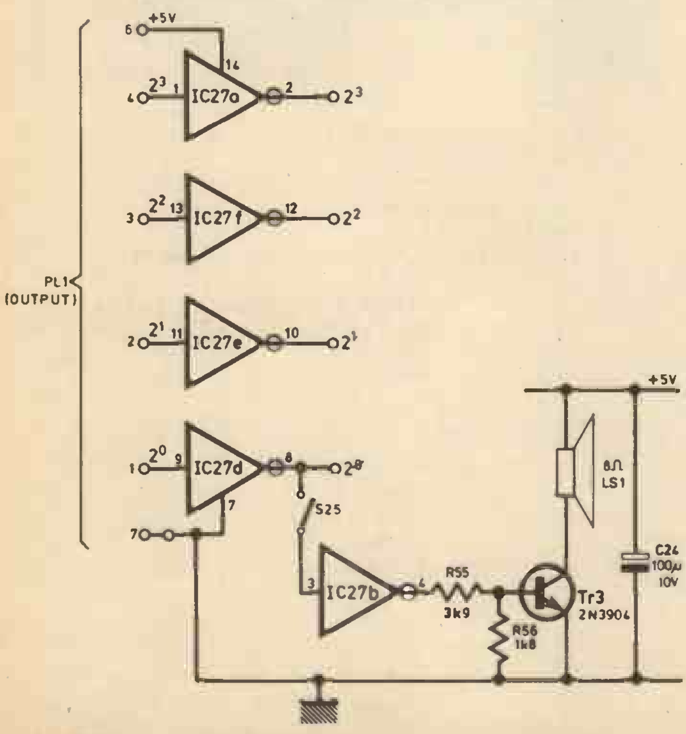


Fig. 3.5a Circuit diagram of output unit

crements once every 11 + 6 + 3932152 + 12 = 3932181 microseconds (≃4 seconds).

INPUT-OUTPUT UNIT

The circuit diagram of the output unit is shown in Fig. 3.5a. It is used to buffer the 2^0 to 2^3 outputs and enables an audio output to be obtained via speaker LS1, which can be switched into the circuit by S25. The input circuit (Fig. 3.5b) uses a 7403 quad NAND gate i.c. to buffer the four push button input switches.

Input-Output Unit

Both the input and output circuits were mounted on the p.c.b. shown in Fig. 3.6 with the component overlay shown in Fig. 3.7.

The input-output unit is mounted in a separate 150 x 80 x 40mm case and is connected to the 1610 via PL1 and PL2.

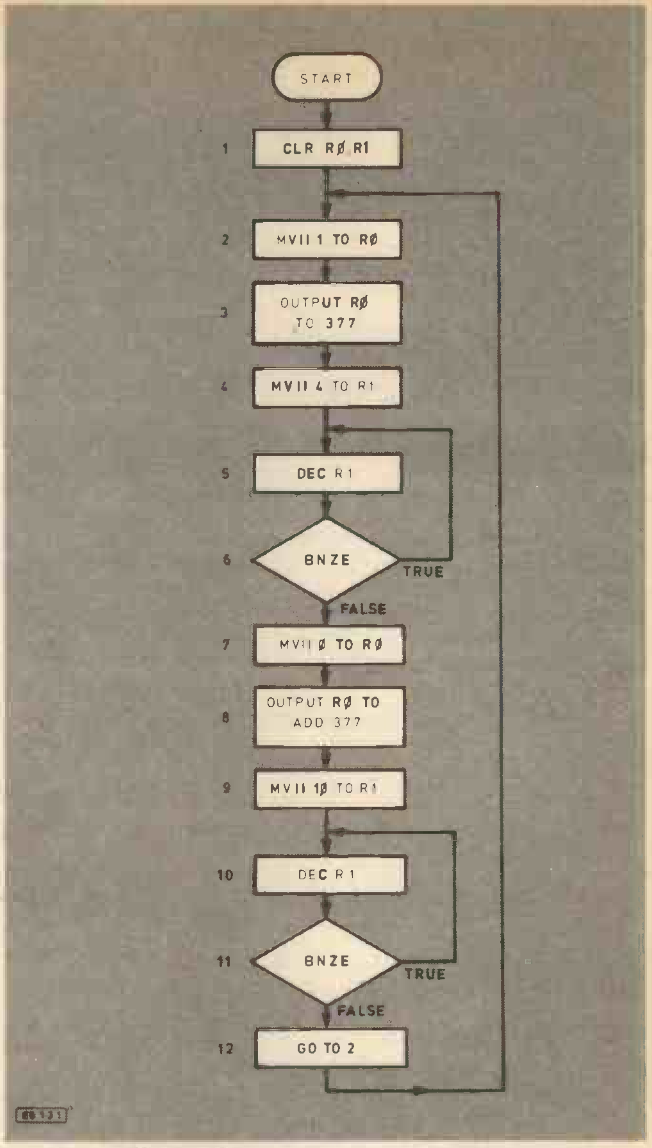
PROGRAM 3

This program enables the system to be used as a variable mark-space pulse generator. The flowchart and listing are shown in Fig. 3.8.

Registers Ø and 1 are cleared. Then 1 is loaded into RØ and this is output to ADD 377, setting the 2^0 output to a '1', which is inverted by the 7404 buffer (IC27d) in the input-output unit. Next a number is moved into R1 (4 in this instance) and R1 is then decremented until it reaches zero. When R1 reaches zero a 'Ø' is loaded into RØ and output to ADD 377, setting the 2^0 output back to zero. We then move a number into R1 (1Ø in this instance) and decrement R1 until it reaches zero. When R1 reaches zero, we jump back to load a '1' into RØ and output it again.

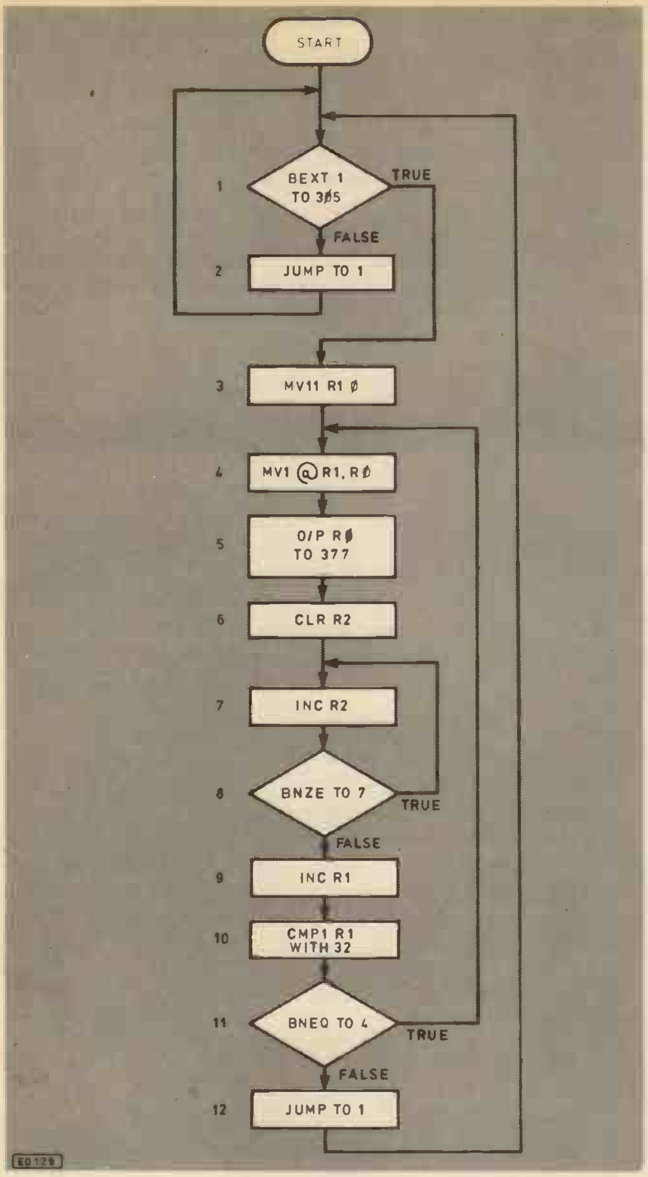
It can be seen that the data in location 7 determines the width of the mark and the data in location 2Ø determines the width of the space. With the values of 4 and 1Ø used in the program the mark is 34Ø microseconds and the space is 628 microseconds. Increasing or decreasing the number in location 7 by 1 will increase or decrease the width of the mark by 6Ø microseconds, and similarly for the space. This is because the boxes 5, 6 and 1Ø, 11 take 15 machine cycles of 4 microseconds.

The instruction in locations 2 and 3 loads immediate data from location 3 into register Ø. Locations 6 and 7, 13 and 14, 17 and 2Ø are similar. This program illustrates "nested loops", the loops formed by flowchart boxes 5, 6 and 1Ø, 11 are nested within the loop formed by boxes 2 to 12.



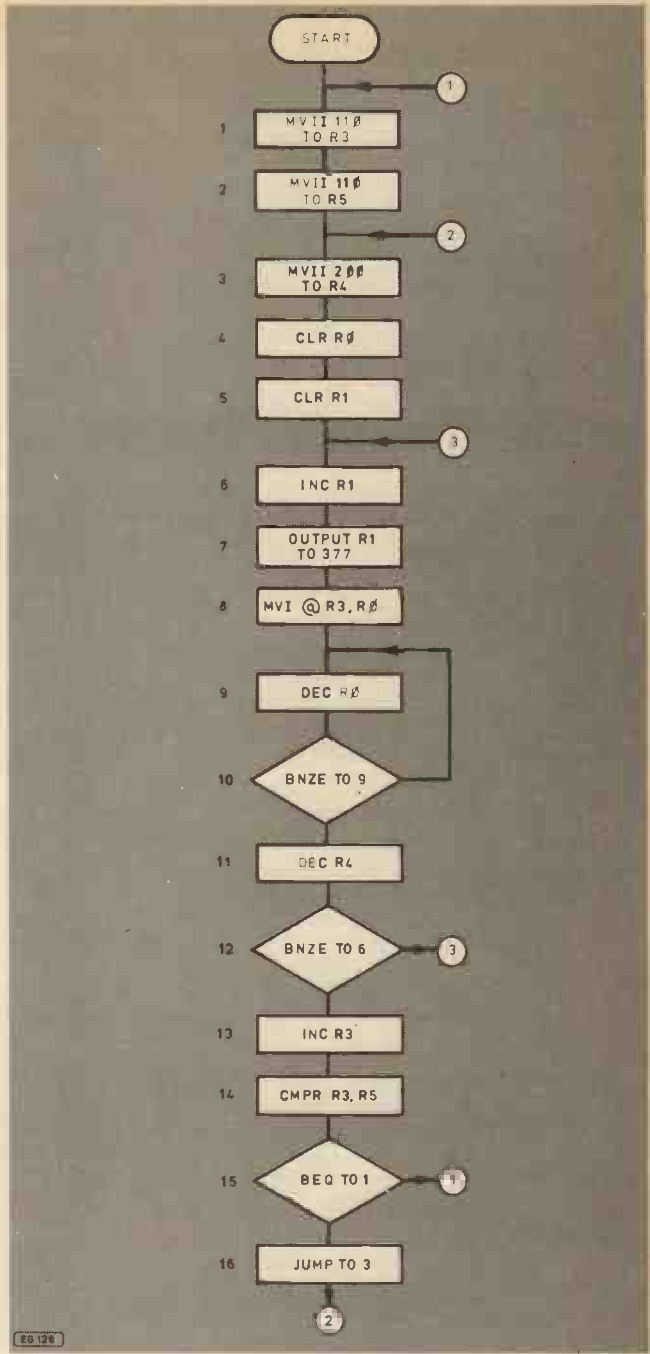
ADD	DATA	OPERATION	INSTRUCTION CYCLES
Ø	7ØØ	CLR RØ	6
1	711	CLR R1	6
2	127Ø	MVII	8
3	1	1 TO RØ	
4	11ØØ	O/P RØ TO	11
5	377	ADD 377	
6	1271	MVII 4	8
7	4	TO R1 (MARK)	
1Ø	21	DEC R1	6
11	1Ø54	BNZE	7/9
12	2	BACK 2	
13	127Ø	MVII	8
14	Ø	Ø TO RØ	
15	11ØØ	O/P RØ TO	11
16	377	ADD 377	
17	1271	MVII 1Ø TO	8
2Ø	1Ø	R1 (SPACE)	
21	21	DEC R1	6
22	1Ø54	BNZE	7/9
23	2	BACK 2	
24	4	JUMP	12
25	14ØØ	TO	
26	2	ADD 2	
376	Ø	ST ADD	

Fig. 3.8. Flowchart and listing for program 3



ADD	DATA	OPERATION
3ØØ	1Ø21	BEXT 1
3Ø1	3	TO 3Ø5
3Ø2	4	JUMP
3Ø3	14ØØ	TO
3Ø4	3ØØ	3ØØ
3Ø5	1271	MVII R1
3Ø6	Ø	Ø (ST ADD)
3Ø7	121Ø	MVI @ R1, R
31Ø	11ØØ	O/P RØ
311	377	TO 377
312	722	CLR R2
313	12	INC R2
314	1Ø54	BNZE
315	2	BACK 2
316	11	INC R1
317	1571	CMPI R1
32Ø	32	WITH 32 (END ADD + 1)
321	1Ø54	BNEQ
322	13	BACK 13
323	4	JUMP
324	14ØØ	TO
325	3ØØ	3ØØ
326	3ØØ	ST ADD

Fig. 3.9. Flowchart and listing for program 4



OCTAL ADDRESS	OCTAL DATA	OPERATION
Ø	1273	LOAD START OF TABLE
1	1ØØ	INTO R3
2	1275	LOAD END OF
3	11Ø	TABLE + 1 INTO R5
4	1274	LOAD TONE DURATION
5	4ØØ	INTO R4
6	7ØØ	CLR RØ
7	711	CLR R1
1Ø	11	INC R1
11	11Ø1	O/P R1
12	377	TO 377
13	123Ø	MVI @ R3, RØ
14	2Ø	DEC RØ
15	1Ø54	BNZE
16	2	BACK 2
17	24	DEC R4
2Ø	1Ø54	BNZE

21	11	BACK 11
22	13	INC R3
23	535	COMPARE R3 WITH R5
24	1044	BRANCH IF EQUAL
25	25	BACK 25
26	4	JUMP
27	1400	TO
30	4	ADD 4
100	200	
101	170	
102	160	TABLE
103	150	DETERMINES
104	140	TONE TO
105	130	BE OUTPUT
106	120	
107	110	
376	0	ST ADD

Fig. 3.10. Flowchart and listing for program 5

PROGRAM 4

When you have entered a program into memory, it is useful to be able to check that you have entered it correctly. Program 4 (Fig. 3.9) will output a block of memory to the l.e.d.s, stepping through addresses at 4 second intervals, which is long enough to check the data entered. Address 306 holds the start address of the block to be read out and address 320 holds the last address plus 1 of the block. Address 326 holds 300, the start address of the routine. To run the routine enter the start and end address + 1, then set the switches to 326 and push the address enter switch. Put all switches to their centre "OFF" position and put the load/run switch to run. When you press the BEXT 1 switch on the input-output unit, the block of memory will be output to the l.e.d.s.

When the load/run switch is put to run, the program loops through the flowchart boxes 1 and 2 examining the BEXT 1 switch. When the BEXT 1 switch is pressed, the program jumps to box 3. The start address of the block is moved into register 1. Box 4 moves the data from the address pointed to by the contents of register 1. This data is then output to the l.e.d.s. Boxes 6, 7 and 8 are used to form a 4 second delay. Box 9 then increments register 1 and boxes 10 and 11 compare register 1 with the last address plus 1 and if the end has been reached the FALSE exit of box 11 leads to a jump back to box 1 to examine the BEXT 1 switch again. If the end has not been reached, the TRUE output of box 11 leads back to box 4 to load and output the next memory location. With the numbers 0 and 32 in addresses 306 and 320 the block 0 to 31 will be output.

PROGRAM 5

This program (Fig. 3.10) is an example of table look up. The values in locations 100 to 107 are used to determine the tone to be output.

Boxes 1, 2 and 3 load the start of the table, end of table and tone duration into registers 3, 5 and 4 respectively. Register R0 and R1 are then cleared and R1 is incremented and output to 377. Box 8 contains an indirect address instruction. It says load register 0 with the contents of the address pointed to by R3. R3 has been previously loaded with 100, therefore R0 is loaded with the data contained in location 100, which is 200. R0 is then decremented until it reaches 0. When R0 reaches 0 we go to box 11. R4 is decremented and checked to see if it has reached 0. If it hasn't, we branch back to box 6 to increment R1 and output it again. We keep going round the loop formed by boxes 6 to 12 until R4 reaches 0. When this happens we go to box 13 and increment R3 to point to the next address in the table. Box 14 compares R3 with R5 to check if we have reached the end of the table. If we have reached the end we go back to box 1 and start again. If we have not reached the end, we jump to box 3 to load the next tone and output it. ★

News Briefs

IC MASTER

The 1979 IC Master from Watts/Steadman is claimed to be the most comprehensive reference book on integrated circuits ever published, and it certainly looks bulky enough, with over 45,000 devices listed. Sources and alternate sources number 102, and the data sheets of more than 25 manufacturers are included, with of course, all the parameters likely to influence the selection of any specific device. Quarterly updates maintain the value of the volume throughout the year. The price? £49·50! From Watts/Steadman and Partners Ltd., 34/36 High Street, Saffron Walden, Essex, CB10 1EP.

POINTS ARISING

INGENUITY UNLIMITED

Varitone Stylophone (May 1979)

R1 should be 27k. TR2 is *pnp* but the type number is correct. Pins 2 and 7 on IC2 should be reversed.

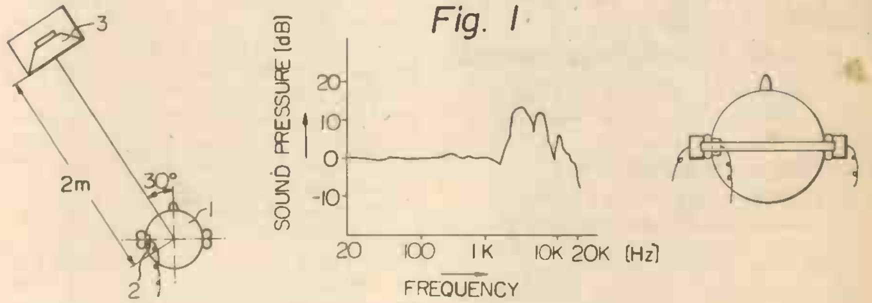
PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

PEAK LISTENING TIME

In recently published British patent application GB 2 000 941 A, Matsushita Electric of Osaka, Japan, seem to contradict their train of thought on improved headphone reproduction recently reported in our feature on *Binaural Stereo Patents* (Practical Electronics, March 1979). In fact Matsushita appear now to be following the line previously adopted by Sony and also reported in the same feature.

In BP 1 517 938 Matsushita originally patented a system for notching out an unnatural peak at around 3kHz allegedly introduced by headphone listening while Sony referred in apparent contradiction to similar peaks introduced by loudspeaker listening. The Matsushita research engineers are however now seeking to patent a headphone which introduces just those peaks they were previously trying to notch out. The new patent application (which dates back to July 1977) explains that Matsushita's investigations using a test loudspeaker and a replica human head which "listens" to the loudspeaker, have shown two resonant peaks in the frequency response curve at the head ears, one due to resonances in the ear canal and the other due to distractions from the head and ear lobes. These peaks, shown graphically in Fig. 1, are missing when the same sound is coupled direct to the head ears via headphones.



Matsushita propose several ideas for artificially introducing the peaks into sound heard via headphones. Fig. 2 shows a conventional headphone, with a transfer curve to the listener's ear as indicated by the broken line (a) of Fig. 3. To provide the required, unbroken line (b) the headphone is modified as shown in Fig. 4. In both old and new headphones the diaphragm 9 between magnets 10 couples with the ear through pad 7. But the open mesh 13 which backs the diaphragm of the conventional headphone is in the new Matsushita 'phone replaced by a pair of bores 14. These function as acoustic tubes with reactance calculated to create parallel resonances and put the required twin peaks into the transfer curve Fig. 3(b).

A more sophisticated approach, which is claimed to replicate the phase transfer characteristic as well as the frequency transfer characteristic of loudspeaker listening, is shown in Fig. 5. An additional cavity 16 is formed on the outside of the phone with a central bore opening 17. This tunes the lower frequency peak more abruptly. Alternatively the extra cavity 16 may be omitted and the same effect achieved by introducing an electrical phase advance circuit into the headphone system.

Fig. 2

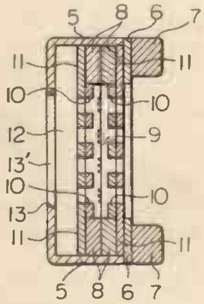


Fig. 3

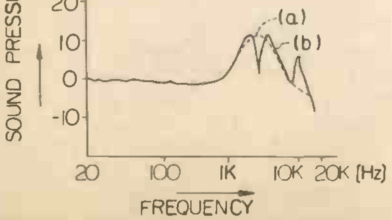


Fig. 4

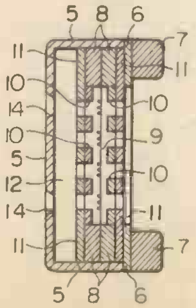
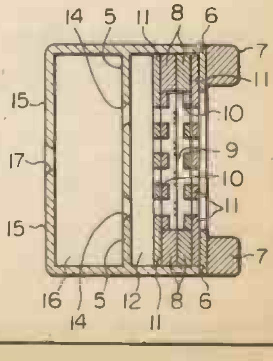


Fig. 5



FRANK W. HYDE

JUPITER AND VOYAGER 1

Fiscal problems are a constant hazard for space funding and there are inevitable delays and disappointments to the designers of new missions. With so much to be done for the good of the world as a whole the priorities create grave difficulties. However the mission of Voyager 1 and Voyager 2 has more than justified the decision to 'Go'. Data and pictures have already caused considerable and unashamed excitement among astronomers. The great Red Spot which has been the source of much controversy has revealed itself as having an anticlockwise rotation. The number of papers that may be expected from this one thing alone will justify the continuous observations that amateurs have made over many years.

One of the surprises came from the pictures of the massive planet's own satellites. One of these, Ganymede, is larger than the planet Mercury, for it has a diameter of 5,270km. The surface of this satellite is covered in craters, many of them with rays of ejected matter. A close-up picture shows grooves and ridges with craters at junction points. Indeed some of these close-up views, where the resolution allows the smallest recognisable feature to be of the order of 3km across, look very much like roundabouts with roads leading off in many directions. Since the density of this moon is low and the satellite is thought to be largely composed of water, these ridges and grooves may well be deformations of the surface by tectonic forces.

Callisto is the outermost satellite of the four, first recognised by Galileo and carrying his name to this day. Voyager 1 photographed Callisto from a distance of 202,000km. The surface is literally peppered with craters caused by meteorite impacts. Some of the craters have rays brightly visible and giving the surface a somewhat speckled look. One very clear feature is visible and looks like a giant bull's eye with surrounding rings. The centre is a deep crater several thousand kilometres across. The rings give the impression of ripples that have spread outwards as if a stone had been dropped in a pool. This is a unique discovery and Callisto is the most cratered body in the solar system. One question that arises when looking at these pictures is the very evenness of the size of the craters almost as though similar units were dropped on the surface at the same time.

The innermost of Jupiter's twelve satellites is a tiny body called Amalthea. It lies at a distance of some 160,000km from Jupiter. Amalthea is a practical demonstration of strength of the giant planet's gravitational pull. This tiny satellite is elongated so that it is twice as long as it is wide, with one end directed towards its parent body. It too is covered with craters and has a low reflectivity (the Albedo). The long dimension of the satellite is about 290km.

Another remarkable discovery made after passing closer to Jupiter was that there is a ring similar to those found round Saturn and Uranus. This ring is some 55,000km from the 'cloud tops' of Jupiter, 8,000km wide and about 30km thick consisting of scattered boulders. Again this is a discovery unforseen and was due to the fact that the spacecraft oscillated slowly as it moved along, also long exposure in use at the time (11·2 minutes) with Voyager's narrow angle camera.

The spacecraft moved on toward the innermost of the Galilean moons, Io, which is about the size of the Earth's Moon. This is a most interesting body. It is some 420,000km from Jupiter and has at least eight active volcanoes. One of these can be seen in the photographs in eruption. The satellite has a surface of broad plains, thought to be salty, having fault lines, channels, depressions and highlands. The surface colour seems to be a yellowish brown. Another special thing is that there are no noticeable craters to mar the surface. There are however large lava fields and it could be that the constantly erupting volcanoes reform the surface continuously. Clouds of ionised suphur which surround Jupiter are perhaps from these eruptions. This does have a link with the decametre radiations which are detected from the vicinity of Jupiter and were originally thought to be from Jupiter itself. Io was very much involved in this matter.

Europa is the fourth of the Galilean satellites and is a brown coloured body a little smaller than the Moon. It is suspected that this satellite may also have volcanoes. This no doubt will be settled when Voyager 2 passes much closer than has Voyager 1. This is expected to be at the beginning of July.

Voyager will now go on its way toward Saturn which it will reach in November 1980. The discoveries by Voyager 1 have already been used to formulate the exact activities within the controllable limits of the spacecraft Voyager 2.

JUPITER SLING SHOT

The final go-ahead has been given for the solar mission. The details of this were given last year in *Spacewatch*. Now an agreement between NASA and the European Space Agency has been signed for the Solar Polar Mission. This is a joint Euro-American project. The European Space Agency will supply one of the probes and the National Aeronautical and Space Administration will supply the other probe and the facilities for launching including the Shuttle. Launch is expected in 1983, possibly February. The two probes will be directed towards Jupiter. The gravity of Jupiter will then give the necessary impetus so that one probe passes over the northern pole of the Sun and the other over the southern pole. The two probes will therefore go though the upper and lower levels of the solar system where no spacecraft has yet penetrated. A new set of data with polar views of the Sun will become available. No doubt this will open new vistas of knowledge.

MARS

At one time there was a programme of missions to Mars with a manned landing expected in the early 1980's. This hope has for one reason and another slipped back in time. However as the Viking mission was such a success there is now every hope that the main theme will be kept in mind. Mars is more like our own world and is the primary candidate for colonisation.

The Martian atmosphere is nearly all carbon dioxide, with some traces of nitrogen, argon and oxygen. The surface pressure of the Martian atmosphere is about one hundredth of that of the Earth. The temperature varies between $-130°$ and $10°C$. As shown on the pictures returned from the Viking mission the surface is mountainous with vast plains which are desert like in appearance. The plains are often covered with rocks and craters. There is water on Mars but it seems to be concentrated at the poles. The measured average wind speed was about 15km/hr. There are however areas where speeds as high as 60km/hr have been recorded. Dust storms are also a hazard and can last for many days. The mechanisms of these dust storms are being studied closely. Since these storms are usually found in specific areas it would be possible to avoid activity in dangerous places.

A study has been made for a vehicle which would be able to deal adequately with the rocky terrain and still be controllable from Earth. Since the distance of the planet from the Earth varies considerably as the two bodies follow their orbits round the Sun, the matter of time delay in control signals is important. To this end a study was made of the various types of vehicle to see which would best serve the purpose. A vehicle moving over the surface would be subject to many hazards. A vehicle in orbit would not be able to fulfil the needs of the mission. It was therefore decided that an aeroplane was the best solution. An intense study of the possibility was made by the Jet Propulsion Laboratories at Pasadena, California. The team who were responsible were, V. C. Clarke Jr., A. Kerem and R. Lewis. This design team studied two types of aeroplane, a cruiser and a lander. The design required that both vehicles would be deployed in the atmosphere. The lander however would be designed for both landing and subsequent take-off. Basically the cruiser, which would be hydrazine powered, was designed to fly at an altitude of 1km and be capable of sustaining aloft a 40kg experiment package for up to 15 hours duration. A maximum range of 4,000km was decided upon so that the 'airspeed' would be 200 to 300km/hr.

In order to achieve a satisfactory environmental survey the height at which the vehicle should fly would be 35km.

The tenuous atmosphere dictates the choice of a 'non air breathing' unit for propulsion. Because of this another weight penalty is introduced. A scaled down version of the Akkerman hydrazine engine was developed by the Dryden Flight Research Centre. The power output is a little over 11kW. Electric power was considered but present units that were available did not have good enough performances. Batteries are being developed with greater efficiency and it could be that when the mission is ready this might be an alternative. A low speed variable pitch propeller was adopted.

The aeroplane is designed to carry a 100kg payload together with 50kg of control systems. This places considerable demands, for an efficient structure, on the designer. The total weight of the airframe engine and fuel is limited to 150kg. The team decided on composite material so a carbon reinforced plastic with some Kelvar-reinforced plastic was adopted. An important point in these matters of design was the need for sterilisation in order to prevent contamination by Earth germs. Since the sterilisation would have to be carried out at 100°C distortion could be a problem. This was solved by specifying a high temperature cure of the composites. The wing structure was hinged with six joints and the skin is made up of carbon fibre reinforced plastic.

Since there is the time lag in communication the aeroplane would need to be autonomous, the flying and landing would be under the control of a computer. Since the surface of Mars is not yet very accurately determined it would be necessary to have some avoidance radar. In order to limit weight it was decided on an elementary system which had limited avoidance capability and Earth guidance would be used to control which areas needed complete avoidance. The landing and take off conditions imposed demanding technical skill so it was decided to use some basic approaches only. A vertical landing powered by retro-rockets was chosen. The aeroplane would commence its descent at an altitude of 1km, with a power pull-up to place the craft in a stall. Once in the stable attitude the aeroplane would fall vertically, reaching a terminal speed of 60m/sec. Hydrazine rockets would then fire, slowing the vehicle to 1-2m/sec.

Take-off would be by power rocket ascent to an altitude of 1km, followed by a dive to gain speed and then a gentle pull out.

The mission proposed by JPL calls for 12 aeroplanes. This would ensure a satisfactory chance of success even if half the number crashed. They would be transported to Mars in groups of four, each cluster being placed on an interplanetary trajectory by a twin-stage Inertial Upper Stage. Three Space Shuttle flights would be required, each delivering an IUS and four packaged aeroplanes in low orbit. Each of the planes would be in its own capsule. A braking parachute would be deployed at an altitude of 9·5km, reducing the descent speed to 60m/sec. The parachute would be jettisonned at 7·5km and the aeroplane would unfold itself and begin flying.

The areas in which the aeroplanes would operate from the point of view of the experiments would be:

- Atmospheric Dynamics and Composition
- Electromagnetic Sounding
- Gamma-ray spectroscopy
- Gravity Field
- Infra-red Reflectance Spectrometer
- Magnetic Field and
- Photography.

News Briefs

by Mike Abbott

ON COURSE

Microcomputer courses brought to our attention.

Texas Instruments—Bedford. Range of "hands on" courses available at T.I.'s new purpose-built centre. Details: (0234) 67466.

Bleasdale Computer Systems—London. Range of "hands on" courses for engineers and management. Details: 01-540 8611.

Membership of the **Computer Education Group** may interest some readers. The edition of *Computer Education* which we received contained much interesting information, including details of microprocessor courses.

NEW RAM

A NEW 16K dynamic RAM which operates from a single 5V supply is now available from Intel. The 2118 is a 16-pin device with access time in the 100ns region. The −5V requirement is generated automatically on-chip, thus being transparent to the user. Power consumption is 130mW operating, and 15mW on standby.

COSMAC CLUB

IT IS proposed to set up a club in Britain for users of the RCA 1802 microprocessor; Cosmac, Elf, Elf II, Super Elf etc. Unofficial assistance has been promised by RCA and HL Audio.

Those interested are requested to contact James Cunningham at: 7 Harrowden Court, Harrowden Road, Luton LU2 0SR, enclosing SAE.

VOICES IN THE SKY

THE Civil Aviation Authority have purchased a new automatic broadcast system developed by Marconi Space and Defence Systems (MSDS), to relay weather reports to airline pilots. Weather reports which are received every half hour by telex at the Civil Aviation Communication Centre at Heathrow, are automatically converted into human voice and transmitted continuously and simultaneously on up to four frequencies. How is it done? A recording of standard weather report phrases, words and figures has been digitised and stored in a computer memory, to be electronically re-constructed as required by the telex messages.

A TERMINAL CASE

THE degree to which microprocessors will irreversibly change our lives is perhaps impalpable at this stage, but when a visiting business or salesman slips open the executive case illustrated below, keys in questions, and stock/delivery details come flying out of the printer, you'll know that the iconoclastic microprocessor has brought the mysterious world of computers down to everyday level.

The Microlink, manufactured by The Micronics Company, is claimed to be the lowest cost portable intelligent terminal on the market, giving the user rapid access to a central database, from perhaps your office, an engineering site, or hotel room. The V820 Microlink contains a CPU, acoustic coupler, expandable ROM and RAM, quiet printer, and solid state keyboard; some typical users being quoted as mobile engineers, reporters and audit teams. A range of plug-in firmware configures the terminal to the requirements of the user.

Interfaces are included for high speed cassette transfer, and VDU or TV monitoring. So, executives be warned, your visitors in future may place one of these cases on your desk and say: *"Have you got a VDU?"*.

readout

... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Best on the market

Sir—In response to your column (April issue), the P.E. is indeed the best magazine on the market.

The greatest fun, or satisfaction, from electronics is being able to improvise on a given "theme" *and* to experiment with different ideas. Your particular format is suitable for *both* first time attempts in a new area (where it is necessary to follow the spec. fairly closely), *while* the design is versatile enough to allow for changes and innovations when the subject is a little more familiar.

Your magazine also includes some unusual and unique ideas and circuits that make a refreshing change and provide even new or further applications for electronics.

Possible Improvements?

1. The "On The Fringe" column you ran at one time was always interesting to read and, where possible, it did give just enough detail to allow an experimenter to try different ideas. For a single page it did provide a great deal of "gen", and many ideas mentioned in that column several years ago are now being presented (on T.V. etc.) as "The very latest". "Air ionisation" and "plant activity" were two good examples that come to mind. Presenting factual details *in electronics* years before those ideas are mentioned elsewhere is indeed a feat worthy of praise. Perhaps the best format would be a combination of "On The Fringe" subjects, together with technical tips/bright ideas, etc.
2. Data: On (semiconductors and i.c.s.) type numbers, especially those that can't be found in most data books, would be a benefit to all constructors.
   Very often one's stock of devices always includes:
   a) A glut of one or two particular types (which *can* often be used as an alternative to the specified type number).
   b) A "hoard" of marked devices whose type numbers are difficult to find in most Data/Equivalent books. Only the most basic parameters and leadout configurations would be required.

I hope the above is of some use to you, in the meanwhile carry on the good work and many thanks for being *the* mag. that does "get it right".

E. Wilcockson,
Moed,
Clwyd.

I.c.s Unlimited

Sir—Ingenuity Unlimited, April '79, Mr. J. Hogarth of Guiseley presents his "Programmable Divider", and an excellent example of how to use 50 per cent more i.c.s than necessary. This comment, when applied to more elaborate devices, may help other readers realise worthwhile economies when devising circuits.

Rather than using a 7430 8-input NAND gate and then inverting its output with 1/6 of a 7404 hex inverter, I believe he might just as well have used a 7420 dual 4-input NAND gate. One quad-input set would have done for the divider; the other 4 inputs wired together would accomplish the inversion.

As it stands 5/6ths or, in fact, 6/6ths of the 7404 are wasted, as well as 1/2 of the 7430.

This situation arises so frequently, where the odd gate on an i.c. is not used, I have found it always worthwhile to keep track of them; need for additional i.c.s can often be avoided.

L. Proctor,
Charlottenlund,
Denmark.

EPROM praise

Sir—I note with interest your "announcement" of the Intel 2758 EPROM, which I can say I have had great success in using, both building a programmer, and using them in quite a few items of equipment during the past year.

I would like to take this opportunity to confirm your enthusiasm for the use of these devices, and additionally to point out a few things which might be of interest to other readers.

Firstly, although the 2758 does allow single byte programming, I have not found much use for this facility for "patching" of existing code, as it is only possible to program bits within the PROM that are at a logic 1 down to a logic 0, and only total erasure of the PROM can return any bits at logic 0 to logic 1. The implication of this is that, although it is relatively easy to program in an entirely new piece of code, it is probably impossible to program in a branch from the old code to the new code, thereby making the patch inaccessible to the old code.

Secondly, the use of the PD/PGM pin on the 2758 as a power saving measure will cause current surges of around 100mA—it is therefore essential to decouple the PROM by the use of substantial decoupling capacitors at the PROM to reduce the effects of the current surges on electrically adjacent circuitry.

Thirdly, for those interested in expansion, there is a pin compatible version of the 2758, also manufactured by Intel as the 2716, which holds 2k × 8bit bytes. Care must be taken if it is intended to use these devices, as Texas also manufacture a 2k × 8bit EPROM called the 2716 which is the 2k version of the 2708, with the 2708's attendant disadvantageous requirement for 3 power supplies. The Texas equivalent of the Intel 2716 is known as the 2516. Hitachi also manufacture a 2716 which appears to be equivalent to the Intel 2716.

J. McCarthy,
East Dulwich,
London.

Envelope Shaper

Sir—I have just successfully completed building the A.D.S.R. Envelope Shaper described in "Practical Electronics", January 1979 and believe that the comments below will be of use to other constructors.

Firstly, chip IC1 (74C00 quad 2-input NAND) is shown with only three gates being used, the remaining one being left floating. This is unwise because floating gates of CMOS chips often burst into very high frequency oscillation which can seriously disturb the other operating gates in the chip. This parasitic oscillation can be completely removed by grounding (earthing) both of the unused gate inputs.

Secondly, a systematic search through all of the excellent mail-order suppliers who advertise in "Practical Electronics" failed to locate a stockist of the 74C00 chip. I therefore used the 4011 which is another 2-input NAND which is both cheap and readily available. However, use of this chip requires the different pin connections listed below.

74C00	*4011*	
1	1	
2	2	
3	3	
4	5	
5	6	
6	4	
7	7	
8	10	
9	8	} spare pins which
10	9	} should be earthed
11	11	
12	12	
13	13	
14	14	

P. McChesney
Bromborough,
Wirral,
Merseyside.

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DOLOMITI MULTIMETER

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The Chinaglia Dolomiti is a very impressive, solidly constructed multimeter with a large clear scale, giving ±2% accuracy on d.c., and ±2·5% on the a.c. and Ω ranges. Input sensitivity is 20kΩ/V, and the movement has a "luxurious" damped action which inspires more confidence than the cheap "flicky" type. The meter also has an active cut-out which isolates one probe within milliseconds of overload, and the probe itself houses a quick blow fuse.

The f.s.d. ranges are as follows: current: 50µA–5A d.c., 5mA–5A a.c. Voltage: 150mV–1·5kV d.c., 5V–1·5kV a.c. The a.c. bandwidth is 20Hz–20kHz.

Resistance is accurately readable from about 50mΩ up to 50MΩ, and capacitance too can be measured (ballastic method) with reasonable precision. A capacitive reactance facility also exists. The meter can read dB in the range −10 to +65 in six ranges (0dB = 1mW into 600Ω).

And if that's not enough, the Dolomiti incorporates a universal signal injector with harmonics up to 500MHz.

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METERMATE

P.R. SPURGEON

THIS HIGH IMPEDANCE UNIT WILL INCREASE THE EXISTING RANGES OF MANY LOW COST MULTIMETERS

HOW many of us have wished for a multimeter that has negligible effect on circuitry, with low d.c. and a.c. ranges? Such instruments are usually priced well beyond most constructors' means but the unit to be described here will convert an existing multimeter into an instrument of medium accuracy with wide ranges which are rarely found on economically priced meters. No modifications are required to the multimeter as the unit is simply inserted between the test prods and the meter.

The ranges shown in the specification cover those needed in semiconductor work and the accuracy depends upon the resistors used, but it should be remembered that most multimeters have scales giving errors of more than 2 per cent of full scale deflection, so high accuracy in the unit is usually unjustified. In use Metermate is as simple as any mutimeter, and measurements on transistor circuitry can be made with confidence that the circuit under test is not affected by the meter. Measurements on CMOS, unijunction and other high impedance circuits are possible, provided the loading effect of the input resistor chain is allowed for. Measurements of a.c. at audio frequencies give valuable information about signal gain; by using the unit in conjunction with a simple sine wave oscillator frequency response curves for amplifiers, filters, etc. can be measured. The higher sensitivity ranges are useful for measuring transducer outputs, and as a null detector in bridge circuits.

DESIGN THEORY

Op amp circuit design is very simple, as gain depends only on passive components. Two basic op amp configurations are possible, inverting and non-inverting (Figs. 1a and 1b).

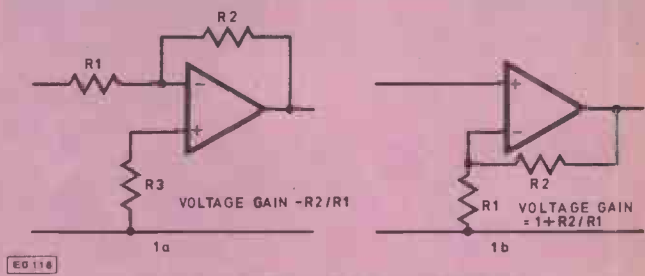


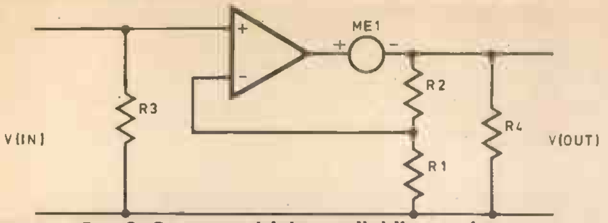
Fig. 1a, b. Basic op amp configurations

The inverting circuit gives an input impedance dependent upon R1, R2 and R3, but the non-inverting circuit has a high input impedance (about 1MΩ for the 741) independent of R1 or R2. By fixing the gain of this circuit accurately it can be used with input dividing resistors to feed a meter, as

SPECIFICATION

D.c. and a.c. voltage (7 ranges): 20V, 10V, 5V, 1V, 100mV, 10mV, 5mV.
D.c. and a.c. current (5 ranges): 1μA, 10μA, 100μA, 1mA, 10mA.
Input impedance: equivalent to 1MΩ/V.
Accuracy: d.c. and a.c. ranges 2 per cent (depending on resistors and meter used).
Frequency response: 20Hz to 30kHz.
Resistance (4 ranges): 1kΩ, 10kΩ, 100kΩ, 1MΩ. Forward reading, linear scale.
Current consumption: 10mA.

shown in Fig. 2. This circuit operates as follows. If an input current of i(in) flows through R3 (negligible current flows



EG 119 **Fig. 2. Op amp with input dividing resistors**

into the op amp due to its high input impedance) developing an input voltage V(in):

$$V(in) = i(in) \times R3$$

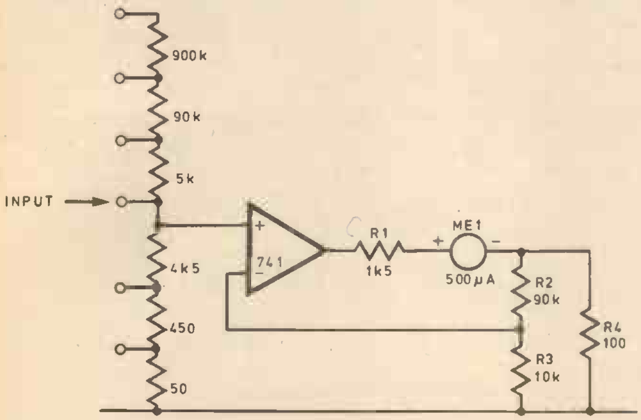
Gain is fixed by R1 and R2 at 1—R2/R1, so the output voltage V(out) is given by:

$$V(out) = i(in).\ R3(1-R2/R1)$$

This voltage is developed across R4 by current flowing from the op amp through the meter. If a current of i(m) is needed to give f.s.d. on the meter, then:

$$R4 = V(out)/V(in) = i(in)/i(m).\ R3(1-R2/R1)$$

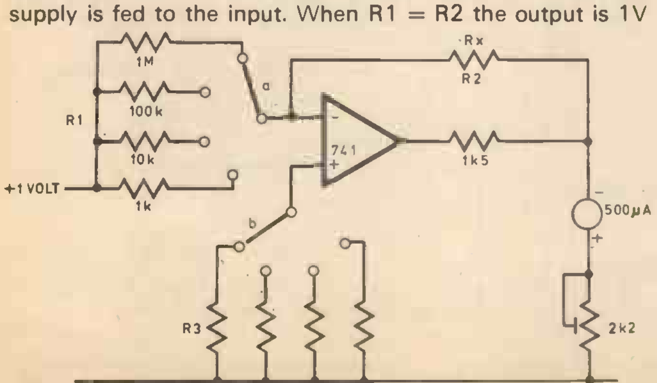
Fig. 3 shows a practical circuit with values suitable for meters with 0·5mA f.s.d. The gain is fixed at 10, so with



EG 120 **Fig. 3. Practical circuit**

5mV at the op amp input (developed across the 5kΩ chain by 1µA) the output voltage is 50mV. As R4 is 100Ω the meter current i(m) will be 0·5mA. Higher current ranges are made by reducing the input resistance from 5kΩ so that 5mV is still fed to the op amp. Series resistors drop higher input voltages to 5mV.

It is not possible to use the non-inverting configuration to give a linear scale for resistance, so Metermate switches the circuitry around IC1 to give an inverting circuit with the unknown resistance in the position of R2 in Fig. 1a. R1 is a switched range of reference resistors, and a 1V stabilised supply is fed to the input. When R1 = R2 the output is 1V



EG 122 **Fig. 4. Inverting op amp circuit**

(as the gain is then 1) and is fed to the meter with a 2·2kΩ resistor in series, as in Fig. 4. R3 is switched so that the impedance at both op amp inputs are approximately equal.

When measuring a.c. voltage or current with Metermate IC1 functions in exactly the same way as for d.c. except its output is not fed to the meter but to a full wave rectifier (Fig.

COMPONENTS . . .

Resistors

R1	1M
R2	100k
R3, R12, R16, R32, R33	10k (5 off)
R4, R9, R10, R17	1k (4 off)
R5	470k
R6	47k
R7	4k7
R8	470
R11	1k5
R13, R34	68k (2 off)
R14, R18, R35	22k (3 off)
R15	100
R19	390
R20	6k2
R21	180
R22	220
R23, R24	1Ω0 (2 off)
R25	4Ω7
R26	12
R27	33
R28	120
R29	330
R30	1k2
R31	3k3
R36	680k
R37	220k
R38	1M8
R39	2M2
R40, R41, R42	10M (3 off)
R43	5k6

Potentiometers

VR1, VR3, VR4	10k (3 off)
VR2	2k2
All sub min hor.	

Capacitor

C1	1µ elect.

Semiconductors

D1, D2	1N4004 (2 off)
D3	BZY88 3V Zener
D4, D5, D6, D7	1N914 (4 off)
D8	TIL 209 l.e.d.
TR1	BC109
IC1, IC2	741 (2 off)

Switches

S1	1 pole 12 way rotary
S2	2 pole 6 way rotary
S3	3 pole 3 way rotary
S4	2 pole slide

Miscellaneous

6 off	2mm plugs and sockets
3 off	knobs
2 off	PP3 batteries
2 off	battery clips
Veroboard	
Case	

Resistors R23 to R42 see Table 2 and text.

5). Gain is R2/R1, so with an input of 50mV from IC1, 222mV will appear across the 400Ω resistor, giving a current of 0·555mA. The overall gain is therefore 1·11. This factor is necessary as we wish the meter to read true r.m.s. values, not average full wave rectified a.c.

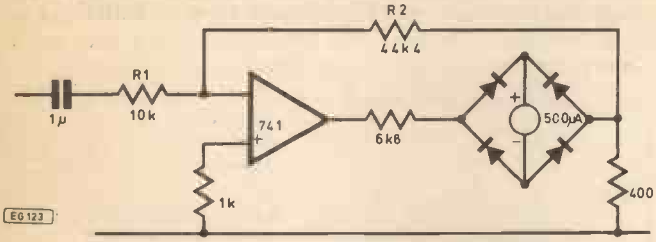


Fig. 5. Circuit for a.c. voltage and current tests

THE CIRCUIT

The full circuit, including meter switching arrangements, stabilised 1V supply, and a complete input resistor chain, is shown in Fig. 6. Two diodes protect the input of IC1 from excessively high voltages. The last position of S2 is used to make IC1 available as an op amp. SK1 is connected to the non-inverting input, with S1 selecting the resistance to earth, SK3 is connected directly to the inverting input, and the meter may be left in circuit or the op amp output taken directly from SK5 with the meter disconnected. The effective circuit is shown in Fig. 7.

CONSTRUCTION AND CALIBRATION

The prototype unit was built on Veroboard, giving the compact layout shown in Fig. 8. The constructor must decide whether to use 1 per cent resistors or an accurate bridge to select values. The former is costly and the latter can be time consuming. If it is decided to buy close tolerance resistors use the components list to select values, and assemble the entire circuit, taking care with both the i.c. and diode orientations. The connection of the chain resistors is shown at Table 1 and the link wiring for the switches is shown in Table 2. Otherwise leave off the board all the chain resistors R23 to R42 and connect temporary resistors for R12, R13, R14 and R15.

Wire a temporary resistor of around 4·7kΩ across the

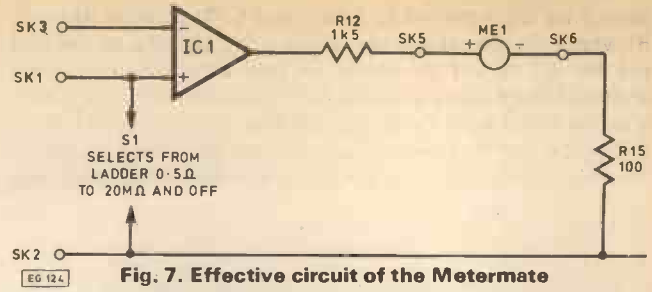


Fig. 7. Effective circuit of the Metermate

unit's input, and switch S1 to 1µA, S2 to d.c./a.c. and S3 to d.c. Metermate can now be used as a sensitive detector in a simple bridge circuit (Fig. 9) once a meter of appropriate

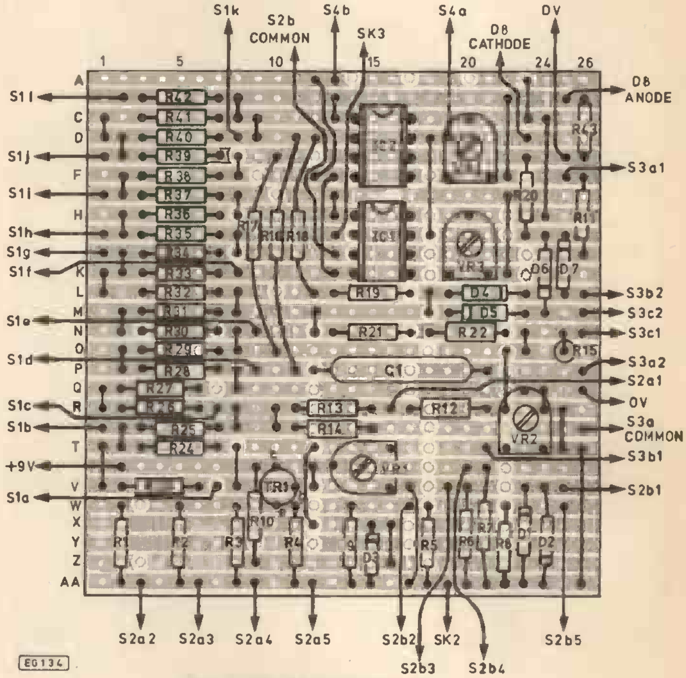


Fig. 8. Veroboard layout

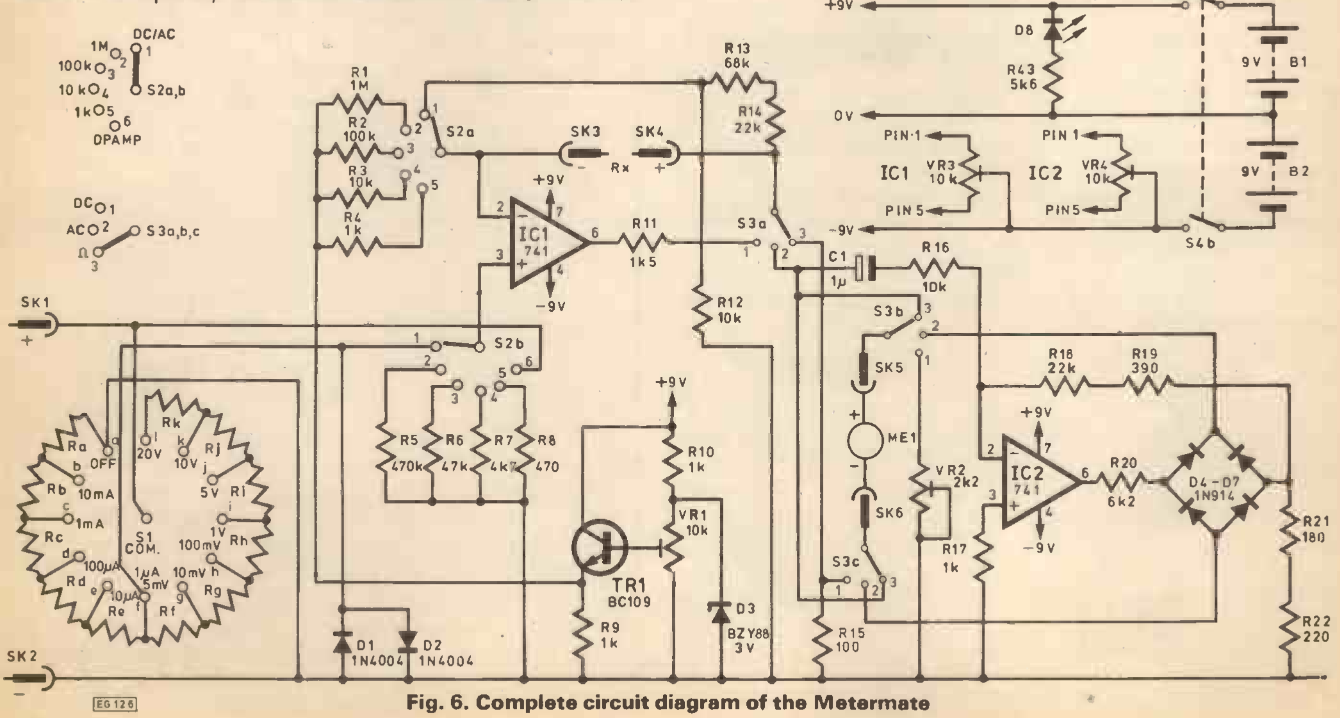


Fig. 6. Complete circuit diagram of the Metermate

sensitivity is connected to SKs 5 and 6. At balance Rx = r x Rf where r is the ratio of the bridge arms. Use the off-set null pot for IC1 to set the meter at zero with the input leads shorted before using the unit. Accurate fixed resistors within a factor of 10 from Rx should be used for Rf. Replace R12, R13, R14 and R15 with accurately measured resistors first. Assemble the input resistor chain by measuring R23 and

SWITCH 1	COMBINED RESISTANCE VALUE	CONNECTION OF COMBINED RESISTORS
Ra = R23, R24	0Ω5	In parallel
Rb = R25	4Ω5	
Rc = R26, R27	45	In series
Rd = R28, R29	450	In series
Re = R30, R31	4k5	In series
Rf = R32, R33	5k	In parallel
Rg = R34, R35	90k	In series
Rh = R36, R37	900k	In series
Ri = R38, R39	4M	In series
Rj = R40, R41	5M	In parallel
Rk = R42	10M	

The values of Ra and Rb can be obtained by using resistance wire or the resistor values given in the components list. In the prototype Rb was a 4·7Ω resistor which was measured at 4·5Ω.

TABLE 1

R24 first, then adding R25 and measuring the total resistance. Repeat for R26 to R42, checking the overall resistance each time. If an accurate meter is available the 10mA, 1mA and higher voltage ranges can be checked, and the resistors adjusted accordingly.

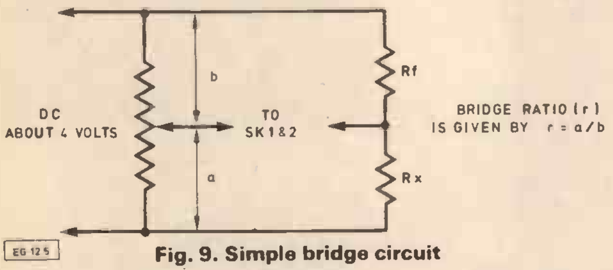


Fig. 9. Simple bridge circuit

R1 to R4, R16, R18, R19, R21 and R22 should also be accurately measured and added to the board. The resistance ranges are calibrated after setting the stabilised 1V supply. To do this connect SK 1 to the emitter of TR1 and switch the unit to read 1V d.c. f.s.d. Adjust VR2 to give a reading of 1V. Connect a known accurate resistor across the Rx sockets, and adjust VR3 to give a true resistance reading on the meter. It only remains to set the off-set null pot on IC2 with the unit switched to a.c. and the input shorted, and setting up is complete.

USING METERMATE

Once set up Metermate is used in exactly the same way as a conventional multimeter. When making voltage or current readings, always start with S1 set to the highest range to avoid overloading the meter, and return to the off position after use. For resistance measurements, switch the unit off before setting S2 and S3, connect the resistance, and then switch on. If the unit is switched on without a resistance equal to, or less than, the range selected by S2, then the meter may be damaged as the i.c. will pass up to 10mA. The same will happen if S2 is turned to the op amp position unless external resistors are connected. Do not leave resistors connected to Rx when using the d.c. or a.c. ranges as readings will be upset.

Metermate's input impedance on voltage ranges is approximately the resistance of the input chain selected; on the 20V range it is 20MΩ and on the 5mV range only 5kΩ. When measuring voltages, ensure that the input impedance is at least ten times the impedance of the voltage source. In practice this means that voltages over 1V can be accurately measured in circuits with impedances of up to 500kΩ, as in most transistor circuits, TTL, many linear i.c.s and some CMOS.

FROM	TO
S1f	S2b1
SK1	S1 common
S2b6	SK1
0V	S1a
0V	SK2
S2a common	SK3
S3b3	S3a2
S3c3	S3b3
S3a3	S3c1
SK4	S3a common
SK5	S3b common
SK6	S3c common

TABLE 2

If a.c. voltages or currents with a d.c. component over 0·5V are to be measured then a blocking capacitor should be used at the input, 1µf being suitable. True r.m.s. readings will only be obtained when measuring a pure sine wave. Frequency response is substantially flat from 30Hz to 30kHz, dropping by 3dB at 10Hz and 50kHz.

MODIFICATIONS

Resistance values can readily be changed to suit different meter sensitivities, or to provide different voltage or current ranges (useful if the meter scale is 0 to 3 instead of 0 to 10). For a meter (or multimeter) of sensitivity i mA.

$$R15 = 50/i\ (\Omega) \qquad R30 = 200/i\ (\Omega) \qquad VR3 = 1/i\ (k\Omega)$$

To give a voltage range of V millivolts the resistance R between IC1's non-inverting input and the voltage source is given by:

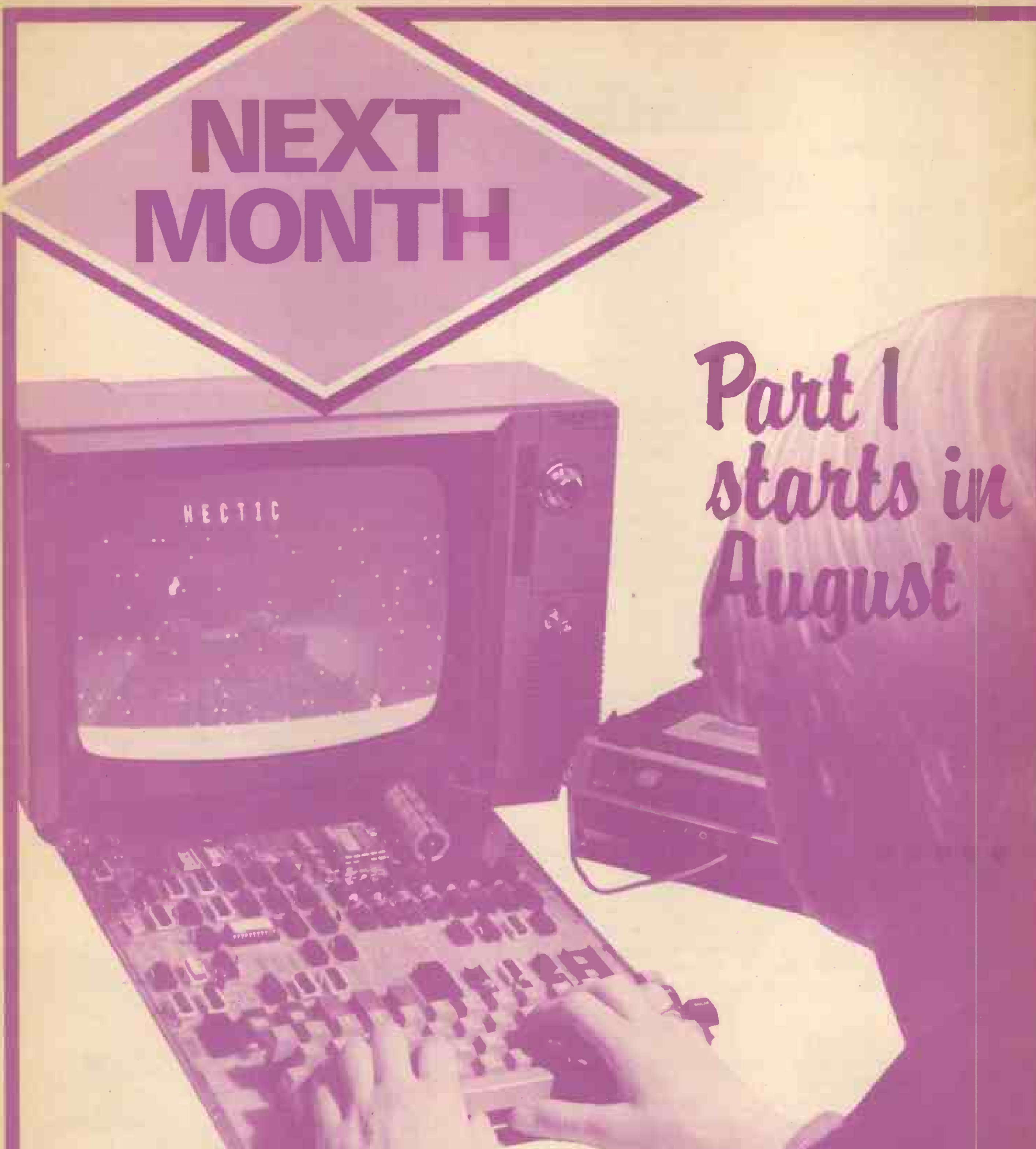
$$R = V - 5\ (k\Omega)$$

For a current range with a f.s.d. of i mA the resistance to earth (i.e. across which the voltage is developed) is:

$$R = 5/i\ (\Omega)$$

A useful feature sometimes found on good quality multimeters with decade ranges is a scale ÷ 2 switch. If a 100kΩ 1 per cent resistor is put in series with R14 with a normally closed switch wired across it, the switch will change the gain of IC1 from 10 to 20, doubling the sensitivity of Metermate on every range (or dividing the f.s.d. by 2).

Ingenious constructors can doubtless think of other modifications to Metermate's circuit. Although the unit was designed to uprate an existing multimeter, by building the circuit in a case with its own self-contained meter, an accurate multimeter could be constructed. ★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PRACTICAL
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FOUR TONE CHANNELS SUBJECTIVELY BALANCED FOR LOUDNESS

IT IS from personal experience that I appreciate how little time the performing musician has available in which to alter settings on equipment. This circuit was originally made up with this in mind, and allows rapid, click-free, switch selection of four preset tonal responses which are subjectively balanced against each other for loudness. The controls are simply two subminiature DPDT toggles, which in combination allow the four tones to be selected, and if mounted close together as Fig. 1, permit easy single handed operation, and a quick visual indication of status.

THE CIRCUITRY

The tone forming section is basically a phase splitter with a low value emitter bypass capacitor giving treble boost at the collector, the signal from the latter being the basis of the two types of treble tones. A single supply rail is used, with d.c. bias for TR2 and IC1 being derived from a single resistive divider. Switching clicks are eliminated by ensuring that no side of a capacitor unless at a d.c. level is ever left without an earth reference path. See Fig. 2.

In an early prototype, the input was simply fed, as in typical commercial treble boosters, to the base of, in this case, TR2. But this did not give good results with guitars, since (a), the input impedance was quite low, becoming lower still at higher frequencies, and (b) internal noise was a problem in treble boost settings. Adding the FET source follower as an input buffer solves both of these problems. The input impedance is now uniformly high (by instrument standards), and noise is greatly reduced by presenting a low a.c. impedance to the base of TR2. The overall noise performance now depends almost entirely on the 741, and so it is recommended that for such as recording work, a 741N be used; for stage use a 741C is more than adequate.

Switched Tone Treble Boost

J.D. ROGERS

The Settings (Switch positions refer to Fig. 1)
Normal setting (2/4) Signal is routed direct to the output amp.
Soft setting (1/4) Modified treble cut and a restricted bass response. Gives a useful accordian-like tone to chords played on Brass ensemble type keyboards, which usually produce sawtooth waveforms. Gives a rounded tone with Fender bass.
Sharp setting (1/3) Treble boost, but with extreme treble (from 3kHz) rolled off and also some cancellation of mid frequencies due to antiphase mixing with emitter signal. Brightens a "muddy" electronic piano without sounding tinny, gives a good "church" organ tone with string ensembles, and gives *presence* boost with guitars.
Bright setting (2/3) Treble boost without upper high roll off. Gives a really crisp, "tingly" guitar treble boost, while still retaining good bass response.

THE CONSTRUCTION

The unit is best built in a diecast aluminium box which is earthed via *one* only of the jack sockets. Internal interwiring could be greatly reduced by rearranging the suggested stripboard layout to accept direct p.c.b. mounting switches. The only internal connection that needs to be made with screened cable is that between the Input jack socket and the p.c.b., the screen should be earthed at one end only. A PP3 is adequate for the power supply (drain is approx. 3mA). If any unwanted distortion is evident when using very high output instruments, two PP3s can be used in series to give +18V. This allows a higher input before overload, but obviously there is a limit, after which series resistance can be added at the input to attenuate the signal. At + 18V, R5 needs to be reduced to about 15k to preserve electrically silent switching.

Apart from being made up as a self-contained unit, the circuit could also find use built into the front end of an instrument amplifier, in which case the supply can be anywhere from 9 to 18V, and extra inputs can be added using the 741 as a virtual earth mixer with gain, see Fig. 4. If the series resistance Rs is not less than 220k in each case, then up to about four inputs can be added, with or without their own volume/tone controls to suit.

SOME GENERAL POINTS

The following are notes on treble boost effects and some notes for guitarists.

(1) The unit complements Gibson and similar pickups well, while Fenders tend to already have a surfeit of treble and do not need further treble boost.

(2) As with any signal processing unit, certain styles of playing will benefit, others will not suit the effect at all. The result you get depends to a large degree on how it is used. With guitars, for example, using the plectrum at different positions along the strings gives widely different timbres and the difference this makes to the sound becomes more noticeable when the harmonics, or "overtones" above the fundamental, are emphasised by treble boosting. For example, try selecting main pickup and playing with the plectrum hand higher up than usual, around the 16th fret. Using gentle plectrum strokes here can give a nice effect on chords with the treble boost settings.

(3) The Sharp setting can be used to heighten the audible effect of phasers, which being swept multiple notch filters, work by selectively attenuating varying components of the audio signal. With guitars, treble boost at about 1 to 4kHz

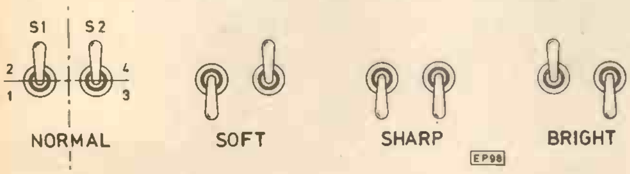
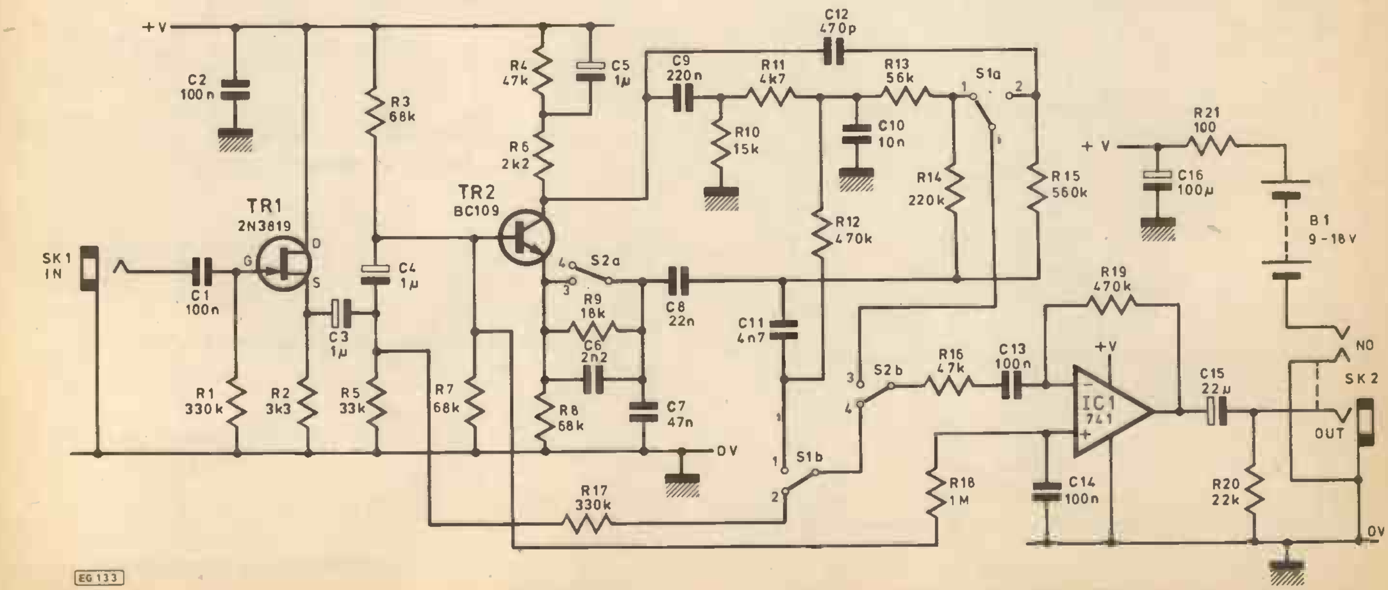


Fig. 1. Switch settings

Fig. 2. Circuit diagram



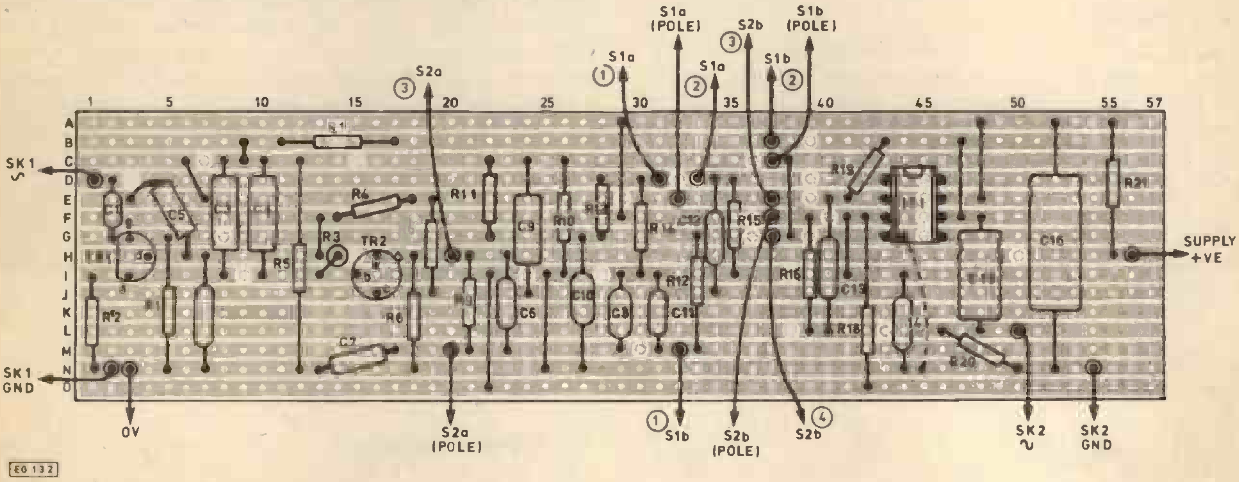
gives them more harmonics to work on. Above 4 to 6kHz however, the notched responses of many phasers flatten out, and so the Bright setting, which boosts mainly in this region, while still altering the overall phased tone, may hardly affect the apparent "movement" in the phasing effect, as it is boosting in a region of static frequency response. *True* phasing, which is now known as flanging, operates by modulation of time delay, as opposed to phase delay, and produces a greater number of notches. These extend above 6kHz to as high as the particular flanging method used allows, and so boosting of any part of the high end of the audio frequency spectrum can heighten the subjective effects.

(4) The effect of the treble boost on Bass guitars is to help give the often heard "click" to the attack transient at the beginning of each note, an effect which may bass players today favour.

(5) A high impedance input, as on this unit, gives smoother working of guitar volume controls and a generally improved responsiveness to the pickups. Some guitars however, are still wired as Fig. 5, where turning down the volume control puts more resistive load on the pickup, affecting tone and sustain qualities. This rather defeats the object of a high impedance input, and so it is both simple and worthwhile to rewire as Fig. 6.

(6) No matter how a guitar's innards are wired, signal degradation will often occur by mains hum pick up, by noise/interference pick up, by the lead being microphonic (crackling when jostled or kicked), and by loss of high frequencies due to the capacitance of the screened cable. The longer the lead you use between guitar and amp, the more noticeable these all become, and turning down a guitąrs, volume control under these conditions will cause even more high frequency losses. An effects unit with a low impedance output, such as this design, can be used to avoid these problems. Use a reasonably short, *not* coily, screened cable from guitar to unit, then any long stretch of cable can be used between unit and power amp without signal degradation.

Fig. 3. Stripboard layout



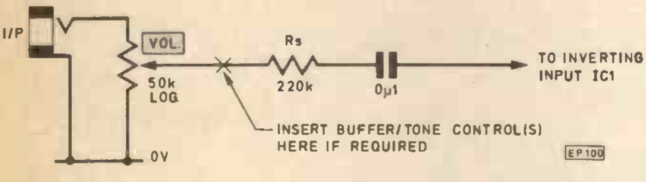


Fig. 4. Suggested arrangement for extra input

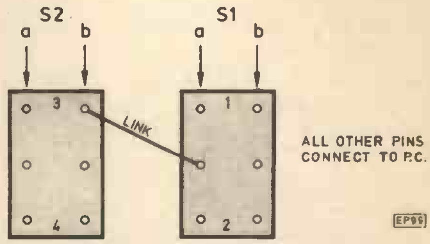


Fig. 3a. Tone switch wiring

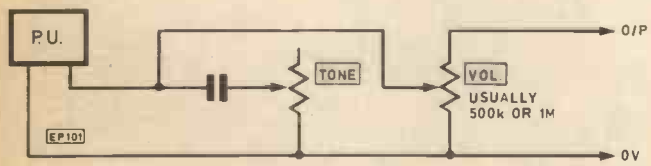


Fig. 5. Some guitars are wired like this, and can be rewired as shown in Fig. 6.

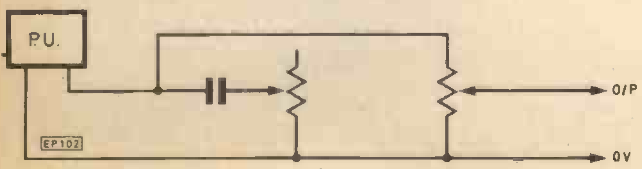


Fig. 6. Guitar rewired to maintain a more constant load across the P.U.

COMPONENTS . . .

Resistors

R1, R17	330k	(2 off)
R2	3k3	
R3, R7, R8	68k	(3 off)
R4, R16	47k	(2 off)
R5	33k	
R6	2k2	
R9	18k	
R10	15k	
R11	4k7	
R12, R19	470k	(2 off)
R13	56k	
R14	220k	
R15	560k	
R18	1M	
R20	22k	
R21	100	

Capacitors

C1, C2, C13, C14	100n
C3, C4, C5	1u
C6	2n2
C7	47n
C8	22n
C9	220n
C10	10n
C11	4n7
C12	470p
C15	22u
C16	100u

Transistors

TR1	2N3819
TR2	BC109

Integrated Circuits

IC1	741

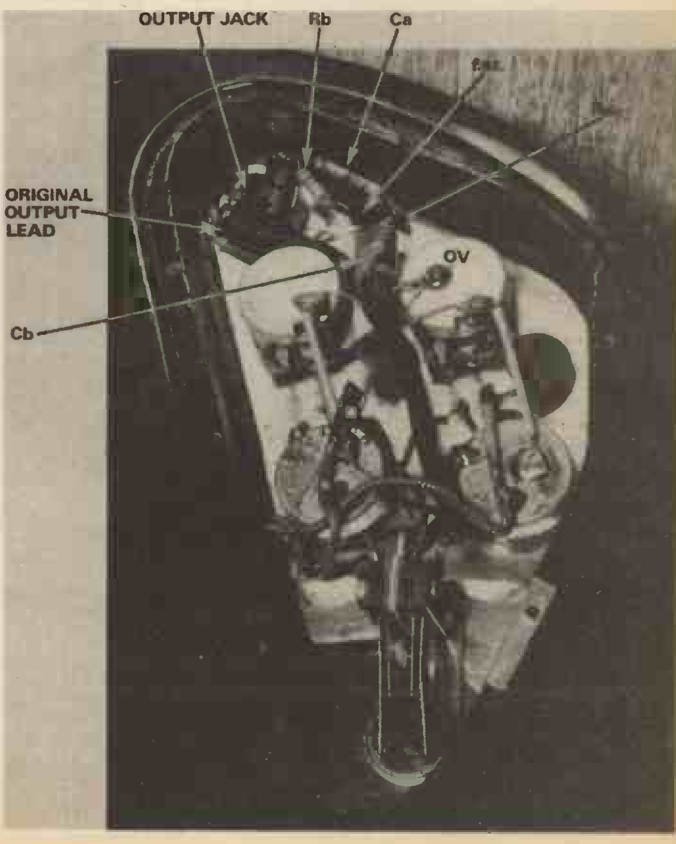
Miscellaneous

SK1	Standard jack socket
*SK2	Switched jack socket

Veroboard, suitable case, 9V battery, d.p.d.t. toggle switches (2 off)

*Bulgin type J21 (Home radio)

The photograph shows the f.e.t. preamplifier installed in the author's guitar, using the non-battery system



(7) An alternative way of avoiding the signal degradations mentioned is to have a low impedance output buffer stage inside the guitar itself. A few guitar manufacturers are now using FET preamps with batteries installed in the guitar. This works extremely well, and much fuss is made of it in sales write-ups. The increase in the price of the guitar, however, is usually far more than is justified by the inclusion of the few extra components.

I have found an interesting way to add an internal FET preamp to *any* guitar without having to install batteries, for which there is often no space without cutting into and enlarging the electrics cavity (not recommended with something that may have cost the owner a few hundred pounds). This circuit utilises the power supply of an existing effects unit or amplifier with a 9 to 18V power line, it costs very little, is simple to install and can be removed just as easily, leaving the guitar exactly as it was. The simplicity of using an ordinary guitar jack lead is retained, by using the central conductor to carry both the power supply from the unit or amplifier to the FET and the signal from the guitar back to the amplifier *simultaneously.*

The advantages obtained by having the preamp are identical to those outlined in notes 5 and 6. The FET is a source follower, obtaining its power supply via R*, in the effects unit or amplifier, and then Rb, the drain resistor. The drain is heavily decoupled by C2, to prevent the signal from the source being cancelled out to zero. A sub-min toggle can be added for restoring the output of the guitar to completely normal operation, or if there is room, a second

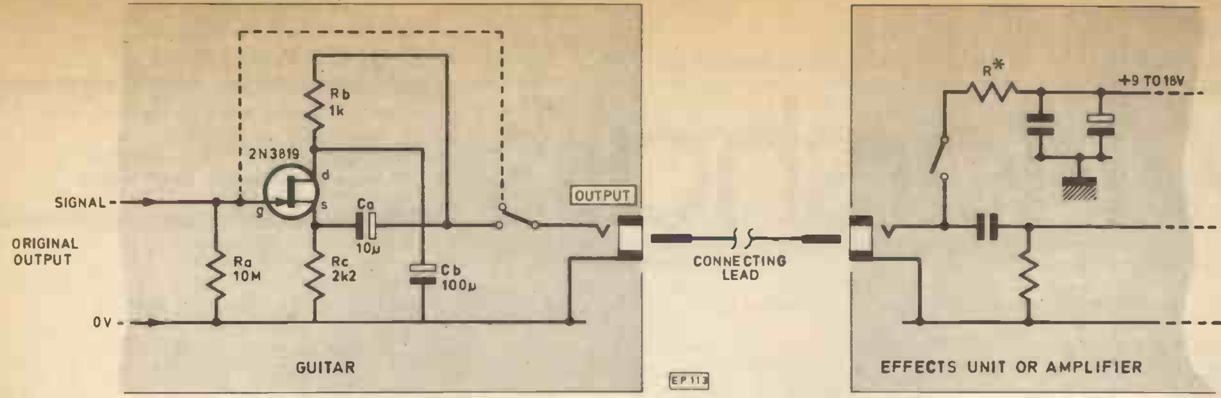


Fig. 7. Installation of a preamp in the guitar, without the need of an internal battery. No isolating capacitor is necessary at the preamp input. The only extra components required in the Treble Boost unit are the switch and 4k7 resistor R*

jack socket can be wired direct to the FET gate. The only modification to the effect unit/amplifier is to add a single 4k7 resistor from the power line (which should be, and usually is, well decoupled) to the input jack socket, before the input capacitor. The guitar toggle switch changes the input back for normal operation. ★

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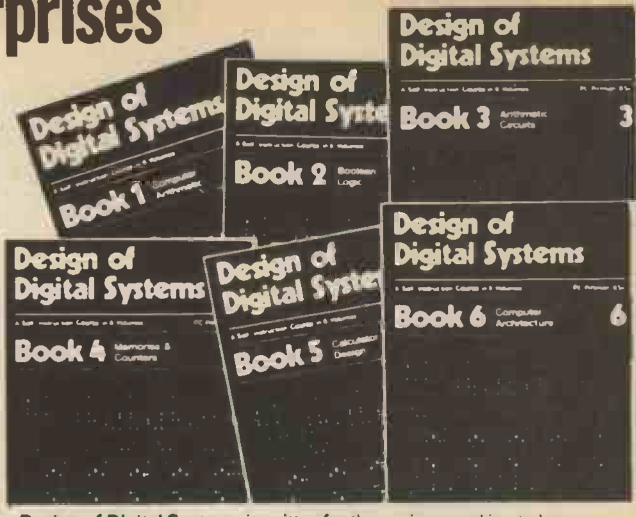

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Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND. NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

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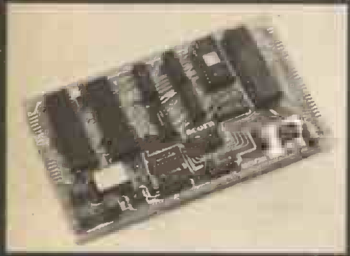

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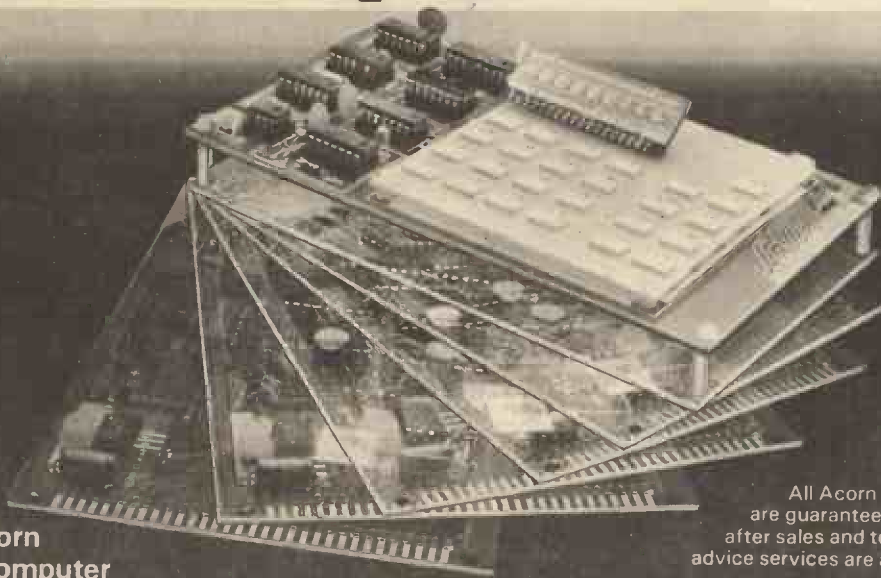

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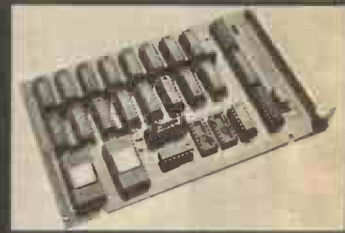

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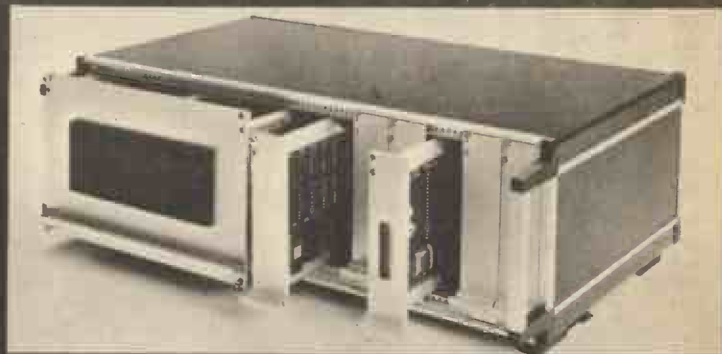

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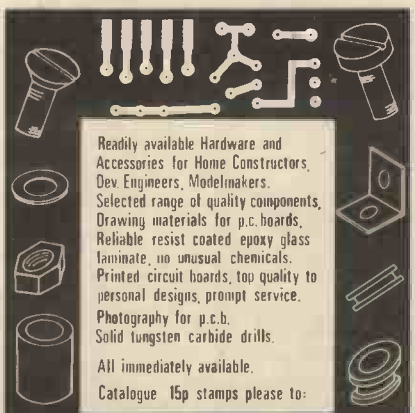

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51	5·0	9·87	1·32
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85	0·5	2·5	5·00	0·96
70	6	3	6·35	0·96
108	8	4	7·42	1·14
72	10	5	8·12	1·14
116	12	6	8·99	1·32
17	16	8	10·72	1·32
115	20	10	13·98	2·08
187	30	15	17·93	2·08
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4022	100p
4023	22p
4024	50
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
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4041	80p
4042	80p
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4067	450p
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4071	22p
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4073	22p
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4082	22p
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75451	72p
75491/2	96p
8T26	250p
8T28	300p
8T95	160p
8T97	160p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
9601	120p
9602	220p
9603	160p

93 SERIES	
9301	160p
9302	175p
9308	316p
9310	275p
8311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	225p
9368	200p
9370	200p
9374	200p

LINEAR I.Cs	
*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	140p
*AY5-1315	600p
*AY5-1317	636p
*CA3019	80p
*CA3046	70p
*CA3048	225p
CA3080E	72p
*CA3089E	225p
*CA3090AQ	375p
CA3130S	100p
CA31140E	70p
CA3160E	100p
FX209	750p
ICL7106	850p
ICL8038	340p
LM301A	30p
LM311	120p
LM318	200p
LM319	200p
LM324	70p
LM339	75p
LM348	95p
*LM377	175p
*LM380	75p
*LM381AN	160p
*LM389N	140p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	20p
LM747	70p
LM748	35p
LM3900	70p
LM3911	130p
LM4136	120p
*MC1310P	150p
MC1458	55p
MC1495L	350p
*MC1496	100p
*MC3340P	120p
*MC3360P	120p
*MFC4000B	120p
MK50398	750p
NE531	110p
*NE540L	250p
NE543K	225p
NE555	25p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
*SAD1024A	1400p
SFF96364	1150p
*SN76003N	175p
*SN76013N	140p
*SN76013ND	120p
*SN76023N	140p
*SN76023ND	120p
*SN76033N	175p
SN76477	250p
*SP8515	750p
*TAA621	275p
*TBA641B11	225p
*TBA651	200p
*TBA800	90p
*TBA810	100p
*TBA820	90p
*TCA940	175p
*TDA1004	300p
TDA1008	320p
*TDA1022	600p
TDA1034B	250p
*TDA2020	320p
TL071	60p
TL072	95p
TL074	150p
TL082	90p
TL084	130p
TL170	50p
XR2206	350p
XR2207	400p
XR2211	600p
*XR2216	675p
XR2240	400p
*ZN414	90p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p

VEROBOARD

	0.1	0.15
(copper clad)		
2½ x 3¾	41p	33p
2½ x 5	49p	45p
3¾ x 3¾	49p	45p
3¾ x 5	56p	60p
2½ x 17	180p	150p
3¾ x 17	225p	190p
4¾ x 17	340p	—

Pkt of 35 pins 30p
Spot face cutter 85p
Pin insertion tool 99p

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Plus spool 325p
Spare spool (wire) 80p
Combes 7p each

TRANSISTORS	
AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116/7	30p
AD149	70p
AD161/2	45p
BC107/8	11p
BC109	11p
*BC117	20p
*BC147/8	9p
*BC149	10p
*BC157/8	10p
*BC159	11p
*BC169C	12p
*BC172	12p
BC177/8	17p
BC179	18p
*BC182/3	10p
*BC184	11p
BC187	30p
*BC212/3	11p
*BC214	12p
BC461	36p
BC477/8	30p
*BC516/7	50p
*BC547B	16p
*BC549C	18p
*BC557B	16p
*BC559C	18p
BCY70	18p
BCY71/2	22p
8D131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD242	70p
BDY56	200p
BF200	32p
*BF244B	35p
*BF256B	70p
BF257/8	32p
BF259	36p
*BFR39	30p
*BFR40	30p
*BFR41	30p
*BFR79	30p
*BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
*BU105	190p
*BU108	250p
BU109	225p
*BU205	200p
*BU208	200p
*BU406	145p
BJ481	175p
MJ491	200p
MJ2501	225p
MJ2955	100p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105/6	40p
MPSA06	30p
*MPSA12	50p
*MPSA13	50p
*MPSA20	50p
*MPSA56	32p
*MPSU06	63p
MPSU65	78p
OC28	130p
OC35	130p
*R2008B	200p
*R20108	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP4055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N940	18p
2N1131/2	20p
2N1613	25p
N1711	25p
2N2102	60p
2N2160	300p
2N2219A	22p
2N2222A	22p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	20p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3663	20p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
2N4037	65p
2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	85p
40410	85p
40411	300p
40594	97p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES	
*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
*15920	9p

HEAT SINKS
For TO220 Voltage Regs and Transistors 22p
For TO5 12p

BRIDGE RECTIFIERS	
*1A 50V	21p
*1A 100V	22p
*1A 400V	30p
*1A 600V	35p
*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
6A 50V	90p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

***ZENEERS**
2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC	
3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS	
1A 50V	40p
1A 400V	65p
1A 600V	70p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
*MCR101	36p
2N3525	120p
2N4444	140p
*2N5060	34p
*2N5064	40p

LOUDSPEAKERS Size		
2½"	64R	70p
2½"	8R	70p
2"	8R	75p
1½"	8R	75p

VOLTAGE REGULATORS

Fixed Plastic TO-220 1A	+ve		−ve	
5V	7805	75p	7905	100p
12V	7812	75p	7912	100p
15V	7815	75p	7915	100p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p
100mA TO-92				
5V	78L05	35p	79L05	80p
12V	78L12	35p	79L12	80p
15V	78L15	35p	79L15	80p

OTHER REGULATORS			
LM309K	135p	TBA6258	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	778MGT2C	135p

OPTO-ELECTRONICS			
2N5777	45p	OCP71	130p
ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p

LEDS 0.125"		0.2"	
TIL32 I.R.	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS			
3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	MAN3640	175p
707 Gr	140p	TIL311	600p
DL747 Red	225p	TIL312/3	110p
747 Gr	225p	TIL321/2	130p
FND357	120p	TIL330	140p
		7750	200p
		7760	200p
		NSB5881CC 4 DIGIT DISP	570p

DRIVERS	
9368	200p
9370	200p

MEMORIES	
2102-2L	120p
2102L-4	120p
2107B	500p
2111-2	225p
2112-2	250p
2114	700p
4044	900p
4116	1100p
5101	510p
6810	350p

ROM/PROMs	
71301	700p
74S188	225p
74S287	350p
74S387	350p
745571	650p
93427	400p
93436	650p
93446	650p
93448	1000p

CPUs	
CP1610	930p
6502	1200p
6800	900p
6802	1250p
8080A	550p
Z80	1150p

EPROMs	
1702A	500p
2708	900p
2716	2900p

SUPPORT DEVICES	
3245	400p
4002	
6820	600p
6850	700p
8250	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	650p
8257	1100p
8259	1400p
Z80P10	650p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART	
AY-3-1015P	500p
AY-5-1013P	400p
IM6402	500p
TMS601 1NC	400p

CHARACTER GENERATORS	
3257ADC	990p
MCM6576	800p
RO-3-2513UC	600p
RO-3-2513LC	600p
SN 74S262AN	1350p

KEYBOARD ENCODER	
AY-5 2376	1000p

TRANSFORMERS
(prim 220 240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-120-12	500mA	280p*
0 25V (5VA)		250p
9-0-9 1A		270p*
12V 2A		350p*
0 12-15 20 24-30 1A		340p*
15-0-15 1A		265p*

(Please add 50p p&p charge to all marked* above our normal p&p charge)

***RESISTORS High**
*Stab 5% E12 Carbon Film Min
*¼W 10R-1M 7p/5pcs one value
*½W 10R-10M 6p/3pcs one value
*Miniature Presets Hor/Vert 100R-1M 12p
*Carbon Track Pots 5K-1M Log or Lin
*Single 30p
*Single with Switch 80p
*Dual 72p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	11p	18 pin	25p	24 pin	33p
14 pin	12p	20 pin	27p	28 pin	42p
16 pin	13p	22 pin	30p	30 pin	51p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	75p	24 pin	90p
14 pin	40p	20 pin	80p	28 pin	110p
16 pin	55p	22 pin	85p	40 pin	140p

SUBMINIATURE SWITCHES

TOGGLE	
SPST	51p
SPDT	53p
DPDT	55p
DPDT (Centre off)	85p
Push to make	15p
break	25p
*SLIDE DPDT	18p
*ROCKER SPST	28p
*WAFER 1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

ANTEX SOLDERING IRONS

C-15W	360p
CX-17W	380p
CCN-15W	380p
X25	380p
SPARE BITS	
C/CCN CX	46p
X25	50p
SPARE ELEMENTS	
C/CX/X25	180p
CCN	200p
IRON STAND	150p

VEROBOARDS
DIP Breadboard 4.15" x 6.15" 270p
(Suitable for 20 x 14 pin or 16 x 16 pin DIL ICs) DIP Breadboard as above with tracks for 31 way connector 340p

CONNECTOR PLUGS
31 way Plug 100p
31 way Socket 105p
S-100 Busboard £12

*CRYSTALS	
100KHz	300p
1MHz	370p
3.2768M	350p
10.7MHz	350p
18MHz	300p
26.690M/27.145M	425p

EDGEBOARD CONNECTORS 0.156" PITCH

2 x 10 way	85p	2 x 22 way	135p
2 x 15 way	100p	2 x 25 way	160p
2 x 18 way	120p		

COUNTERS	
74C925	550p
ICM7217A	850p
ZN1040E	700p

Full range of 74 TTLs and 74LS, CMOs, etc. stocked. Data books on TTLs, CMOs, Linears, Memories stocked. Send S.A.E. for details.

16 Key Keypads (Reed switches) 400p

BREADBOARD
EXP300 Suitable for up to 6x14 or 5x16 pin DIL ICs 575p
EXP350 5x14 pin DIL ICs 315p
EXP600 (28/40 pin DIL IC) 630p

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5A Stabilized variable voltage Power Supply

PE microprocessor evaluation system as described in current issue, all parts available.
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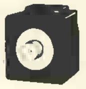
High intensity multi turn. high voltage. neon glow. discharge flash tube Design for ignition timing. etc £1·50. P & P 25p (£1·89 inc VAT) 3 for £3. P & P 50p (£3·78 inc VAT & P.)

RODENE UNISET TYPE 71 TIMER

N.M.S.

0-60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6.** P. & P. 60p. **£7·13** inc. VAT & P. & P.



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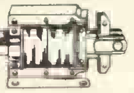
MULTI RANGE METER Type MF15A a.c. d.c. volts 10 - 50. 250. 500, 1000. Ma 0–5, 0–10, 0–100. Sensitivity 2000V. 24 range. diameter 133 by 93 by 46mm including test leads. Price £7·00 plus 50p P. & P. (£8·10 inc.VAT & P.)

N.M.S.

METERS (New) – 90 mm DIAMETER

A.C. Amp., Type 62T2. 0-1A., 0-5A., 0-20A.
A.C. Volt. 0-150V. 0-300V.
D.C. Amp., Type 65C5. 0-2A., 0-10A., 0-20A., 0-50A., 0-100A
D.C. Volt. 0-15V., 0-30V.
All types £3·50 ea. + P. & P. 50p (£4·32 incl. VAT), except 0-50A. 0-100A. D.C., price £5.00 + 50p. P. & P. (£5.94 incl. VAT).

NEW HEAVY DUTY SOLENOID. mfg. by Magnetic Devices. 240V a.c. operation approx. 10lbs pull (intermittent rating) at ⅜ths in. Price **£4·00** P. & P. 60p. (£4·96 inc. VAT & P.). N.M.S.



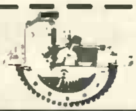
A.C. SOLENOID pye ether type 176/2 240 AC. Approx 1lb at ½ inch, intermittent rating. Price **£1** p&p 20p (£1·30 inc VAT + P)

WESTOOL TYPE MM8 Model 2, 240V AC. Approx 1¾lb pull at ½ inch. Rating 1. Price **£1·50** p&p 20p. **(£1·84** inc VAT + P) N.M.S.

MINIATURE UNISELECTOR

12 volt. 11-way, 4 bank (3 non-bridging 1 homing), **£2·50.**

P. & P. 35p (£3·08 inc. VAT & P.). N.M.S.



240 A.C. SOLENOID OPERATED FLUID VALVE

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring ½ in. b.s.p. Inlet outlet. Precision made. British mfg. PRICE £3·50 Post 50p (£4·32 inc. VAT & P).

N.M.S.

MICRO SWITCHES

Sub min Honeywell roller m/s type 3115m 906t. 10 for **£2·50** post paid.
LEVER OPERATED 20 amp. C/O. Mfg. by Unimax USA 10 for **£4,** P. & P. 50p (min. order 10) (£4·86 inc. VAT).
D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for **£2·25** P. & P. 30p. Total inc. VAT **£3·02** (min. 10).

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Size 27mm x 5mm, 10 for **£5.00** (inc VAT **£5.72**) min quantity 10.
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VORTEX BLOWER AND VACUUM UNIT

Dynamically balanced totally enclosed 9in rotor with max. air delivery of 1·5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular appertures fitted to base of unit. Powerful continuously rated 115V a.c. motor mounted on alloy base with fixing facilities. Dimensions: length 32cm x width 25cm x height 25cm. These units are ex equipment but have had minimum use. Fully tested prior to despatch. Price **£12** + £1·50 P. & P. **(£14·50** inc. VAT & P.).
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CENTRIFUGAL BLOWER Smith type FFB

16 · 022 220/240V A.C. Aperture 10 x 4½cm overall size 16 x 14cm. Price **£3·75** P. & P. 75p. (inc. VAT **£4·86**).
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N.M.S.

24 volt. D.C. BLOWER UNIT

Precision 24 volt. D.C. 0·8 amp Blower that works well on 12V 0·4 amp D.C. Producing 30 cu.ft. min at normal air pressure. **£4.50** P. & P.75p (inc. VAT £5·61). N.M.S.

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Test to I E E Spec Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb, **500V,** 500 megohms, **£49.**Post 80p **(£53·78** inc. VAT & P.). **1,000V** 1,000MΩ, **£55.** Post 80p **(£60·26** inc. VAT & P. SAE for leaflet.

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INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types SHROUDED TYPE

200 watt (1 amp inc, a.c. voltmeter	£14.50
0.5 KVA (2½ amp (MAX)	£17.00
.1 KVA (5 amp MAX)	£22.50
.2 KVA (10 amp MAX)	£37.00
.3 KVA (15 amp MAX)	£45.50
.5 KVA (25 amp MAX)	£74.00
10 KVA (50 amp MAX)	£168.00
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25-0-25V at 2½ amp **£4·50** P. & P. 75p **(£5·67** inc. VAT & P.)
0-4V/6V/24V/32V at 12 amp **£18·50** P. & P. £1·90 **(£22·03** inc. VAT & P.)
0-6V/12V at 20 amp **£14·70** P. & P. £1·50 **(£17·50** inc. VAT)
0-12V at 20 amp or 0-24V at 10 amp **£12·00** P. & P. £1·50 **(£14·58** inc. VAT & P.)
0-6V/12V at 10 amp **£8·25** P. & P. **£1·25 (£10·26** inc. VAT)
0-6V/12V/17V/18V/20V at 20 amp **£19·00** P. & P. £1·50 **(£22·10** inc. VAT & P.)
0-10V/17V/18V at 10 amp **£10·50** P. & P. £1·50 **(£12·96** inc. VAT)
Other types in stock; phone for enquiries or send sae for leaflet.

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Latest type Xenon white light flash tube. Solid state timing and triggering circuit 230/240V a.c. operation. Designed for larger rooms, halls, etc. Speed adjustable 1–20 f.p.s. Light output greater than many (so called 4 Joule) strobes. Price £19·00. Post £1 (£21·60 incl. VAT & P.). Specially designed case and reflector for Hy-Light **£8·80.** Post £1 (£10·58 inc. VAT & P.)

XENON FLASHGUN TUBES

Range available from stock S A E for details

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Diamond H heavy duty A.C. relay 230/240V a.c., two C/O contacts 25 amps res at 250 a.c. **£2.50** p&p 50p. (£3.24 inc VAT + p&p) Special base 50p. N.M.S.

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4½ rpm. 115V. a.c. 50 cycle, mf. **SIGMA** Inst. Ltd. U.S.A. Price: **£7·50** + 75p. P. & P. **(£8·91** inclus. VAT). supplied with transformer. N.M.S.

7½ rpm. 115V. a.c. 50 cycle approx. 25lb. mf. **KLAXON.**
28 rpm. **115V.** a.c. 20lb. in. reversible.
71 7rpm. 115V. a.c. 10lb. in reversible, all approximately similar to drawing.
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19 rpm FHP 220/240V. a.c. reversible, torque 14·5kg. Gear ratio 144—1. Brand new including capacitors. mf. **CITENCO.** Price: **£14·25** + £1·25 P. & P. **(£16·20** inclus. VAT). N.M.S.

30 rpm. 230/240V. a.c. 50lb. in. mf. **PARVALUX.** Price: **£15·00** + £1·50 P. & P. **(£17·82** inclus. VAT). N.M.S.

56 rpm. 240V. a.c. 50lb. in. 50Hz 0·7 amp. Shaft length 35mm. Dia. 16mm. Wt. 6kg. 600g. mf. **FRACMO.** Price: **£15·00** + £1·50 P. & P. **(£17·82** inclus. VAT). N.M.S.

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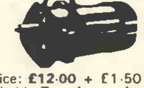

200 rpm. 35 lbs. in. 115V. 50Hz.
Price: **£16·00** + £1·50 P. & P. **(£18·90** inclus. VAT). N.M.S.
Suitable Transformer for 230/240V. a.c.
Price: **£8-00** + £1·00 P. & P. **(£9·72** inclus. VAT). N.M.S.

500 rpm. 230/250V a.c. 3½lb. in. 2 right-angled spindles. Mf. **PARVALUX.** Price **£11·00** + £1·00 P. & P. **(£12·96** inclus. VAT). N.M.S.

6/9V. D.C. Miniature Geared Motor, precision built, incredibly powerful for size –
approx. speed @ 6V.- 60 rpm 40 ma.
approx. speed @ 9V.- 80 rpm 50 ma.
Size: 27mm dia., 30mm length, 55gr. weight, drive spindle 5 x 3mm dia.
Price: **£2·50 post paid (£2·70 inclus. VAT).** N.M.S.

12V. D.C. type SD2. Shunt 1/30 ph continuously rated 4000 rpm. Mf. **PARVALUX.** Price: **£10·00** + 75p. P. & P. **(£11·61** inclus. VAT). N.M.S.

1 rpm 230/240V. a.c. Synchronous geared Motor, mf. **HAYDON.**
2 rpm 230/240V. a.c. Synchronous geared Motor, mf. **CROUZET.** Price above 2 Motors: **£2·90** + 30p. P. & P. **(£3·46** inclus. VAT). N.M.S.

1,400 rpm 115V. a.c. Motor, HP 1/8 continuously rated. Fitted with anti-vibration cradle mounting. Mf. **FRACMO.** Supplied complete with Transformer for 230/240V. a.c. operation. Price: **£10·00** + £1·00 P. & P. **(£11·88** inclus. VAT). N.M.S.

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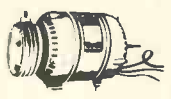

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English Electric 3 phase AC. motor 220/250V. Or 380/440V. 1,425 r.p.m. ¼ h.p. continuously rated. Direct coupled to William Allday & Co Alcosa carbon vein blower/vacuum pump 0.9 cfm 8.HG. Price **£22** p&p £2 **(£25·92** inc VAT + p) N.M.S.

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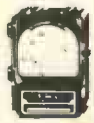
R. & T.



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R. & T.

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