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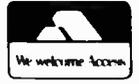
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VOLUME 14 No.15 NOVEMBER 1978

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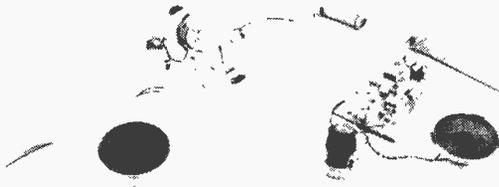
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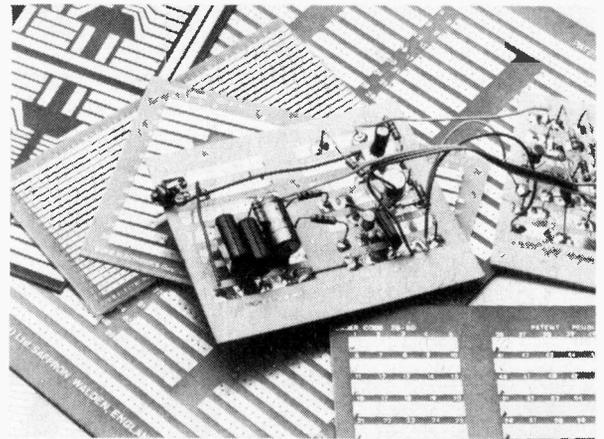
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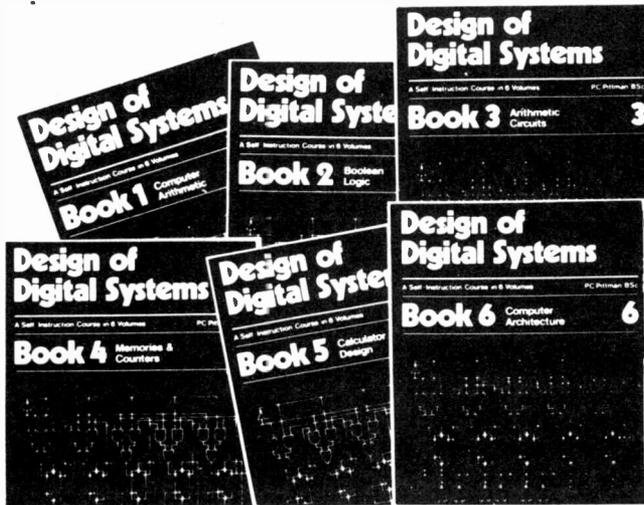
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7458	0.12	0.21	7543	0.26	0.38	74391	1.68	74392	1.94	74393	1.18	1.12	74394	1.12				
7459	0.12	0.21	7544	0.26	0.38	74395	1.68	74396	1.94	74397	1.18	1.12	74398	1.12				
7460	0.12	0.21	7545	0.26	0.38	74399	1.68	74400	1.94	74401	1.18	1.12	74402	1.12				
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PE22

BREADBOARD

1978

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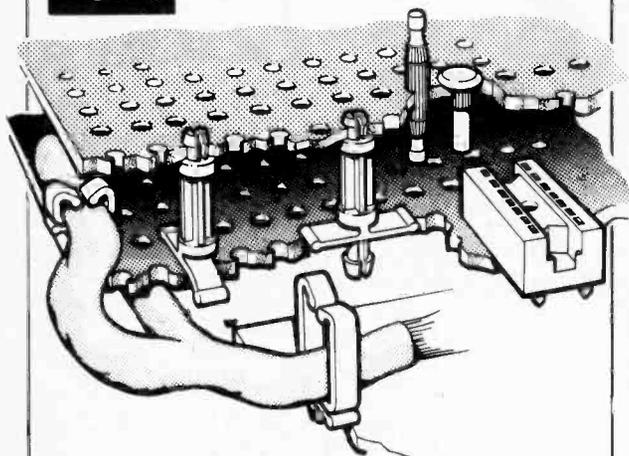
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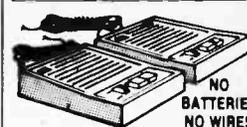
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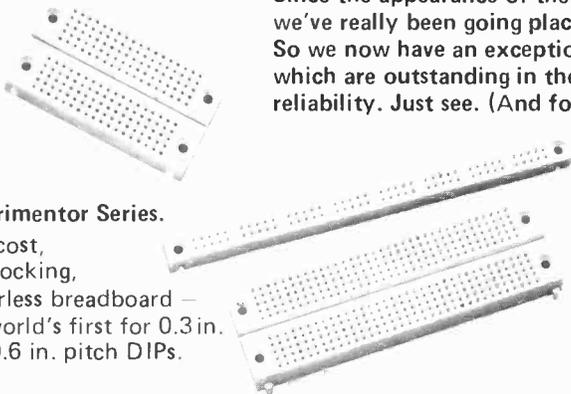
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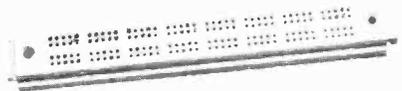
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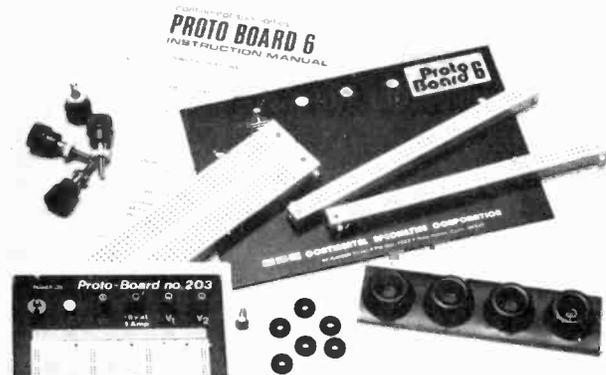
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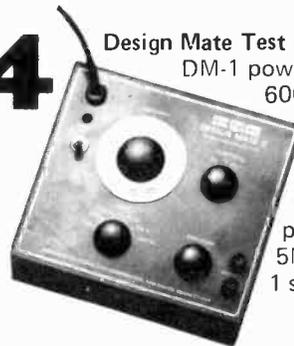
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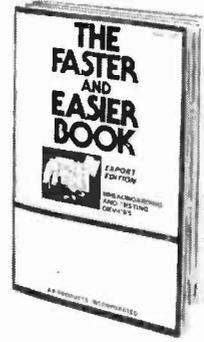
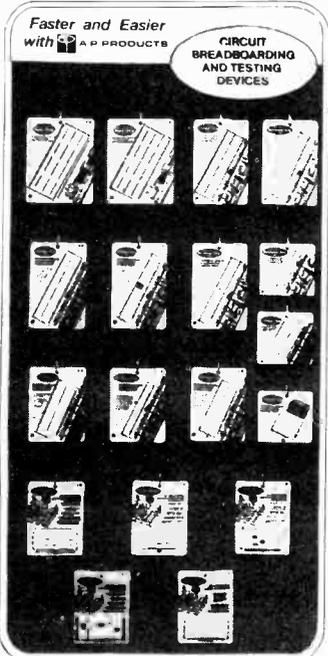
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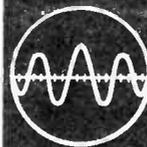
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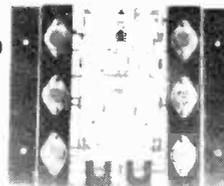


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Day,
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Chronograph

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£49.95

25CS-16B

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Hours, mins, seconds (or hrs, mins, date) day, am/pm. Day, date, month, year. 24 hr alarm, on/off indicator.

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Left: 4 digit

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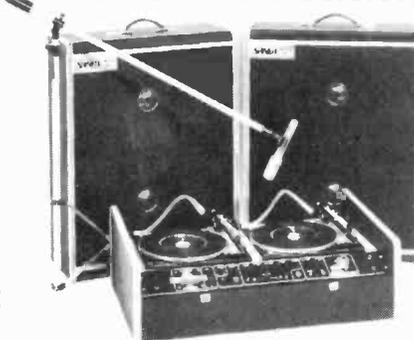


Illustration shows GXL Centaur System

These systems feature full mixing for two decks tape & mic with monitoring facilities – override and are supplied complete with sound to light – sequencer, display, speaker leads etc.

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+ carr. £15

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SA608 60W 8 ohms 65V	£14.25	SUPPLY FOR TWO MODULES	
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SA1208 120W 8 ohms 95V	£21.00	SUPPLY FOR TWO MODULES	
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0.2% Distortion, 30Hz-20, KHz + 2dB, Fully Short/Open Circuit proof input sensitivity 240 mV to suit most mixers – D.C. & Output Fuses fitted.

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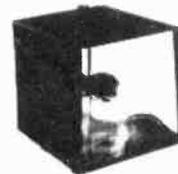
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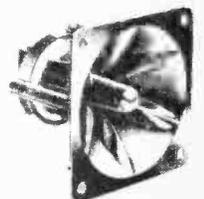
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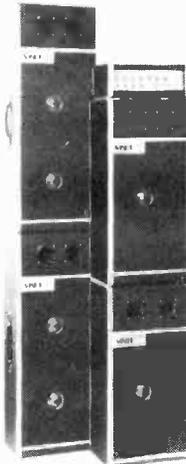
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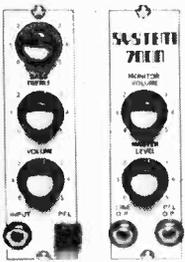
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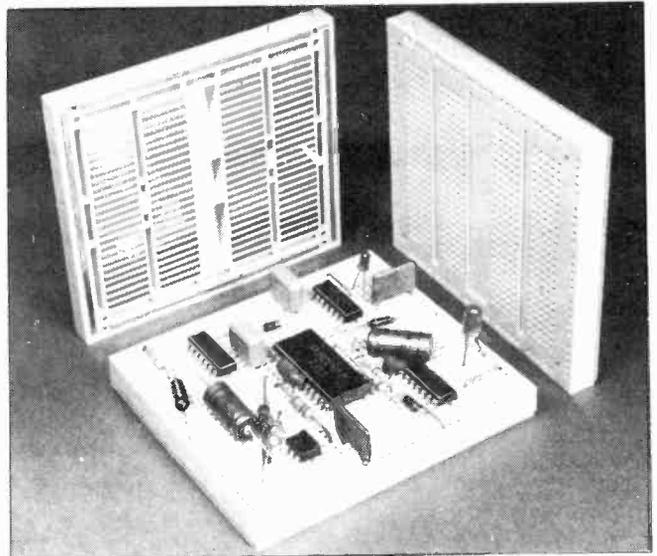
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Type	No.	Price	Type	No.	Price
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Type	No.	Price	Type	No.	Price
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2BA	860	£0.12	6BA	862	£0.12

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2BA	852	£0.28	6BA	854	£0.22

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Toggle switch SPST 1 amp 250V a.c.	1975	£0.33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0.42*
Rotary on-off mains switch	1977	£0.50*
Push switch - Push to make	1978	£0.13*
Push switch - Push to break	1979	£0.18*

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Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0.70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0.85*
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Panel mounting 1 1/2in	510	£0.30

QUICK BLOW 20mm					
Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1.5A	616	4A	620
500mA	613	2A	617	5A	621
800mA	614	2.5A	618		
All 5p each excepting 616 which is 7p.					

ANTI-SURGE 20mm					
Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	629
250mA	623	2A	626	3.15A	628
500mA	624	1.6A	627	5A	630
All 7p each					

QUICK BLOW 1 1/2in					
Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634
All 7p each					

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
1.6A	636	3A	639	5A	642
2A	637				
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163	4in	2 1/2in	2in	64p*
164	3in	2in	1in	44p*
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2022	9V-0-9V 100mA	90p*	
2023	12V-0-12V 100mA	95p*	

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No.	Secondary	Price	
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2028	12V-0-12V 1 amp	£2.60*	P & P 55p
2029	15V-0-15V 1 amp	£2.75*	P & P 66p
2030	30V-0-30V 1 amp	£3.45*	P & P 86p

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Voltages available by use of taps:
4 7 8 10 14 15 17 19 25 31 33 40 25-0-25V.

No.	Rating	Price	
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2032	1 amp	£6.60*	P & P 86p
2033	2 amp	£8.40*	P & P £1.10

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+ 12½% VAT



1 + 7w R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

AUDIO AMPLIFIER MODULE
25 Watts RMS
£4.55 + 35p p&p
+ 12½% VAT



25w R.M.S.

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0.1%.

AL80

AUDIO AMPLIFIER MODULE
£7.15*
+ 35p p&p
+ 8% VAT



35w R.M.S.

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0.1%.

AL250

POWER AMPLIFIER

125w R.M.S.



£17.25* + 40p p&p + 8% VAT

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

AUDIO AMPLIFIER MODULES

10w R.M.S.



£3.75 + 35p p&p
+ 12½% VAT

These low cost 5 and 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED POWER SUPPLY
£4.25 + 35p p&p
+ 12½% VAT



Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO PRE-AMPLIFIER



£15.80
+ 40p p&p
+ 12½% VAT

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3.0 μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (± 2% Hz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm x 110mm x 32mm

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than 5% (Typically 3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm x 130mm x 33mm

OUTPUT POWER	25 Watts RMS
SUPPLY	30-50 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 0.6%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

OUTPUT POWER	35 Watts RMS
SUPPLY	40-60 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 0.6%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80 V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz to 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION	50 WATTS into 4 ohms 0.1% 50 WATTS into 8 ohms 0.06%

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than 25%
LOAD IMPEDANCE	8-16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz-25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm x 63mm x 28mm

INPUT A.C. VOLTAGE	33-40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA-1.5 amps
OVERLOAD CURRENT	1.7 amps approx.
DIMENSIONS	105mm x 63mm x 30mm

FREQUENCY RESPONSE	20 Hz to 20 kHz - 1 dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 0.7%)
SENSITIVITY 1. TAPE INPUTS	100 mV/100 K ohms For an output of 250 mV
2. RADIO TUNER	100 mV/100 K ohms
3. MAGNETIC P.U.	3.5 mV/50 K ohms
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10-20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 x 90 x 33mm (less controls)

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER



£2.95
+ 35p p&p
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3.5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V -re earth
DIMENSIONS	110 x 50 x 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER



£7.10
+ 30p p&p
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz-20 kHz (-3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	-60 dB
SIGNAL/NOISE RATIO	-65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm x 84mm x 25mm

PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538.

INPUT VOLTAGE	17-20v AC	£1.30
OUTPUT VOLTAGE	27-30v DC	+ 35p p&p
OUTPUT CURRENT	800mA	+ 12½% VAT
SIZE	60mm x 43mm x 26mm	

GE 100 NINE CHANNEL MONO-GRAPHIC EQUALIZER

The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12dB. Max. Voltage handling 2 V RMS, T.H.D., 0.05%, input impedance 100K. Output impedance less than 10 K. Frequency response 20 Hz-20 KHz (3dB). The nine gain controls are centred at 50, 100, 200, 400, 800, 1,600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders (not supplied with the module) See Paks S31 and 16192. **£22.00** + 35p p&p + 12½% VAT

SG30 POWER SUPPLY BOARD for GE100 15-0-15 VOLT **£5.50** + 12½% VAT + 35p p&p

SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car, burglar alarm, freezer breakdown and other security purposes. Order No. S15. No. BP124. **Only £3.50** + 8% VAT + 35p p&p

MA60 HI-FI AMPLIFIER KIT

Build your own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 x AL60 amps, 1 x PA100 pre-amp, 1 x SPM80 stab. power supply, 1 x BMT80 transf. giving 17 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad. **Price £32.00** + 12½% VAT + 8p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Nolen, etc. Ideal for the MA60. Size: 425mm x 290mm x 95mm. **Price £19.95** + 12½% VAT + 8p p&p

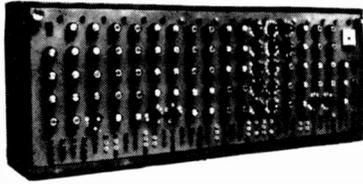
TRANSFORMERS

T538 For use with S.450 AL30A MPA30 Order No. 2036 Price: **£3.20** + 55p p&p + 12½% VAT
T2050 For use with Stereo 30 Order No. 2050 Price: **£3.25** + 55p p&p + 12½% VAT
BMT80 For use with AL60 SPM80 Order No. 2034 Price: **£5.40** + 86p p&p + 12½% VAT
BMT250 For use with AL250 Order No. 2035 Price: **£6.35** + **£1.10** p&p + 12½% VAT

BI-PAK

DEPT. PE11, P.O. Box 6, Ware, Herts

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 outlined".

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 SYNTHESIZER

A portable mains-operated Miniature Sound Synthesizer, 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 **from £81.00**
Set of printed circuit boards **£8.99**

P.E. SYNTHESIZER (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.

The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp.

Set of basic component kits **£79.09**
Set of printed circuit boards **£13.20**

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and PSU.

Set of basic component kits **£47.34**
Set of printed circuit boards **£7.66**

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**

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.

Component set for above functions (excl. SWs) **£8.17**
Printed circuit board **£1.81**
Optional extra—additional Audio Modulator the use of which, in conjunction with the above component set, can produce jungle-drum rhythms. **£2.88**
Component set (incl. PCB)

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**

SOPHISTICATED PHASING AND VIBRATO UNIT

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

Component set **£17.38**
Printed circuit board **£2.33**

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**

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 circuitry. (Order as KIT 71-5) **£99.25**
Set of PCBs (Order as PCB SET 71-6) **£29.18**

SYNTHESIZER TUNING INDICATOR (P.E. July 77)

A simple 4-octave frequency comparator for use with synthesizers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl. sw.) **£7.45**

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 **£8.89**
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**

P.E. TUNING FORK (P.E. Nov. 75)

Produces 84 switch-selected frequency-pure 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**

New Electronic Piano.
Elektron Aug. 1978
Details in our list.

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)

3-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**

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**

WAVEFORM CONVERTER

Slightly modified from a circuit published in "Elektron". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and square-wave 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 synthesizers.

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 synthesizers.

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 synthesizers.

Component set (incl. PCB) (Order as Kit 60-1) **£3.64**

SOPHISTICATED POWER SUPPLIES

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

MICROPHONE PRE-AMP (P.E. Apr. 77)

Component set (incl. PCB) **£3.82**

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**

DYNAMIC RANGE LIMITER (P.E. Apr. 77)

Automatically controls sound output to within a preset level.

Component set (incl. PCB) **£4.58**

POST AND HANDLING

U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £2.00 plus VAT.

Optional insurance for compensation against loss or damage in post, add extra 50p for cover up to £50, £1.00 for £100 cover, £2.00 for £200 cover.

Fire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

DON'T FORGET VAT!

Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

EXPORT ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list send 50p.

PHONOSONICS · DEPT. PE6N · 22 HIGH STREET · SIDCUP · KENT DA14 6EH MAIL ORDER AND C.W.O. ONLY
SORRY BUT NO CALLERS PLEASE

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 keyboards (1 required for each note):

Type GJ: Single-pole change-over	each 25½p
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 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 55½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with GJ, GB and 4PS contacts (thus eliminating much interwiring) are available. Details in our lists.

RHYTHM GENERATOR

15-Rhythm Tempo, Timing and Logic control unit (excl. sw's but incl. PCB)	£9.75
10-Instrument Effects circuits	£14.25
PCB for Effects circuits	£4.25
Power Supply incl. PCB	£8.75

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.

FORMANT SYNTHESISER (Elektr 1977/78)

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

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, alpha-phone, cardiophone etc.

Pre-Amp Module Components set (incl. PCB)	£3.95
Basic Output Circuits—combined component set with PCBs, for alpha-phone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6.59
Audio Amplifier Module Type PC7	£7.75

10% DISCOUNT VOUCHER (PEGN)

TERMS: Correctly costed, C.W.O., U.K. orders over £50 goods value. Valid until end of month on cover of P.E. This voucher must accompany order.

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
BC214	11p
BC262	18p
BC415	15p
BC478	15p
BD131	60p
BD132	44p
BF244A	32p
BF245A	38p
BSY95A	22p
MD8001	210p
OC71	20p
OC72	30p
RPY58A	62p
TIS43	50p
ZTX108	74p
ZTX301	13p
ZTX384	12p
ZTX501	13p
2N2219	28p
2N2646	70p
2N2905	28p
2N2905A	29p
2N2906	22p
2N2907	24p
2N3054	68p
2N3055	76p
2N3702	12p
2N3704	12p
2N3819	24p
2N3820	61p
2N3823	39p
2N5459	45p

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	85p
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	171p
4011 14-pin DIL	171p
4024 14-pin DIL	461p
4069 14-pin DIL	18p
4136 14-pin DIL	126p
AM2833 8-pin DIL	360p
AY1021 16-pin DIL	1617p
AY1672 1/6	188p
CA3046 14-pin DIL	71p
CA3080 8-pin DIL	63p
CA3084 14-pin DIL	209p
FX209 16-pin DIL	729p
LM32	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



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THE firm for speakers!

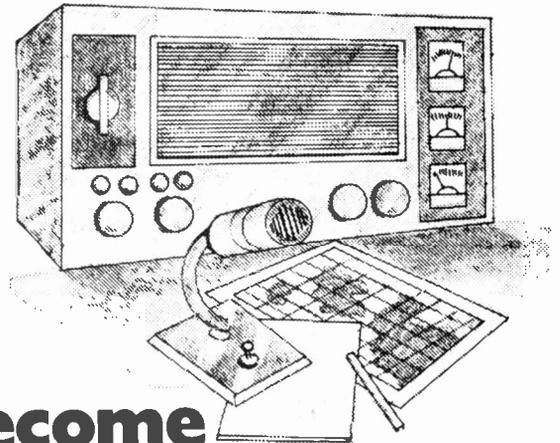
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GAUSS ● GOODMAN'S ● HELME ● I.M.F.
ISOPHON ● JR ● JORDON WATTS
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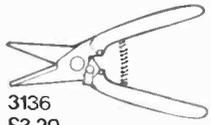
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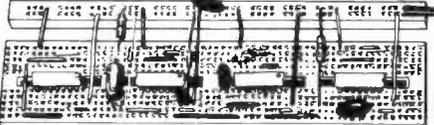


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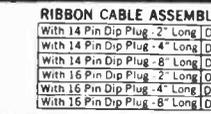
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MORE RAM

WE HAVE heard plenty about the 64K RAM over the last few months—so much that we hesitate to mention it again—however, it was only a couple of months ago that everyone was contemplating the government proposals and wondering if a sponsored company would be competitive. We have today received news of a Texas TMS 4164 which is—you've guessed it—a 64K RAM. This new device comes in a standard 16 pin d.i.l. package and is expected to be available in sample quantities towards the end of the year; volume production early 1979—where were we?

It is interesting to note that the photomasks for volume production will be made using electron-beam equipment. It has been stated that the 64K RAM is probably as far as we can go using the present production methods, this does not however mean that we are about to come to the end of further miniaturisation.

THE BUBBLE BURSTS!

New technologies are always coming along. One that we heard much of a few years ago was the discovery of magnetic bubbles and how they would effect the whole electronics industry.

Well they haven't, have they? But wait, development of such things takes time and the bubble is just about to burst.

It seems that far from being contented with a probable first in the 64K RAM area, Texas have also been playing with a few bubbles. A few did we say, the TIB0303 92k bit bubble memory will soon be available. This device contains 252 minor loops each with 1137 bubble positions! Of course this takes up more room than the regular 64K semiconductor device and is therefore mounted in a 20 pin d.i.l. package! Can we go on believing it's all possible? (More details on this bubble memory can be found on page 1170.)

We find it harder to accept the fact that the quarter million bit bubble chip is with us than that 100,000 active elements can be put on a silicon chip. This is probably because we tend to think of bubbles as having a relatively large minimum size, whereas we hardly had time to accept the transistor before it became integrated. We must look at bubbles again.

COMPONENT COUNT

Dr. Robert R. Heikes, Vice President of Motorola Inc. and Assistant General Manager Semiconductors Group, speaking at a recent press conference

made the following statement:

"By the early 1980's, we will no doubt see the routine production of integrated circuits containing at least 100,000 active elements per chip, and by the mid-80's, that device count will reach an incredible one million components on a chip no larger than one-quarter of an inch square; or several billionths (*American billionths that is—Ed.*) of a square inch per device.

With this degree of chip density, it is perfectly logical to assume that we will see the development, for example, of a product no larger than a hand-held calculator that will contain the computing power of today's largest main-frame computer. That's obviously a tremendous amount of computing capability."

It has been calculated that theoretically 10,000,000 components per chip might be achievable and, at the rate things are progressing (generally speaking the chip count has been doubling every year since the sixties), this will only take to the end of the eighties. What then? Many will say we will have gone far enough by then, but history tells us that we will continue to progress.

Mike Kenward

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MOON LANDING GAME

A. RUSSELL

AT the controls of this game you can land your own space ship on the Moon and test your skill and timing by guiding the rocket to a safe landing before the fuel runs out.

Moon Landing is essentially a hard wired analogue computer which simulates approximately the dynamics of a space craft landing on the Moon. Additional circuitry monitors the computer and switches off the rocket motor when the fuel runs out, indicates when the craft has landed, and shows when a safe landing velocity is achieved.

Playing the *Moon Landing* game gives children a feel for the concepts of distance, velocity and acceleration and the relationships between them. Thus as well as being fun to play it also has an educational value.

CONTROLLED DESCENT

You are pilot of the first British expedition to the Moon. At one minute before touchdown the flight control computer blows a fuse, leaving you to land under manual control. There is a lever to control rocket motor thrust and a meter which can be switched to read velocity, height or fuel reserves. Your object is to achieve touchdown at a safe landing speed.

Two lights are provided; one tells you that you have landed and the other indicates whether or not the touchdown was at a safe velocity. Therefore when both lights are on together you have completed a successful landing.

A "Panic" button is provided. In the event of fuel running out before landing (because of a bit of ham fisted driving on the part of the pilot) it will divert the contents of the medicinal whisky tank into the rocket fuel tanks, giving an extra 15 per cent fuel.

SCHEMATIC

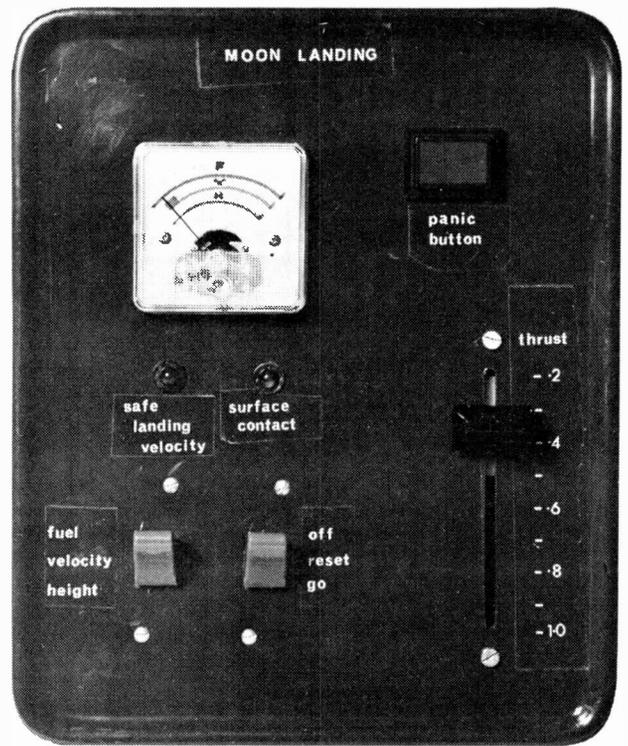
The analogue computer in *Moon Landing* represents a simplified view of a space craft landing on the Moon. No account is taken of the changing mass of the rocket as it burns fuel or changing gravitational attraction, etcetera.

A schematic diagram of the game is shown in Fig. 1. It is not intended to explain in detail the theoretical background of integral calculus and analogue computers. Those interested in finding out more could start by reading the "Analogue Computer" series currently running.

In Fig. 1, the value of thrust selected by the pilot is fed into Integrator 1 which calculates the total quantity of fuel used. When fuel runs out a level detector switches off the thrust. A "Panic" switch feeds more fuel into the fuel tank when it is pressed. Thrust from the rocket engines is added to Moon gravity to give total acceleration acting on the ship. Integrator 2 calculates the resulting velocity and a level switch lights the "Safe Landing Velocity" light when the downward velocity of the space craft falls below a certain value. Velocity is integrated by Integrator 3 to give space craft height and another level switch detects when this is zero to light the "Surface Contact" light.

CIRCUIT

The circuit diagram is shown in Fig. 2. Switch S2 has three positions. In the "Off" position power is disconnected



Control panel layout

from the circuit. In the "Reset" position capacitors in each integrator are charged to +5.1V to fill the fuel tanks (Integrator 1), give the rocket a large downward velocity (Integrator 2) and set the initial height above the Moon (Integrator 3).

When S2 is moved into the "Go" position the analogue computer starts its calculation. Slider pot VR1 ("Thrust") controls the voltage across R4. This voltage is fed into Integrator 1 (IC1) through R3. Output voltage of IC1 falls at a rate determined by the voltage across R4 (the "Thrust" setting) until point A goes sufficiently negative to forward

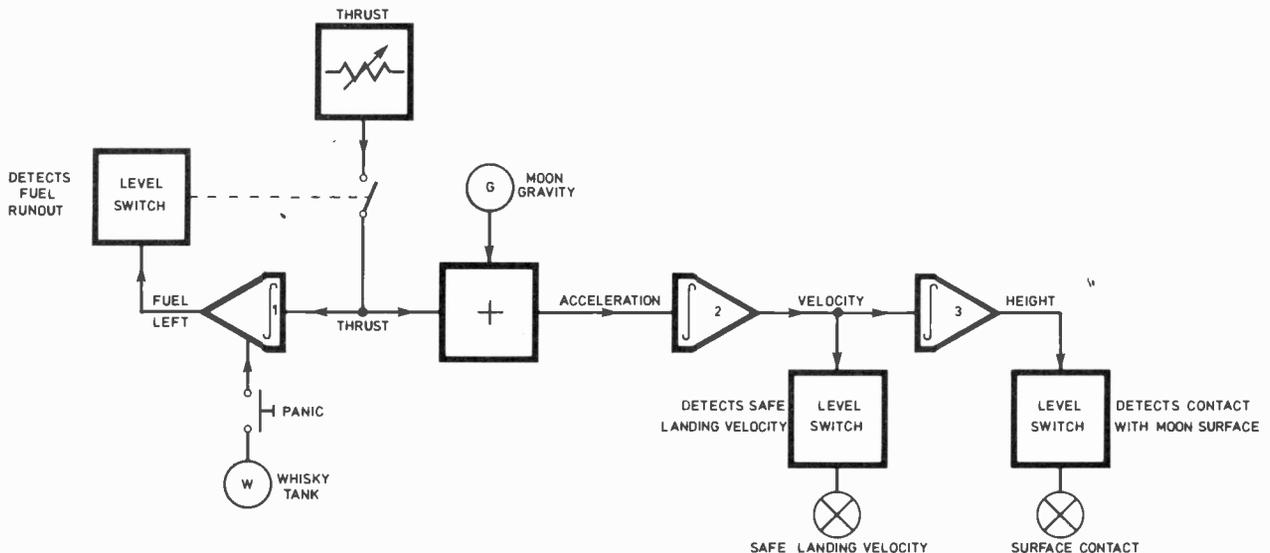


Fig. 1. Schematic diagram

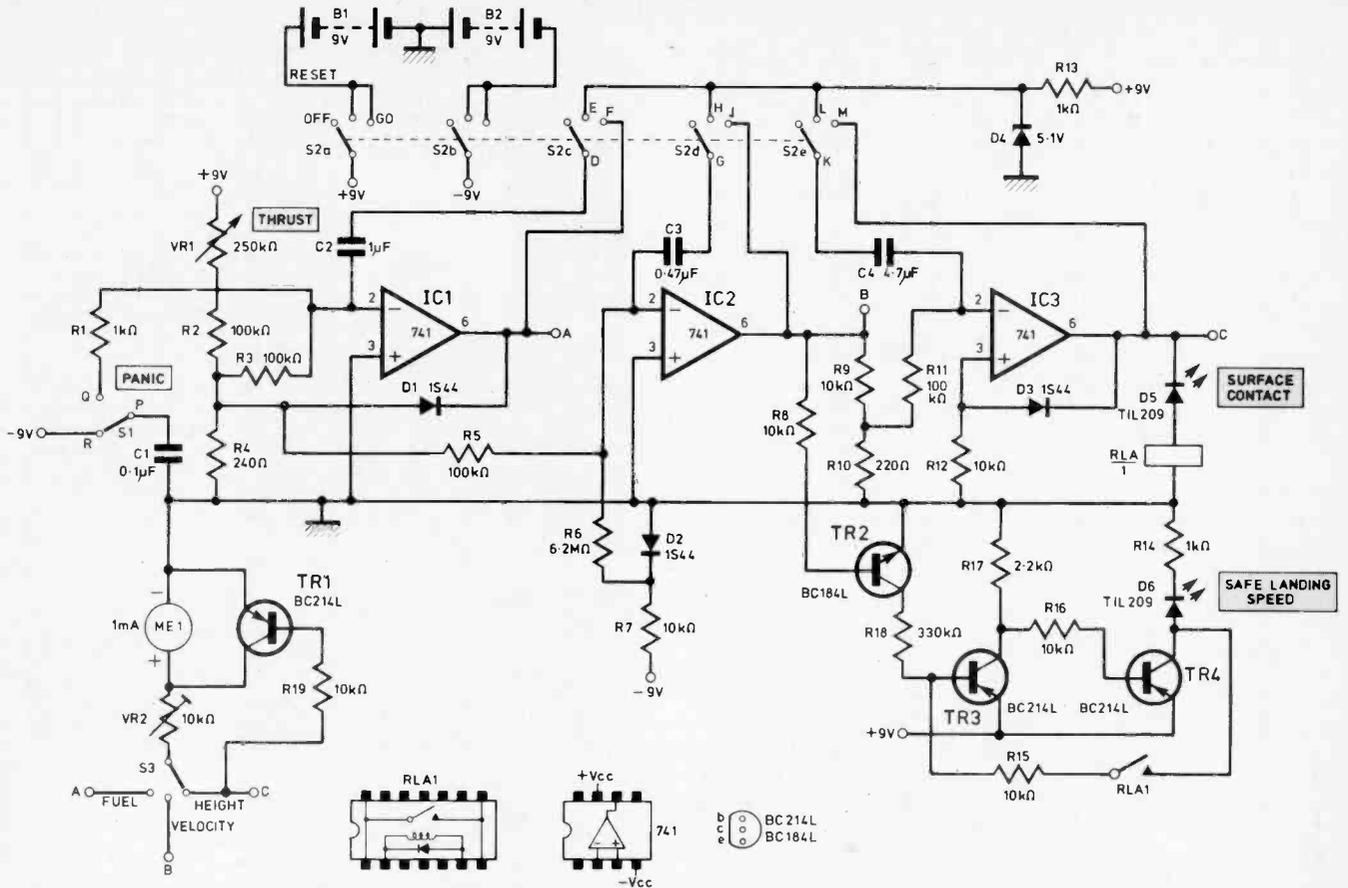


Fig. 2. Moon Landing circuit

COMPONENTS . . .

Resistors

R1	1k Ω	R11	100k Ω
R2	100k Ω	R12	10k Ω
R3	100k Ω	R13	1k Ω
R4	240 Ω	R14	1k Ω
R5	100k Ω	R15	10k Ω
R6	6.2M Ω	R16	10k Ω
R7	10k Ω	R17	2.2k Ω
R8	10k Ω	R18	330k Ω
R9	10k Ω	R19	10k Ω
R10	220 Ω		

All resistors $\frac{1}{2}$ watt 5% carbon

Capacitors

C1	0.1 μ F
C2	1 μ F
C3	0.47 μ F
C4	4.7 μ F

All capacitors polyester

Diodes

D1	1S44
D2	1S44
D3	1S44
D4	5.1V Zener
D5-D6	TIL209 (2 off)

Transistors

TR1	BC214L
TR2	BC184L
TR3	BC214L
TR4	BC214L
IC1	741
IC2	741
IC3	741

Potentiometers

VR1	250k Ω slider pot
VR2	10k Ω trimmer pot

Switches

S1	s.p.d.t. push-button
S2	PO type 1000 lever switch
S3	PO type 1000 lever switch

Miscellaneous

ME1 1mA meter. B1 and B2 PP3 batteries and suitable connectors. RLA d.i.l. reed relay 500 Ω coil 3.7-10V operation. Veroboard, suitable plastic case, nuts and bolts, etc.

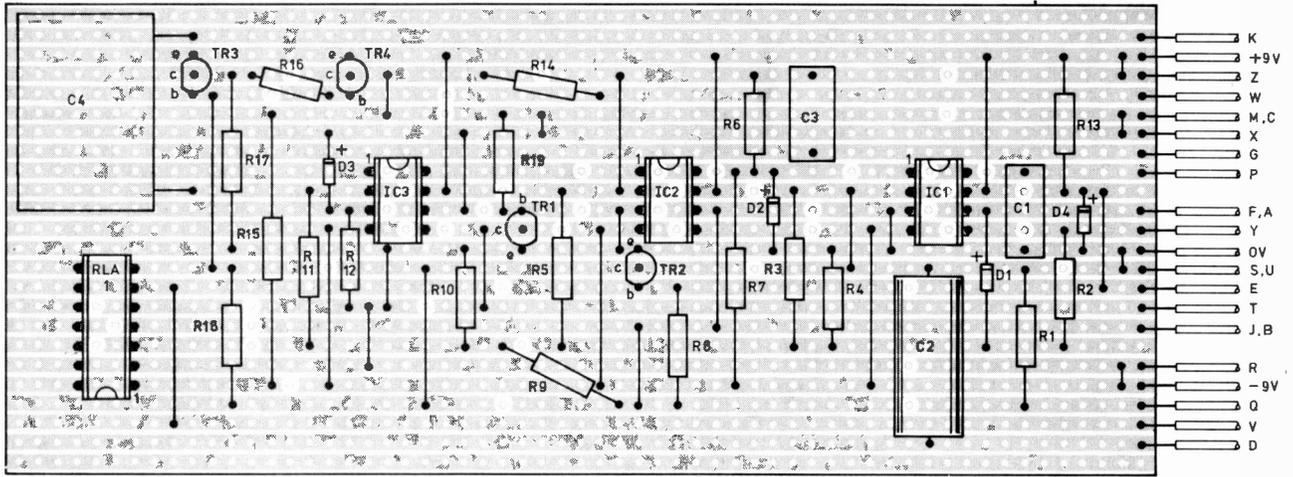


Fig. 3. Veroboard component layout

bias D1. Current drawn through D1 reduces the voltage across R4 to zero and effectively switches off the thrust.

If the "Panic" button is pressed, charge on capacitor C1 is fed into Integrator 1 which increases the voltage at A by about +0.9V thus adding to the fuel reserves.

The voltage across R4 is also fed into Integrator 2 (IC2) along with the effect of gravity (voltage across D2). These two inputs represent the accelerations acting upon the space craft and the output of Integrator 2 is the resulting velocity.

This output is monitored by TR2 which forms the "Safe Landing Velocity" level switch. When the voltage at B is above +0.5V, TR2 is biased on and feeds current into the base of TR3, via R18, which also switches on.

TR3 collector voltage is about +9V when it is switched on and so no current can flow through R16 to switch on TR4. D6 is therefore off. As the voltage at point B falls below +0.5V TR2 switches off and so TR3 also switches off. TR3 collector voltage becomes more negative, current flows into TR4 base, switching it on and lighting D6. When the relay pulls in upon landing, TR3 and TR4 are connected into a bistable circuit, by feedback through R15, which remembers the condition of D6 at the instant of landing.

The voltage at B ("Velocity") is fed through a potential divider R9 and R10 and then into Integrator 3 (IC3) which calculates the space craft height. When the voltage at C ("Height") falls to about -0.4V ("Surface Contact") diode D3 becomes forward biased and current flows through R12. The resulting voltage across R12 appears on the non inverting input of IC3 and is amplified in a positive feedback loop which forces the output of IC3 to -9V. D5 becomes forward biased and lights ("Surface Contact") and the relay is energised which latches D6 into the state it was in when the rocket landed.

METERING

The meter ME1 may be switched by S3 to read "Fuel", "Velocity" or "Height". When the voltage at C switches to -9V on landing, TR1 is switched on and shorts out the meter so that all readings fall to near zero on landing.

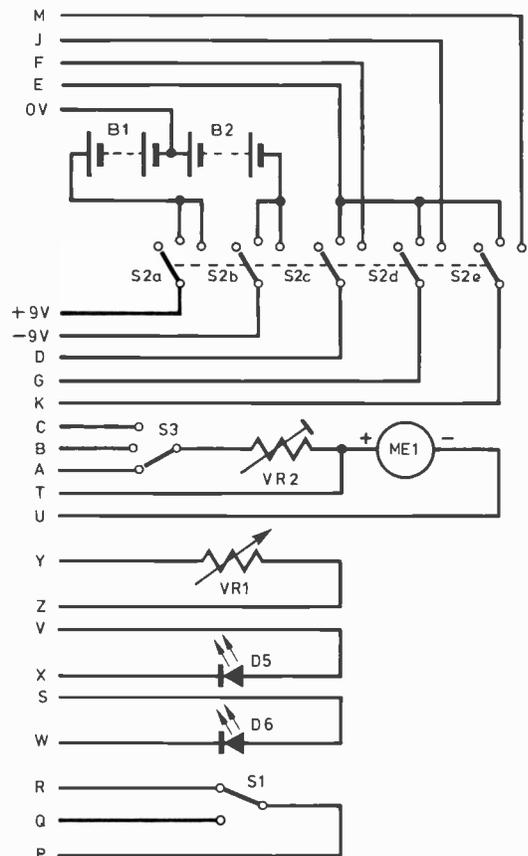


Fig. 4. Control panel wiring to Veroboard

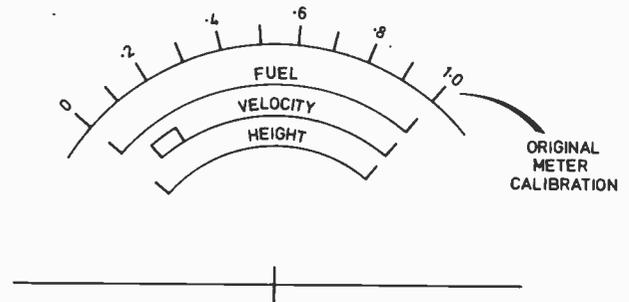
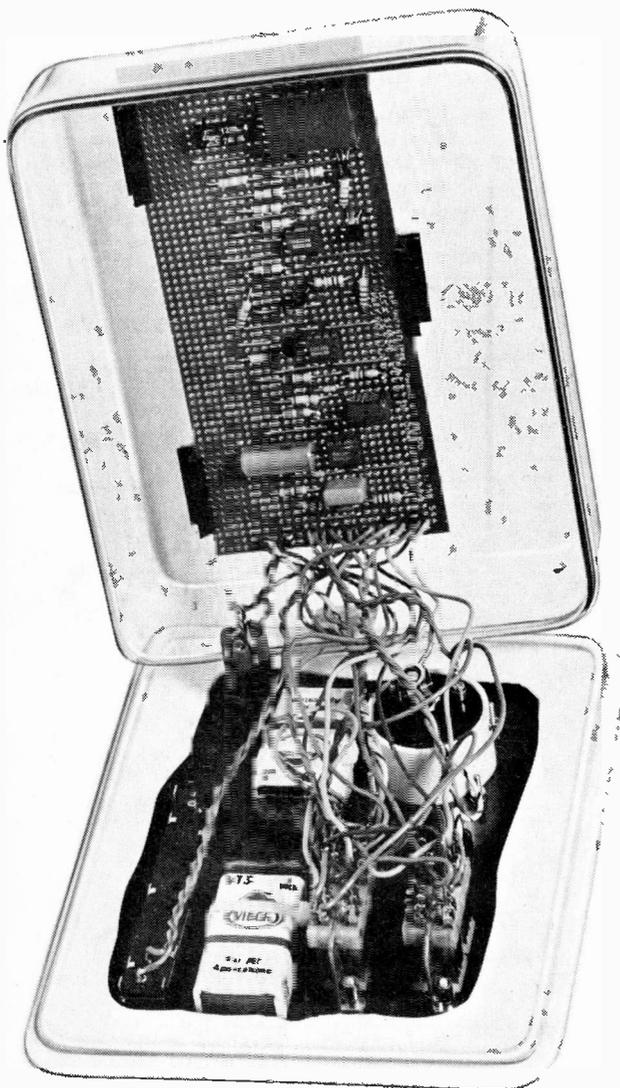
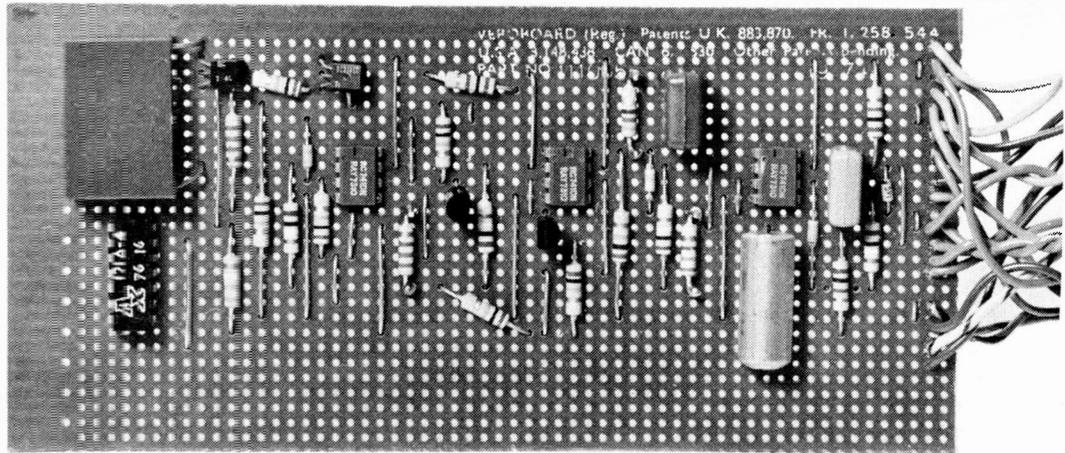


Fig. 5. Rescaling an existing milliammeter

CONSTRUCTION

The Veroboard layout of the *Moon Landing* circuit is shown in Fig. 3 and should present no constructional difficulties. Connections between the Veroboard circuit and the switches, l.e.d.s, etc. are shown in Fig. 4. These components are all mounted on the front panel. A plastic sandwich box was used to house the complete game and the layout chosen for the front panel controls is shown in the photograph.

CALIBRATION

The 1mA meter ME1 requires a new scale. Fig. 5 shows the relationship between the original 0–1mA calibration and the new one for fuel, velocity and height. The new scale may be drawn on plain white paper, cut to shape and glued into position. Take great care not to damage the meter movement while taking it apart.

Use the zero adjusting screw on the meter to set the pointer at zero on the velocity scale with the power off. Adjust VR2 to make the initial values (immediately after "Reset") of fuel, velocity and height agree with the new scale. The meter is now calibrated and landing is for "go".



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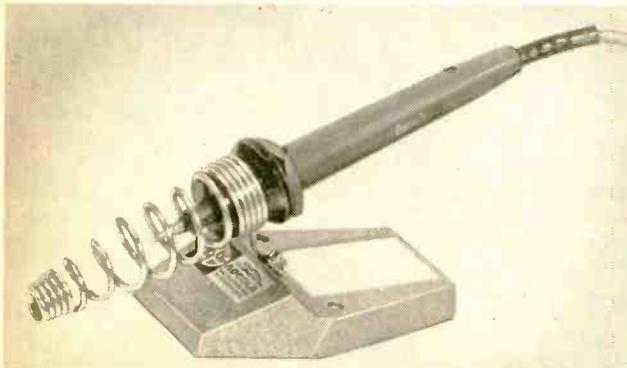
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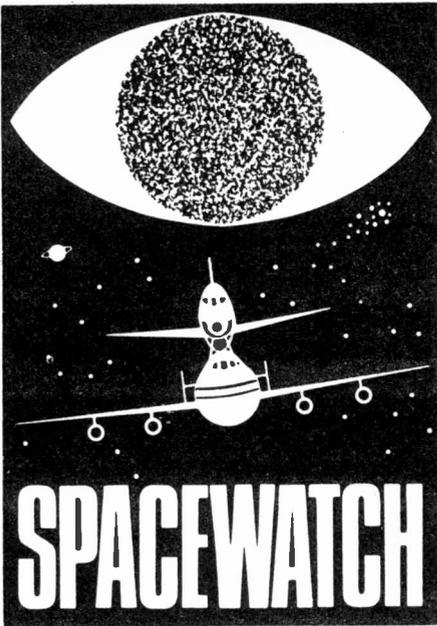
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A satellite is being built at the Max Planck Institute for Extraterrestrial Physics near Munich. It will contain sub-satellites made in Britain, Germany, USA and, it is hoped, the Soviet Union. The main portion is the Firewheel Satellite. It will perform like a firecracker when it begins its special mission.

The satellite will be launched from Kourou in French Guinea. The sub-satellites will eject ionised barium and lithium which will become clouds of plasma. Instruments on the ground, in aircraft and in the satellites will monitor the way in which the plasma is affected by the Earth's magnetic field. This will create similar circumstances that exist in the fusion experiments where a plasma is confined by a magnetic field in a Torus. The great advantage in doing this in space compared with the Earth based laboratory is that in space the plasma will continue to exist for 30 minutes or more, whereas in the laboratory it lasts for only a few seconds.

The satellite will be launched using the Ariane 200 ton vehicle from the new site in Guyana. It is a relatively cheap launch since its work load will last only a few hours. This means a very large saving in equipment and back up facilities. It is an important launch under the auspices of the European Space Agency.

MILITARY WEATHER SATELLITE

A third satellite has been launched by the US Air Force from the Vandenberg base. The satellite which weighs 513kg was put into a circular orbit at 833km by a Thor launcher. This satellite is part of what is known as Block D Integrated Spacecraft System and is part of the Defence Meteorological Satellite programme. These rather special satellites have been designed to operate in the higher radion levels which are expected during the increase of radiation as the sunspot cycle nears maximum. It is heavier than its predecessors.

A particular technological note in respect of these satellites is that the on-board computers eliminate the need for a separate booster guidance system. The computers can also keep the pointing of the vehicle to Earth with an accuracy of 0.1° . Block D can take pictures of the whole of the Earth's surface twice a day. It has a high resolution, both in the visible and infra-red bands, of up to 0.5km. Other facilities carried are an auroral detector, a line scanning radiometer, temperature-moisture sounder and pressure measuring equipment. The weather information is distributed to civilian users as well as the armed services.

TRACKING AND DATA RELAY SATELLITE SYSTEM, TDRSS

An expensive re-design of the TDRSS has been set in motion after a report of the preliminary design review. The report showed that there was a hazard from Soviet interference. Several of the present ground stations will be replaced by two geosynchronous satellites capable of handling television, voice telemetry and scientific data to and from Earth orbiting spacecraft in the next decade.

The new programme was conceived when the fact was realised that the shuttle would demand extensive expansion because of the increase in traffic. NASA decided that the answer was to orbit spacecraft that could collect information and then pass it to selected stations. The report showed that the present designs were vulnerable and could be disabled by Soviet radar.

Western Union is providing \$796 million for the design of six of the satellites. NASA will lease two of the satellites for its own communications purposes in late 1980, at the time of the first shuttle launch. The two satellites will operate at 41°W over the Atlantic and 171°W over the central Pacific basin. Engineers were particularly concerned about the vulnerability, and have begun the complete redesign of the integrated circuits and ground facilities to make for immunity.

The present time allowed for data entry is 0.01 sec. As the time to be used in order to avoid interference is of the order of 0.00001 sec, NASA finds itself in dispute with the contractors who claim that this item was not stipulated in the original requirement.

PIONEER VENUS 2

Pioneer Venus 2 made a flawless start on its journey with four special probes to achieve a controlled landing through the atmosphere of Venus and make special observations. These were described in detail in a previous Spacewatch. Pioneer Venus 1 is due to encounter Venus on December 4th. It is the orbiter spacecraft of the mission and will observe Venus 2 as it approaches on December 9th. The probes will be released ahead of the main craft.

The important thing about the Venus 2 is that it is the last of the spacecraft to be launched by an expendable rocket. The next missions will be flown by shuttle techniques, in 1982. That will be the Galileo flight to the planet Jupiter.

Under monitor now there are no less than eight missions. In addition to the Venus encounters on the 4th and 9th of December,

there is continuous coverage of Voyager 1 which will fly past Jupiter in March 1979, Voyager 2 will follow in July. Pioneer 11 is due to reach Saturn by September 1979. The Viking orbiter and the landers will continue to report from Mars at least to the end of this year.

TELEOPERATOR RETRIEVAL SYSTEM

NASA have contracted to Martin Marietta the development project for the service work on satellites in orbit. Teleoperator Retrieval System, TRS, is a reusable TV equipped spacecraft which will be used by the crew of the shuttle to deliver and stabilise satellites and when necessary recover them from orbit.

The TRS is a low thrust type of spacecraft which is to be operated by remote control from the shuttle. It is possible to carry it from, and return it to, Earth in the cargo bay. It can, if required, be left in orbit, parked, until it is collected at a later date. From time to time it would be returned to Earth for service.

The shuttle will take the TRS into a low orbit, and an astronaut will operate it by remote control from the Orbiter. A camera mounted on the bow of the vehicle will be the eye for the operating astronaut, enabling him or her to carry out the necessary manoeuvres required for docking with satellites and carrying out any task required.

The TRS has its own guidance control system. It will be able to take itself to higher orbits in order to deliver payloads or deliver them to the shuttle. It is a very exciting step for the new shuttle age.

The TRS chassis, or core as it were, will measure 1.2m by 1.5m. There will be 24 attitude thrusters on its eight corners, three to each corner. With the thrusters, three axis controls will be available, also forward and reverse movements. Up to four 680kg Hydrazine propulsion kits (90cm in diameter and 1.5m long) will each have eight rocket engines.

On the after flight deck of the Orbiter will be the hand controls for the TRS together with the communications and data management equipment, also a television monitor and displays which will allow control of the TRS through all its operations. From here it will be possible to transmit, receive and process telemetry, receive television pictures and to issue commands. A flight unit is scheduled to be delivered by September 1979.

INTELSAT TERMINAL

At Goudji in Chad, the Central African Republic, an Earth satellite station has been installed by Thomson-CSF and CIT-Alcatel. The station is equipped with a 14.5m antenna and can handle telegraph, telex and telephone communications via the Intelsat satellites. After 14 years of operation Intelsat is still expanding.

SPACELAB 2

It is announced that there will not be a British astronaut on the Spacelab 2 mission. Two Britons were short listed but lost place to two Americans. The British pair were Bruce Patchett of the Appleton Laboratory and Keith Strong of the Mullard Space Science Laboratory.

NEXT MONTH

GUITAR SOUND MULTIPROCESSOR

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CHROMOSONICS

24 Page

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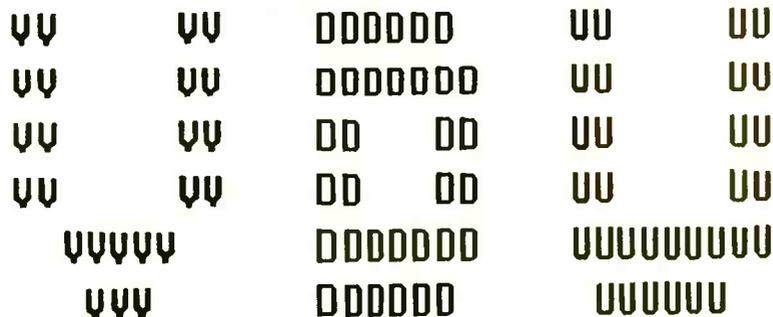
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PRACTICAL ELECTRONICS

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PRACTICAL ELECTRONICS



SYSTEM Part 2 A.A. BERK B.Sc. Ph.D.



IN PART 1 of this article, the theory and circuit description of the VDU and its operational characteristics were presented along with a block diagram. In this part, construction, testing and setting up are dealt with. Construction falls readily into two component units: the RAM module and the main p.c.b.

RAM MODULE

The 1K block of RAM is constructed from eight 2102 i.c.s. Each of their ten RAM Address lines (RA1-10) must be connected together from chip to chip (80 interconnections). Similar common lines are required for their power supplies, chip select and R/W lines (a further 32 interconnections). The RAM unit Data-In (DI . . .) and Data-Out (DO . . .) lines are all separate. Conventionally these i.c.s would be placed on an area of p.c.b., with all interconnections being made by fragile narrow copper tracks of minimal spacing (easy to solder-bridge or break) and consuming a considerable area of the board. The RAM module featured in this design drastically reduces the area of p.c.b. required, and the number of interconnections.

Two pieces of 0.1in matrix stripboard are cut to include 8 tracks by 17 holes each, and on one of these boards, 14 cuts are required as shown in Fig. 3(e). The leads of the eight RAM i.c.s must be fully and carefully straightened using a pair of long-nosed pliers (preferably non-serrated). These packages, even in plastic, are very robust and no harm will come to them as long as the pins are bent just once and with the minimum of stress. The pins may then be inserted through the Veroboards into alternate rows of holes *leaving the copper tracks outwards*. One complete row of holes is left free at each end of these boards to use as solder pads for connection to the main p.c.b. Check that the orientation of the chips is such that pins 11 and 12 are fitted into the

isolated portions of tracks of Fig. 3(e).

As soon as the i.c.s are in place, a couple of pins on each board should be soldered down to prevent the boards from slipping apart. The soldering should be done as fast as possible with a clean narrow bit, working along one *track* at a time so that successive solder joints are made to different i.c.s. This exposes each element to the minimum build-up of heat. Finally, the bottom two tracks (holding pins 8 and 9 of the i.c.s) are soldered to the copper strips on the main p.c.b. via stiff copper wire "legs", ensuring that the Vero track containing the pin 9s of the i.c.s is soldered to the 0V rail, refer to Fig. 3(a). Two legs should be used for each strip—again using the minimum heat necessary.

This technique, of course, is not restricted to 1K blocks of memory, and the reader will appreciate how easy it is to extend this method to large blocks of RAM for the MPU main memory.

An excellent investment of effort is to carefully and fully clean away the solder flux from the work with cellulose thinners using a paint brush. This facilitates a check with a watchmaker's glass or magnifying lens, for solder bridges and dry joints, thus preventing flux laying across the joints, picking up moisture, and causing noise and cross-talk.

Having produced the RAM module, it is now necessary to connect buses of ribbon cable between the block and the main p.c.b. Three buses need to be connected to the RAM module: Data In (DI0 to DI7), Data Out (DO0 to DO7), and RAM Address RA0 to RA9). The p.c.b. component layout of Fig. 8 contains the above identifications (in brackets) marked against their respective vero-pin positions, and this should simplify interwiring of the RAM module and main p.c.b. Figs. 3(c) and (e) show the connections at the RAM end of the buses. Alternatively, Fig. 5 showing the RAM module circuit

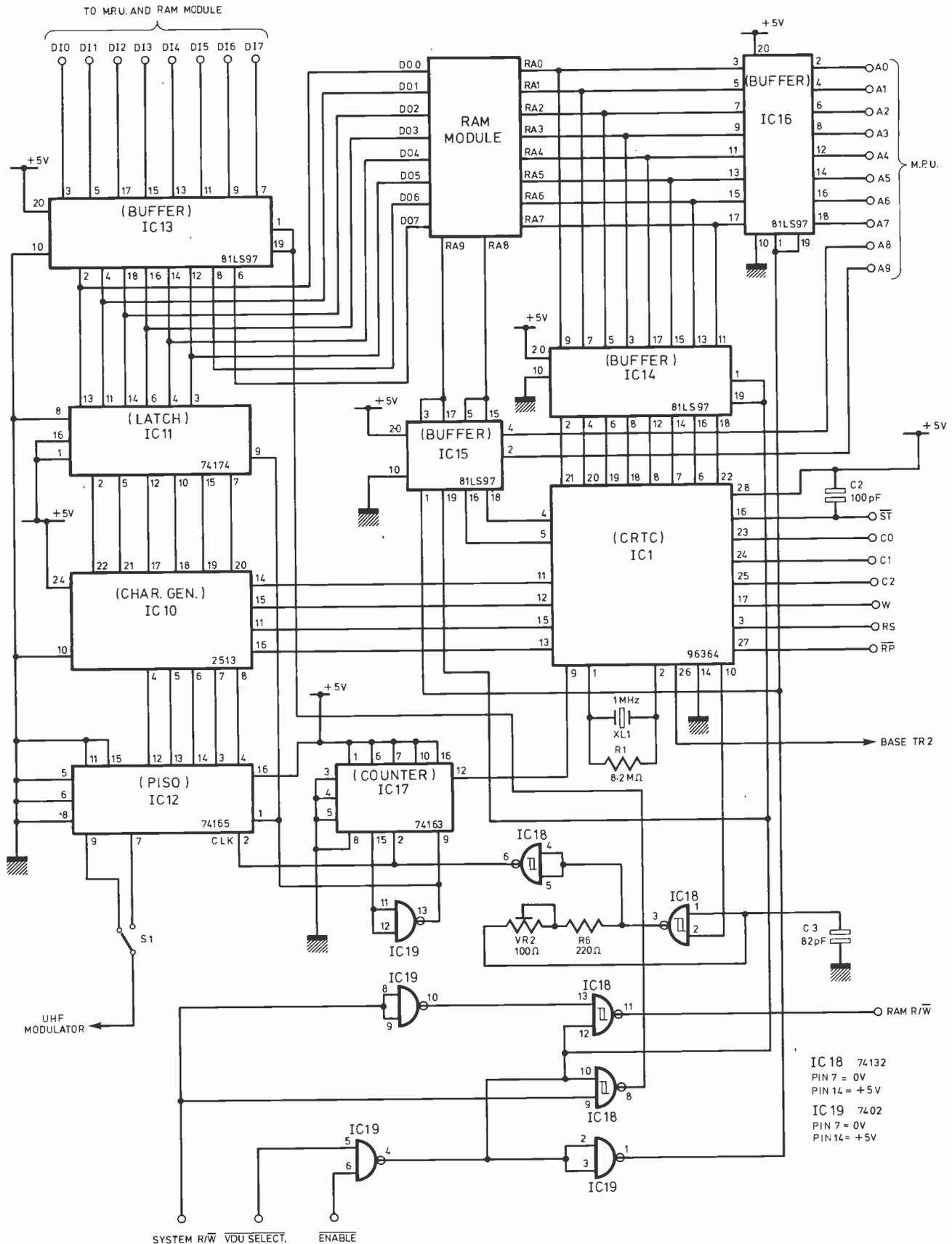


Fig. 1. Circuit diagram of VDU. (The video switching stage and stripline modulator are shown in Fig. 2)

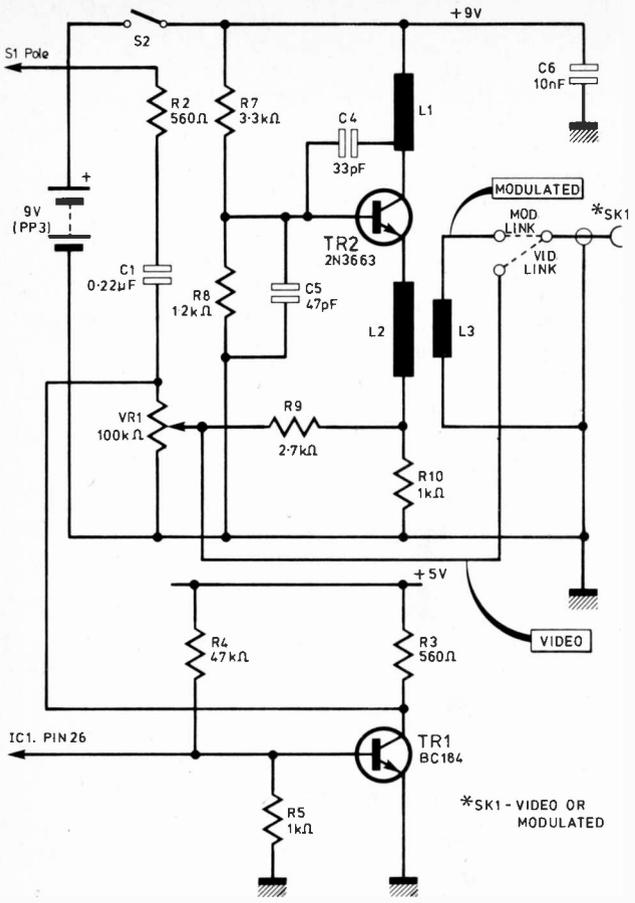


Fig. 2. UHF (stripline) modulator and video switching stage. See P.E. June 1977 for description of this modulator

diagram can be used for wiring up. It should be remembered that the RAM address lines are separate from the MPU address lines. but the Data In lines connect both to the MPU and the RAM module.

The order of connection of the data bits is irrelevant, except that data bit numbers IN must agree with bits OUT. Thus, if one of the i.c.s is chosen to accept data bit 4 IN (i.e. from the MPU bus) make sure that the same chip is chosen to supply data bit 4 OUT (to the buffer IC13).

The use of ribbon cable (preferably coloured) greatly facilitates checking faults. However, any type of thin wire is suitable, and p.t.f.e. covered wire is useful since the insulation is not prone to the usual effects of heat.

The RAM R/W line, and +5V line may now be added. Finally, connect CS (pins 13) to the OV rail. This completes the RAM module and its wiring.

MAIN BOARD ASSEMBLY

The construction of this section is conventional and straightforward. All pins for through-connections should be soldered in place first. Veropins will be found suitable. Next insert and solder all the i.c.s except for IC1 and IC10. Pay careful attention to i.c. orientation, positioning and minimum application of heat. It is better to make successive solder joints to different i.c.s, swopping back and forth between devices to expose each element to as small a temperature rise as possible. The i.c.s chosen are robust devices and, apart from IC1 and IC10, reasonably cheap, making sockets less important. However, ICs 1 and 10 should be provided with sockets. These should be soldered in next, taking care not to overheat them as the thermoplastic of which they are usually constructed melts easily at soldering temperatures.

The capacitors, resistors and transistors may now be soldered in, afterwards clipping all leads as close to the board as possible. Particular care should be taken to construct the modulator components neatly. It should be borne in mind that many of the copper foil sections on the modulator are deliberately employed as inductors. The precision of their geometry, for those who are producing their own boards, is therefore, of utmost importance.

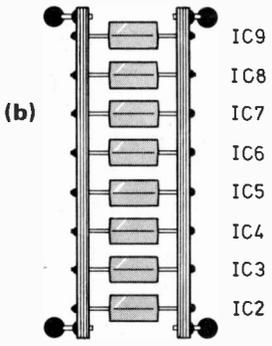
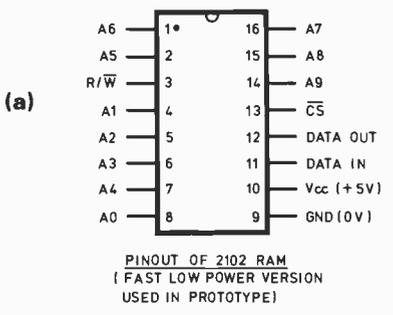
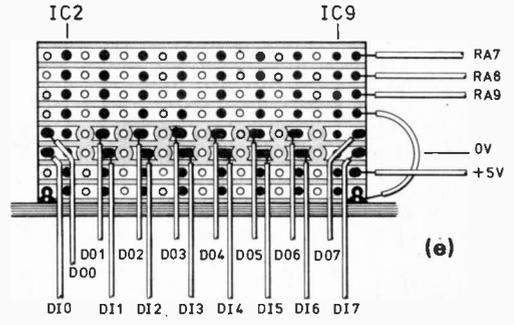
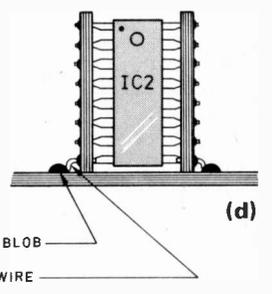
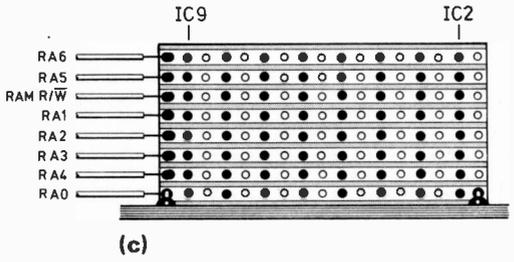


Fig. 3. RAM module construction. Four pieces of stiff wire can be soldered to each end of each bottom track, to produce mounting "legs" which can then be soldered to secure the module to the p.c.b.



The external wire links, sockets, variable resistors, PP3 battery connector (with appropriate lead length) may now all be soldered in place. The 1MHz crystal can then be inserted with a piece of insulating material between its case and the p.c.b. The crystal should be pressed up against the board and soldered, *very carefully*. A note of caution on this final component is necessary. Whether the crystal be of the wire or the pin type, excessive heat or vibrational shock will detach it from its connections within the metal case, *as the author has discovered to his cost*. Thus, once the crystal is in place, subject the board to as little physical impact as possible.

The final operation should be, as mentioned before, to fully clear the p.c.b. of flux. This is especially important around the pins of i.c.s 12, 17, 19 and associated components, and the whole of the UHF modulator section.

SETTING UP

Provision has been made on the p.c.b. for an inverting switch (S1). Initially, link \bar{Q} (pin 7) output of IC12 to the centre wiper position of the switch (i.e. to R2). Q may be used later, and an external switch fitted.

IC1 and IC10 may now be inserted and, after a final check of the other i.c.s to ensure all are inserted correctly, the 5V and 0V lines may be connected to their appropriate pins on the p.c.b. A 'scope is quite useful at this point to check for the presence of a signal at the video output (collector of TR1). This should appear as in Fig. 4 when using a range of about 10 μ s per centimetre.

The portion A-B is a negative going TV line synchronisation pulse to ensure that the electron beam strobescs across the TV screen at the right time to catch and display the video information from the VDU board. Portion B-C is at a high level to ensure that the part of the line before the character display is bright. C-D contains information controlling the line's brightness across the screen (depending upon which line of characters is being built up, and the height along these characters at which the electron beam is passing through). D-E produces the bright portion at the end of the line. Bright portions are also placed at the top and the bottom of the picture as well as between character rows. This displays the 16 lines of characters *as black upon a white background* and spaced away from the distorting edges of the screen. VR2 is used to set the length of the character rows and may be varied to suit the TV set being used.

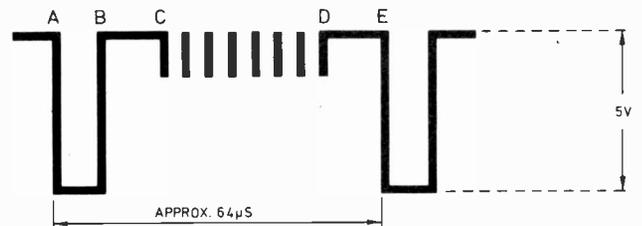
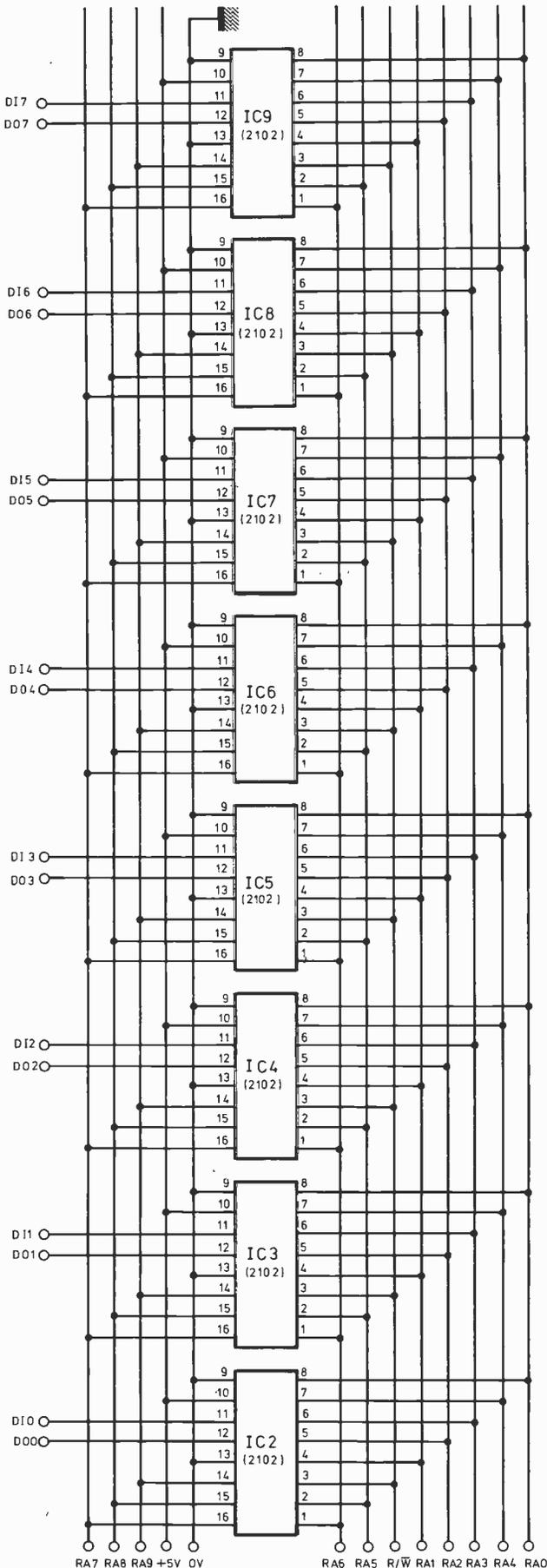


Fig. 4. Video output signal. Several of these sweeps are required to build up a line of characters on the screen, and the "light-dark" information is contained between C and D

Fig. 5 (left). RAM module circuit diagram



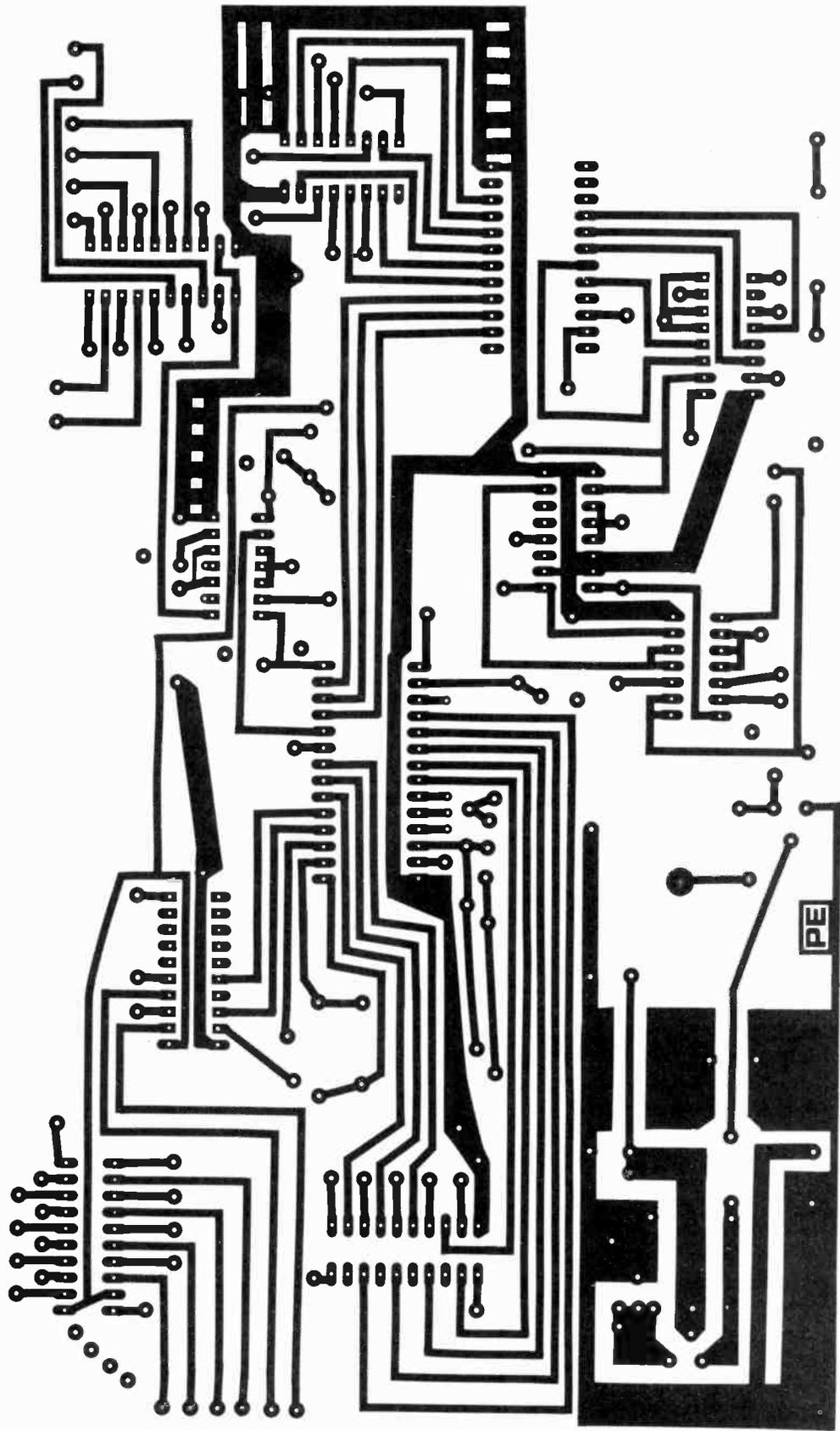


Fig. 6. Conductor side p.c.b. (Actual size). Copyright Technomatic

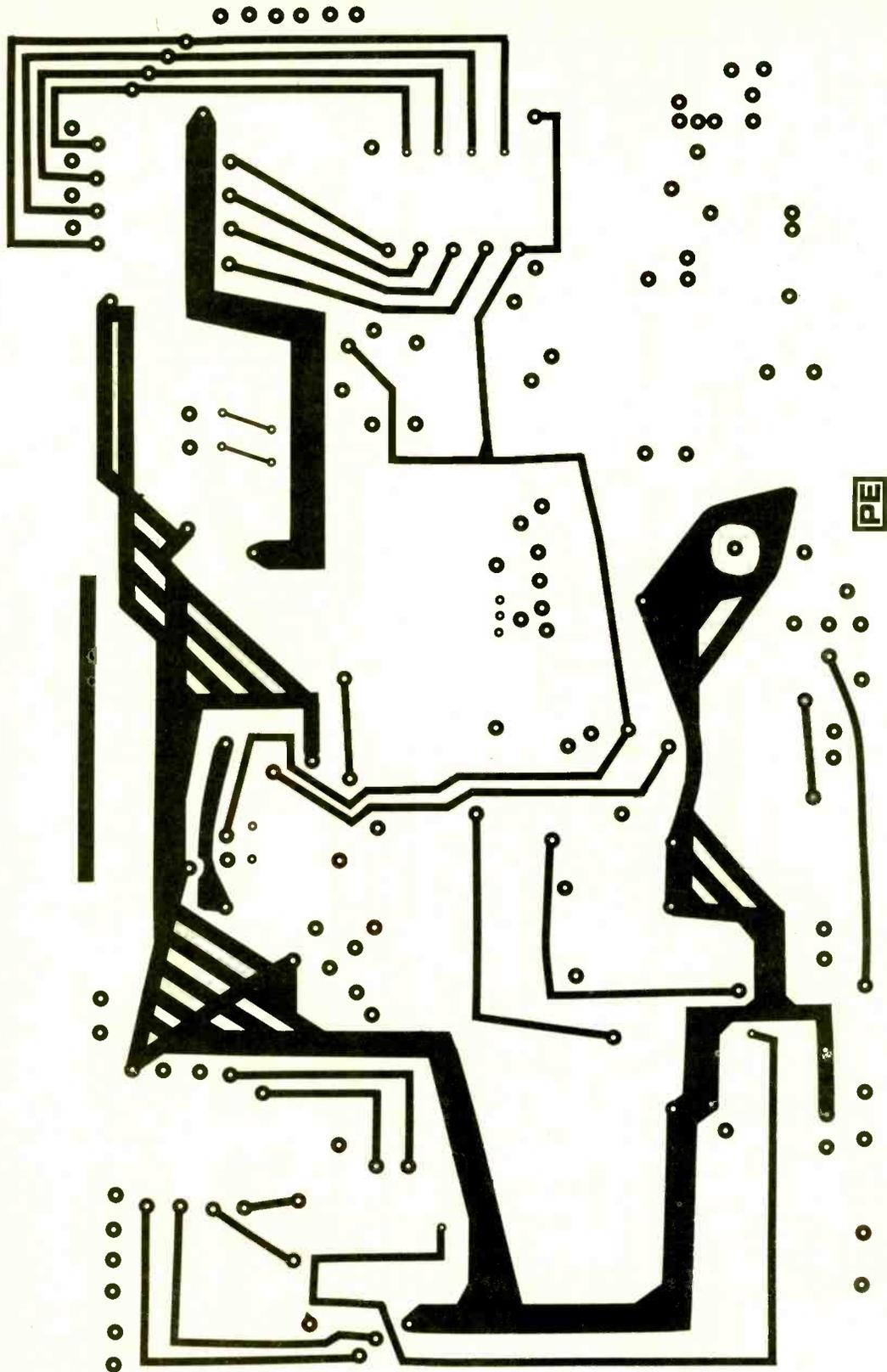


Fig. 7. Component side p.c.b. (Actual size). Copyright Technomatic

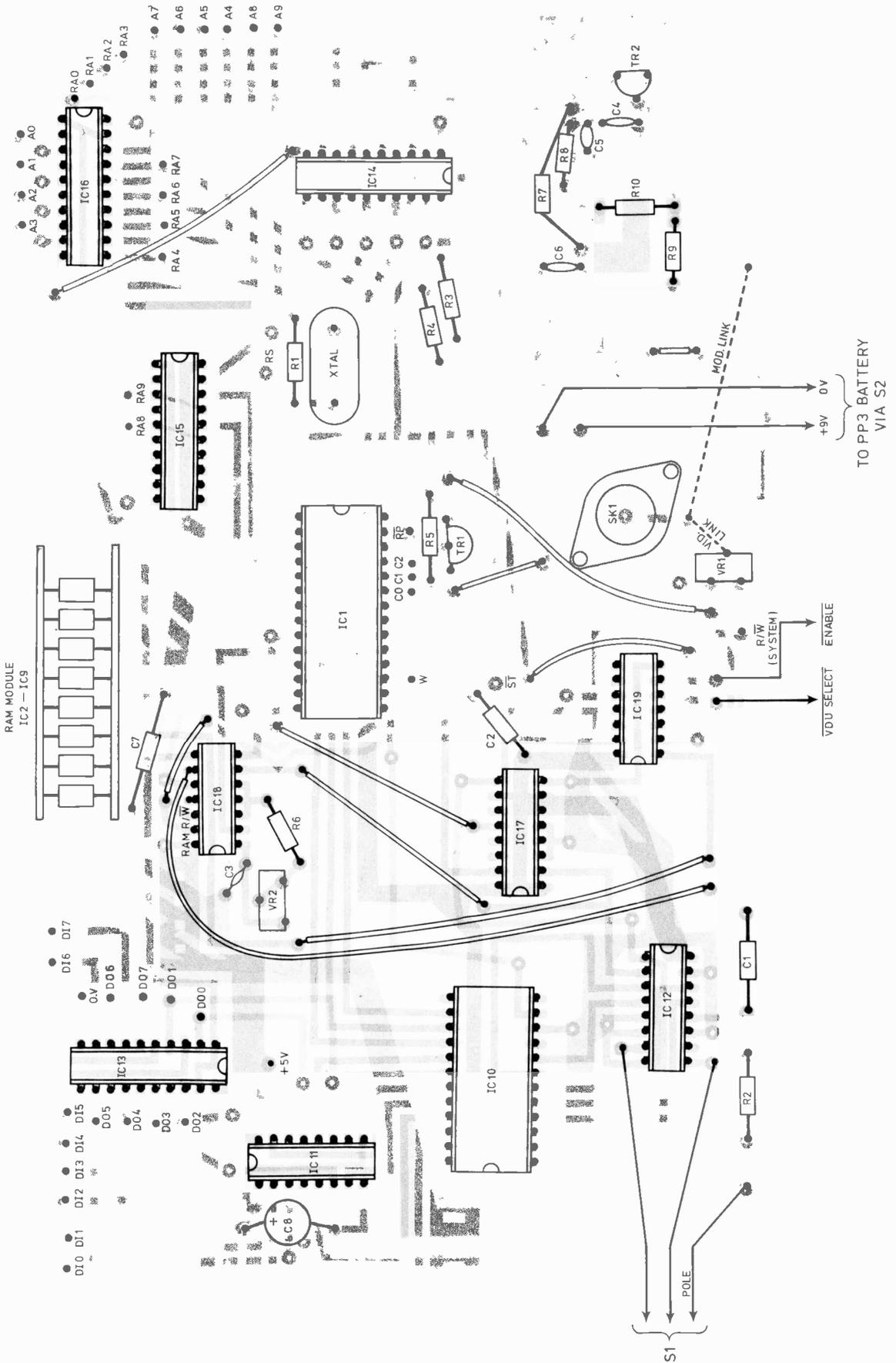


Fig. 8. Component layout for VDU board

If the correct waveform is *not* found at the collector of TR1, try looking at the ϕ_1 input to the CRTIC. If no oscillation is observed, suspect IC17, IC18, the crystal, R1, R6, VR2 or C3. If 1 to 2MHz oscillations are present at ϕ_1 with a good amplitude, check that R_0 , R_1 , R_2 , PT, address lines and sync are all oscillating. CRTIC is suspect if not. If all are in working order, only IC10 and IC12 are left. R_0 , R_1 , R_2 and PT inputs in a state of oscillation will produce dynamic information on b_0 to b_5 outputs of IC10. LOAD and CLOCK oscillations to IC12 will produce outputs on Q and \bar{Q} of IC12. By this process, the fault should be narrowed down easily.

The TTL oscillator IC18, should produce between 10 and 15MHz, which will be difficult to resolve into a sine-wave on 'scopes with a lower band-width, but the waveform ϕ_1 , out of pin 12 of IC17 should be seen easily on most 'scopes.

If either a monitor or modified TV set (which can accept video directly) is available, link SK1 on the p.c.b. to the video output, and turn VR1 to minimum signal and connect up. Turn VR1 up and a display of random characters should be seen. If necessary, adjust the horizontal and frame holds. The line length can then be adjusted by VR2. VR1 should be set for the clearest display setting. The prototype gave the best picture on a modified TV by feeding the video through a very small capacitor, about 0.0001 μ F is adequate but some experimentation is worthwhile here.

If there is only an unmodified UHF (625 line) TV available, setting up is restricted to linking SK1 to the modulator output, plugging in the PP3 battery and tuning the set (with VR1 up full), until it receives the field and then adjusting VR1 for the best picture. Use coaxial cable with proper coaxial plugs for connections.

UHF MODULATOR

For those experiencing trouble with the modulator, the following information should be of use. The modulator has an isolated power supply which will last for some time with normal use. Check that its e.m.f. is 8 to 9 volts on load. The modulator section should not be resting on anything. Raise the whole board and support it an inch or two from the bench. The foil pattern or the value of the capacitor, C4, may be inaccurate—try replacing C4 by a trimmer and, with the TV tuned well away from any stations, tune the trimmer in to the TV.

If the TV tunes in, but the picture is unsatisfactory, even after adjustment, then the only recourse is to house the p.c.b., or at least the modulator and battery, in a properly earthed metal box (connected to the 0V line). This final

construction gives very good results with the modulator if the p.c.b. is properly suspended away from the box sides (about 25mm being sufficient).

TV MODIFICATION

If you have decided to modify a TV to accept video, a few words of advice will be useful. As most sets do not have a mains isolating transformer, the first check must be to determine whether the *live side of the mains is connected to the TV's chassis*. Use an ohmmeter between mains plug and chassis. *If so reverse the live and neutral wires and use a polarised mains plug to ensure neutral remains connected to chassis.*

Somehow, the video line in the TV has to be found, broken and fed from the video output of the VDU. As mentioned before, video may be fed through a small capacitor to the TV set. The chassis of the set may also be connected through a capacitor to the 0V line of the VDU, though it was found that too small a capacitor caused an intolerable degree of mains "beating" on the display. Once again some experimentation is advantageous here.

Some sets cannot be modified as the video line is contained within an integrated circuit, and so it is as well to check this before beginning.

One final note: the constructor should appreciate that the neater the wiring, the better the display. Use coaxial cable and sockets wherever possible, especially if using UHF.

CONSTRUCTOR'S NOTE

A complete kit of parts including drilled p.c.b. is available from Technomatic Ltd. (01-452 1500) for £49 including VAT and P. & P. The p.c.b. is not plated-through as previously stated, and we apologise for this error. Constructors will find that minimal extra effort results from using the p.c.b. supplied.

A limited number of assembled and tested boards will also be available at £69 inclusive, from **Technomatic Ltd., 17 Burnley Road, London, NW10**, where a model is available for demonstration during normal hours.

Note: C9 in Part 1 components list, does not exist.

NEXT MONTH: Some ideas for interfacing to a system, some expansions of the basic VDU, and some hints on hardware for using the cursor control referred to last month.

News Briefs

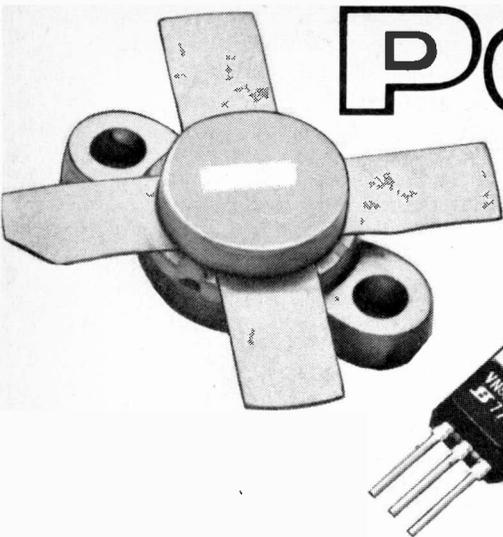
STARLIGHT VISION

A HIGH sensitivity proximity image intensifier now available from Mullard weighs less than 100 grams, and measures only 30mm in length and 43mm diameter. It is therefore particularly suitable for use in night-vision goggles and other applications where low weight and

small size are of prime importance. The intensifier, type XX1410, operates from a level of illumination below starlight (10^{-4} lux), has a luminance gain of between 7500 and 15000 and incorporates automatic gain control which maintains a constant level of 3cd/m² on the screen.

The XX1410 comprises a fibre-optic input window on the rear of which is deposited a low noise, high sensitivity, tri-alkali S25 photocathode (300 to 900nm). A micro-channel plate multiplies the electrons from the photocathode which are then focused onto the eye-adapted JEDEC P20 phosphor screen of a fibre-optic image inverter to form a bright image. Resolution is 25 line pairs/mm over the useful photocathode diameter of 18mm.

The intensifier is encapsulated in a white plastic body together with its own integral d.c./d.c. converter incorporating switched-mode power supply techniques. Nominal supply voltage is 2.7V d.c. and the current drain is typically 15mA.



POWER FET'S

A recent development in semiconductor technology



DAVID SHORTLAND

WHEN bipolar transistors are used in high power circuits, many limitations are imposed on the designer because of inherent problems within the structure of the device. These limitations, which include thermal runaway, secondary breakdown, non-linear distortion and a limited frequency response, restrict the use of the device and have resulted in the need for complex and expensive protection circuits.

With the introduction of the Junction Field Effect Transistor (J-FET) and the Metal Oxide Semiconductor Field Effect Transistor (MOSFET) many of these limitations were overcome but the FETs themselves were limited by their poor power handling capability. Now new fabrication processes are enabling FETs suitable for high power applications to be manufactured and these power FETs will directly challenge the supremacy of the bipolar transistor in many applications.

The new processes have resulted in the manufacture of three basic devices:

- The VMOS power FET
- The V-JFET
- The power MOSFET

The first two devices utilise vertical current flow whilst the third retains the conventional horizontal current flow normally associated with low power field effect transistors.

VMOS POWER FETs

VMOS, which is currently being developed by the Siliconix Corporation, enables a vertical channel MOSFET structure to be fabricated using a diffusion process similar to that used in the manufacture of double diffused bipolar transistors. After diffusion a "V" groove is cut into the silicon to create the vertical current channel which is a characteristic of VMOS FETs. A cross section of a typical device is shown in Fig. 1. (A double diffused bipolar transistor and a conventional MOSFET are also shown for comparison.)

The substrate of the device which is n+ material is used as the drain with the p- body separated from it by an epitaxial layer of n- material. This epitaxial layer increases the drain-source breakdown voltage by absorbing the depletion layer from the drain-body junction. Because the gate overlaps n- rather than n+ material the concentration of impurities is less, the feedback capacitance is reduced and the frequency response of the device increased. After the "V" groove has been etched through the

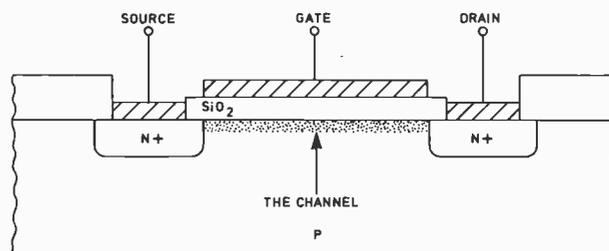


Fig. 1b. Cross section of a conventional MOS device

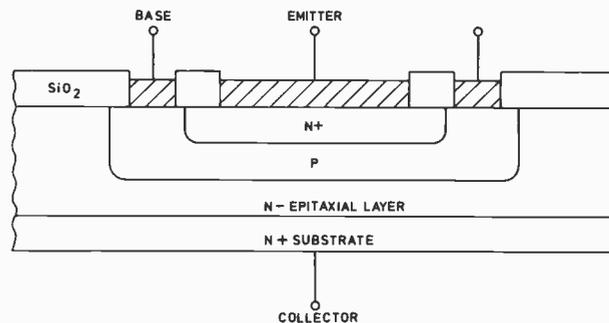


Fig. 1c. Cross section of a typical double diffused bipolar transistor

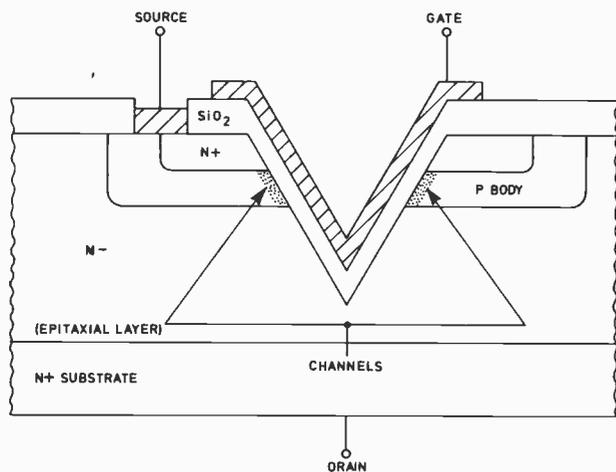


Fig. 1a. Cross section of a typical VMOS device

source and body into the epitaxial layer, oxide is then grown over the surface of the device and aluminium deposited to form the source and gate connections.

ADVANTAGES AND DISADVANTAGES

A comparison between VMOS and bipolar transistors includes many of the trade offs which are associated with their low signal counterparts. There are, however, several important differences which exist at higher power levels. These include:

- (1) The very high input impedance of VMOS, which enables it to directly interface with other high impedance devices such as CMOS and opto-isolators. With a typical leakage current of less than 0.01mA a fanout of more than 100 can be obtained from a CMOS device which is far higher than is possible with any bipolar transistor.
- (2) The absence of minority carrier storage time. This is the time taken for excess charge carriers stored in the base

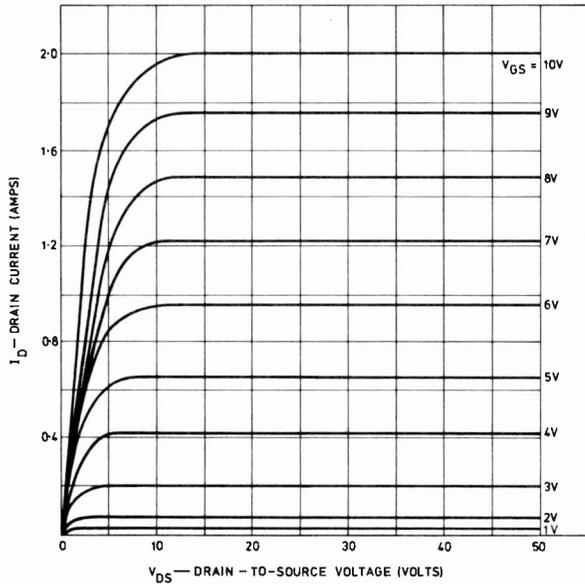


Fig. 2. Output characteristic curves of a VN66AJ VMOS device

region of a bipolar transistor to be depleted before the junction can change from the forward to reverse bias state. This delay affects the efficiency of a circuit especially when transistors are used in switching applications, with the result that in some switching circuits faster switching transistors with a low power rating are sometimes preferred to the slower types with a high power rating. As a VMOS power FET is a majority carrier device, with its charge carriers being controlled by electric fields rather than the injection and recombination of minority carriers, the only delay is caused by parasitic elements such as series gate inductance. A typical switching delay for a VMOS device is about 4 nano seconds to turn a 1 amp current on or off which is about 10 to 200 times faster than for a bipolar device.

- (3) The absence of secondary breakdown. In power transistors this is caused by the very narrow base structures that are used to improve their high frequency response. The condition occurs because the distribution of current becomes non-uniform at certain high levels of current and voltage. With the current being focused on very small areas, localised thermal runaway or "hot spots" develop which melt the silicon, causing a short circuit between the collector and emitter. This problem cannot develop in a VMOS device because its temperature coefficient is negative (a bipolar's is positive). Therefore as its temperature increases it draws less current instead of more thus eliminating the device from both ther-

- mal runaway and secondary breakdown problems.
- (4) The very high gain of these devices enables them to directly replace Darlington pairs with improved reliability.

The two major disadvantages of VMOS are:

- (1) With VMOS technology still being relatively new there is no "p" channel device presently available for complementary circuits although one is planned for the near future. It is however possible to overcome this problem by using "n" channel devices in a quasi-complementary configuration which does not appear to impose many of the problems associated with similar bipolar designs.
- (2) The saturation voltage of a VMOS device (up to 3V at 10A) is higher than for a comparable bipolar device (2V or less). This affects the efficiency of an amplifier using VMOS and as a result slightly higher power supply voltages must be used for a given power output or with the saturation region being resistive, two devices can be connected in parallel which halves saturation voltage of a single device. However, as the technology improves the saturation voltage should be substantially reduced.

There are also several advantages offered by VMOS over conventional MOS:

- (1) The current density of a VMOS channel—which is deter-

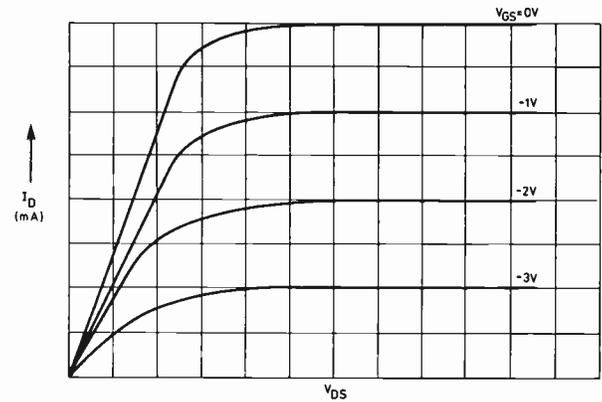


Fig. 3. Output characteristic curves of a conventional MOSFET device

mined by its width/length ratio—can be increased in a VMOS device by making the length shorter. This is because the channel length is determined by diffusion depths which can be more precisely controlled than the photolithographic techniques used to define the source-drain spacings of the horizontal MOSFET. The minimum channel length obtained in VMOS is 1.5µm while a conventional MOSFET is limited to about 5µm.

- (2) Because its characteristic "V" groove creates two drain channels (one on each face of the "V" groove) the current density of a VMOS device is inherently doubled.
- (3) With the substrate of the device being used as the drain there is no need for drain metallisation runs on the surface of the chip. This allows the size of the chip to be further reduced and also keeps the saturation resistance low.
- (4) In conventional MOS the amount by which the gate overlaps the source and drain must be large to allow for the tolerances in the photolithographic mask. This overlap increases the channel capacitance and limits the frequency response of the device, whereas the overlap in VMOS can be controlled more precisely by the diffusion techniques used.

CHARACTERISTIC CURVES

The output characteristic curves of a VN66AJ are shown in Fig. 2. If these curves are compared to those of a conventional MOSFET (shown in Fig. 3) the main difference is that the drain

current is in amps rather than milliamps. The output curves are very flat because the output conductance is low, therefore any increase in the drain to source voltage, i.e. variations in the power supply voltage, will have little effect on the drain current above 10 volts due to the buffering effect of the epitaxial layer, allowing the current flow to be almost entirely controlled by the gate voltage.

HEAT DISSIPATION

Although VMOS has a negative temperature coefficient which inherently reduces the current flowing in the device as its

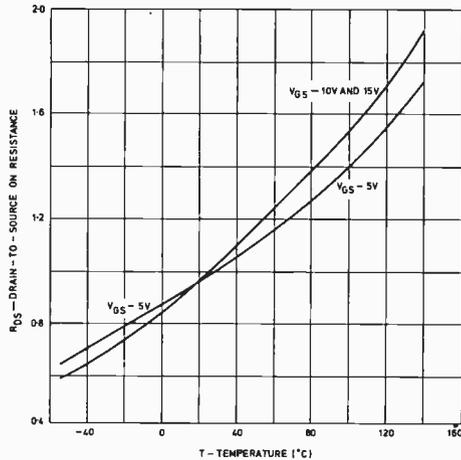


Fig. 4. Graph showing drain-source resistance against temperature (Siliconix)

temperature increases, it is not totally immune from thermal problems. From the graph in Fig. 4, which shows how the drain-source resistance (R_{ds}) is affected by increases in temperature, it can be seen that as the temperature of the device rises its "on" resistance increases causing the current through the device to decrease. However, this rise in resistance causes an increase in the gate-source voltage which will increase the temperature of the device. If no action is taken to dissipate this increase in temperature the resistance of the device would not stabilise until after the safe operating temperature of the junction has been exceeded. So although the device is free from both thermal runaway and secondary breakdown problems it can still be permanently damaged by operating temperatures unless it is mounted on a suitably sized heatsink.

SERIES AND PARALLEL CIRCUITS

The negative temperature coefficient of VMOS enables several devices to be connected in parallel to increase the current handling capacity without the need for either power wasting ballast resistors or matching networks. If one of the devices shown in the parallel arrangement of Fig. 5 starts to draw more

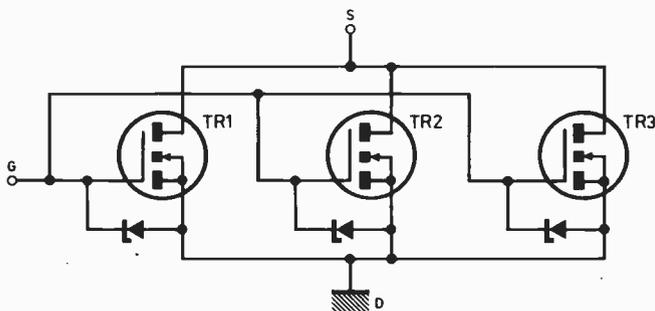


Fig. 5. Method of correcting VMOS devices in parallel (Siliconix)

current, its temperature increases causing the current flow to be reduced and equalised throughout the devices. When two or more VFETs are connected in parallel their total "on" resistance is lowered. This effect results in low insertion losses when VMOS is used to switch low impedance systems. If parallel devices are used in the output stage of an amplifier the lower resistance enables the same amplification to be achieved with less current being drawn from the driver stage, whereas parallel bipolar devices require current to be supplied to both bases with the result that the driver must be updated to handle this increase in current.

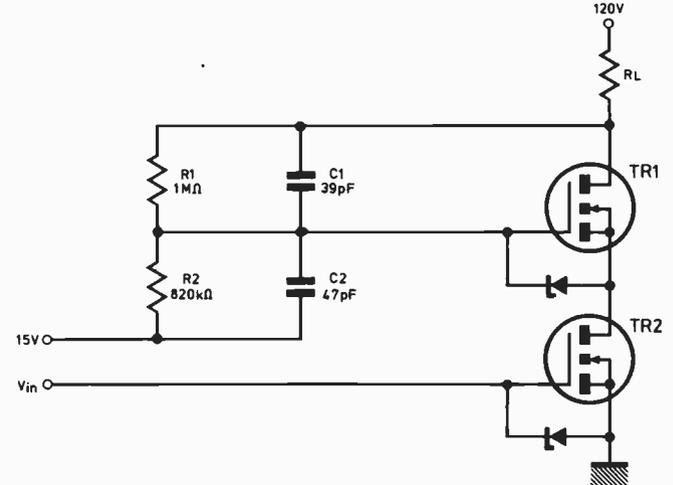


Fig. 6. Method of correcting VMOS devices in series (Siliconix)

When two or more devices are connected in series, as shown in Fig. 6, the breakdown voltage is increased. The resistors R_1 and R_2 have very high values because the gate drive current to TR_1 is very small. To ensure a fast switching time the gate is dynamically balanced by the capacitance divider formed by C_1 and C_2 . If the values of the resistors and capacitors are chosen correctly any number of VFETs can be connected in this way.

VMOS DEVICES

The complete range of VMOS devices available from Siliconix is shown in Table I. They are split into three main categories: general purpose, RF and power peripheral drivers.

General Purpose N-Channel Enhancement Mode VMOS FETs

Type	Package	Power Dissipation $T_c = 25^\circ\text{C}$ (W)	I_D (Max) (A)	V_{GS} (Min) (V)	$V_{DS(on)}/I_D$ $V_{GS} = 10\text{V}$ (V/A)	V_{GS} (th) $I_D = 1.0\text{mA}$ (V)	t_{ON} (nsec)	t_{OFF} (nsec)
2N8656	TO-3	25	2.0	35	1.8/1.0	0.8	2.0	10.0
2N8657	TO-3	25	2.0	60	3.0/1.0	0.8	2.0	10.0
2N8658	TO-3	25	2.0	90	4.0/1.0	0.8	2.0	10.0
2N8659	TO-39	6.25	2.0	35	1.8/1.0	0.8	2.0	10.0
2N8660	TO-39	6.25	2.0	60	3.0/1.0	0.8	2.0	10.0
2N8661	TO-39	6.25	2.0	90	4.0/1.0	0.8	2.0	10.0
VN86AF	TO-202	12.5	2.0	40	3.0/1.0	0.8	2.0	10.0
VN86AF	TO-202	12.5	2.0	60	3.0/1.0	0.8	2.0	10.0
VN86AF	TO-202	12.5	2.0	80	4.0/1.0	0.8	2.0	10.0
VN86CA	TO-3	80.0	12.5	80	—	—	50.0	50.0

F N-Channel Enhancement Mode VMOS

Type	Package	Power Dissipation $T_c = 25^\circ\text{C}$ (W)	I_D (Max) (A)	V_{GS} (Min) (V)	$V_{DS(on)}/I_D$ $V_{GS} = 10\text{V}$ (V/A)	V_{GS} (th) $I_D = 1.0\text{mA}$ (V)	t_{ON} (nsec)	t_{OFF} (nsec)
VN83AJ	TO-3	25	2.0	35	1.8/1.0	0.8	2.0	8
VN86AJ	TO-3	25	2.0	60	3.0/1.0	0.8	2.0	8
VN86AJ	TO-3	25	2.0	90	4.0/1.0	0.8	2.0	8
VN83AK	TO-39	6.25	2.0	35	1.8/1.0	0.8	2.0	8
VN86AK	TO-39	6.25	2.0	60	3.0/1.0	0.8	2.0	8
VN86AK	TO-39	6.25	2.0	90	4.0/1.0	0.8	2.0	8
VMP4	380 SOE-F	25	2.0	80	—	—	—	—

Power Peripheral Drivers

Type	Output Voltage (V)	Output Current (A)	Propagation Delay—Typical nsec	Input Voltage Logical "1" (V)	Logical "0" $I_D = 30\text{mA}$ (V)	Power Dissipation $T_c = 25^\circ\text{C}$ (W)	Package
S75V01	60	2.0	8.0	0.8	5.0	25	TO-3
S75V11	36	2.0	8.0	0.8	5.0	25	TO-3
S75V12	90	2.0	8.0	0.8	5.0	25	TO-3
S75V02	60	2.0	8.0	0.8	5.0	8.25	TO-39
S75V21	36	2.0	8.0	0.8	5.0	6.25	TO-39
S75V22	90	2.0	8.0	0.8	5.0	6.25	TO-39

TABLE 1

The general purpose range has ten types of VFET available in three different packages according to the power dissipation required. This range was designed primarily for amplifier and switching circuits and can be obtained in the following voltage ratings: the 2N series 35V, 60V and 90V; the VN series 40V, 60V and 80V. All the general purpose VFETs except the VN84GA include a gate to source Zener diode to protect the gate oxide from rupture due to static charge build up.

The VN84GA is a second generation device capable of handling up to 12.5A with a breakdown voltage of 80V. At low frequencies it can deliver up to 80 watts whilst at 30MHz its power output is only reduced to 50 watts.

Of the seven RF types available six are in the VN range and are used in RF power amplifiers, high current analogue and bridge switching circuits. These are available in TO3 and TO39 packages with voltage ratings of 35V, 60V and 90V. The VMP4 device, designed for VHF broad band amplifiers, receiver front ends and power oscillators, is available in the flange mounted, opposing source, strip line 380-SOE-F package.

The third category covers power peripheral drivers designed to switch reactive loads such as solenoids, relays, lamps, displays and alarms. Because VMOS devices do not have secondary breakdown problems they are particularly well suited to handling the high voltages and currents which simultaneously occur in inductive loads.

PRACTICAL CIRCUITS

In order to drive a VMOS device the supply voltage must be applied to the source and drain with the drain being positive with respect to the source. Then because it is an "n" channel enhancement type device the gate voltage must be taken positive with respect to the source and body. The electric field set up by the gate voltage induces an "n" channel on both surfaces of the body facing the gate. This induced channel enables electrons to

flow from the negative source through the epitaxial layer and into the drain via the substrate. This current flow is almost entirely controlled by the gate voltage.

The simple audio power amplifier shown in Fig. 7 has an output power of 4W over a frequency range of 100Hz to 15kHz. A

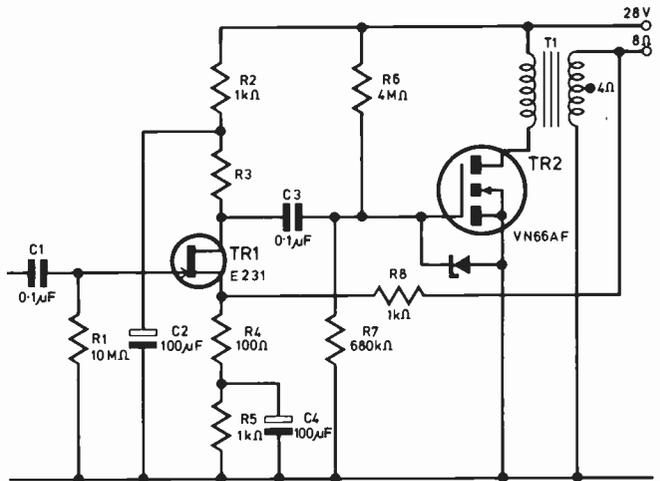


Fig. 7. Circuit diagram of a simple 4W audio power amplifier (Siliconix)

small signal JFET is used for the gate drive of TR2 and the design is greatly simplified by using an output transformer. The negative feedback applied via R8 keeps the overall distortion to 2 per cent at 3W.

The amplifier design shown in Fig. 8 is a basic configuration using the second generation VN84GA device which is capable of handling 12.5A. It will deliver 100W into 4Ω or using 120V VNGs and raising the supply voltages to 55V. 100W into 8Ω.

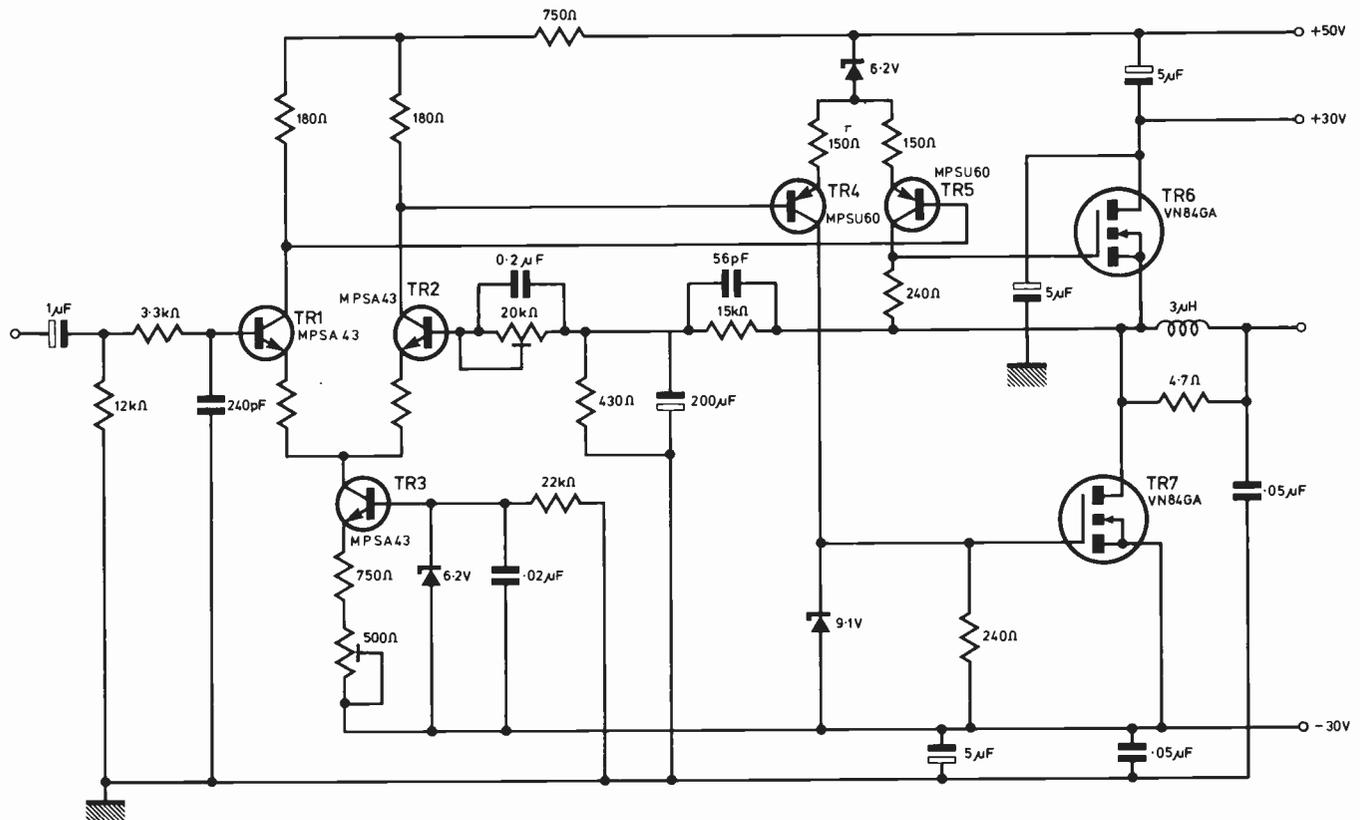


Fig. 8. Basic circuit configuration of a 100W audio amplifier (Siliconix)

THE VERTICAL JUNCTION FET (V-JFET)

The vertical junction FET, the first commercially manufactured power FET, was developed in Japan based on conventional JFET technology. Yamaha were commissioned by the Japan Development Foundation to develop a device using techniques invented by Professor Jun'ichi Nishizawa of the Electronic Telecommunications Laboratory, Tohoku University.

A cross section of a typical device is shown in Fig. 9. The body of the device which is n- material has a p+ type grid mesh diffused into it. This grid mesh structure has the effect of splitting the device into thousands of tiny FETs connected in parallel. Current flows through the channels between the gate grid and into the source. The depth of the depletion region around the gate is controlled by the gate voltage and if the depletion region is increased the current flowing through the device is reduced. Although the operation of a V-JFET is similar to that of a conventional JFET, it has many of the same advantages over the JFET that VMOS has over conventional MOS.

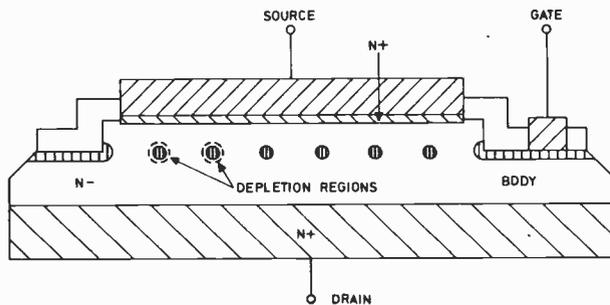


Fig. 9. Cross section of a typical V-JFET device

There are two main differences between the operation of a V-JFET and a VMOS power FET:

- (1) The V-JFET is a normally on device with its maximum drain current being delivered when the gate voltage is zero. In order to bias a V-JFET off, a voltage must be applied to its gate. This effect does not cause problems at low power levels but if a V-JFET is to be used in high power applications the gate must be biased off before the supply is switched on, otherwise the drain current will rise rapidly and damage both the V-JFET and associated circuitry. On switch off the power must be removed from the output stage before the driver stage. This requirement results in a very complex power supply arrangement.
- (2) Because the input capacitance of a V-JFET is higher than for a comparable VMOS device, its frequency response is lower.

V-JFET amplifiers are currently being manufactured by both Yamaha and Sony. For use in their B2 amplifier Yamaha have developed the 2SK-76 (n channel) and 2SJ-26 (p channel) power FETs which have complementary characteristics. Their respective performance figures are shown in Table 2, with their output characteristic curves shown in Fig. 10. The output power stage of the B2 is shown in Fig. 11. A higher supply voltage is used on the driver stage to ensure the FETs turn on to full conduction,

	2SK-76	2SJ-26
Drain-Gate Breakdown Voltage	200V	-150V
Gate-Source Breakdown Voltage	-40V	40V
Drain Current	10A	-10A
Gate Current	1A	-1A
Drain Dissipation	100W	100W
Max. Junction Temperature	150°C	150°C

TABLE 2

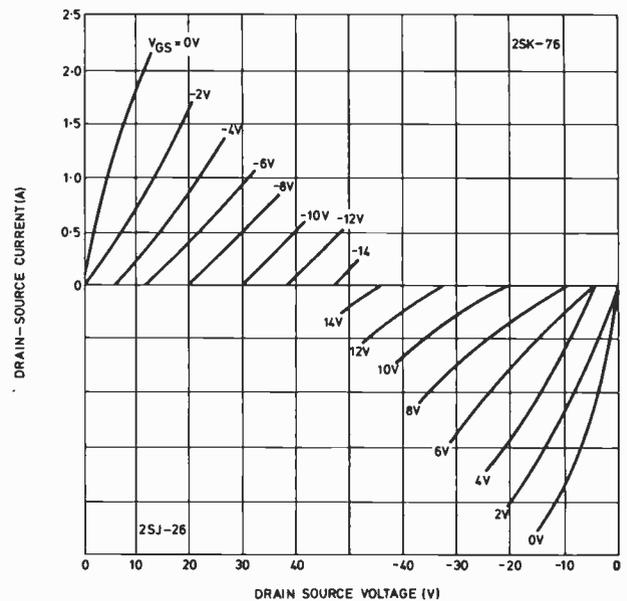


Fig. 10. Output characteristic curves of the 2SK-76 and 2SJ-26 devices

and to reduce the effect of the input capacitance a symmetrical push-pull drive circuit is used. This also reduces the time taken for the gate to source input capacitance to charge or discharge and gives the largest possible high frequency response

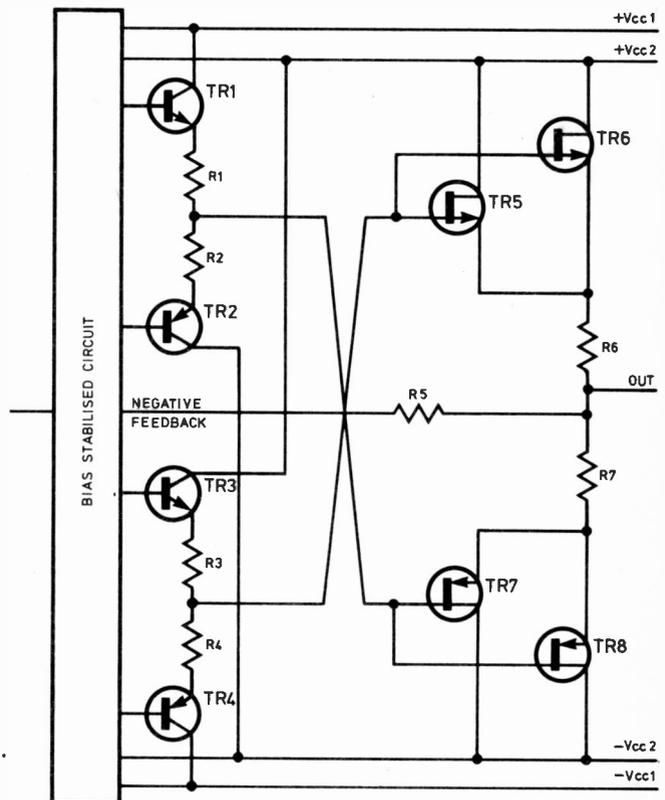


Fig. 11. Output power stage of the Yamaha B2 audio power amplifier

(0-100kHz). To ensure effective heat dissipation the power FETs, which are connected in parallel, are mounted on separate heatsinks by a special process which reduces the thermal resistance to less than half that achieved with conventional mica construction.

THE POWER MOSFET

The power MOSFET developed by Hitachi for use in their range of audio power FET amplifiers is a horizontal current device capable of handling 7 amps at 160 volts. This high current capability is achieved (as it is in all power FETs) by using a wide channel of short length which, in the case of the power MOSFET, is constructed under the gate electrode.

The power MOSFET has the same advantages over bipolar transistors that VMOS and V-JFETs have, but because it has both a high input capacitance and gate resistance, applications for the device are restricted to the audio power range.

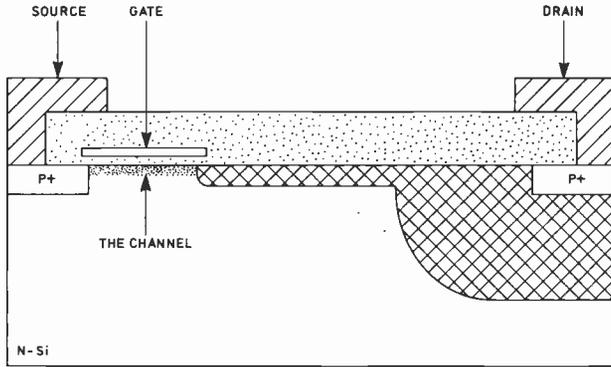


Fig. 12. Cross section of a typical power MOSFET device

A cross section of a typical MOSFET device is shown in Fig. 12. The high drain to source breakdown voltage is obtained by using an ion implanted offset gate structure. This technique, which is also used in small signal MOSFETs, reduces the electric field around the gate electrode and also helps prevent an excessive gate charge damaging the device.

	2SK135	2SJ50
Drain-Gate Breakdown Voltage	160V	-160V
Gate-Source Breakdown Voltage	14V	14V
Drain Current	7A	-7A
Gate Current	0.63A	-0.63A
Drain Dissipation	100W	100W
Max. Junction Temperature	150°C	150°C

TABLE 3

The performance figures of two complementary devices are shown in Table 3, and the graph in Fig. 13 compares the respective input powers required to drive bipolar and MOSFET devices, to achieve a 100W power output over a frequency range of 100Hz to 1MHz. With the MOSFET requiring a much smaller input power the driving circuit is greatly simplified.

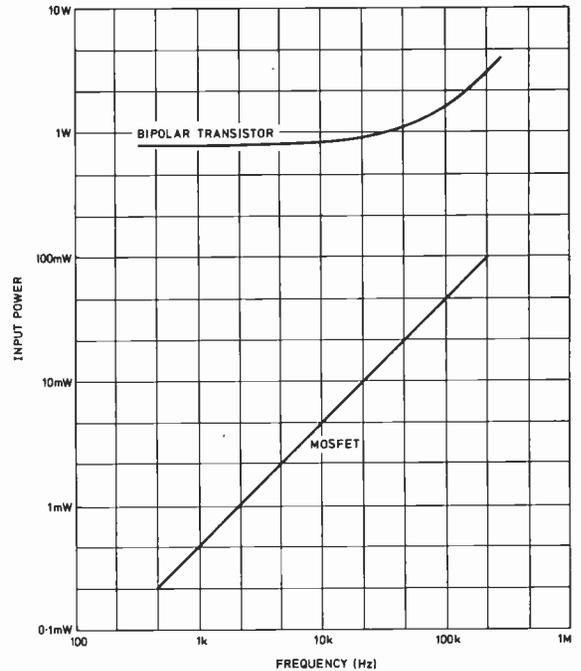


Fig. 13. Graph of the input power required to obtain 100W using MOSFET and bipolar devices (Hitachi)

The circuit diagram in Fig. 14 shows the basic design of a 100W MOSFET amplifier with parallel complementary devices in its output stage. The first two stages of the amplifier use differential pair configurations with an active collector load in the second stage to provide the push-pull action. The coil in the output line reduces the residual distortion which is induced by magnetic coupling between the output line and power supply wiring, from 0.01 per cent to 0.003 per cent. The total harmonic distortion at 100W is about 0.01 per cent, which is about ten times better than ordinary bipolar amplifiers. ★

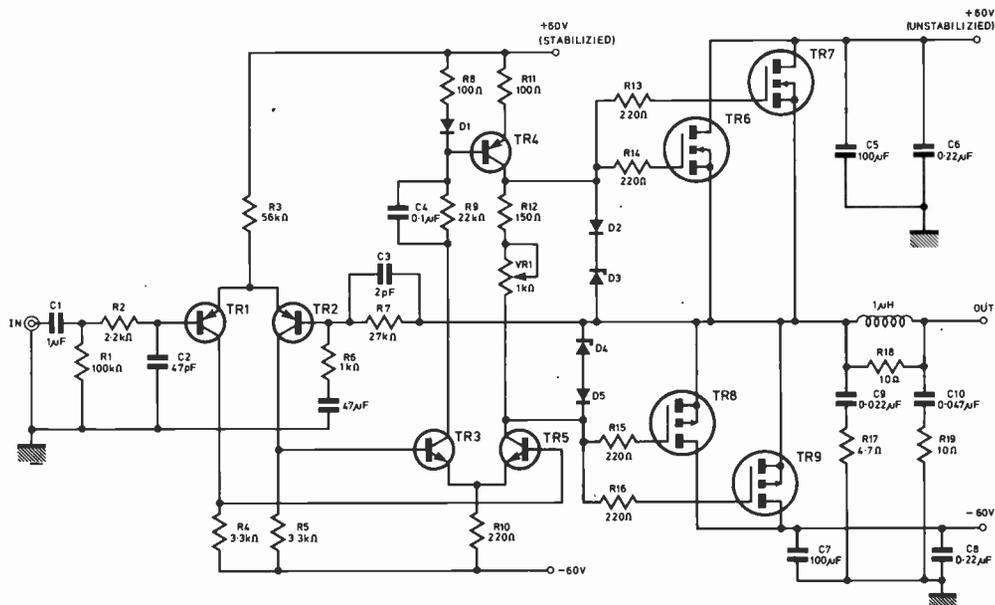


Fig. 14. Basic circuit configuration of a 100W MOSFET amplifier (Hitachi)

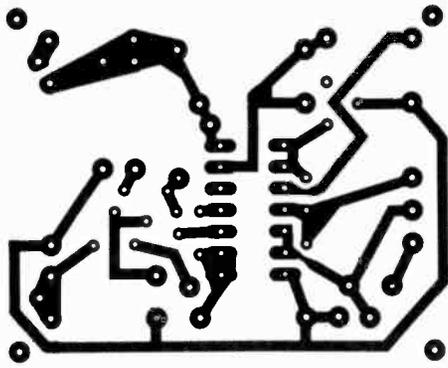


Fig. 2. P.c.b. layout

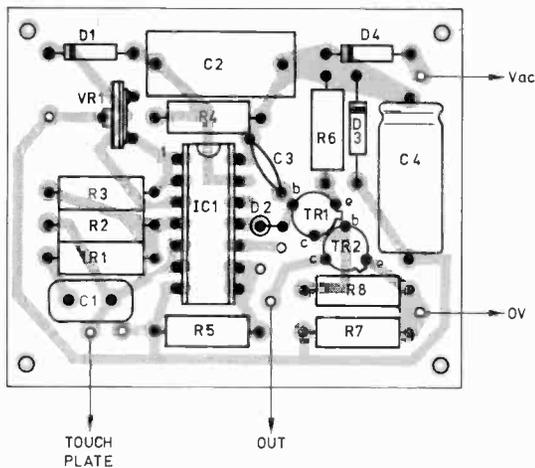
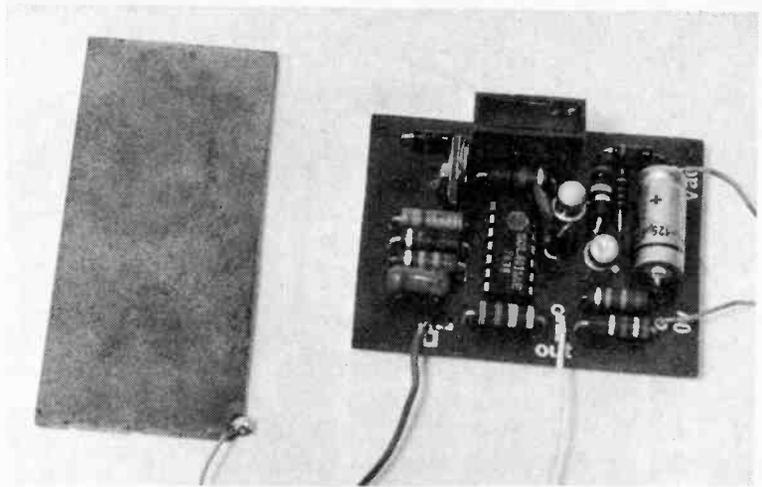


Fig. 3. Component layout

COMPONENTS . . .

Resistors

R1	27k Ω
R2	1M Ω
R3	6.8k Ω
R4	10M Ω
R5	1M Ω
R6	100k
R7	2.2k Ω
R8	56k Ω
All $\frac{1}{2}$ W carbon 10%	

Potentiometer

VR1	50k Ω preset
-----	---------------------

Capacitors

C1	27pF
C2	1 μ F
C3	0.05 μ F
C4	150 μ F elect. 40V

Semiconductors

TR1	BC477
TR2	BC107
IC1	CD4011
D1-D2	OA200 (2 off)
D3	4.7V Zener 400mW (BZY88C)
D4	OA200

frequency pickup by the plate.

The amplified 50Hz signal is fed to the second gate which has its input switching threshold set by VR1, serving as a sensitivity control. The setting of this level is stabilised by the output voltage of gate 1 being used as the reference. By the action of R2, this is the characteristic switching voltage for the i.c.

Gate 2 shapes the signal and this charges C2 through D1, thus switching gate 3. The R4/C2 time constant determines the period for which the display is on. With the values shown this is about five seconds.

The output from gate 3 is not suitable for driving logic circuitry working from the zero volt supply. Therefore TR1, TR2 are used as level shifters, with TR1 acting as an inverting current switch driving TR2.

This was used to operate the blanking input to a CD4511 decoder/latch/driver. This input was held high to inhibit the display, with operation of the proximity switch causing TR2 to turn on and so allow the time to be seen.

For other applications it may be that reverse operation of TR2 is required (i.e. TR2 normally on, and is turned off by touching) and for this purpose gate 4 is available to invert the output from gate 3. If this is the case the connection A-D is removed and connections A-B, C-D substituted.

CONSTRUCTION

A printed circuit layout is shown in Fig. 2. Extra holes are not shown for optional mounting of a horizontal preset resistor for VR1. Here the choice will depend on the mounted position of the board so that there is easy access to adjust for sensitivity.

Further holes are present to allow for the addition of the inverting gate 4, if this is required. Alternatively the printed circuit could be modified to include this gate.

The sensing plate may be a piece of aluminium foil or copper laminate glued inside the plastic or wooden case of the switched equipment, and is connected by a short length of wire (less than 12in) to the component board.

ADJUSTMENT

The size of the sensing plate is not critical and a 5cm square worked well on both 12 and 25V a.c.

The sensitivity control should be finally adjusted when the plate and switch board are mounted in their permanent positions. If the zero volt line is "mains earthed" then there will be a change in sensitivity, but this is easily compensated for by adjustment of VR1. The sensitivity can be adjusted to trip at a distance of several inches, or by lightly touching the case—depending on individual preference. ★

Market Place

Items mentioned are usually available from electronic equipment and component retailers. However, where a full address is given, general enquiries may be made direct to the firm concerned.

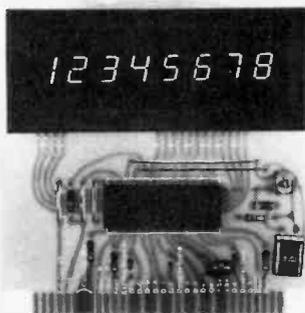
All quoted prices are correct at time of going to press.

by
Alan
Turpin

and
David
Shortland

8-DIGIT COUNTER-TIMER

The 8-digit counter/timer introduced by Lascar Electronics is claimed to perform all the major counting and timing functions. The module can measure frequency from 0-10MHz, period from 0.5 micro-seconds to 10 seconds, frequency ratio between two inputs, time intervals in increments of 0.1 micro-seconds, and can also function as a normal 8-digit totaliser. Mode selection is by a single external switch.



Four different ranges can be selected which determine the time or the number of cycles that the displayed data is accumulated over.

Fitted with 0.4in, high efficiency orange l.e.d.s, the modules operate from +5V d.c. Controls include store, hold and reset, while various outputs enable all functions to be monitored externally. The module is fitted with a 10MHz quartz crystal to give a highly accurate timebase, with a temperature stability of ± 10 ppm over a temp range -20°C to $+70^{\circ}\text{C}$. Price is £54.95 plus VAT.

For further information contact Lascar Electronics Limited, P.O. Box 12, Module House, Billericay, Essex.

ALL THAT GLITTERS

Autumn is here and the beauties on the beach are covering up, so take a last look at this detectable detector by courtesy of Dixons publicity department.

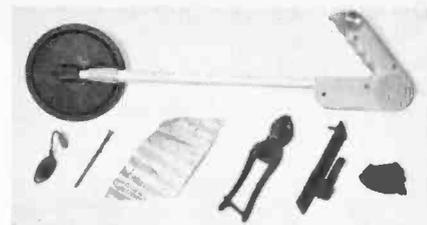


Dixons offer four versions; one for children and beginners at £29.95, two sophisticated models at £39.95 and £49.95, and an enthusiasts machine with meter, at £69.95, which Dixons claim can detect a single coin at one foot, or larger objects at four feet.

ANY OLD IRON/ALLOY/CARBON

Rumour has it that there is five hundred million pounds of lost or buried treasure in the country.

Market Place has been trying out an induction balance detector over lawns, paths, flower beds, etc. We didn't find any valuables



but did dig up one of Uri Geller's old spoons, a six inch nail, aluminium lawn edging, a pair of rusted secateurs, a large garage door hinge pin, and a piece of coke.

At only £13, inc. p&p, you might well uncover the cost of your investment.

Readers P.C.B. Services Limited, P.O. Box 11, Worksop, Notts.

HANDY DETECTOR

Pocket size detectors which can trace wiring or water pipes and show the presence of iron reinforcing are available from sole U.K. distributors HDP Electronics Ltd.



There are three models: a metal detector (403), a voltage indicator (405), and a combination unit (407).

The detectors run off one 9V battery and indication is by a signal lamp.

Volltronic is the name of the range which is manufactured in West Germany.

403 and 405 are £13.19 and the 407 is £28.64, including p&p and VAT. Trade enquiries invited.

HPD Electronics Limited, 34/38 Dock Street, Leeds LS10 1JF. Telephone 450222.

6800 PROGRAMS

JCN Electronics have four programs for 6800 based microprocessors. They have been written to run with MIKBUS firmware and are available as photocopy listings or all together on a Cuts Format Cassette at £2 inc.

Lunar Landing	75p
Mastermind	30p
Matchsticks	30p
Print Formatter	20p

Send large s.a.e. to JCN Electronics, Hodsock Park, Langold, Worksop, Notts. S81 0TF. Telephone Worksop 730282.

Note. October Market Place, Wonderboards. Orders should include 30p for p&p.

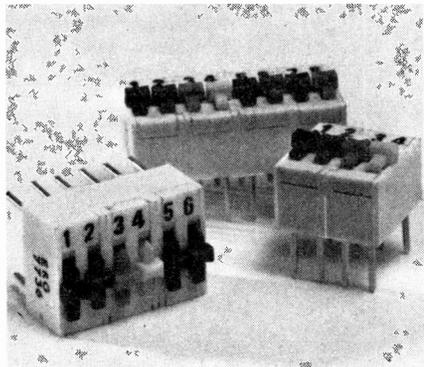
ON BOARD SWITCHING

If you are prone to housing small projects in tobacco tins these dual in line switches may help the aesthetics.

Fit them on the track side of 0.1 inch matrix board, then stand the board off the lid.

As well as smarten up a front panel they can be used, on board, as function/mode selectors, test switching, range changing, etc.

Contact ratings: 1 μ V to 100V a.c., 1 μ A to 1A—at up to 10VA.

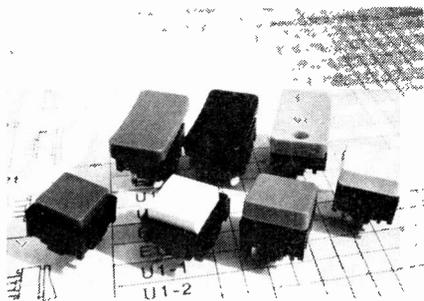


They are colour coded as per the resistor colour code and are available in banks of 4, 6 and 8 at 84p, £1.24 and £1.52 each, including p & p but add VAT at eight per cent.

Verspeed, Barton Park Industrial Estate, Eastleigh, Hants SO5 5RR. Telephone: 0703 618525/6.

MINIATURE PUSH BUTTON SWITCHES

A range of miniature snap-action push button switches, designed for 0.1in printed circuit board mounting is now available from Impetron Ltd.



They have a positive snap or rocker action. Single pole press-to-break and changeover configurations are all available as standard, and an l.e.d. indicator can be incorporated to provide visual warning of function selected.

The basic body size of all types is 12.4 x 12.4 x 7.5mm. The selected push button or rocker action will add a further 5mm to body depth.

Switches may also be mounted in line or block format to form key sets with mechanical interlocking and release mechanisms.

Despite their small size the switches are capable of handling up to 25mA at 50V d.c. Contact resistance is less than 20m Ω and operational life is in the excess of 10⁵ operations at full load. Operating temperature range is -25° to +75°C.

Impetron Limited, Impetron House, 23-31 King Street, London W3 9LH. Telephone 01-992 5388.



"I AM YOUR AUTOMATIC MUSIC CENTRE"

Sharp's SG500 has front located controls so that there is no need to lift the dust cover to operate. It has a LW/MW/SW/FM/FM MPX stereo tuner amplifier, a two motor drive cassette deck and a direct drive record player.

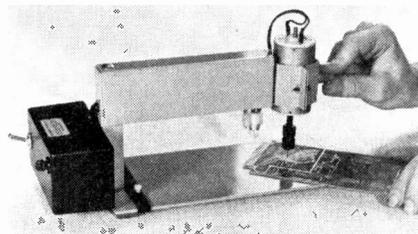
The amplifier has a 45W/channel (r.m.s.) output with 0.5 per cent THD at 4 Ω and sensor touch tuning on FM with up to seven preset stations.

Sharp's Auto Programme Search System is included in the cassette section, which locates and plays back automatically the track required, as well as Dolby noise reduction and tape selectors and changeover facilities.

The sensor touch player has a 31cm turntable and a VM type cartridge. An auto disc detection system determines whether there is a record on the turntable and also its size, so that it automatically plays at the right speed and leads the arm to the correct position. Price is £644.95. Remote control accessory, £84.95.

LARGE THROAT P.C.B. DRILL

A p.c.b. drill stand, specially designed for drilling small quantities of boards, prototypes, one-off production specials, missed production holes and modifications, is now available from Technomark, Maidstone, Kent.



The motor body is supported on a cantilever spring system which switches the motor on when depressed. If the motor body is adjusted so that the motor switches on with the drill just touching the board surface, drill wander can be eliminated to enable accurate drilling of plain copper surfaces.

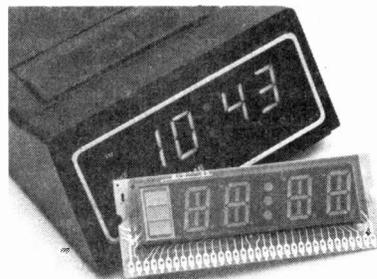
It has an integral 12V d.c. power supply, fused and switched, low voltage lighting and a reliable high speed motor. Throat depth is 168mm.

Each unit comes complete with chuck, collets, light and x-y locating jigs. Price is £61 plus VAT.

Technomark, Allnut Mill, Church Road, Lower Tovil, Maidstone, Kent.

CLOCK DISPLAY

A four-digit, seven-segment light-emitting diode display designed for digital-clock applications has been introduced by Micro Electronics Ltd. The MCD 461 Series has a red numeric display which uses 0.6in (15mm) high gallium arsenide phosphide light-emitting diodes. Both 12 and 24 hour versions are available.



The display is designed to offer a wide viewing angle, and can be mounted with a 0.1 in-pitch edge connector or connection pins.

The static forward voltage per segment is 1.7V and the maximum ratings at 25°C are: reverse voltage 5V; peak forward current per segment 200mA; continuous forward current per segment 20mA; and power dissipation 300mW. Operating temperature range is -20°C to +75°C.

The price of the unit is £54.95 plus VAT and for further information contact Micro Electronics Limited, York House, Empire Way, Wembley, Middlesex.



REVIEW OF INTRUDER ALARMS AND SECURITY SYSTEMS

Beat the burglar if you can. He'll be straight in through everyday doors and windows. Mortice locks will make him think twice, but until we have shuttered windows like our EEC neighbours then a piece of treacle paper is all he needs for a silent entry—unless you detect him and sound the alarm. Vandalism of private property is on the increase too. Big dogs are expensive to feed so how about this doppler fido.

ELECTRONIC WATCHDOG

The BD 100 is a security device which combines the function of electronic clock with an intruder alarm. Unobtrusively built into a digital clock, the burglar alarm is brought into readiness by removal of an electronic 'key'. This sets up transmission of an inaudible high-frequency signal which establishes a sensitive field completely filling the room in which the alarm is set. Disturbance of the field by an intruder or any movement in the room is registered by the unit, setting off a high intensity audible alarm similar to that of a motor car horn. The alarm signal may be silenced only by the insertion of a uniquely-matched electronic key.



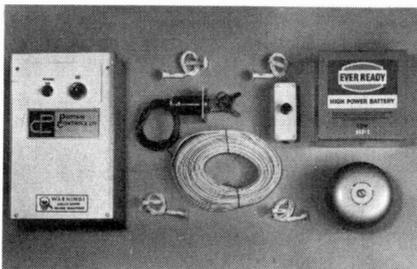
The device allows a 20-second delay between entry into the room and insertion of the key without setting off the alarm. A similar delay allows removal of the key on departure.

Unlike many burglar alarm systems designed for the home, the BD 100 requires no special wiring. The unit simply plugs into a standard 13-amp mains socket. If there is a power cut, or if the plug is removed from the socket, internal batteries take over the power supply. The batteries are recharged when mains power is resumed.

The price of the BD 100 is £62.00 plus VAT and further information can be obtained from **Fotherby, Willis Electronics Ltd, Gladstone Terrace, Stanningley, Leeds.**

ALARM KIT

The "Remick" burglar alarm kit, complete with instructions and wiring diagram enables a handyman to install the system to suit his own requirements. The kit—which includes a control unit, four sets of magnetic switches (for doors or windows), pressure pad (for front door mat), mini siren and cable—can be extended to suit any size premises by fitting additional sensors and alarms which can be obtained separately.

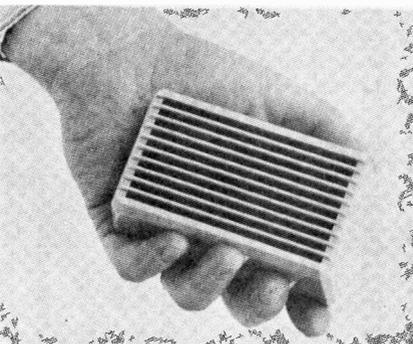


The system operates from mains supply with the loop circuits and alarm bell at 12V d.c. The double loop circuit is provided so that any attempt to cut or short the leads will result in the alarm operating. Whenever the alarm rings it continues until it is manually switched off by the keyholder. A 12V battery is supplied to maintain the operation of the system during a mains failure.

The price of the kit is £56 plus VAT. For further information contact **Photain Controls, Unit 18, Hangar No. 3, The Aerodrome, Ford, Sussex.**

MINI-MICRO

The ML-1500, which is also available from Photain Controls, is a miniature doppler microwave detector which has a linear range of 15 metres with a wide 140 degrees horizontal beam pattern. A special protection circuit prevents any interference from fluorescent lights affecting the circuit.



The unit should be mounted 2-3 metres above floor level and as microwaves can penetrate certain building materials such as glass and thin partitions, the unit should be pointed away from windows wherever possible. Price £80 plus VAT.

TOUCHLESS CONTROL

The door control system marketed by Inertial Systems is virtually vandalproof because the sensor and control equipment are concealed in the wall near the door and operated by presenting a "command key", rather like a credit card, a few inches away

from the sensor. Once the validity of the card is established the control unit operates the electronic lock on the door.

The command keys are precision tuned passive circuits which when energised by the sensor return a specific frequency pattern. The keys can be programmed with individual private codes to enable the system to grant or deny individual access according to the time and day. If required, the system can maintain a printed record of individual entries and exits by the time and date.

For further information contact **Inertial Systems Limited, Elvaco House, High Street, Egham, Surrey.**

SELF TEST SYSTEM

The Mk III Harley alarm system has a self test facility which checks the unit when it is switched on. The complete system includes a 12V battery, key bypass switch, battery level indicator, a "bell test" circuit, five magnetic contacts for doors or windows and two anti-



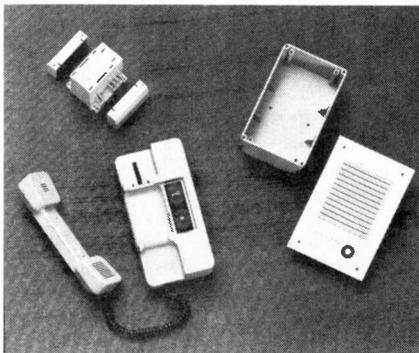
tamper micro switches, one of which will operate the alarm whether or not the unit is on or off if any attempt is made to interfere with the control unit.

For further information contact **Harley Security Systems, 94 Normandy Street, Alton, Hants.**

DOOR ANSWERING SYSTEM

The Siedle 2000 door communication system available from Baron Security is a D.I.Y. unit suitable for use in individual homes.

The system consists of a door loudspeaker/microphone, home telephone, bell transformer and door release mechanism. The front plate of the door loudspeaker unit is flush mounted and includes a call button in the name plate.



The entrance door latch can be released by pressing the button mounted on the telephone.

The recommended price of the Siedle 2000 is £76.15 plus VAT and it is available from **Baron Security, 52 Monmouth Street, London.**

Car Devices



Here is a collection of simple projects for use in vehicles with 12V systems

AUTO-LIGHT

P. Scargill

THE circuit to be described will be especially useful to those motorists who have been in the unfortunate situation of being left with a flat battery through leaving their lights on all day, or worse still, those who have been stopped at night by the police for having no lights on, as it will automatically switch both side and dipped lights on when the ambient light level warrants such action.

It is left unaffected by short tunnels, street lights, etc. so that before long the user will wonder why all cars don't have such a device.

Construction should present no problems, and as an added bonus, the front panel has a couple of indicators so that you can amaze non-technical friends with the wonders of modern science. These also function as lighting status indicators so that if you should ever have cause to use the car lighting on manual, they will act as a handy switch off reminder. By the use of moderately rated components, it is most likely that the life of the unit will outlast that of the vehicle.

CIRCUIT

The operation of the circuit is shown in block form in Fig. 1. The ambient light level present at any one time is sensed by a



Fig. 1. Block diagram

photocell and the output of this is compared to a fixed reference. When the light level falls, a timing circuit is started up. The instantaneous light level is hence averaged out over a period of time.

The output from this section is again compared to a fixed reference and when a certain level is exceeded, the resulting output is fed to a relay which controls the car lighting.

Fig. 2 shows the basic diagram of a Schmitt of the type used in this circuit.

R_a and R_b hold the op amp + input at a level of around half the supply voltage.

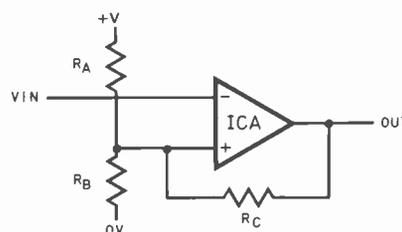


Fig. 2. Schmitt circuit

Hence if V_{in} exceeds $+V/2$, the output will swing low. R_c introduces positive feedback to the circuit which as well as ensuring sharp switching of the output, introduces a certain amount of hysteresis which is determined by the combination of the relative values of R_a , R_b and R_c .

The format used in Fig. 1 ensures that there is no loading of the input by the presence of R_c .

In referring to Fig. 3— $R1$, $VR1$, and $R11$ form a resistive voltage divider across the supply rails, the voltage at the junction of $R11$ and $VR1$ varying in accordance with changes in ambient light level.

This voltage is fed via $R2$ to $IC1$, a Schmitt as described previously, so that the output of $IC1$ changes state at two different light levels, an upper and lower level brought about by the hysteresis produced by the presence of $R5$.

So we have a simple light sensor, but one incapable of distinguishing between light-up time and, say, a short dark tunnel.

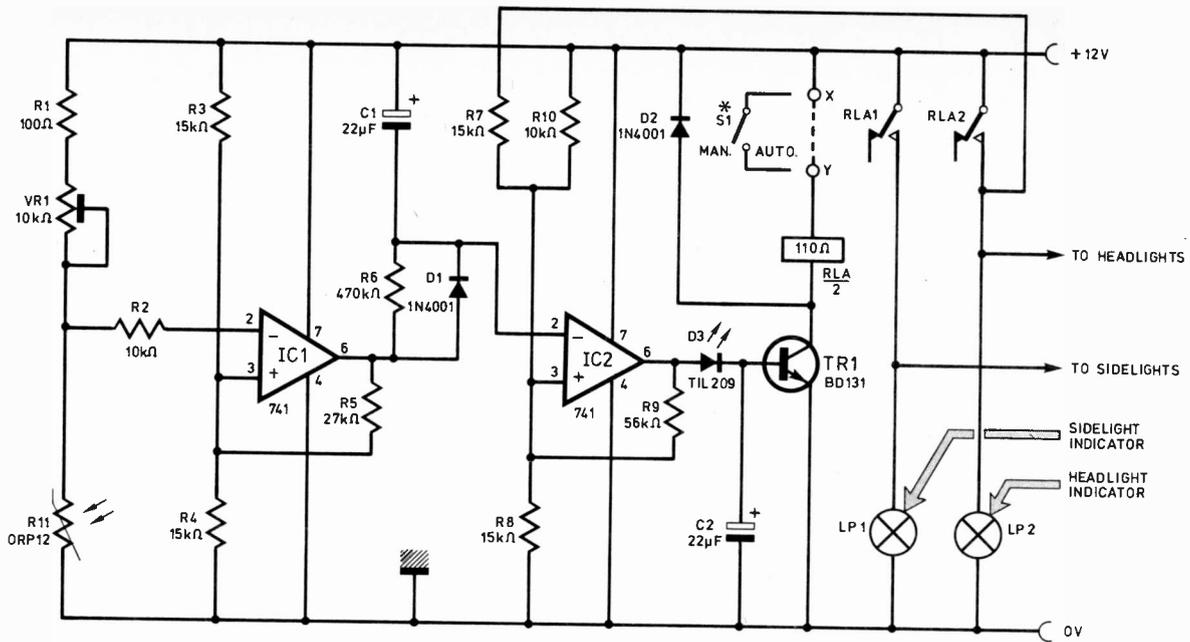


Fig. 3. Circuit of Auto-Light Fig. 4 (below). Modification for positive earth

The following stages are therefore essential for correct operation of the circuit for the application with which we are concerned.

Components R6 and C1 form a charging circuit which produces a 20 second delay in conjunction with IC2. C1 has been taken to +V so that at switch-on, it will be discharged and will hold IC2 input high, keeping the output low.

If the situation was reversed and C1 was returned to 0V, when the ignition was switched on, there would be a momentary flicker of the lights in daylight. This could be put to good use if a momentary delay was introduced to the output to combat this pulse, as a delay defeat would be realised at ignition switch-on.

However, for the sake of reliability and simplicity this feature has been omitted from the present circuit.

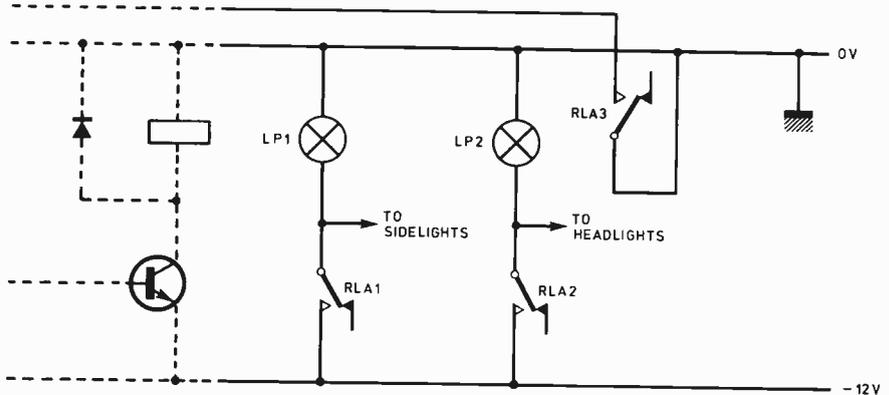
D1 ensures that the delay is not cumulative—a succession of short tunnels will not trigger the relay.

In this situation without D1, the motorist would find his lights triggering prematurely which, to say the least, might annoy other motorists.

TR1 is the relay driver, with C2 preventing any supply generated pulses from reaching the relay.

D3 is not used as an indicator (although there is no reason why it should not be brought out to the front panel if desired) but is used as a form of Zener to ensure that TR1 receives no input when IC2 output is low.

Feedback is applied from the relay back to IC2 pin 3 to ensure that any battery voltage changes do not cause relay chatter. Normally this would not occur but it has been found that in freak conditions this can occur if R7 is not present. It is essential to prevent relay chatter in this application in order to prolong the life of the relay contacts.



In this circuit, use is made of the output current limiting of the 741 op amp in restricting the current to D3, therefore it is not recommended to use any other type of op amp. However, most *npn* power transistors are suitable for TR1 and the relay is not critical provided it has a 12V coil and that the contacts are capable of handling the current.

CONSTRUCTION

Construction and layout are not critical as there are no particularly sensitive sections in the unit. However, good soldering is essential in any gadget for use in a vehicle because of vibration effects.

In the prototype, a copper-clad etched circuit board was used, details of which are given in Figs. 5 and 6.

A relay with 5 amp contacts was used in this prototype as the headlights in many modern cars have their own relay drive. If the unit is to be used in a vehicle without this facility (particularly if extra lights have been fitted) a relay with 10A contacts may be better.

Tandy sell a very nice enclosed relay with DPCO contacts with this rating. However, a

bigger case will be required than that shown unless the relay is housed separately to the main unit.

FITTING AND SETTING UP

The unit should be mounted as near to the lights switch as possible. From that switch it will be possible to obtain tappings into dipped lights, side lights and in some cases a live switched through the ignition. An earth will have to be found elsewhere.

Finding out which wire is which on the car lights switch is a matter of consulting the vehicle wiring diagram and no advice can be given as all cars are different in this respect.

The sensor should not be mounted in a position where it is in direct line with any strong source of artificially generated light, i.e. opposing traffic headlights, although the unit is not particularly sensitive to this light. The best place to mount it is in the left hand corner of the dash, preferably out of sight. Positioning is not critical, however.

Having wired the unit up, it is simply a matter of waiting till lighting up time for final adjustment of VR1. A voltmeter across 0V and IC1 output will give an

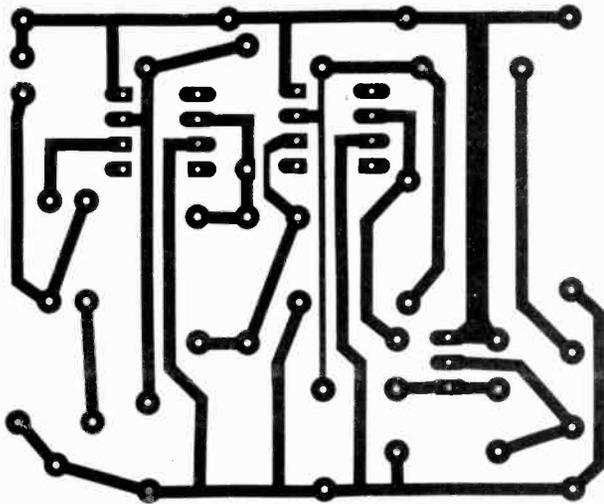


Fig. 5. P.c.b. layout

instantaneous indication of triggering rather than having to wait out the delay after every small adjustment.

Adjust VR1 until the exact point at which IC1 output goes low is found and leave the preset at this exact point. Now fasten the case up and that is all there is to it.

The car lights should now come on after about 20 seconds, and should go off immediately the ignition is switched off. On turning the ignition back on, there should be a further 20 second delay before the lights come back on. Check to make sure the correct lights are operating and also that both of the indicators on the unit itself are working correctly. If the auto/manual switch is fitted, switch to manual, put side lights on manually in the normal way, and make sure the correct indicator shows on the unit.

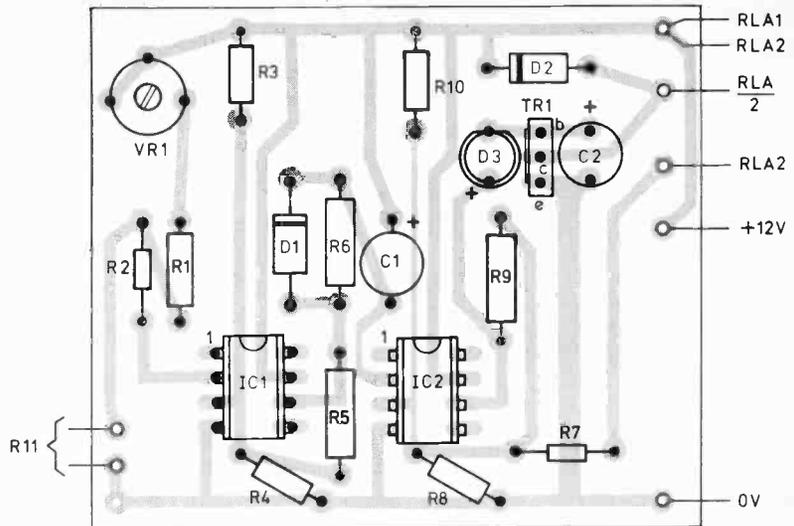


Fig. 6. Component layout

COMPONENTS . . .

Resistors

R1	100Ω
R2	10kΩ
R3	15kΩ
R4	15kΩ
R5	27kΩ
R6	470kΩ
R7	15kΩ
R8	15kΩ
R9	56kΩ
R10	10kΩ
R11	ORP12

All resistors $\frac{1}{8}$ watt 5% carbon.

Potentiometer

VR1	10kΩ preset
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Capacitors

C1, C2	22μF elect 16V (2 off)
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Semiconductors

D1	1N4001
D2	1N4001
TR1	BD131
IC1, IC2	741 (2 off)
D3	TIL209

Relay

RLA 12V d.c. 110Ω coil two-pole changeover (R.S. Cat. No. 348-835).

Miscellaneous

S1* S.p.s.t. miniature on/off (if required)
LP1-LP2 12V indicator lamps

VARI-WIPE

B. A. Bell

AN intermittent wiper control facility is now standard equipment of many new cars. Such a unit proves indispensable in British weather, and the present design allows a wiper delay to be added to any car. It is of very simple design, making it easy to build successfully. The small number of components make the unit reliable, and keeps the cost below that of four gallons of petrol.

CIRCUIT DESCRIPTION

The circuit is shown controlling a two-speed wiper motor with a motor-shortening parking switch; this represents the arrangement on most recent cars. The simpler circuit used on older cars, with a non-shortening parking switch, will also work with this design.

In normal operation of the wipers, with the unit turned off by S1, RLA/1 restores the original connection which is broken on installation. When the wiper switch is moved to "Slow" or "Fast", the appropriate winding on the motor is disconnected from the limit switch and connected to the 12 volt supply, the motor running

continuously. On switching the wipers off, the motor is connected to the limit switch which maintains the 12 volt supply until the park position of the wipers is reached. The limit switch then disconnects the 12 volt supply and short circuits the motor, providing rapid braking.

If the intermittent control is now switched on with S1, C2 begins to charge at a rate determined by R2 and VR1. When the voltage across C2 exceeds the Zener voltage of D1, the Zener diode conducts and switches TR1 on. RLA/1 operates and connects the 12 volt supply to the motor "slow" winding via the wiper switch. As the motor runs, the limit switch moves to the "Run" position to maintain the motor supply, and also short circuits the intermittent control unit, discharging C2 via D2 and S1, and resetting the circuit completely. At the completion of one sweep of the wipers, the limit switch parks the motor and removes the short circuit across the intermittent control, restarting the cycle.

The repetition rate of the cycle depends on the setting of VR1, and the values given in the circuit provide a delay adjustable

between five and 30 seconds. R2 may be decreased in value if a shorter sweep delay should be required. R1 limits the base current in TR1 when D1 conducts, and C1 charges rapidly when RLA/1 operates to hold the relay closed until the limit switch takes over the supply to the motor.

CONSTRUCTION

The components making up the circuit can be conveniently housed in a small plastics box.

The box may be mounted underneath the dashboard or may be mounted remotely, with VR1 connected by flying leads. Only three connections are required to the vehicle, a 12 volt supply from the ignition switch, and an interruption in the wire which connects the wiper switch to the motor.

This connection can be made by unplugging this wire from the switch behind the dashboard, and connecting the unit to the now vacant terminal on the switch and to the free end of the unplugged wire. If the unit is removed from the car at a future date, this wire must be replaced.

COMPONENTS . . .

Resistors

R1 39 Ω
R2 1k Ω
All $\frac{1}{4}$ watt 10% carbon

Potentiometer

VR1 10k Ω

Capacitors

C1 1,000 μ F elect 15V
C2 1,000 μ F elect 15V

Semiconductors

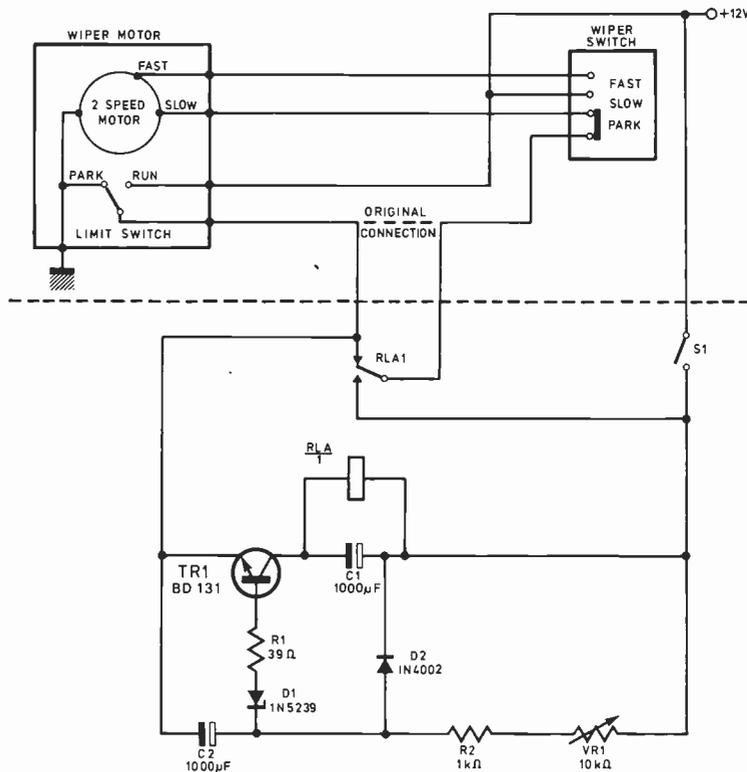
D1 1N5239
D3 1N4002
TR1 BD131

Relay

RLA KMK1/12DC Keyswitch

Miscellaneous

Plastics box 5in x 2in x 2in with lid
S1 on/off switch



Vari-Wipe circuit

IN USE

The unit is operated by rotating VR1 and setting the desired delay. If there is a temporary increase in spray or rainfall, the intermittent action is over-riden by operating the wiper motor in the normal way. This automatically disconnects the unit until the wiper switch is turned off, when the intermittent action will be resumed. The prototype has functioned faultlessly for two years on a number of cars, and worked first-time when it was assembled.

ASSISTED IGNITION SYSTEM

G. C. Wride

BACK in the early 1900's a man invented an ignition system comprising of two coils of copper wire, one with a large number of turns, the secondary, and the other a few turns, the primary; he then connected the primary across the battery via a pair of contact breakers across which he connected a condenser. This is the Kettering system which has changed very little since then with the exception of improved materials. Well, way back in 1905 I doubt if they had an engine which would rev much over 2,500 r.p.m. so the system worked very adequately, but most cars these days can rev to at least 5,500 and quite a few to 7,000 and the Kettering system starts to have a hard time keeping up.

Let's look at the low rev end first, for instance, tick over—the points are opening slowly, this gives some of the stored energy in the coil time to arc across the gap so not only burning the points but losing valuable output to the plugs. At the mid range, say, between 2,000 to 4,000, things are not so bad, the output rising to about the maximum to be expected. Things start to go wrong at about 5,000 and above as the available time for the coil to recharge itself is very short (coil recovery time).

Points may bounce, further reducing coil

current, and to make matters even worse, because of high cam speed the points tend to close late and the net result of all this is very low output to the plugs.

Finally, after 5,000 miles, the points are so burned that they have to be thrown away and the timing re-done.

SYSTEMS COMPARED

Now we've looked at the problems, let's see how we can get over them. About 10 years ago the "Capacitive Discharge System" arrived on the scene; this was really excellent but in the early days it suffered from s.c.r. "hang-up's" or "latch on's", also the discharge capacitor was somewhat unreliable.

It operated by inverting the 12 volt supply up to 350 volt with a pair of 2N3055s, charging a capacitor then dumping the lot across the coil via the s.c.r. which was triggered by the points.

Its counterpart the "Points Assisted System" basically replaces the points with a power transistor capable of withstanding 300–400 volts or so, which is a very good move since the transistor in this position is a far better switch; secondly, point burn is

eradicated, other than this, unfortunately, the system mimics the points exactly. Taking a long look at the aforementioned system I decided there were a number of improvements that could be made.

The ignition coil is basically efficient, its losses mainly being due to its own internal resistance, which we can't do anything about and the external components, which we can. Firstly, we replace the points with a transistor, preferably the type specially designed for switching; secondly we can "tune" the coil to the engine's requirements, these being:

- A fast rising waveform
- Large amplitude
- A slow decay

Unfortunately, none of these conditions are complementary so a compromise must be found.

This design ensures that the maximum possible current for the longest possible time flows in the primary of the ignition coil, this being determined very simply by the use of a monostable; the only work that the contact breaker does is to trigger the monostable via a differentiator so their life is only determined by mechanical wear.

By careful differentiator design it was possible to build in three other innovations,

these being:

- (a) Contact bounce suppression
- (b) Over-rev limitation
- (c) Anti-theft provision

The system was tried on various makes of car and was found to work very well, even on those with very dubious electrical systems. Four connections are all that are required and no modifications need be carried out to rev counters or tachometers.

It should be noted that although the cars tested were four cylinder, I see no reason why the system shouldn't work equally well on six or eight cylinder engines.

CIRCUIT

Resistor R1 supplies the contact breaker with approximately 120mA. This is sufficient current to wet the points to prevent corrosion and provide a low impedance source for the differentiator (Fig. 1).

The differentiator is formed by components C1, R1, D3, R2, R3, VR1, R4, D2, R5 and R8. R5 and R8 are also a potential divider to the input of TR2. VR1 sets the upper revolution limit, R4 being normally short circuited by the anti-theft switch and is selected according to the maximum revs required before the engine starts to misfire.

The anti-theft switch is obviously mounted discretely under the dash or other convenient place.

The time constants on the positive half cycle of the differentiator (as the points open) mainly consists of R2 as D2 is conducting; D3 also conducts, raising the base of TR2 to its triggering potential, i.e. 2 volts. As the points close the output across C1 swings negative, D2 and D3 are non-conducting and C1 now discharges through R3 and VR1.

The time constant on the positive swing (points open) is arranged to allow C1 to be fully charged at the shortest dwell time or maximum revs (Fig. 2a). When the points close the negative output swings to -12 volts approximately, Fig. 2b. Now as the time constant is longer the voltage across C1 becomes progressively larger (-ve) as the revs are increased, therefore, eventually a point will be reached where the positive output pulse will be below the trigger voltage of TR4 and engine misfire will result (Fig. 2c). Point bounce suppression is effected in the same way. The bounce occurs just after closure so as C1 has had very little time to discharge the resulting pulse is well below the trigger potential of TR2 (Fig. 2c).

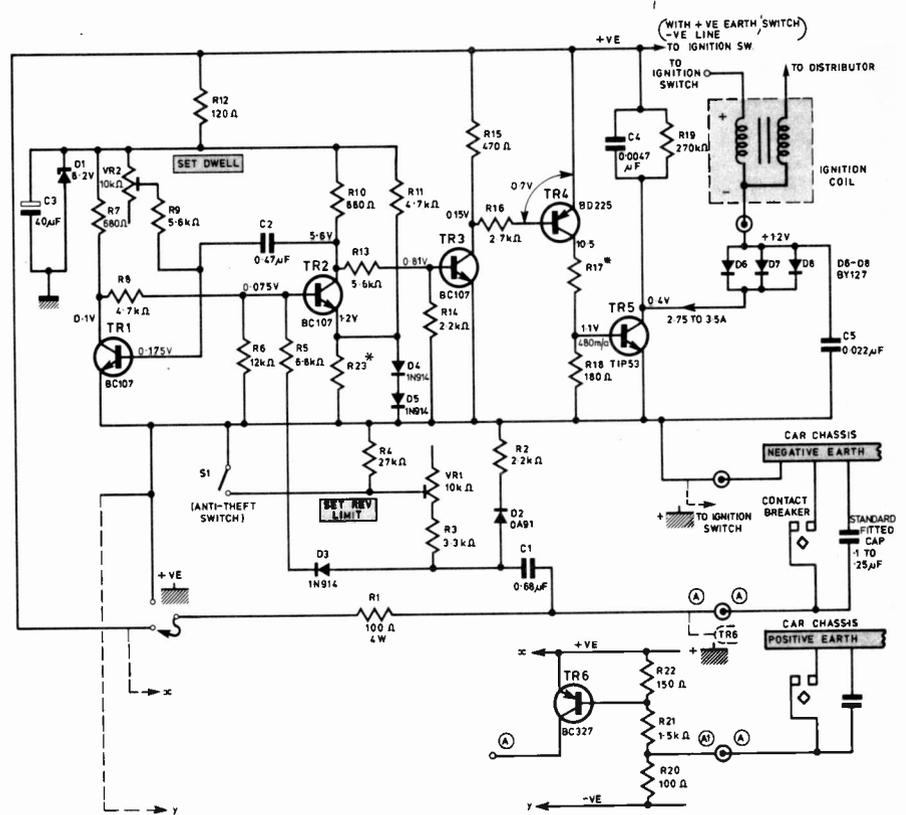


Fig. 1. Assisted Ignition System

MONOSTABLE AND OUTPUT STAGE

The monostable is conventional except for the offset diodes D4 and D5 which, in conjunction with the base emitter voltage of TR2 and D3, define the triggering potential.

The output pulse width is set within the limits of 1.9ms to 5.5ms with VR2 ("Set Dwell").

Regulating the 6.2 volt supply ensures a constant pulse width, even if there is a considerable change in battery voltage.

The negative going pulse is taken from TR2 collector to TR3 base via R13 which turns off TR3, TR4 and TR5. R17 is chosen to fully bottom TR4.

The output transistor TR5 carries all the coil current and is driven as a fast switch. D6, 7 and 8 protect TR5 from the negative swing from the ignition coil. When TR5 is

turned off the collector swings to approximately 400 volts. D6, 7 and 8 conduct, charging C4 to this potential, as the potential at the anodes of the diodes moves below that on the cathode D6, 7 and 8 become non-conducting so isolating TR5 from the negative transient. The discharge time of C4 is through R19.

By the time TR5 is ready to turn on again the voltage across C4 will be approximately +24 volts, so the remaining charge left in C4 will not damage TR5.

TR5 must be mounted on a heatsink of 18 s.w.g. aluminium of not less than 4 square inches.

CONSTRUCTION

The prototype was constructed on 0.1in copper strip board and mounted in an "MK" wall mounting box with a cover plate; this was found to be eminently suitable as it can be made almost watertight. There is no need to screw down the component board as this can be made a snug fit, also if the cables are all taken out from one side in the event of service, the top plate can be unscrewed and the whole panel hinged out for service.

A recommended layout is shown in Fig. 4 and is by no means critical with the exception of the components R17, D6, 7 and 8 which run warm; these must be mounted away from the panel.

Leads carrying high currents, i.e. 100 milliamps or more, should not have long lengths of print between them unless a wire

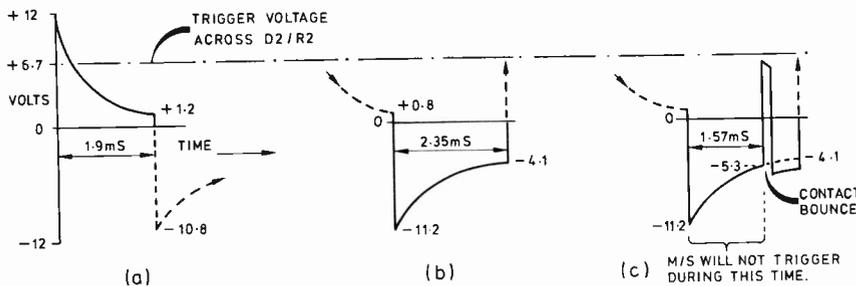


Fig. 2. Differentiator output waveforms at 7,000 rpm

link is also inserted (my experience is that if you don't do this, the print will fuse at the holes, this of course being the weakest point).

If the construction is done on 0.1in matrix board, the heavy duty auto cables will not pass through the holes so the use of Veropins is a good idea.

The cover plate can be drilled to accept TR5 and heat sink.

COMPONENTS . . .

Resistors

R1	100Ω 4W wirewound
R2	2.2kΩ
R3	3.3kΩ
R4	27kΩ
R5	6.8kΩ
R6	12kΩ
R7	680Ω
R8	4.7kΩ
R9	5.6kΩ
R10	680Ω
R11	4.7kΩ
R12	120Ω 0.5W 5% carbon film
R13	5.6kΩ
R14	2.2kΩ
R15	470Ω 0.5W 5% carbon film
R16	2.7kΩ
R17	18-22Ω 11W wirewound (see text)
R18	180Ω
R19	270kΩ
All ¼W 5% carbon film except where otherwise stated	

Capacitors

C1	0.68μF 63V
C2	0.47μF 63V
C3	40μF 16V
C4	0.0047μF 1,500V polyester paper
C5	0.022μF 1,500V polyester paper

Potentiometers

VR1	10kΩ miniature preset
VR2	10kΩ miniature preset

Diodes

D1	BZY88-6.2 400mW Zener
D2	OA91
D3-D5	1N914 (3 off)
D6-D8	BY127 (3 off)

Transistors

TR1-TR3	BC107 (3 off)
TR4	BD225 or TIP30
TR5	TIP53

For positive earth systems the following are required:

TR6	BC327
R20	100Ω 4W wirewound
R21	1.5kΩ ¼W 10% carbon
R22	150Ω ¼W 10% carbon

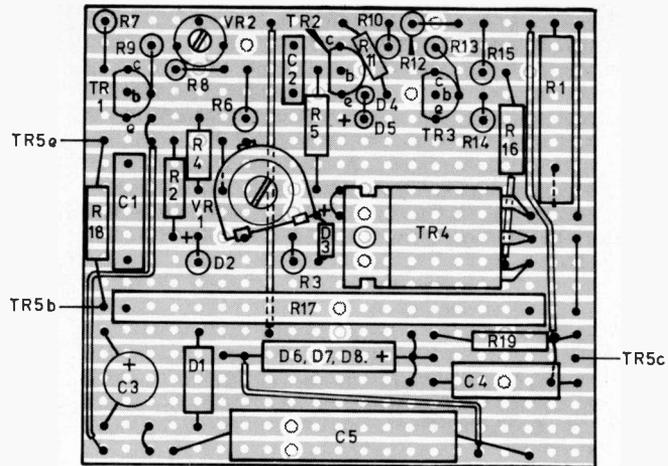


Fig. 4. Component layout on Veroboard

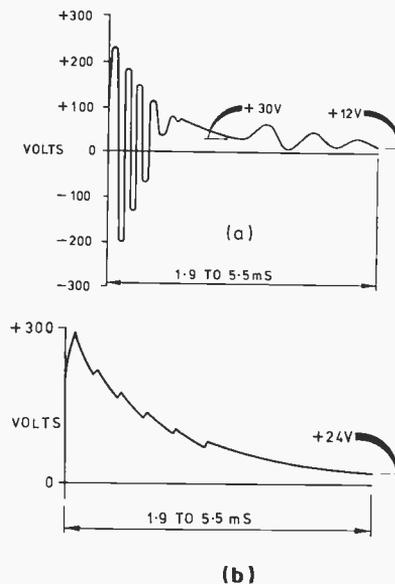


Fig. 3(a). Waveforms at anodes of D6, 7, 8; (b) at collector of TR5

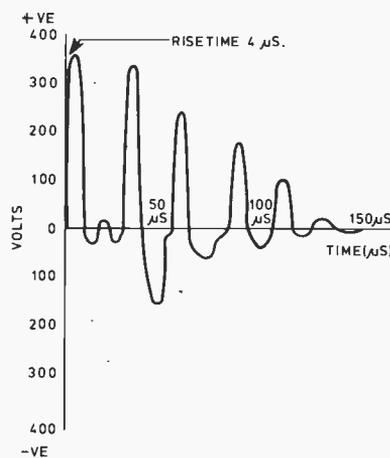


Fig. 5. Output across coil primary

SETTING UP

Set VR1 to its minimum resistance and run the engine to its correct operating temperature.

With standard production car engines VR2 can be set to the centre or three-quarters of its maximum travel; with high performance engines (where revs of 7,000 or more are to be expected) VR2 must be set with a 'scope connected to the anodes of D6, 7 and 8.

With the engine at tick-over the waveform should be that shown in Fig. 3a. Adjust VR2 to show facsimile ringing.

VR1 can now be set to limit maximum revs. With the car at rest bring the revs up to the required maximum and adjust VR1 so that the engine just begins to misfire. Now seal both components with sealing wax.

COIL TUNING

This can only be done using an oscilloscope. Start with a value of 500 pf and bridging with progressively larger values; aim for a waveform approximately as that in Fig. 5. If an oscilloscope is not available the specified value will be approximately correct.

If the unit is going to be used on racing engines and revs in excess of 7,000 are to be expected, the monostable time constant can be reduced down to the actual active period of the coil, 150 to 200 microseconds, this being done by lowering the value of C2 only.

INTRUDER ALARM

A. Chadwick

THIS car burglar alarm incorporates many of the attractive features of previously published circuits.

In operation is enabled and disabled by a hidden switch in the interior of the car. There is a delay between applying the switch and the enabling of the alarm, giving time for leaving the vehicle.

The alarm is triggered by any load put on the battery; for example the interior light on opening the door.

A shorter delay exists between triggering and any audible output, giving time for the circuit to be disabled.

ALARM

The actual alarm consists of pulsed operation of the horn. After a set time the horn is switched off, and the alarm reverts to the enabled state, ensuring that false triggering does not lead to a flat battery.

CIRCUIT

Operation of the enable switch S1 causes the output of the R-S flip-flop, formed by IC1a and IC1b, to go to logical zero. After a delay determined by VR1 and C2, the input to IC1c goes to zero. This allows any triggering pulses from TR1, C5, D2 and VR3 caused by a load being put on

the battery to set the output of the R-S flip-flop IC2a, IC2b to logical one.

After another delay, caused by VR2/C4 monostable IC2c, IC2d is triggered, enabling the astable multivibrator IC3a, IC3b and thus producing pulsed operation of the horn via TR2, TR3, D6 and relay RLA.

TRIGGER GUARD

Triggering of the monostable causes flip-flop IC2a, IC2b to be reset via IC3c, IC3d. R4, C3 cause the reset to IC2b to be held for a short interval after the end of the monostable timing cycle to prevent re-triggering of the alarm by the horn or relay RLA.

Disabling of the alarm resets both the flip-flops and the monostable.

All i.c.s are CMOS 4001 quad 2-input NOR gates. D4 protects the circuit against incorrect supply polarity which would quickly destroy the i.c.s. The contacts of RLA must be fairly substantial, as they carry the full horn current.

VR1, VR2 were set to give exit and entry delays of 80 seconds and 15 seconds respectively. R9, C6 gave an alarm time of about 3.5 minutes, at a frequency (governed by R10, C7) of 0.4Hz.

COMPONENTS . . .

Resistors

R1, R2	1M Ω (2 off)
R3	1k Ω
R4	470k Ω
R5	1k Ω
R6	1M Ω
R7, R8	1k Ω (2 off)
R9	10M Ω
R10	4.7M Ω
All 10% $\frac{1}{2}$ W carbon	

Capacitors

C1	150 μ F elect 25V
C2	150 μ F elect 16V
C3	4.7 μ F elect 63V
C4	150 μ F elect 16V
C5	0.1 μ F
C6	22 μ F elect 16V
C7	0.33 μ F

Potentiometers

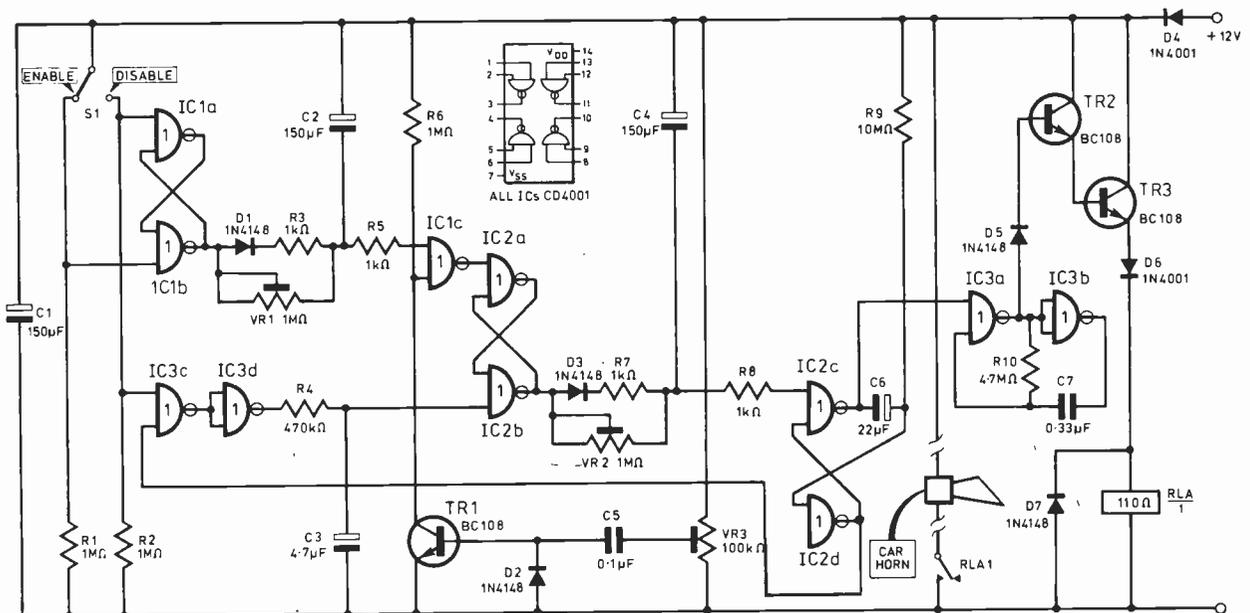
VR1, VR2	1M Ω miniature preset (2 off)
VR3	100k Ω miniature preset

Semiconductors

IC1-IC3	CD4001 (3 off)
TR1-TR3	BC108 (3 off)
D1-D3	1N4148 (3 off)
D4, D6	1N4001
D5, D7	1N4148

Miscellaneous

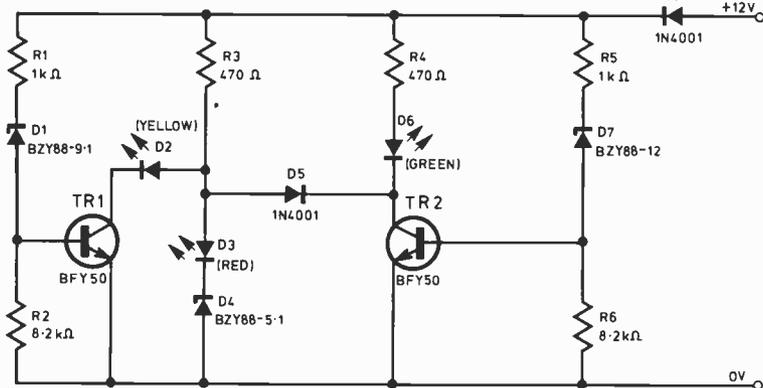
S1	Single pole double throw switch
RLA	12V, 110 Ω (R.S. 348-835)



Circuit of Intruder Alarm

BATTERY STATE INDICATOR

A. M. Owen



MANY car owners take their battery for granted, rarely giving it the maintenance it requires. As the winter nights advance the demands made on this vital power source increase. When you combine this with the inevitable ageing process and the diminishing ability to store a charge for a long period, the requirement for a simple aid to continuous battery voltage monitoring is obvious.

The indicator was therefore designed to forestall any incipient failure by providing "at a glance" information on battery state with three coloured l.e.d.s; green indicating a battery voltage adequate for normal use; yellow, that the voltage is fairly low and red that there is a failure in the electrical system, such as a dead cell, poor connection, defective regulator or generator.

PRINCIPLE OF OPERATION

An upper and lower battery voltage limit is set by selection of two Zener diodes which allow the transistors to be turned on at set points. These are in turn interconnected via a conventional diode and l.e.d.s to give a display of the state of the car's battery.

When the car's battery is in top condition, its output voltage will be around 14V and of course even higher when charging. This potential is applied, via D8 (reducing it by some 0.8V), through R5, D7 and R6 to the base of TR2 which will be turned "on" causing D6 to illuminate via R4. TR2 at this time, effectively places a short-circuit across the rest of the circuit via D5 preventing D2 and D3 from emitting light as the potential across them is only some 2V.

As the battery voltage becomes lower, TR2 begins to turn off as the threshold of D7 is reached. This allows D2 to start to come on as TR1 has all the time been turned on via R1, D1, R2. The current thus drawn via R3 precludes D3 from illuminating as the potential across it and D4 is not above the Zener level.

Eventually, at still lower battery voltage, TR1 will begin to turn off in the same manner as for TR2, allowing the potential at the junction of D2, D3, D5 to rise in excess of the 5V Zener level of D4 which begins to pass current and illuminates D3.

Zener diodes may be selected for other switching points and/or battery voltages.

COMPONENTS . . .

Resistors

R1/R5	1k Ω
R2/R6	8.2k Ω
R3/R4	470 Ω
All	$\frac{1}{2}$ W 10% carbon

Semiconductors

TR1, TR2	BFY50 (2 off)
D1	BZY88-9.1
D2, D3	TIL209 (Yellow, red)
D4	BZY88-5.1
D5	1N4001
D6	TIL209 (Green)
D7	BZY88-12
D8	1N4001

Battery Voltage (Vb)

Vb \leq 10V
10V < Vb < 12V
Vb \geq 12V

L.e.d. Illuminated

Red (D3)
Yellow (D2)
Green (D6)

POLARITY INVERTER

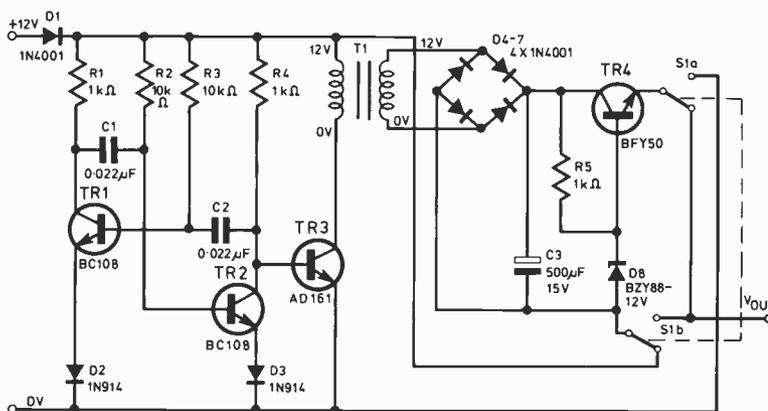
C. D. Williams

THE circuit illustrated was originally designed to enable a negative earth eight-track player to be used in a car with a positive earth, but other uses are obvious, since polarity is reversible.

CIRCUIT

Diode D1 is arranged to prevent incorrect connection to supply. D2 and 3 increase the V_{be} ratings of TR1 and 2 which are connected as a multivibrator operating at about 700Hz.

The output of this is buffered by the AD161 which drives the transformer T1. This must be a low voltage (12V) high current (\sim 1A) one to one transformer, which are rare and expensive. The solution was to use a low voltage mains transformer with individual 12V secondaries and ignore the primary and use the two secondaries. Components D4-8, C3, R5 and TR4 rectify and stabilise the output at 12.6V which is floating relative to the supply rails.



COMPONENTS . . .

Resistors

R1	1k Ω
R2/R3	10k Ω
R4/R5	1k Ω

Capacitors

C1, C2	0.022 μ F (2 off)
C3	500 μ F elect. 15V

Miscellaneous

S1 s.p.d.t. T1-240V prim, 12-0-12V, 0.8A sec

Semiconductors

TR1, TR2	BC108 (2 off)
TR3	AD161
TR4	BFY50
D1, D4-D7	1N4001
D2, D3	1N914
D4	BZY88-C12V 400mW



ANALOGUE COMPUTER

P. J. KRONIS B.Sc.

PART 3

- ★ Wiring
- ★ Testing
- ★ Programming

AFTER the p.c.b.s have been assembled and checked, all the components should be fitted into the case with the overload warning p.c.b. mounted on the base of the box using 6BA screws. With all the components mounted in the case the coefficient multipliers and the two panel meters should be wired first, following the wiring diagram shown in Fig. 3.1. Resistors R6, R7 and the links shown in Fig. 3.2 should be wired to each of the ten computing amplifiers. The wiring to the relay board and main p.c.b. is via eight edge connectors and to ease the problem of wiring these connectors a wiring schedule is given in Fig. 3.3. The numbering and layout arrangement of the patch panel and switches is given in Fig. 3.4.

The main p.c.b. is mounted above the patch panel and the relay board above the offset null potentiometers as shown in the photograph. After the computer wiring has been completed and checked a $\pm 15V$ power supply should be connected to the unit and the following test procedures followed.

THE OFFSET NULL TRIM PROCEDURE

Set all the amplifiers to "add" by pushing all the slide switches down. Put the computer into the "compute" mode using the mode control switch and turn the sensitivity of the meters down as far as possible. Connect the output of the first amplifier (A1) to meter 1 (M1). Ground one of the $\times 10$ inputs of A1. This can be done by touching one end of the wire lead on the case. Connect the power supply and switch on. Increase the sensitivity of M1 gradually until the needle deflects to maximum if possible. Bring the needle back to zero by adjusting the offset null potentiometer of amplifier A1. Increase the sensitivity of the meter and repeat the same procedure until the needle is on zero when the meter is at maximum sensitivity.

Decrease the sensitivity fully and repeat the trim procedure for all amplifiers in the same way.

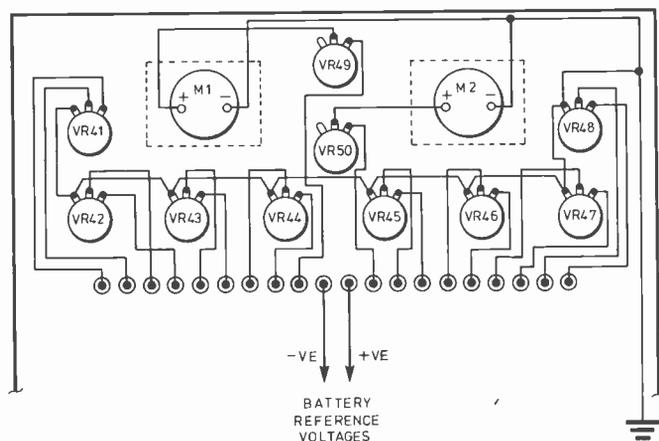


Fig. 3.1. Wiring diagram for the coefficient multipliers and panel meters

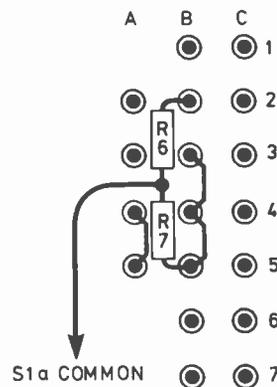


Fig. 3.2. Link wiring for amplifiers and multipliers

X and Y inputs
Common outputs
Coefficient multiplier input
Coefficient multiplier output
Initial conditions
Amplifier outputs
Amplifier inputs (X1)
Amplifier inputs (X10)
Spare socket
Integrate with nose gain of one
Integrate with nose gain of ten

Edge Connector 1

From	To
pin 3	A3 Patch Panel
pin 4	Earth
pin 5	A2 Patch Panel
pin 6	-15V Supply
pin 7	A4 Patch Panel
pin 8	Edge Connector 6 pin 10
pin 9	C5 Patch Panel
pin 10	C4 Patch Panel
pin 11	C3 Patch Panel
pin 12	C2 Patch Panel
pin 13	TB1 Terminal Block
pin 14	VR51
pin 15	Edge Connector 6 pin 11
pin 16	E5 Patch Panel
pin 17	E4 Patch Panel
pin 18	E3 Patch Panel
pin 19	E2 Patch Panel
pin 20	TB2 Terminal Block
pin 21	VR52
pin 22	Edge Connector 6 pin 14
pin 23	G5 Patch Panel
pin 24	G4 Patch Panel
pin 25	G3 Patch Panel
pin 26	G2 Patch Panel
pin 27	TB3 Terminal Block
pin 28	VR53

Edge Connector 2

From	To
pin 1	Edge Connector 6 pin 15
pin 2	J5 Patch Panel
pin 3	J4 Patch Panel
pin 4	J3 Patch Panel
pin 5	J2 Patch Panel
pin 6	TB4 Terminal Block
pin 7	VR54
pin 8	Edge Connector 6 pin 18
pin 9	L5 Patch Panel
pin 10	L4 Patch Panel
pin 11	L3 Patch Panel
pin 12	L2 Patch Panel
pin 13	TB5 Terminal Block
pin 14	VR55
pin 15	Edge Connector 5 pin 19
pin 16	N5 Patch Panel
pin 17	N4 Patch Panel
pin 18	N3 Patch Panel
pin 19	N2 Patch Panel
pin 20	TB6 Terminal Block
pin 21	VR56
pin 22	Edge Connector 5 pin 20
pin 23	Q5 Patch Panel
pin 24	Q4 Patch Panel
pin 25	Q3 Patch Panel
pin 26	Q2 Patch Panel
pin 27	TB7 Terminal Block
pin 28	VR57

Edge Connector 3

From	To
pin 3	Edge Connector 5 pin 23
pin 4	S5 Patch Panel
pin 5	S4 Patch Panel
pin 6	S3 Patch Panel
pin 7	S2 Patch Panel
pin 8	TB8 Terminal Block
pin 9	VR58
pin 10	Edge Connector 5 pin 24
pin 11	U5 Patch Panel
pin 12	U4 Patch Panel

pin 13	U3 Patch Panel
pin 14	U2 Patch Panel
pin 15	TB9 Terminal Block
pin 16	VR59
pin 17	Edge Connector 5 pin 27
pin 18	W5 Patch Panel
pin 19	W4 Patch Panel
pin 20	W3 Patch Panel
pin 21	W2 Patch Panel
pin 22	TB10 Terminal Block
pin 23	VR60
pin 24	X2 Patch Panel
pin 25	X4 Patch Panel
pin 27	X3 Patch Panel

Edge Connector 4

From	To
pin 2	+15V Supply
pin 3	VR51
pin 4	B6 Patch Panel
pin 5	S1d Add
pin 6	B5 Patch Panel
pin 7	C6 Patch Panel
pin 8	VR52
pin 9	D6 Patch Panel
pin 10	S2d Add
pin 11	D5 Patch Panel
pin 12	E6 Patch Panel
pin 13	VR53
pin 14	F6 Patch Panel
pin 15	S3d Add
pin 16	F5 Patch Panel
pin 17	G6 Patch Panel
pin 18	VR54
pin 19	H6 Patch Panel
pin 20	S4d Add
pin 21	H5 Patch Panel
pin 22	J6 Patch Panel
pin 23	VR55
pin 24	K6 Patch Panel
pin 25	S5d Add
pin 26	K5 Patch Panel
pin 27	L6 Patch Panel

Edge Connector 5

From	To
pin 2	VR56
pin 3	M6 Patch Panel
pin 4	S6d Add
pin 5	M5 Patch Panel
pin 6	N6 Patch Panel
pin 7	VR57
pin 8	P6 Patch Panel
pin 9	S7d Add
pin 10	P5 Patch Panel
pin 11	Q6 Patch Panel
pin 12	VR58
pin 13	R6 Patch Panel
pin 14	S8d Add
pin 15	R5 Patch Panel
pin 16	S6 Patch Panel
pin 17	VR59
pin 18	T6 Patch Panel
pin 19	S9d Add
pin 20	T5 Patch Panel
pin 21	U6 Patch Panel
pin 22	VR60
pin 23	V6 Patch Panel
pin 24	S10d Add
pin 25	V5 Patch Panel
pin 26	W6 Patch Panel

Edge Connector 6

From	To
pin 3	-15V Supply
pin 4	S2c Common
pin 5	S1c Common
pin 9	TB1 Terminal Block
pin 10	S1b Add
pin 11	S2b Add
pin 12	TB2 Terminal Block
pin 13	TB3 Terminal Block
pin 14	S3b Add
pin 15	S4b Add
pin 16	TB4 Terminal Block
pin 17	TB5 Terminal Block
pin 18	S5b Add
pin 19	S5a Common
pin 20	S4c Common
pin 21	S3c Common
pin 22	S11a Compute
pin 23	TB2 Terminal Block
pin 24	TB1 Terminal Block
pin 28	Earth, Edge Connector 7 pin 3

Edge Connector 7

From	To
pin 1	S1a Integrate
pin 2	S2a Integrate
pin 3	Edge Connector 7 pin 4
pin 4	Edge Connector 7 pin 7
pin 5	S3a Integrate
pin 6	S4a Integrate
pin 7	Edge Connector 7 pin 8
pin 8	Edge Connector 8 pin 9
pin 9	S5a Integrate
pin 10	TB5 Terminal Block
pin 11	TB4 Terminal Block
pin 12	TB3 Terminal Block
pin 13	S7c Common
pin 14	S6c Common
pin 18	TB6 Terminal Block
pin 19	S6b Add
pin 20	S7b Add
pin 21	TB7 Terminal Block
pin 22	TB8 Terminal Block
pin 23	S8b Add
pin 24	S9b Add
pin 25	TB9 Terminal Block
pin 26	TB10 Terminal Block
pin 27	S10b Add
pin 28	S10c Common

Edge Connector 8

From	To
pin 1	S9c Common
pin 2	S8c Common
pin 3	+15V Supply
pin 4	TB7 Terminal Block
pin 5	TB6 Terminal Block
pin 9	Edge Connector 8 pin 12
pin 10	S6c Integrate
pin 11	S7a Integrate
pin 12	Edge Connector 8 pin 13
pin 13	Edge Connector 8 pin 16
pin 14	S8a Integrate
pin 15	S9a Integrate
pin 16	Edge Connector 8 pin 17
pin 18	S10a Integrate
pin 19	TB10 Terminal Block
pin 20	TB9 Terminal Block
pin 21	TB8 Terminal Block
pin 22	Reset Switch (S12)

Fig. 3.3. Wiring Schedule

Wiring Schedule—cont.

From	To
S1b, S1d Common	TB1 Terminal Block
S2b, S2d Common	TB2 Terminal Block
S3b, S3d Common	TB3 Terminal Block
S4b, S4d Common	TB4 Terminal Block
S5b, S5d Common	TB5 Terminal Block
S6b, S6d Common	TB6 Terminal Block
S7b, S7d Common	TB7 Terminal Block
S8b, S8d Common	TB8 Terminal Block
S9b, S9d Common	TB9 Terminal Block
S10b, S10d Common	TB10 Terminal Block
Reset Button (S12)	S11b Compute
S11a	+15V Supply
S11b	-15V Supply
-15V Supply	VR51 Wiper
VR51 Wiper	VR52, 53, 54, 55, 56, 57, 58, 59, 60 (Wipers)

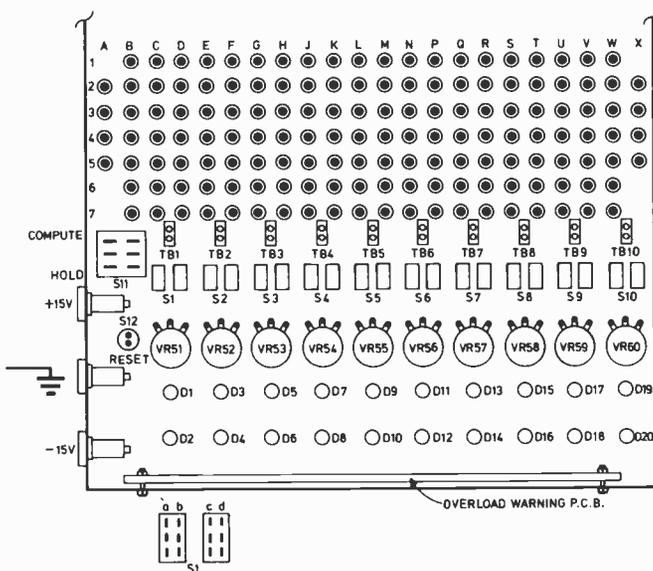
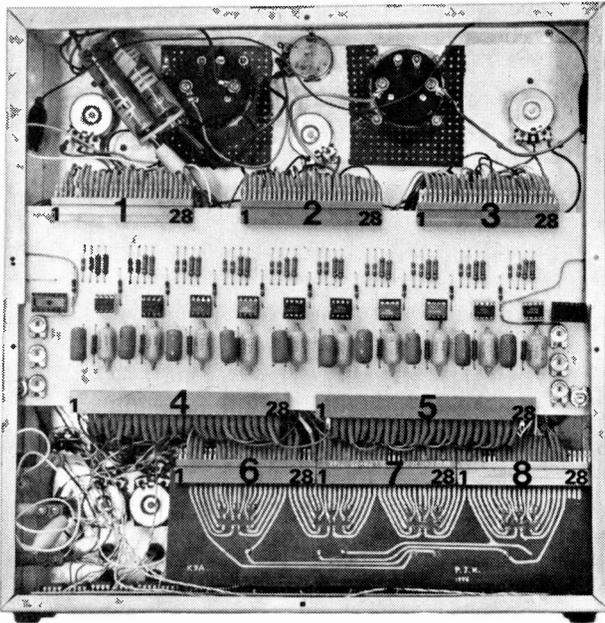


Fig. 3.4. Layout arrangements for edge connectors, patch panel and switches

MODE CONTROL TEST

Set amplifier A1 to "integrate", and the mode to "compute" and monitor the output with one of the meters. Apply a voltage to a $\times 1$ input. The needle should deflect gradually in the positive direction, if the applied input voltage is negative, and vice-versa, until the amplifier saturates. When this happens, adjust the meter sensitivity so that the needle is at maximum deflection. Put the computer in the "hold" mode and press the "reset" switch. The needle should go to zero. Release "reset" and switch to "compute". The needle will again start to deflect and this time switch the mode to "hold" before the amplifier saturates. The needle should then stop moving. Carry out this test with all the amplifiers. While doing this, observe the operation of the overload warning circuit. The appropriate l.e.d. should come on when the amplifier output exceeds +11V or goes below -11V. Check both positive and negative operation by applying both positive and negative input voltages.

The above tests are not complete by any means but any remaining problems will show up when the examples described under "programming" are attempted.

COMPONENTS . . .

Resistors

R6, R7 100k Ω $\frac{1}{4}$ W carbon (2 off)

Potentiometers

VR41-VR48 100 k Ω linear (8 off)

VR49-VR50 300 k Ω linear (2 off)

Miscellaneous

1 off d.p.d.t. switch (R.S. type 316-793)

20 off d.p.d.t. sub-min slide switch

2 off 50-0-50 μ A (ME15 T40 Watford Electronics)

1 off Push button (R.S. type 337-914)

151 off Square 4mm panel mounted sockets (55 red, 32 yellow, 22 green, 21 white, 21 black)

8 off Skirted knob

12 off Plain knob

6 off 28 way edge connector 0.1in matrix

2 off 28 way edge connector 0.15in matrix

Banana plugs (as required)

PROGRAMMING

It has already been mentioned, that it is necessary to form a mathematical model of the problem to be solved and the computer cannot help us to do this, but being very faithful however, it will happily try to solve a problem even if the wrong information is fed into it. Fortunately, in such cases the programmer could get an indication that something had gone wrong by studying the results which are usually meaningless. The general rule "Garbage In, Garbage Out" (well known to digital computer programmers) applies here also. Unfortunately, error checks cannot be incorporated in the analogue programs, as is the case with digital programs. It is important therefore to adopt a methodical procedure for programming to avoid errors.

Having formed the mathematical model, the equations are rearranged and a flow diagram is constructed which satisfies the equations. All values to be input and all computing elements to be used, are marked on the flow diagram to avoid confusion. Referring to the diagram the computer is then programmed by patching the panel. This procedure will be illustrated by several examples. The flow diagrams are constructed using standard symbols representing computing elements. Some of these have already been given. Fig. 3.5 shows all the symbols to be used in this article.

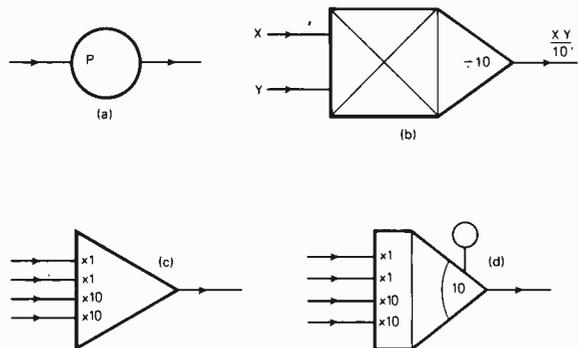


Fig. 3.5. Computing element symbols: (a) coefficient multiplier; (b) Four quadrant multiplier; (c) Summer; (d) Integrator with initial conditions.

As a first example let us examine the operation of potentiometers, adders and integrators, using simple experiments.

Apply a reference voltage to the input of P1 and connect the output to M1. Adjust the sensitivity of M1 so that when P1 is at maximum, M1 deflects fully. Operate the potentiometer and observe the results.

Switch the power on and calibrate M1 by applying a known voltage (e.g. supply voltage), to read 15V at full deflection. Switch A1 to "add" and apply the output of P1 to the input of A1 and the output of A1 to M1. The flow diagram and patch panel connections are shown in Fig. 3.6. Test all A1 inputs in turn and observe the gain of the adder each time.

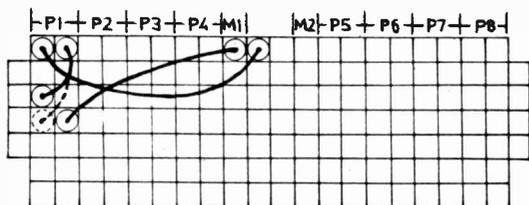
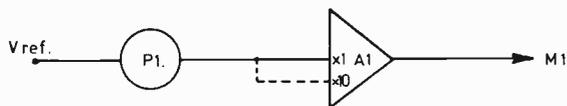


Fig. 3.6. Flow diagram and patch panel layout for the potentiometer example

To examine the operation of the integrators, we can integrate various functions and study the results. First let us see what happens when we integrate a constant, C. The mathematicians will immediately give us the answer as $C \cdot t + K$, where t is the variable (time in this case) and K is another constant. This is a straight line, of gradient C and passing through the origin, if we have no initial conditions, i.e. $C = 0$ at $t = 0$. To verify this we can set up the program shown in Fig. 3.7.

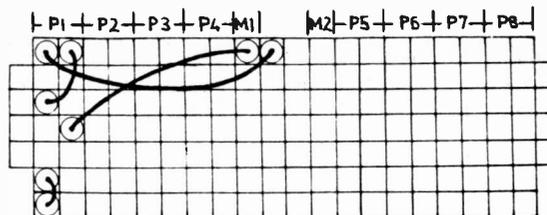
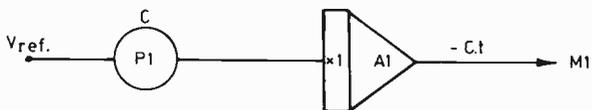


Fig. 3.7. Flow diagram and patch panel layout for the integration example

To run this program follow these steps:

- (1) Check A1 is in "integrate"
- (2) Computer mode: "hold"
- (3) Switch power on
- (4) Press reset for a few seconds and release
- (5) Switch to "compute" and observe the meter.

Vary the value of C by adjusting P1 and repeat the above steps. If an X-Y plotter is available the results can be plotted for different values of C. The graph would look like Fig. 3.8. With C set to 1 volt the output should increase at 1 volt per second ($C = C \cdot t$). This can be verified by timing the deflection of the needle.

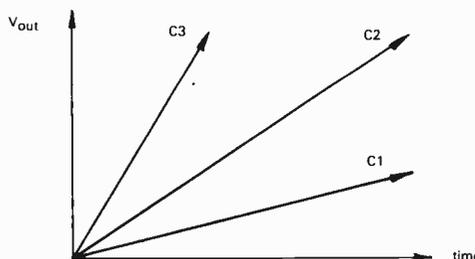


Fig. 3.8. Graph showing the resultant curves when various values for the constant C are integrated

These examples serve to illustrate the use of the analogue computer as a function generator. By integrating a step function we obtained a ramp function, the slope of which we could easily control. The ramp function can be integrated again to produce a square law function. This is shown in the flow diagram in Fig. 3.9. Still higher power functions can be obtained by successive integrations.

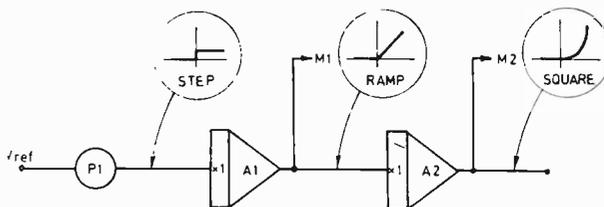


Fig. 3.9. By integrating waveforms the analogue computer can be used as a function generator

INITIAL CONDITIONS EXAMPLE

In the previous integrator examples we assumed that at time $t = 0$ all variables had zero value. Suppose that we wanted to give a value to the output of the integrator, before the computation begins. It is not difficult to imagine examples where this might be used. We may for example like to investigate the flight of a rocket, not from the point of launch but from some height above the launching pad, at which the rocket will have some velocity and acceleration. To illustrate the use of initial conditions we can repeat the first integrator example, but this time we are going to give an initial value to the integrator output of 5V. We therefore

require 5V to be applied to the initial condition socket of A1. Since the value of the reference voltages is only about 1.5V, we shall have to multiply this value. This we can do with the aid of an adder and a potentiometer. The flow diagram and patch panel connections are shown in Fig. 3.10.

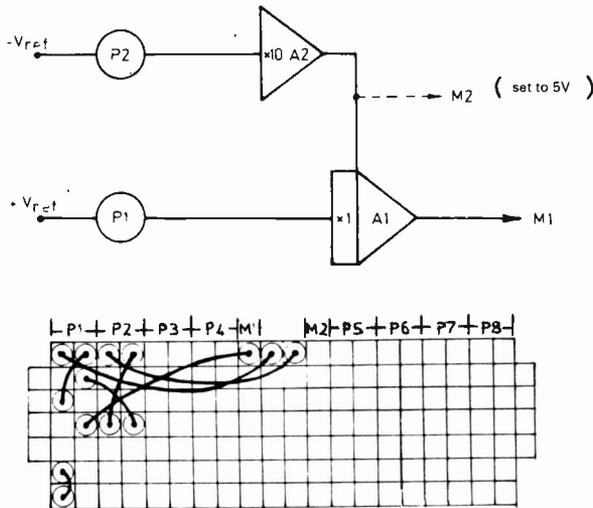


Fig. 3.10. Flow diagram and patch panel layout for the initial condition example

To run this program follow these steps after the panel has been patched.

- (1) Switch power on
- (2) Amplifier A1 integrating and A2 adding
- (3) Computer mode: "hold"
- (4) Monitor A2 output and adjust to 5V using P2
- (5) Set output of P1 to 1V
- (6) Press "reset" for a few seconds and release (Output of A1 should now show 5V)
- (7) Switch mode to "compute" and observe M1.

The initial condition value is invariably formed using an adder and a potentiometer, unless of course the exact value is available. It is therefore common practice not to show these two computing elements, but simply to note the value being applied to the initial condition socket as shown in Fig. 3.11.

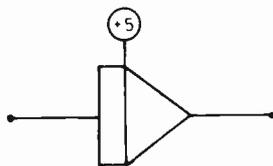


Fig. 3.11. Initial condition symbol

Another point worth noting here is that it is not essential for the potentiometer to precede the adder as shown in the flow diagram. In fact in such cases it is better for the amplifier to precede the potentiometer, as the former presents a higher input impedance to the battery than the latter and therefore saves battery energy.

ENGINEERING PROBLEMS

Consider a mass M supported on a spring of stiffness K . If the mass is disturbed, the system will begin to oscillate about the equilibrium position. Mechanical systems usually have electrical equivalents or vice-versa. The electrical equivalent to the spring mass system is the capacitor inductor series circuit. Both systems are shown in Fig 3.12.

The equation of motion of the spring mass system is $M \ddot{x} + Kx = 0$. The electrical system is described by a similar

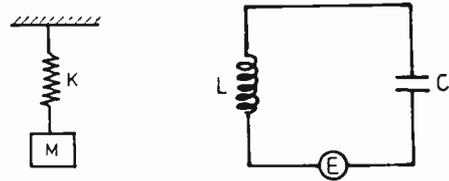


Fig. 3.12. The mechanical spring/mass circuit and its electrical equivalent the inductor/capacitor series circuit

equation but with electrical symbols substituted for the mechanical ones. The "dot" notation is used where time derivatives are involved. For example, one dot means the first derivative of the variable in question, with respect to time, two dots mean the second derivative and so on. So if x represents displacement, then \dot{x} represents velocity, and \ddot{x} acceleration. The equation can be rearranged so that the highest derivative appears on the left-hand side, with everything else on the right-hand side. This is normal practice when solving a problem on the analogue computer. The

equation becomes $\ddot{x} = -\frac{K}{M}x$ and the flow diagram is shown in Fig. 3.13.

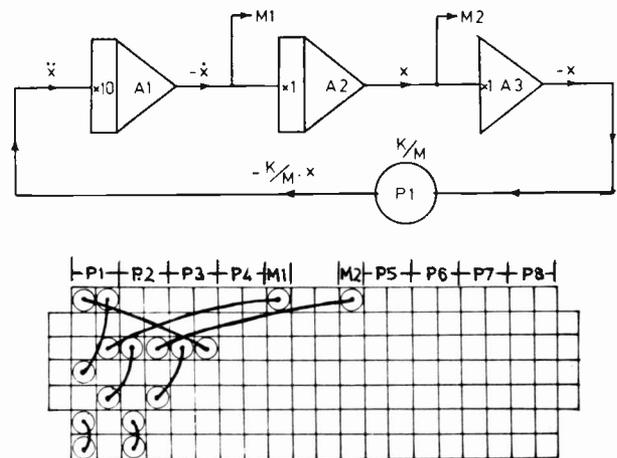


Fig. 3.13. Flow diagram and patch panel layout for the spring/mass example

By integrating \ddot{x} twice we obtain $-\dot{x}$ and x . In our equation, however, we require $-x$ and so A3 is used as a sign inverter. The value K/M is set up on potentiometer P1, the output of which becomes $-K/M \cdot x$. This is equal to \ddot{x} and therefore we can close the loop by connecting the output of P1 back to the input of A1. The system as it stands will not vibrate unless it is disturbed. Theoretically once it is disturbed, it should go on vibrating for ever. In practice, however, we know that this is not true, because of the presence of some damping, due to air resistance in the case of the mechanical system and electrical resistance in the case of the electrical system. The analogue computer should produce results very near to the theoretical predictions, i.e. very little damping should be present. To run this program follow these steps.

- (1) Check A1 and A2 are integrating and A3 is adding.
- (2) Switch power on.
- (3) Switch mode to "compute".
- (4) Apply a disturbance to the input of A2 or A3. (This can be done by momentarily touching the input socket, with a wire lead connected to a reference voltage socket. This is equivalent to giving the weight a gentle push.)

(5) Observe the meters and adjust the sensitivity to produce a reasonable needle deflection.

(6) Operate P1 and see what happens to the frequency and amplitude of oscillation.

You should find that a high value of K/M (i.e. high spring stiffness or small mass or both) gives a high frequency and vice versa. The other point to note is that the oscillation is sinusoidal. The output of A1 (i.e. the velocity) is a cosine function, whereas that of A2 (the displacement) is a sine

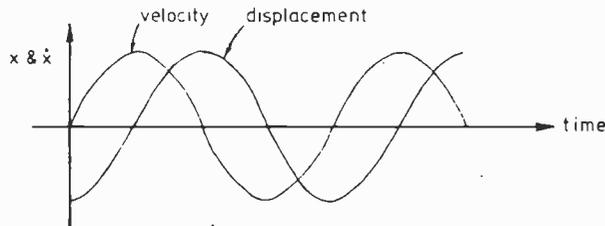


Fig. 3.14. Graph showing the phase difference between velocity and displacement

function. There is a phase difference of 90 degrees between the velocity and the displacement. (The mass comes to a momentary stop when the displacement is at a maximum.) This is shown in the graph in Fig 3.14.

In this last example we have seen how the analogue computer can be used as a function generator for sine or cosine functions, with variable frequency. The frequency of oscillation is given by

$$f = \frac{1}{2\pi} \sqrt{\frac{K}{M}} \text{ Hz (cycles per second)}$$

This can be checked by counting the number of cycles in one minute and dividing by 60 to convert to cycles per second. If the value of P1 is set to 1.0 and the input of A1 is multiplying by 10 then $K/M = 10$ and the frequency should be $f = 1/2 \sqrt{10} = 0.503\text{Hz}$.

NEXT MONTH: PROGRAMMING AND SPECIAL CIRCUITS (conclusion of series)

News Briefs

by Mike Abbott

BUBBLING WITH BITS

THE IDEA of the magnetic bubble conjures up a picture of quivering clusters gurgling their way to the North Pole. In fact powerful magnetic bubble memories are about to "pop" onto the scene from at least two major electronics manufacturers in the near future, one of which is Texas Instruments.

Sample quantities of a new quarter-million-bit bubble memory will be available from T.I. before the end of this year, but at \$500 each there probably won't be many P.E. constructors in the queue. (A 92k-bit bubble memory is now in volume production at a price of \$100 in 100 unit quantities). The big one however, designated the TIB0303, is full of three micron diameter magnetic bubble domains, and uses separate I/O, minor loop architecture, and features block replication of data. Separate read and write tracks with minor loop data storage are at the heart of this block replicate-based architecture to provide improved performance.

A total of 252 minor loops, each consisting of 1,137 bubble positions, results in a single-chip memory capacity of 286,524 bits. However, 224 loops are utilised resulting in a minimum data capacity of 254,688 bits.

Data bits are written into the write track and exchanged with stored data in the minor loops via swap gates. Data blocks are replicated simultaneously at minor loop and output track junctions, rather than serial duplication which is characteristic of major/minor loop architecture. Consequently, power-down cycle time is significantly reduced from 12.8 milliseconds in the 92K-bit major/minor loop configuration to 12.5 microseconds for block replicate, representing three orders of magnitude improvement.

Other key features include: advanced asymmetric chevron design for improved bubble propagation and transfer, merged data that allows a continuous flow of data bits at the read track, and a dedicated loop for storage of on-chip redundancy information and address synchronisation.

Performance specifications at 100 kilohertz operation are an average access time of 7.3 milliseconds for the first bit of the 224-bit page and a typical power consumption of 0.9 watt for continuous operation. A data-merge function allows a read data of 100K bits per second. Operating temperature is 0° to 50°C with non-volatile storage range of -40° to 85°C.

Bubble control functions are executed by providing current pulses through the appropriate control element on the chip.

The bubble chip is comprised of a gadolinium-gallium garnet substrate upon which a magnetic epitaxial film is grown. Patterns of permalloy metal are deposited on the epitaxial film to define the path of the bubble domains in the presence of a rotating magnetic field. As the field rotates, the bubble domains move under the permalloy pattern in shift register fashion.

The TIB0303 will be offered in a 20-pin dual-in-line package, measuring 30 x 30 x 10mm. The package contains the quarter-million-bit bubble chip surrounded by two orthogonal coils that provide the rotating magnetic field, a permanent magnet set, and a magnetic shield to protect data from external fields.

Taking a systems approach, TI will offer a family of interface and control circuits for the TIB0303 in the second quarter of 1979.

BLINKING GOOD

IF ONE of your projects requires an l.e.d. to wink on-and-off to catch someone's eye, here's something to save you the effort of building a multivibrator to do it.

Available from the Norbain Optoelectronics Division is the first Flashing Light Emitting Diode, Type FRL 4403, to appear on the market. The T 1½ l.e.d. is manufactured in Gallium Arsenide Phosphide technology with a red diffused plastic lens. The built-in integrated circuit flashes the l.e.d. on and off at roughly 3 pulses per second, and can be driven directly by standard TTL and CMOS devices, eliminating the need for external switching circuitry.

Optoelectronic characteristics include a luminous intensity of 1.2mCd (typ), an emission peak wavelength of 650nm, spectral line half width 40nm, operating voltage 5 volts (typ), and current of 20 milliamps (typ).

The l.e.d. gives a large full flood radiating area, wide viewing angle and finds application as a condition warning light, monitoring process control system and in many other applications where warning of failure is essential.

Norbain Optoelectronics Division, Norbain House, Arkwright Road, Reading, Berkshire RG2 0LT.

ON THE LEVELL

THE very popular and stout a.c. microvolt meters, type TM3B, made by Levell Electronics Ltd., have just been upgraded.

The improvements include increased input impedance and meter scale length. A brief specification follows:

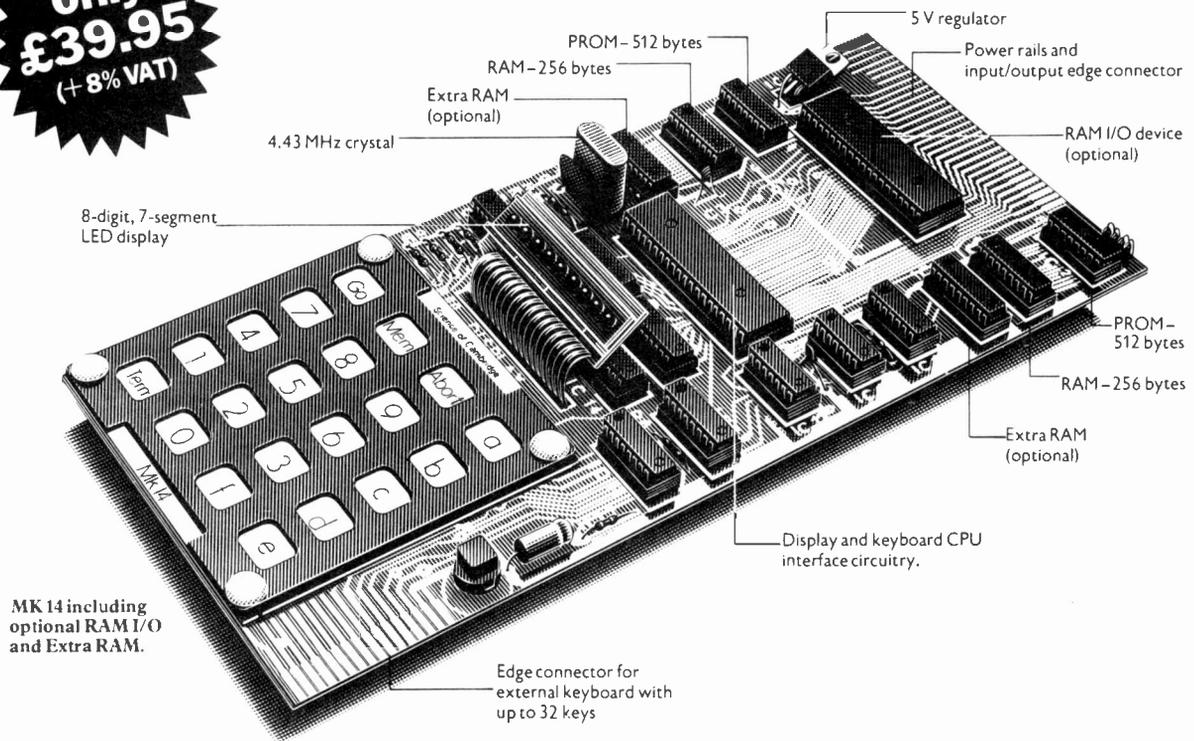
VOLTAGE and dB RANGES: 15µV to 500V. f.s.d. Acc. ±1% f.s.d. ±1µV at 1kHz, -100, -90 ... +50dB. Scale -20dB/+6dB ref. 1mW/600Ω.

RESPONSE: ±3dB from 1Hz to 3MHz, ±0.3dB from 4Hz to 1MHz above 500µV.

INPUT IMPEDANCE: Above 50mV: 10MΩ<20pf. On 50µV to 50mV: >5MΩ<50pf.

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

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MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

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1. Extra RAM – 256 bytes.
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 4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
 5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.
- All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

- Hexadecimal keyboard • 8-digit, 7-segment LED display • 8 x 512 PROM, containing monitor program and interface instructions
- 256 bytes of RAM • 4 MHz crystal • 5 V regulator • Single 8V power supply • Space available for extra 256-byte RAM and 16 port I/O • Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc.), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

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The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

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Telephone: Cambridge (0223) 311488

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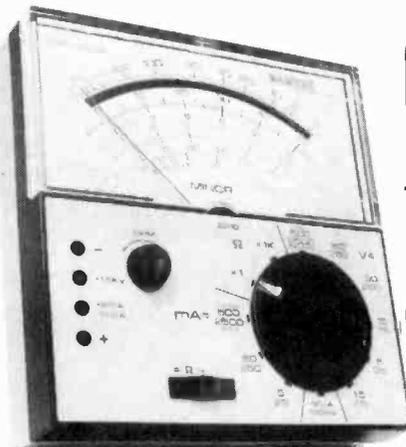
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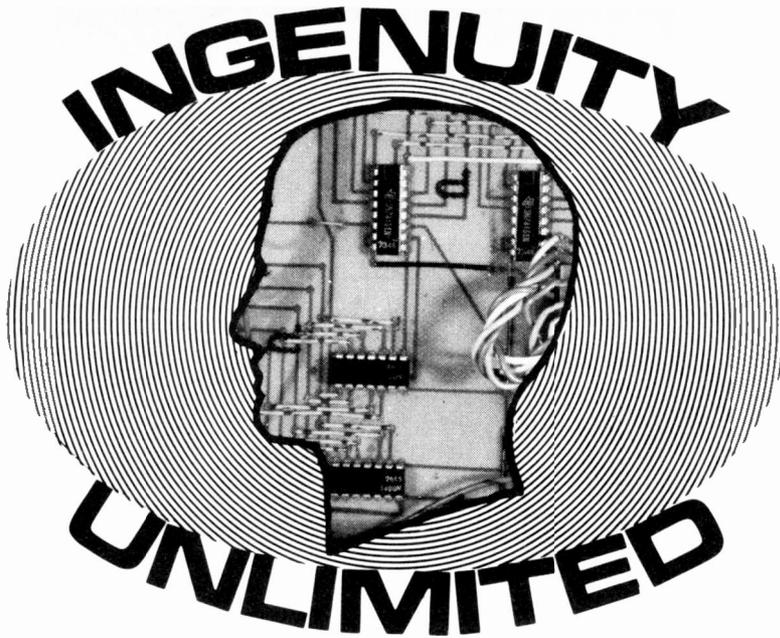
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Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

741 SUPPLY

WHEN two independent power supplies are used to run 741 circuits, problems can arise if one is loaded more than the other. This is particularly so if the circuits use reference voltages taken from the supply rails, e.g. the comparator in Fig. 1.

The power supply circuit shown (Fig. 2) avoids this by using a negative feedback loop; a 741 sensing the mid-voltage between the two supply rails and controlling the voltage at the bases of the transistor pairs. This feedback keeps the point "A" at zero volts so, provided that the two sensing resistors (R6 and R7) are equal, the two output voltages are equal and opposite.

In the circuit tested AD161, 162 and AC127, 128 transistors were used which could give a $\frac{1}{2}$ amp supply.

M. G. Kiff,
Wallingford, Oxon.

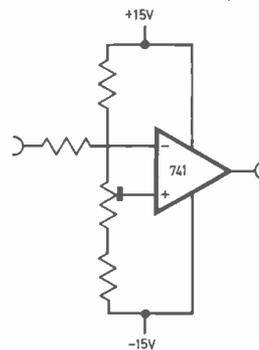


Fig. 1

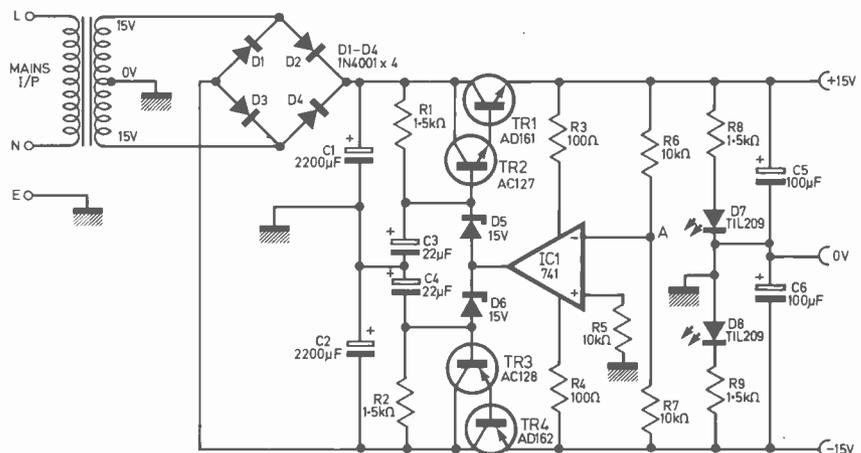


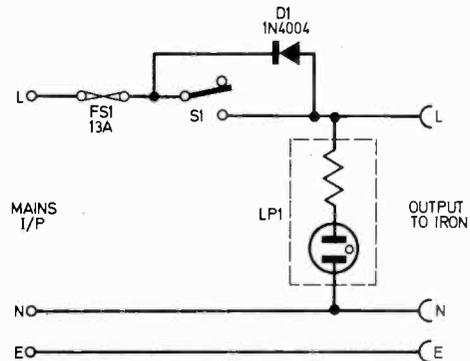
Fig. 2

SOLDERING IRON SIMMER CONTROL

WHEN soldering intermittently it is annoying to wait for the iron to heat up each time, while leaving it on uses up both the bit and electricity. This circuit supplies half power to keep the iron just warm, giving rapid rise to full temperature.

A common type of switched 13A plug is used with a rectifier in parallel with the switch. The rectifier (type 1N4004 is suitable) is soldered, either way round. The neon is left connected as before, giving full and half brightness to indicate power selected.

M. A. Wheatley,
Maidenhead,
Berkshire.



L.F. FREQUENCY METER

THIS instrument is capable of measuring frequencies in the range 10Hz to 100kHz. Four switched ranges are available, these being:

1. 0-100Hz
2. 0-1kHz
3. 0-10kHz
4. 0-100kHz

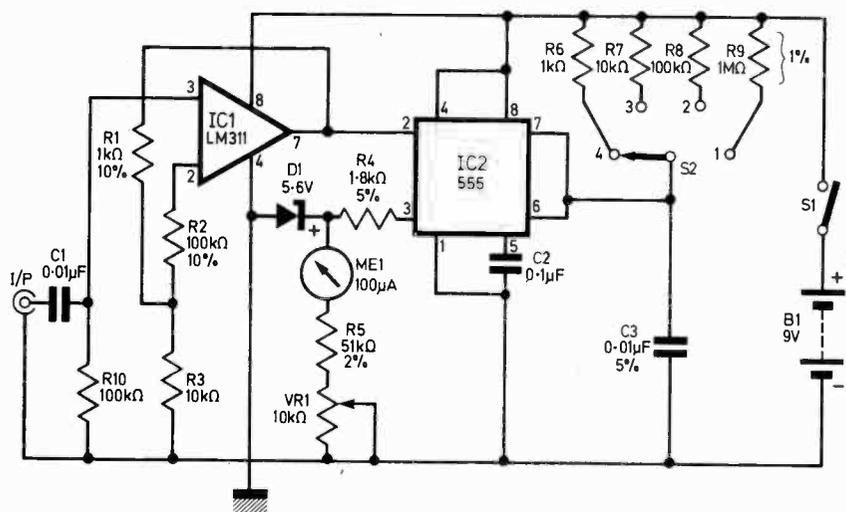
The meter scale is linear to facilitate reading the frequency. The power consumption is 9V at 10mA, and this may be conveniently supplied from a battery.

The first stage of the circuit is an LM311 comparator which converts the input waveform into a square-wave. The LM311 i.c. was chosen because of its low input current and because of its ability to run off a single supply. The output of this i.c. is then fed to the 555 which is connected as a monostable. Hence, the average voltage at the output of IC2 is directly proportional to the frequency at its input. The length of the pulses from the 555 depends on the value of C3 and R6, R7, R8 or R9.

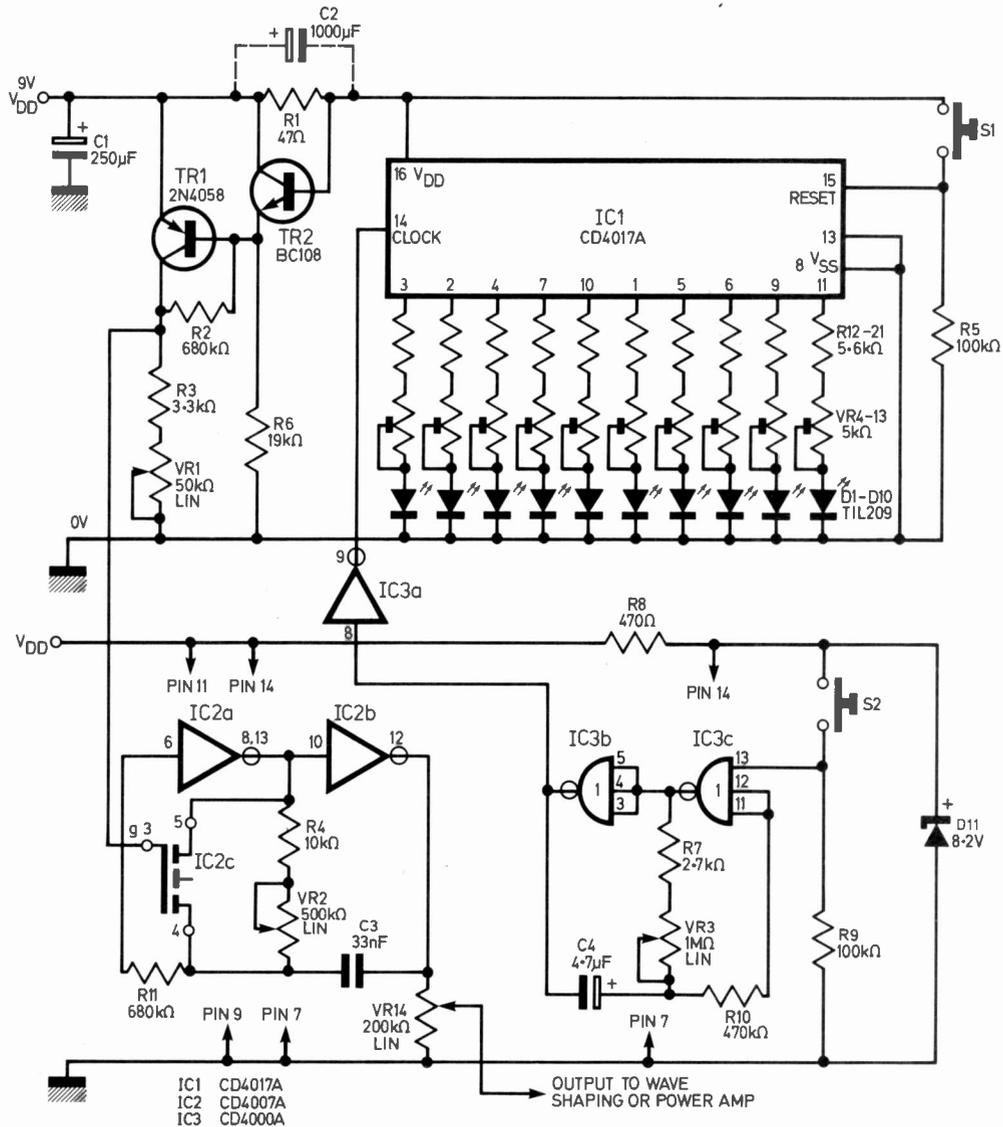
The output of IC2 is fed first to a 5.6V Zener diode via a current limiting resistor. This has the effect of preserving instrument accuracy despite fluctuations in supply voltage. The output from the Zener is then fed to the meter. VR1, a preset potentiometer, is adjusted to calibrate the instrument.

Finally, components that govern the pulse length should be high quality types. R6-R9 need to be 2% or better, and C3 must be a 5% polycarbonate type.

D. P. Akerman,
Dagenham,
Essex.



AUTO-TUNE GENERATOR



THIS circuit enables a preset series of 10 notes to be played over and over again.

With this basic operation, possible applications could be: novel doorbells; background to music synthesis; audio-visual displays, etc. IC1 (CD4017A) is a decade counter which counts one on each positive transition of a clocking oscillator. That is, it applies a high signal to D1, then D2, then D3 and so on up to D10. Depressing S1 resets the counter.

Each note is set by adjusting the current drawn from a particular output (D1 to D10), with VR4-13. A l.e.d. is placed on each output to indicate which note is being

played at that moment; they are optional and can be omitted (tuning is much harder without the l.e.d.s). The varying current taken by IC1, as it counts along the preset notes, is monitored by TR2 and R1 which convert the current into a corresponding, changing voltage. TR1 amplifies this and presents it to an audio VCO. VR1 varies the range of notes over which each preset note can be tuned.

IC2 forms the VCO from a CD4007A, IC2a, b being the audio oscillator tuned manually with VR2. IC2c, which is a CMOS f.e.t., is in parallel to VR2 and R4 and so a changing potential on the f.e.t.'s gate will cause a changing frequency.

VR14 then attenuates the output signal for an amplifier.

The clock oscillator is a CD4000A (IC3) and oscillates from about 0.2Hz to 5Hz—fully variable with VR3. S2 will stop the oscillator (a tuning aid), and D11 and R8 ensure that the oscillator's fluctuating current doesn't affect the VCO's steady tone.

Finally, C2 can be added for an interesting effect. The whole unit will run from a small 9V battery. IC1, 2 and 3 are CMOS and should be handled with care.

T. D. Davey,
Berkhamsted,
Herts.

TOUCH TUNER

THE circuit shown forms a simple "touch tuner" for use with varicap devices. It is based on the CMOS integrated circuit MC14514 which is a 4 line to 16 line latch/decoder, so up to 16 channels can be switched (if only 8 are required input D can be grounded as shown).

When the strobe input is high the BCD inputs to the i.c. are encoded as 1 of 16 outputs.

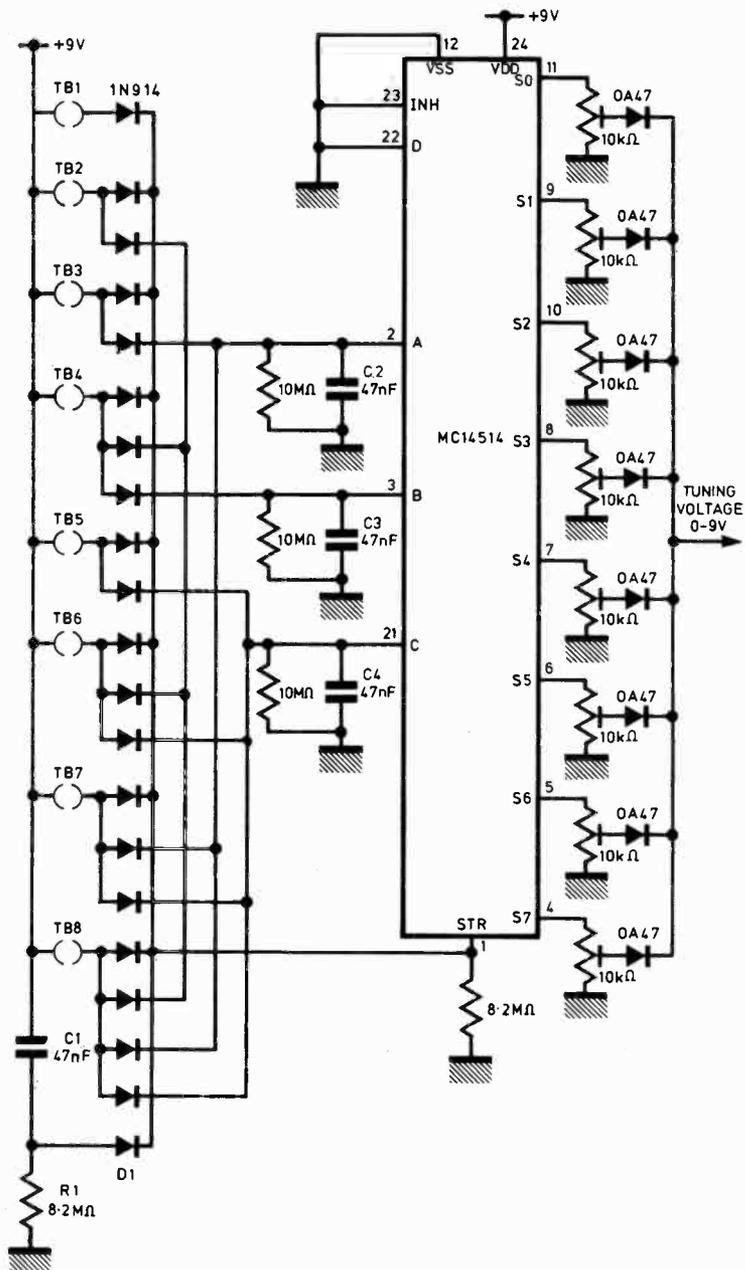
The touch buttons are decoded by the diodes to produce the BCD pattern, at the same time pulling the strobe input high (STR). This selects one of the 16 outputs which drive up to almost V_{dd} which is in turn divided down, by preset potentiometers, to give the tuning voltage that is applied to the tuner via the isolating diodes.

When the touch button is released the state at the BCD input is retained for a short time by the capacitors C2-C4, but the strobe input immediately goes low thus latching the BCD inputs and retaining the selected output.

The circuit formed by C1 and R1 cause a pulse on the strobe input during switch on to reset the tuner to the station selected by the S_0 output.

If it is required that the common contact of the touch buttons be at earth, the decoding diodes could be reversed, the BCD inputs pulled up to V_{dd} together with the capacitors and the strobe input inverted.

K. R. Drage,
Edmonton,
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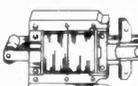


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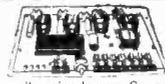


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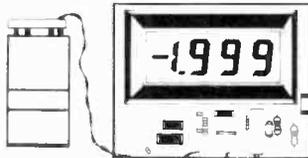
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Semiconductor UPDATE...

FEATURING : TDA2002 TDA 1083 HSCH1001

R.W. Coles

BRICK OUTHOUSE

The first integrated circuit I managed to lay my hands on, way back in 1966 I think, was an audio amplifier device from R.C.A. By today's standards, that pioneering miracle would be a joke, needing transformers on the input and output and delivering only about 250mW, but to me at the time it was pure magic!

Apart from the fact that you could hardly see the i.c. for its supporting "cast-of-thousands", the thing which eventually disappointed me the most about it was its short life.

Yes, you guessed it, whilst trying my precious miracle in one of a variety of data sheet applications circuits there was a wisp of smoke—then silence.

Now all that is behind me. We have become accustomed to the blow out proof, short circuit proof devices which the wise chip designers provide for us.

Or have we? I still see *myself* as the arch enemy of the audio amplifier chip, blow-out proof or not, and wisps of smoke are by no means unknown on my breadboard socket!

With this sort of background, then, I am always interested in the latest "built-like-a-brick-outhouse" claim for a new audio amplifier chip. Take the **TDA2002** device from Fairchild for example, a much more difficult nut to crack than any I have come across lately.

It comes in a tiny five pin plastic power-tab package and yet boasts an output power of 8W with loads down to 1.6 ohm and output currents of up to 3.5A.

The thing that makes the TDA2002 such a worthy adversary is its long list of fiendish protective measures, Thermal Shutdown, Short Circuit Protection and Overvoltage Protection, not bad for a chip which boasts a typical T.H.D. of 0.2 per cent at 5W.

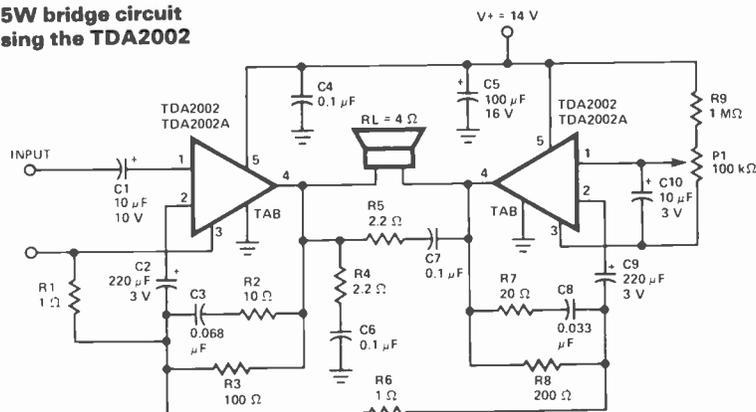
This apparent challenge to my reputation will not go unanswered however. I am already burnishing the tip of my soldering iron in anticipation.

Oh, and by the way Fairchild, I am into lightning-strikes at the moment!

SNUFF TIN SPECIAL

If there is *any* electronic subject likely to raise a yawn from our readers, it must surely be the prospect of an "even smaller" pocket broadcast receiver of the type I like to call squawk boxes! I must confess to having entered the electronics fraternity via the crystal set, the two valve t.r.f. (ask your dad!) and the "ham-band-special", before

15W bridge circuit using the TDA2002



ever discovering the delights of op-amps or logic gates, but even so, the suggestion of *yet another* advance in radio receiver miniaturisation, did not exactly have me choking on my breakfast cornflakes!

Not that I wouldn't have been keen 15 years ago mind you (as a lad, I once built a transistor set in a snuff tin) but our oriental cousins have had the whole thing so well tied up for so long now, that even before the introduction of integrated circuits, all the stuffing (*should this be snuffing?—ed*) had been knocked out of the subject as far as I was concerned. If I have *any yen* (sic) at all for broadcast receivers nowadays, it's for the antique variety with rows of fat glowing valves, solid mahogany cabinets, and the vain hope that one day whilst tuning through "Hilversum" or "Athens" I might just detect an eerie "Germany calling-Germany calling!"

But enough of my life story. The new development I am about to update you with, is, believe it or not, of the very sort to which I have just been objecting. The reason it appears at all, is because I consider it a development so final in its scope, that I confess to feeling a twinge of the old "snuff tin excitement", and if you can stifle your yawns long enough, I think you might agree with me.

The device is an integrated circuit from Sprague, coded ULN 2204A by its American maker, but already boasting a European Proelectron code of **TDA 1083**. Quite simply this new chip is a complete radio receiver in a sixteen pin dual in line package. Complete, because it contains an a.m. front end, an i.f. amplifier, an a.m. and f.m. detector stage, an audio amplifier and a power supply regulator.

True, it does *not* boast a loudspeaker, and you *do* still need a couple of r.f. coil cans and a capacitor or two, but until we switch to telepathic broadcasting, it's about as integrated as a radio receiver can get.

You can't even fault it on its performance. It is a full superhet with a.g.c. facilities, and has a 20 microvolt sensitivity for full output on a.m. When used in a dual mode receiver, a.m./f.m. switching is all carried out at d.c. so you could use a D.P.S.T. toggle switch if you wanted to. The audio amplifier, depending on supply voltage (the dip works on 2 to 12 volts, or much higher voltages with a single external resistor) will provide up to a watt into an 8 ohm speaker.

It's true that my snuff tin special needed an earphone and about 200 feet of aerial for correct operation, but how can mere technology replace it?

BARRIERS DOWN

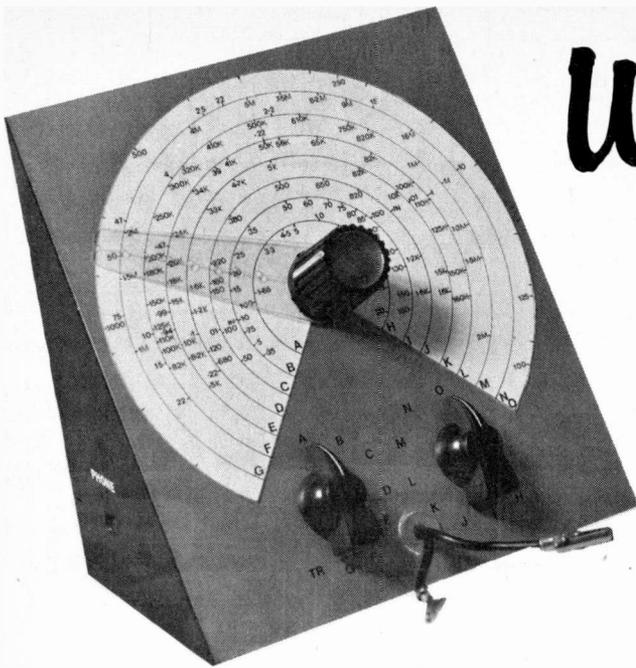
Still using germanium diodes in low forward voltage applications such as r.f. detector circuits and logic clamps? Do yourself a favour and try a Schottky barrier diode instead.

Schottky barrier diodes have a forward drop of only about 400mV at 1mA and have low capacitance and pico-second switching speeds to match. Hewlett Packard have now introduced a low cost S.B.D. in a common or garden DO35 package, coded **HSCH1001**.

Apart from the usual advantages of S.B.D.s, the new device features a 60V reverse breakdown voltage, and only a 200nA leakage at 50V.

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W. ENGLISH



THIS CR bridge is a wide range instrument capable of measuring resistance values from 0.5Ω to $20M\Omega$ and capacitance values from 0 to $1,000\mu F$. The unit has 15 ranges (seven resistance and eight capacitance) which are arranged as follows:

Range	Range
A 0.5Ω – 20Ω	H 0 – $100pF$
B 3.3Ω – 180Ω	I $75pF$ – $1,000pF$
C 33Ω – $1.8k\Omega$	J $800pF$ – $0.01\mu F$
D 470Ω – $18k\Omega$	K $7nF$ – $0.1\mu F$
E $3.9k\Omega$ – $180k\Omega$	L $75nF$ – $1\mu F$
F $33k\Omega$ – $2M\Omega$	M $0.75\mu F$ – $22\mu F$
G $1M\Omega$ – $20M\Omega$	N $8\mu F$ – $100\mu F$
	O $100\mu F$ – $1,000\mu F$

The certain amount of duplication that appears is an advantage when balancing the bridge, because it allows the most open part of the scale to be selected.

CIRCUIT DESCRIPTION

The circuit diagram of the CR bridge is shown in Fig. 1. It is energised by an AF oscillator housed in a separated case and its balance or null point is detected by using a crystal earphone.

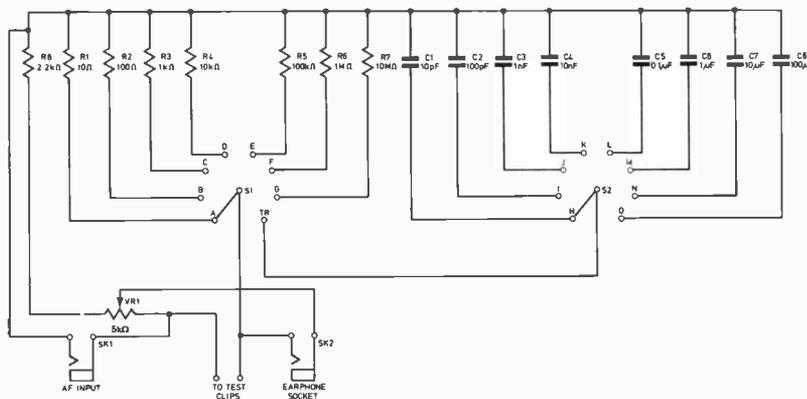


Fig. 1. Complete circuit diagram of the CR Bridge

When a resistor is placed in the test clips it forms a bridge circuit with VR1, R8 and one of the resistors R1–R7 (according to the position of S1).

If a capacitor is to be measured S1 should be switched to the TR position which transfers the circuits through to the capacitor range and the bridge then balanced using VR1 and S2. When measuring the value of electrolytic capacitors it will be necessary to "bias" these with the appropriate voltage.

CONSTRUCTION

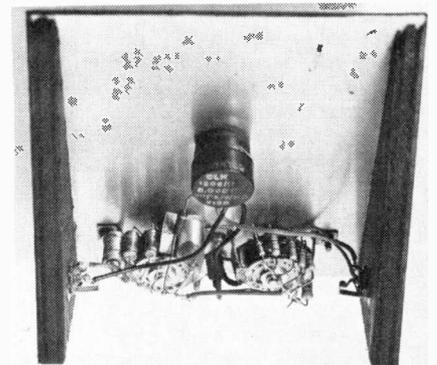
The components for the bridge are mounted on a 18 s.w.g. aluminium panel $150 \times 130mm$, which is fitted to two wooden side pieces so the front panel is inclined at an angle of 60 degrees.

The resistors and capacitors should be mounted on the two 12-way wafer switches as shown in the photograph before the switches are mounted onto the front panel. The free ends of the components are connected to a bus-bar across the two switches and the leads for the test clips are passed through a grommet on the front panel and have two small crocodile clips connected to them.

The scaleplate should be marked out as shown in the photograph; no component values should be marked on the scale plate until the calibration stage. The cursor consists of a piece of thin perspex sheet scribed with a centre line which is drilled so that the holes correspond with the lines on the scaleplate, enabling accurate calibration. The cursor is then fixed to a suitable knob.

AF OSCILLATOR

The circuit diagram of the AF oscillator is shown in Fig. 2. The unit consists of an astable multivibrator formed by TR1 and TR2 with TR3 used as an output amplifier stage. VR2



Rear view of CR Bridge

COMPONENTS . . .

Resistors

R1	10Ω
R2	100Ω (2 off)
R3	1kΩ
R4	10kΩ
R5	100kΩ
R6	1MΩ
R7	10MΩ
R8	2.2kΩ 10% carbon
R9, R12	7.5kΩ (2 off)
R10, R11, R13	120kΩ (3 off)
R14	1kΩ 1/8W 5%
All 1% 1/4W unless otherwise stated	

Potentiometers

VR1	5kΩ wirewound
VR2	25kΩ linear

Capacitors

C1	10pF
C2	100pF
C3	1,000pF
C4	10nF
C5	0.1μF
C6	1μF 16V tant
C7	10μF 16V tant
C8	100μF 16V tant
C9, C10	0.01μF C280 (2 off)
C11, C12	4.7μF tant 16V (2 off)
All 2% polystyrene unless otherwise stated	

Semiconductors

TR1, TR2, TR3	BC113 (3 off)
---------------	---------------

Miscellaneous

- 3 off 3.5mm jack plugs and sockets
- 2 off 1 pole 12-way wafer switch
- 2 off pointer knobs
- 2 off crocodile clips
- 1 off PP3 battery
- battery clips (if req)
- crystal earphone

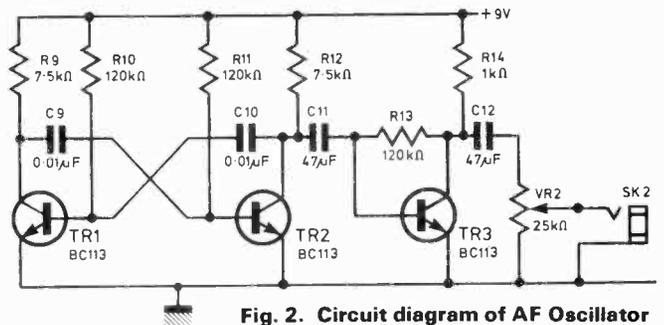
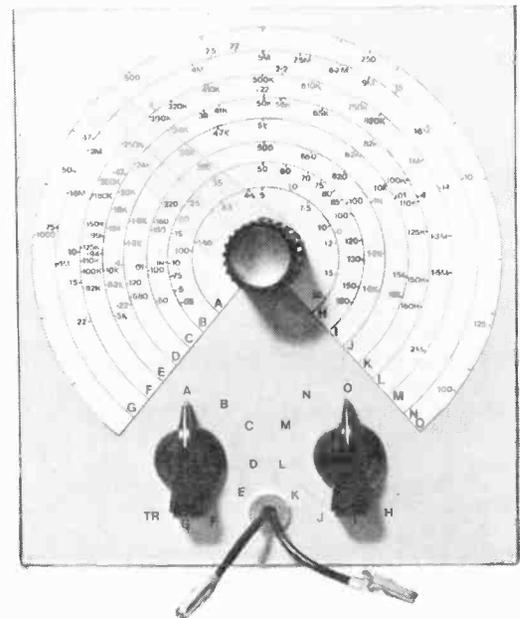
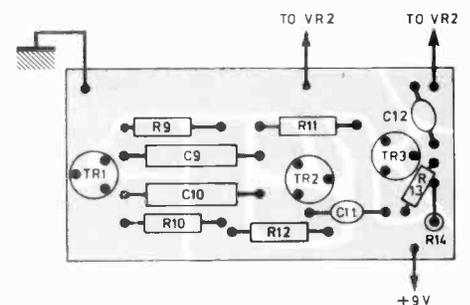


Fig. 2. Circuit diagram of AF Oscillator

Fig. 3. Printed circuit board design for the AF Oscillator



Fig. 4. Component layout for AF Oscillator



enables the output of the oscillator to be adjusted as required.

The prototype unit was constructed using the printed circuit board layout shown in Fig. 3 with the component overlay shown in Fig. 4. The unit which is connected to the bridge via 3.5mm jack plugs and sockets uses a screened lead and is powered by a PP3 battery.

CALIBRATION

After the unit has been assembled and checked the earphone should be plugged in and the AF generator connected and switched on. VR1 should be adjusted for maximum output and then VR2 adjusted so the output to the earphone is not excessive.

To calibrate the unit a wide range of close tolerance components are required. Starting at range A the upper and lower limits of each range should be marked on the

scaleplate by suitable value resistors in the test clips and adjusting VR1 until the bridge balances (when the output to the earphone is at minimum). The rest of the values can then be filled in. The null will not be so well defined on the higher ranges but the linear markings around the outside of the scale should make it easier to judge the effective null point. The capacitance ranges should be calibrated using the same method. The lettering on the scale is arranged so that the range letter is at the minimum end of the range. Resistor values increase clockwise and capacitor values anticlockwise. ★

News Briefs

by Mike Abbott

DATA ENCRYPTION UNIT

I'M SURE many readers will have been struggling for some time now, to get to grips with the bytes and bits of machine code and computer programs. Well, you've arrived just in time to be left behind again, because data encryption is here. Actually, this development shouldn't worry you unless you intend to tap confidential data lines for illicit purposes. A less impressive name for Intel's Data Encryption Unit would be data scrambler/unscrambler, and it is intended as a processing peripheral chip which prohibits "listening in" to confidential information in data form which is communicated using land lines.

Applications that immediately spring to mind are in inter-bank communication, military communications and inter-company confidential reports. The American National Bureau of Standards

(NBS) have defined a Federal Information Data Encryption Standard, and Intel's new integrated circuit codes and decodes data in accordance with the NBS standard. The new chip, known as the 8294 Data Encryption Unit, has been approved by NBS.

The 8294 codes and decodes 64-bit blocks of data in accordance with a 56-bit user specified key (algorithm) to produce 64-bit cipher words. It is necessary to use the same key for both coding and decoding to produce intelligible information at the receiving end. This means that $2^{56}-1$ ways of encoding the data are provided. In other words, even with the services of a large and very fast computer, it would be virtually impossible for an unauthorised person to hit upon the right key.

The 8294 is designed to act as a peripheral chip in a processing system. The 56-bit key and the 64-bit message are transferred to the 8294 over the system data bus a byte at a time. A DMA interface and three interrupt outputs are available to minimise the software overhead associated with data transfer. With a DMA interface two or more 8294s may be used in parallel to achieve effective conversion rates which are virtually any multiple of 80 bytes per second. As a bonus, the 8294 has a general-purpose seven-bit TTL output port for user specified functions.

The 8294 operates from a $5V \pm 10$ per cent power supply and is based in a standard 40-pin package.



STATESIDE SCENE

I HAVE been fortunate this year that my work has taken me to New York on a couple of occasions. This has enabled me to take a quick look at the electronics hobby scene on the other side of the pond. To an outsider the market place seems to be dominated by Citizens Band radio and computers.

C.B.

The Citizens Band consists of a group of 40 channels around 27MHz set aside for private low power communication. Any U.S. national can apply for a licence and there is no test to pass. The equipment used usually runs about four watts on a.m., although s.s.b. is creeping in, and it is designed to be idiot proof. There are no tuning controls to set up, you just turn the knob to the required channel, adjust the volume as desired and press the button on the mike to speak.

Homebrew rigs are frowned upon, as are linear amplifiers. Prices range from just under 40 dollars for a mobile rig for the car to several hundred dollars for a microprocessor controlled, keyboard entry, band scanning, base station.

The system may have some faults, with a few million rigs in service there is bound to be some abuse, but it has a lot going for it too. It provides communication between home and the car and enables you to get traffic reports and directions from other drivers. It is reassuring to see a sign beside the road saying "Nassau police monitor channel xx", allowing you to call for help in case of accident or emergency. The coastguard have also started to monitor one of the channels allowing small C.B. equipped boats to call for help in an emergency.

COMPUTERS

As far as home computers are concerned it seems to be a sellers market; they are selling like hot cakes. The demand is for machines with high level language with a good size memory, cassette recorder and/or floppy disc. When you consider that electronics prices in the U.S. are about half these over here and salaries over there are about three times ours, this gives the computer enthusiast in the States a 6-1 advantage over us in purchasing equipment. This means he can afford to skip the switch and i.e.d. machines and buy or build from a kit a relatively powerful machine.

For the kit builder the local Heathkit showrooms had the H8 and Heath/Dec 11 machines on display. The local computer shops stock various S100 bus compatible p.c.b. kits for memory, I/O, etc. and

numerous mail order firms offer boards and card frames for this bus. There are various ready to use machines available via the computer shops and a bewildering array of books on software to get you started programming.

One machine that seems to be going to lead the field is the TRS80, retailed by the Radio Shack shops. The Radio Shack shops are not as their name might suggest ham radio shops, they sell hi-fi units, C.B. transceivers, car radios, tape players, etc. and now the TRS80 computer. As there are Radio Shack shops everywhere and each one seems to have one TRS80 in the window and a demonstration model inside, sheer weight of numbers should help the machine fight its way to the front. It also seems to be a rather nice machine (*The TRS80 is available from Tandy in the U.K.—Ed*)

It has the Z80 C.P.U., level 1 basic in 4K ROM, and 4K RAM. Level II basic and 16K RAM are available as an option, and there are printers, floppy discs, etc. available to order.

The computer section seems to be well served by magazines such as Kilobaud, Byte and Interface Age, etc. and there appears to be a thriving market in software offerings for the more popular machines, cassettes being available with games and maths programs from numerous sources.

RACING CARS

One interesting offering in the hobby shops was a radio controlled electric racing car with a single chip microprocessor in the transmitter and another one in the car. The method of encoding allows four cars to be raced together although the receivers in the cars are simple super-regen types. The frequency band it operates in is around 50MHz but it should be possible to use the sets at 27MHz with suitable mods. to the r.f. side.

I was lucky enough to visit a small exhibition put on by the Long Island Mobile Amateur Radio Club. The club is very active and they operate five repeaters on v.h.f. and above, one of them for TV. They put on quite a good show, with a couple of 2 metre stations, RTTY and slow scan using the ROBOT slow/fast scan converter. Apparently repeaters are very thick on the ground in the area. I was told that there were 200 within a 70 mile radius of the Empire State building. This gives good coverage but interference between repeaters must be a problem!

Dave Coutts

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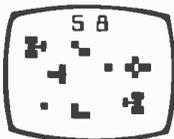
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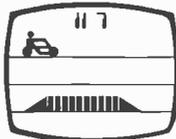
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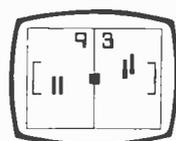
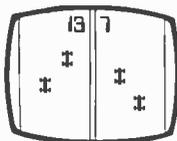
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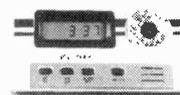
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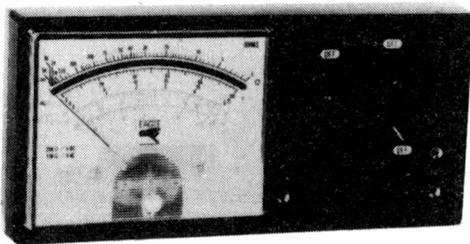
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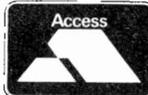


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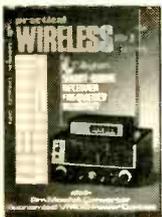
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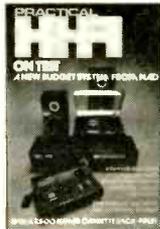
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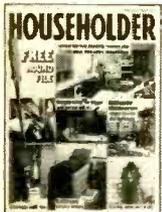
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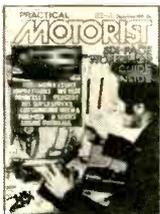
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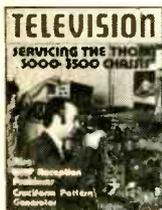
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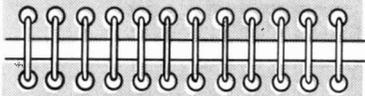
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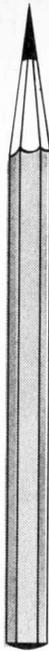
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INDUSTRY NOTEBOOK

By Nexus



The Great Debate (3)

One of the hazards of monthly comment is that of being overtaken by events. This has happened in the Great Debate. The philosophical impact of VLSI on life-style and attitudes on which I wrote two months ago still stand.

But since my comments last month on the practicality or otherwise of pushing Britain into the forefront of technology and large-scale production of VLSI circuits, there has been positive action, or at least some positive statements.

First came the news of INMOS, the completely new entrant in the field, backed by the National Enterprise Board and headed up by former Texas Instruments and Mostek employee Dr Richard Petritz, assisted by Dr Paul Schroeder, another ex-Mostek man, and Iann Barron, the British whizz-kid who founded Computer Technology some years ago and said to have been the mediator between Dick Petritz and the NEB.

Then, the well-ventilated rumour that GEC was seeking an arrangement with Fairchild was confirmed by a public statement that this was indeed the case and that a joint 50/50 GEC/Fairchild venture was going ahead.

INMOS will get £25 million of government backing initially, with another £25 million top-up, if necessary, later on. Headquarters will be in the UK but pilot production in the USA. Eventually, so it is claimed, INMOS will have a manufacturing plant in the UK employing 4,000 people in a depressed area. INMOS director Paul Schoeder is quoted, "We think we have the most exciting enterprise in the world."

GEC's move is more realistic. It involves a working capital of £20 million (GEC is flush with cash and will put up £10 million) and aims at a production rate of £40 million of product in the first full year in 1981. The plant will be set up in existing buildings and

employ about 1,000 people, will be on-stream ahead of INMOS and using proven technology the plant will actually be producing in 1980. GEC Semiconductors, in more specialised products, will continue as a separate entity and will enjoy some of the government support channelled through the Department of Industry.

Good news indeed. But it doesn't take much imagination to see which of these two operations will be the more successful. Realism, the GEC approach, must be a better bet than optimism. Private cash is always spent more prudently than public cash. GEC/Fairchild is already in the business and has marketing outlets. Not to mention technology. And from the business point of view GEC's Sir Arnold Weinstock has an unparalleled track record in shrewd management.

Among the many handicaps facing INMOS is uncertainty. A change of government could kill the project stone dead before it gets beyond the planning stage. Powerful voices in industry regard INMOS plans as controversial, if not downright fanciful, and should the Conservatives be returned to power it is already clear that they would not encourage the establishment of any new state-backed enterprises that could become a future burden on the economy.

A factor which could affect both INMOS and the GEC/Fairchild venture and, for that matter, all the semiconductor industry in the UK is the availability of scientists and engineers. INMOS is reported to be seeking 800 graduates and development engineers. GEC/Fairchild will need 300 engineers and 150 technicians. If these, or a fair proportion of them, are milked from existing operations this could weaken the whole infrastructure of the established UK semiconductor industry. One thing is certain, that any semiconductor engineer worth his salt need never be in the dole queue.

Employment

Accompanying the immediate convenience of new microelectronic applications, welcome to most of us, is the unwelcome impact on employment. Yet another set of figures, this time from Plessey, underlines the downward trend. In financial years 1973/74 turnover was £400 million with a world total of 76,000 employees. In FY 1977/78 the figures were £611 million with only 58,700 employees. If the overseas employees are eliminated from the figures, the UK employment by Plessey has dropped from 50,600 to 43,600 in the past three years.

Plessey, of course, was particularly hard-hit by savage cut-backs in orders from the Post Office, but even allowing for that special circumstance the trend is obvious and will continue.

Economics

The economics of microcircuits are fascinating. A study by Marconi engineers points out that for a four-channel mobile radio you can break even in cost by using a

frequency synthesiser rather than four separate crystals. For a ten-channel set, use of a synthesiser saves £25 per unit. The synthesiser, of course, only uses a single standard reference crystal. So on a ten-channel set there is a saving of nine crystals. The set-maker gets more profit, the set-user has a simplified and less costly spares holding, but the poor old crystal manufacturer loses 90 per cent of his business. Well, not quite, because mobile radio is still a big growth area with the world market increasing at over nine per cent a year.

Electronic Warfare

The hush-hush business of electronic warfare (EW) is flourishing as never before. Mostly kept under security wraps in the UK, a glimpse of happenings is occasionally allowed. Decca, for example, has over a dozen equipments of various types in production for detection, analysis and jamming of radar signals. A £2 million order is in hand for the Royal Danish Navy and another £8 million of Decca EW equipment will go into Lynx helicopters for the Royal Navy.

What makes EW such good business (and so expensive) is that every advance in technology needs a new countermeasure. Marconi Radar Systems, for example, has just announced a new mobile long-range air-defence radar, the very thing for the 1980s and 1990s. Called Martello, it has every refinement to beat the hostile jammers. But back-room boffins will rise to the challenge. Marconi is one of the biggest firms in EW and it is conceivable that while Martello was in development in one laboratory, another team of engineers next door was already working on how to defeat the system.

Video War

Discounts of up to 20 per cent are said to be offered by US dealers to shift home VTRs to a reluctant public. VTR sales in the USA have been only half those predicted. UK sales, however, have been as expected, according to manufacturers and dealers. But if stocks pile up in the USA it seems likely that surplus production could come to Europe and there could be some bargains in the shops, next year if not this.

TV Progress

The Matsushita factory in South Wales, opened only last year, is now stepping up production of National Panasonic colour TV sets to nearly 1,000 a week. The factory employs some 250 people.

Mullard is spending £24 million on updating TV tube production in the UK. The Department of Industry is helping with a £4.5 million handout. Mullard supply some 50 per cent of all tubes used in the UK and would like to supply as much as 75 per cent of the popular 22-inch size. Hopes that the tide of imports of TV tubes would be reduced by increased tariffs or import quotas are not bright. It looks therefore as if Mullard can increase market share only by intense price competition which would erode profits.



PATENTS REVIEW...

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 the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

INCREASING SYNCHRONOUS MOTOR SPEED

Astro Dynamics of Massachusetts, USA have recently patented in BP 1 509 766 an intriguing proposal for producing high running speeds from a.c. motors, without the use of commutators, brushes, gear boxes or frequency changers.

Although the patent wording (originating from the USA) refers to 60Hz mains the principle of the invention is of course applicable to any mains frequency. On 60Hz mains the maximum running speed normally available from a synchronous motor is 3600rpm. The invention idea is to achieve higher speeds by using a three phase supply in a manner hitherto regarded as impossible.

It is, the inventors point out, an axiomatic rule for three phase power supply that two power phases must not be connected to the same load at the same time, since they differ in phase. The invention breaks this rule by the use of SCRs. The SCRs are triggered to switch on during the last half period of each phase, ideally the last 60 degrees before zero axis crossing where of course the SCR is automatically turned off again.

The motor poles are bifilar so that there are two windings around each pole, a first winding of each pole being used to pass the current from one phase and the other winding of the same pole used to pass the current from another phase. Figs. 1A, 1B and 1C show the manner in which each

phase of the supply is chopped by the SCRs and figures 2A, 2B and 2C show the manner in which the chopped supply is fed to the windings on magnetic poles A, B and C respectively.

Thus the positive winding of the pole A receives its power from the C phase whereas the negative winding of the pole A obtains its power from the A phase. In similar fashion the windings of the magnetic pole B are powered by phases B and C and the windings for the pole C are powered by phases A and B. It follows that the individual magnetic poles share a different combination of excitation phases to produce 120Hz magnetomotive forces.

As the inventors point out the rules of three phase power supply, although apparently broken, are in fact observed. At no time are two phases of power applied to the same magnetic pole. For example phases A and C which are fed to pole A, are turned on alternately. To overcome the problems likely to result from current-lagging-voltage, the exact firing point of the SCRs needs careful selection.

The inventors claim to have modified and successfully operated a Westinghouse aircraft motor by re-winding it in bifilar manner. It is also suggested in passing that frequency tripling can be achieved by applying all three phases to each winding.

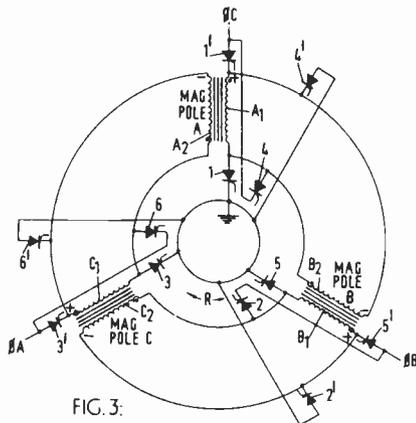


FIG. 3.

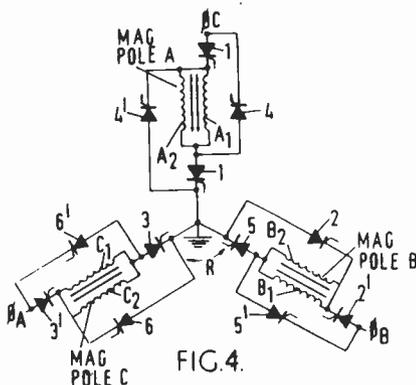
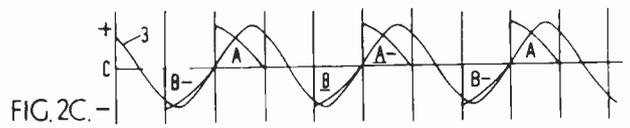
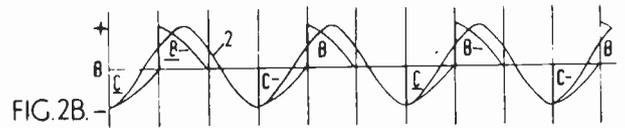
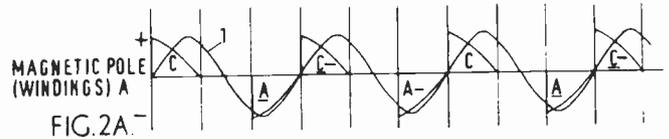
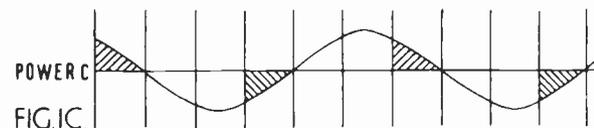
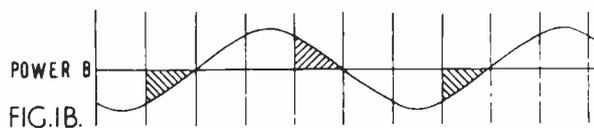
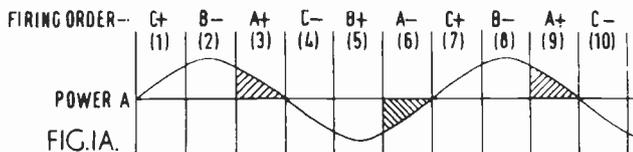


FIG. 4.



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.

Another Range

Sir—Whilst attempting to construct the Linear Capacitance Meter, a few “deliberate mistakes”, were found. After correcting these errors the instrument was tested and found to work correctly on all ranges, but 7 and 8 were found to be $\times 10$ high.

To rectify this the $10M\Omega$ resistor connected to S2b terminals 7 and 8 was disconnected, and terminals 7 and 8 were connected to 5 and 6 of S2b. This then brought ranges 7 and 8 into line with the others, i.e. in steps of ten. The switch used for the range selection has more than 8 positions, it was therefore decided to add another range: 1 volt = $10,000\mu F$.

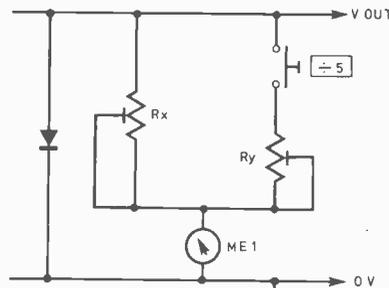
This was achieved by connecting terminal 8 of S2a to terminal 9 of S2a, and connecting the $10M\Omega$ resistor that was removed from terminals 7 and 8 of S2b to terminal 9 of S2b.

A $50\mu A$ meter movement which was calibrated 0–5 has been used, hence the capacitance meter now has nine switched ranges:

- | | | |
|-------------------|---|------------------|
| (1) $500pF$ | = | $1V/100pF$ |
| (2) $5nF$ | = | $1V/1nF$ |
| (3) $50nF$ | = | $1V/10nF$ |
| (4) $500nF$ | = | $1V/100nF$ |
| (5) $5\mu F$ | = | $1V/1\mu F$ |
| (6) $50\mu F$ | = | $1V/10\mu F$ |
| (7) $500\mu F$ | = | $1V/100\mu F$ |
| (8) $5,000\mu F$ | = | $1V/1,000\mu F$ |
| (9) $50,000\mu F$ | = | $1V/10,000\mu F$ |

To increase the accuracy of the instrument a divide by 5 switch has been added as shown in the diagram. The switch used for this *must* be a push-to-make type so that it cannot be inadvertently left on, as this could lead to funny shaped meter pointers.

The meter multipliers used were miniature



$$R_x = \frac{V_{out\ max}}{I_m} - R_m$$

$$\frac{R_x \cdot R_y}{R_x + R_y} = \frac{0.2 V_{out\ max}}{I_m} - R_m$$

Where: I_m = meter f.s.d. current
and R_m = meter resistance

potentiometers. These were adjusted to obtain the correct reading on the moving coil meter, whilst observing the readout on a digital meter connected between V_{out} and $0V$. The meter used to read this voltage must be a high impedance meter or an oscilloscope, not the “run of the mill” $20k\Omega/V$ type.

This design has been proven by a friend of mine who has made the instrument incorporating the mods; needless to say he is highly delighted.

T. L. Woodger Reading.

Oh Yes!

Sir—I have just read “Readout” in P.E. October 1978 and find myself compelled to reply to R. E. Hurst’s letter about pH. The concept of pH is a chemical one, and as a chemistry graduate I feel the pH scale must be looked at in context. The pH of a solution in equilibrium is equal to the negative logarithm

of the hydrogen ion concentration i.e.

$$pH = -\log [H^+]$$

Using this expression the pH of a solution 1 molar in H^+ is in fact 0.

$$pH = -\log 1 = 0$$

All commercially available pH meters use a 0–14pH scale. As to R. E. Hurst’s theory of “absolute acid” this is utter nonsense. If we were to push the theory to its limit a solution of 10 molar acid would have a pH of -1.

$$pH = -\log 10 = -1$$

Since concentrated acids are often stronger than 10 molar, even $pH = -1$ does not constitute “absolute acid”. In short W. Hediger is quite correct in giving his pH meter a “0” on the scale and R. E. Hurst would do well to get his facts straight before going off the deep end over technicalities which have deeper roots than simple logarithm theory.

A. K. Strange. Grad R.I.C., F.Chem Soc
Bristol.

Okay!

Sir—When today I read what I had written in trying to make a simple point (No Oh! Readout, October 1978) my eyes nearly popped out. This is an object lesson in what can happen if you over simplify. My real point is that the logarithmic scale is an absolute with an origin which can be approached and conceived of but *never* reached. Log graduated scales disclose this, but scales which are linear because the log is used conceal the nature of the basis of the measurement. By omitting the “0” the nature of the underlying concept is shown.

Ugh! Mea culpa, mea maxima culpa. I hope the ancient alchemists will rest in peace.

R. E. Hurst
Blackpool.

(*Enouph, the matter is now at pH7—Ed.*)

POINTS ARISING

TWO RANGE TIMER (October 1978)

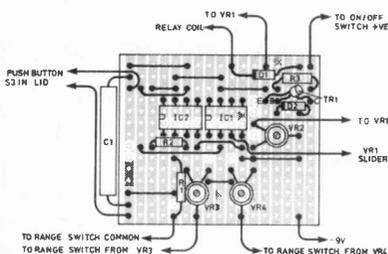


Fig. 2

FUMBLE NUDGE GAME (April 1978)

Resistor R23 appears correctly in the power supply diagram Fig. 5. It is shown incorrectly in the centre of the wiring diagram Fig. 6, where, in fact, IC2 pin 11 connects directly to IC1 pin 11.

KEYBOARD (September 1978)

Under “components”, IC8 should be a 7474

METRONE (September 1978)

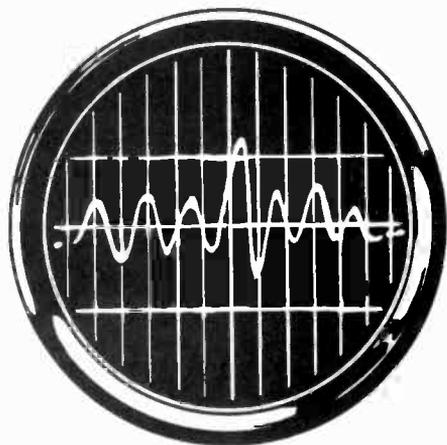
Diode D3 should be 7.5V and not 5.1V.

CAR BURGLAR ALARM (December 1977)

Constructors still undertaking this project, and unable to obtain the capacitors specified for C1 and C4 should follow the author’s recommendation, which is to obtain $100\mu F/16V$ tantalum bead capacitors from Watford Electronics and increase R6 and R8 to $150k\Omega$.

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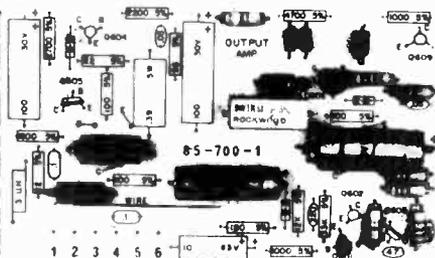
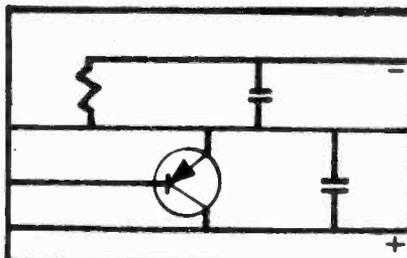
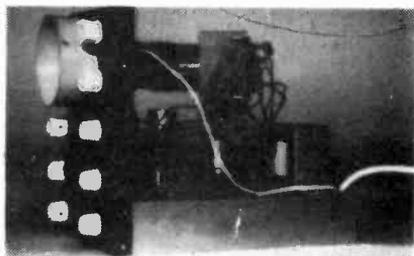
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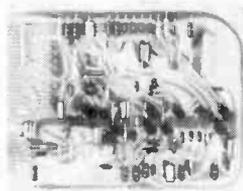
2 Read, draw and understand circuit diagrams

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

3 Carry out over 40 experiments on basic circuits

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.

FREE GIFT



All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

To find out more about how to learn electronics in a new, exciting and absorbing way, just clip the coupon for a free colour brochure and full details of enrolment.

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PEB11



Handy size Reels and Dispensers

OF THE WORLD'S FINEST CORED SOLDER TO DO A PROFESSIONAL JOB AT HOME

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.

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 58p

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.

PC115 69p

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

Size 19A 63p



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
Size 3	40/60 Tin/Lead	1.6	10.0	For economical general purpose repairs and electrical joints.	£2.16
Size 4	ALU-SOL	1.6	8.5	For aluminium repairs. Also solders aluminium to copper, brass etc.	£2.46
Size 10	60/40 Tin/Lead	0.7	39.6	For fine wires, small components and printed circuits.	£2.38
Size 12	SAVBIT	1.2	13.7	For radio, TV and similar work. Increases copper-bit life tenfold.	£2.29

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 97p

Pat. No. 1443913

SOLDER-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 97p

Sole U.K. Sales Concessionaires:
Bib Hi-Fi Accessories Limited,
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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.

4 1/4 in x 3 1/4 in **METER**. 30µA, 50µA or 100µA, **£5.43**. 19p P. & P.

MICROPHONES FOR TAPE RECORDERS

DM228R 200 ohm with 3.5 and 2.5mm Jack Plugs **£1.30**

DM229R 50K with 3.5 and 2.5mm Jack Plugs **£1.60**

DM18D 200 ohm with 5 and 3 pin Din Plugs **£1.75**

Postage on above microphones 11p

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Model UD-130 Frequency response 50-15,000c/s. Impedance Dual 50K and 600 ohms. **£8.02**. 26p P. & P.

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60 x 45mm meters 50µA, 100µA 500µA and 1mA VU meter, **£4.46**. 11p P. & P.

6V BUZZERS. 50mm diameter 30mm high, **52p**. 15p P. & P.

MULTI-METER

Model IT1-2 20,000 ohm/volt, **£10.38**. 33p P. & P.

TRANSFORMERS Primary 240V

6-0-6V	100mA	£0.75
9-0-9V	75mA	£0.75
12-0-12V	50mA	£0.85
12-0-12V	100mA	£1.05

Post on above transformers 30p.

9-0-9V	1A	£1.80
12-0-12V	1A	£2.15
15-0-15V	1A	£2.36
30-0-30V	1A	£3.10
6-3V	1 1/2A	£1.80
6-0-6V	1 1/2A	£2.20

Post on above transformers 45p.

All above prices include V.A.T. Send 40p for new fully illustrated catalogue, S.A.E. with all enquiries. Special prices for quantity quoted on request.

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BAD NEWS FOR KNOB TWIDDLEDERS

A 300W Lightdimmer with NO knob. Dimming and on/off functions are controlled by touch. Features include:

- ★ No mains rewiring
 - ★ Easy to build - uses one MOS 1C
 - ★ Switches on to preset brightness
 - ★ Can be switched and dimmed from many locations using TDE/K kit making 2-way switching easy
- ★★ PRICE **£9.67** TDE/K **£1.08**.



LIGHTING CONTROL KITS (300W) TSD300K TOUCH-SWITCH & DIMMER combined. One touchplate for on/off. Small knob controls brightness. **£5.62**

TS300K TOUCHSWITCH. Two touchplates, ON/OFF **£4.32**.

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LD300K LIGHTDIMMER. **£3.02**

DIGITAL VOLTMEETER/THERMOMETER KIT



Based on the 7106 single IC 3 1/2 digit D.V.M. the Kit contains a PCB, resistors, capacitors, presets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor.

ONLY £23.75

TRIAC BARGAINS

400V Plastic Case	
3A	64p
6.5A with trigger	86p
8A	80p
12A	90p
16A	113p
20A	178p
25A	205p
SCR (C106D) 5A/400V	54p
Diac	23p

COMPONENTS

0.2" L.E.D.s	
Red	11p (86p/10)
Green	23p
Yellow	27p
DL727, 5" display	£1.62
LCD, 5 1/4" digit	£9.72
LDR, 5" dia	45p
NE555 31p	(4 for £1.08)
741 27p	(5 for £1.08)
LM3911 temperature IC	£1.08
AY-5-1224	£3.51
AY-5-1230	£5.23
ZN1034E	£1.94
ICL7106 DVM IC	£9.99
IN4001	7p
IN4148	5p
BC182L	11p
2N3819	25p

MINI MAINS TRANSFORMERS

Standard 240V mains primary 100mA secondary	
6-0-6V	92p
9-0-9V	97p
12-0-12V	102p

24HR CLOCK/APPLIANCE TIMER KIT



Switches any appliance of up to 1KW on and off at preset times once a day. KIT contains: AY-5-1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. **£14.85**

White box (56 x 131 x 71mm) - drilled **£2.70**

- undrilled **£2.38**

ABOVE PRICES INCLUDE V.A.T.

Quantity discounts on request. Add 25p postage and packing. Mail order only to:

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EASY BUILD SPEAKER DIY KITS

Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak simulate enclosures, two EMI 13" x 8" (approx.) woofers, two tweeters and a pair of matching crossovers. Supplied complete with an easy-to-follow circuit diagram, and crossover components.

£28.00
STEREO PAIR Input 15 watts rms, 30 watts peak each unit. + p & p £5.50 Cabinet size 20" x 11" x 9" (approx.)
SPEAKERS AVAILABLE WITHOUT CABINETS
It's the units which we supply with the enclosures illustrated. Size 13" x 8" (approx.) woofer (EMI) 2 1/2" app. **£17.00** per tweeter, and matching crossover components. stereo pair Power handling 15 watts rms, 30 watts peak + p & p £3.40

BUILT AND READY TO PLAY

SPEAKERS Two models - Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18 1/2" x 13 1/2" x 7 1/2" (approx.). Duo III, 20 watts rms, 40 watts peak, 27" x 13" x 11 1/2" appx Duo IIb **£17** PER PAIR Duo III **£52** PER PAIR p & p £6.50 p & p £7.50

EASY TO BUILD



RECORD PLAYER KIT

for the D.I.Y. man who requires a stereo unit at a budget price, comprising ready assembled stereo amp module Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phono socket and record/replay socket including 2 SPHERICAL HI-FI speakers **£19.95** p & p £4.05

AM/FM STEREO TUNER AMPLIFIER CHASSIS COMPLETE

Ready built. Designed in a slim form for compact, modern installation.
Rotary Controls Vol On/Off, Bass, Treble, Balance
Push Buttons for Grant, Tape VHF, MW, LW and 5 button rotary selection switch
Power Supply Selenium Bridge—35V DC from 21D-250V AC 50Hz input
Aerial Ferrite 8" x 1/2" built into chassis for LW and MW plus flying lead for FM aerial
Power Output 5 watts per channel. Sine at 2% THD into 15 Ohm; 7 watts speech and music
Tape Sensitivity Playback 400mV/30K OHM for max. output Record 200mV/50K output available from 25KHz (150mV/100K) deviation FM signal **Frequency Range (Audio)** 50Hz to 17 KHz within ±1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV
AM sensitivity for 20 dB S/N MW 350 uV/Metre LW 1mV/Metre
Size approx. length 16" x height 2 1/2" x depth 4 1/2" **£19.95** P & P £2.50

VALUE FOR PERSONAL SHOPPERS

- 160 16 VOLT MAINS TRANSFORMER, 2 1/2 amp. **£2.50**
- BSR Record auto deck on plinth with stereo cartridge ready wired **£11.95**
- LED 5 function men's digital watch stainless steel finish **£5.95**
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- 125 Watt Power Amp Module **£13.95**
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- 100K Multiturn Varicap tuning pots, 6 for **£24.95**
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- MULLARD Built power supply **£5.95**
- DECCA DC 1000 Stereo Cassette P.C.B. complete with switch oscillator coils and tape-heads **£1.50**
- DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3 1/2" approx. tweeter inc. crossovers **£2.95**
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- VIDEO MASTER Door Tunes (24 different titles) **£14.95**
- Micro cassette tape recorder **£12.95**
- 7" TAPE TRANSPORT Mechanism—a selection of models from **£13.95**
- DIGITAL CLOCK RADIO Mains operated. **£8.95**
- STEREO RADIO/CASSETTE RECORDER, MW, LW, SW and Stereo VHF 6 watts output Battery mains operation **£10.95**
- PORTABLE RADIO/CASSETTE RECORDER, AM/FM with clock, LW, MW, SW, VHF mains/battery operation. **£75.00**
- £41.95**

Mullard

AUDIO MODULES IN BARGAIN PACKS

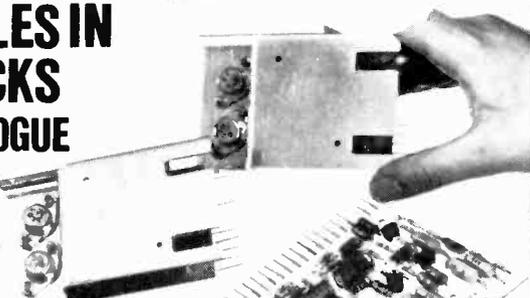
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PRICE **£** AT OVER **25** PER PACK

SEE OUR PRICES

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- 2** PACK 2. 2 x LP1173 10w. RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs. **OUR PRICE** **£7.45** p+p £1.00
- 3** PACK 3. 1 x LP1179/2 FM Tuning head with AM gang, 1 x LP1165/1 AM/FM IF module, 2 x LP1173/10w. RMS output power audio amp modules + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input. **OUR PRICE** **£9.95** p+p £1.00

TRADE ENQUIRIES INVITED

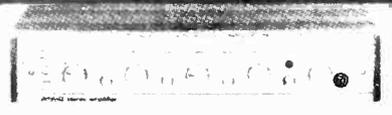


ACCESSORIES

Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors. **£1.00** p+p **£1.95** p+p 50p **95p**

THIS MONTH'S OFFER

added to our bargain packs
When you buy Pack 3 at **£9.95**, together with a mains transformer at **£1.95** and a set of controls for 85p you receive **FREE** a Mullard LP1400 Decoder to match. Listed at **£11.90** **£12.85**



20 x 20 WATT STEREO AMPLIFIER
Viscount IV unit in teak-finished cabinet. Silver fascia with aluminium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick-ups, tape, tuner, and auxiliary. Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse. 20 x 20 watts rms, 40 + 40 watts peak. **£29.90** p & p £2.50

30 x 30 WATT AMPLIFIER KIT
For the experienced constructor complete in every detail. Similar facilities as Viscount IV amplifier. 60+60 peak. **£29.00** p & p £2.50

*** SPECIAL OFFER: PACKAGE PRICE WITH 30x30 KIT.**
Mk II version operates into 4 to 15 ohms speakers. Specially designed by RT-VC for the experienced constructor, complete in every detail. Same facilities as Viscount IV amplifier. 60+60 peak, supplied with 2 **GOODMANS COMPACT 12"** Bass woofers with cropped sides, 14,000 Gauss magnet, 30 watts rms handling + 3 1/2" approx. tweeters and crossovers. **£49.00** p & p £4.00

MDV AVAILABLE fully built and tested Output 30x30 watts rms. 60+60 peak. **£39.00** p & p £2.50

ADD-ON STEREO CASSETTE TAPE DECK KIT

Designed for the experienced D.I.Y. man. This kit comprises of a tape transport mechanism, ready built and tested record/replay electronics with twin V.U. meters and level control for mating with mechanism. Specifications: Sensitivity Mic 0.85 mV @ 20K OHMS, Din 40mV @ 400K OHMS. Output—300mV RMS per channel @ 1KHz from 2K OHMS source. Cross Talk—30db. Tape Counter 3 Digit, Resettable. Frequency Response 40Hz-8KHz ±6db. Deck Motor 9 Volt DC with electronic speed regulations. Key Functions: Record, Rewind, Fast Forward, Play, Stop & Eject. **£19.95** p & p £2.50
Opt. extras: Mains transformer to suite **£2.50** + **£1** p & p.

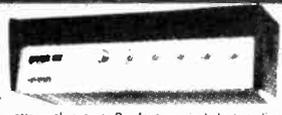


323 EDGWARE ROAD, LONDON W2
210 HIGH STREET, ACTON W3 6NG
ALL PRICES INCLUDE VAT AT 12 1/2%
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Order by giving credit card NUMBER only

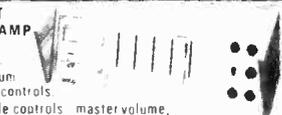


50 WATT MONO DISCO AMP
£29.95 P & P £2.50
Size approx. 13 1/2" x 5 1/2" x 6 1/2"



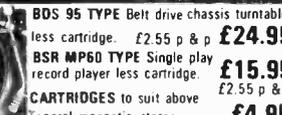
50 watts rms 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume. **SPECIAL OFFER.** The above 50 watt amp plus 4 Goodmans Type 8P 8" speakers. Package price **£45.00** + **£4.00** P & P

70 & 100 WATT MONO DISCO AMP
Size approx. 14" x 4" x 10 1/2"



Brushed aluminium fascia and rotary controls. Five vertical slide controls: master volume, tape level, mic level, deck level. PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control 70 watt peak (PFL) lets YOU hear next disc before fading. 140 watt peak in VU meter monitors output level. **£57** p & p £4.00
Output 100 watts RMS 200 watts peak. 100 watt **£65**

BDS 95 TYPE Belt drive chassis turntable less cartridge. **£2.55** p & p **£24.95**



BSR MP60 TYPE Single play record player less cartridge. **£15.95** £2.55 p & p **£4.95**

CARTRIDGES to suit above. Tenorel magnetic stereo. **£4.95**

BSR automatic record player deck, cueing device and stereo ceramic head. **£2.55** p & p **£9.95**

GARRARD DECK CC10A. Record changer with cue and stereo ceramic cartridge. Size 12" x 8 1/2" approx. **£2.00** p & p **£7.95**

PERSONAL SHOPPERS
GARRARD 86SB Deck. **£24.95** **GARRARD SP25 MKIV Deck** with Shure head. **£26.95**
GARRARD 355B Deck. **£24.95**

PORTABLE DISCO CONSOLE
Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier. **£64.00** p & p £6.50



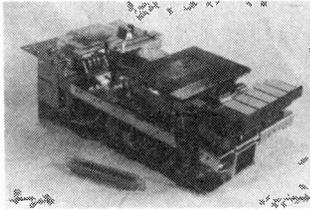
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STEREO



CASSETTE RECORDER DECK

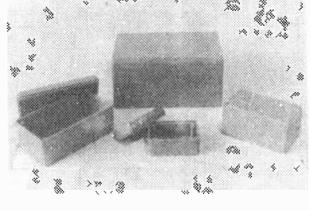
- + solenoid auto-stop
- + CrO2 switch
- + piano key operation
- + twin level meters
- + mic. sockets

Tech. Spec.:
Bias and erase freq. 88 kHz
4 ICs 8 Transistors
1 SCR 10 Diodes

Diagrams and top panel template supplied

£25.75 + £1.25 p&p

HIT-BOX



SHOCK-PROOF POLYSTYROL IN GREY
4mm thick walls

Larger sizes are pillar fixing
Smaller sizes are slotted

Inside Measurements:

Box No.	Breadth mm	Length mm	Height mm	Weight gm
1001	60	90	50	100
1002	75	130	61	175
1003	90	160	71	285
1004	93	193	95	340
1005	125	220	110	575

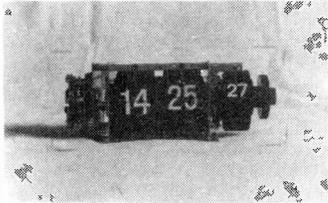
1001 - 90p 1004 - £2.00
1002 - £1.60 1005 - £3.00
1003 - £1.80 50p each p&p. £1.00 for 3 p&p

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DIGITAL CLOCK

BATTERY DROP LEAF
CLOCK MOVEMENT

Hrs. Mins. Date
Easy-to-set regulator screw
Size: 140mm x 85mm x 60mm
Window size: 63mm x 28mm
No. height: 19mm
Date height: 10mm
Weight: 270gm



£4.95 + 50p p&p

LCD WATCHES

TOUCH GENTS
CTG

£14.95

LADIES S/S C652

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6 Colours

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LARGE GENTS

C165

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ALL WATCHES 5 FUNCTION... 1 YEAR GUARANTEE
P&P 50p per watch, Inc. Insurance

We can now supply TOP PANEL FOR STEREO CASSETTE DECK £3.50 + 50p P&P · ALL PRICES INCLUDE VAT

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All full spec Grade 1 displays

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LEDS. Bright full spec. 0.2" or 0.125" Red -10p*

TIL209 Red & Clip 12p*

0.2" Dia Red & Clip 12p*

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12 volt Fluorescent Light £5*

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Decon Board Cleaner Pad 50p*

6x4" Nylon/Copper Board 60p*

Vero Stocked A11 10% off i.e. 3"x5"x0.1" Board 56p*

DISCO TRIAC 10A 400v

BR100 Diac 25p*

C1060 4A 400v SCR 55p*

TAG 1/400 lamp 55p*. 1/600 65p*

Switches Mini SPST 55p*

Mini DPDT 69p*. Centre off 89p*

Slide Switch 25p*

Push 'On' 35p*

FULL SPEC PAKS ALL £1

Pak A: 12 x Red LEDs £1*

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TRANSISTORS

Look at our Pak T. Ten Plastic Power £1

Or Pak C: 4 x 2N3055 £1*

Matching 20p*. Inc. Krt 10p*

AC127 17p* BFY50 16p*

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AC187 20p* BFX29 28p*

AD161 40p* BSX20 18p*

AF162 40p* NJE2955 £1*

AF239 42p* NJE340 44p*

BC107 8p* NJE2955 £1*

BC108 8p* NJE3055 80p*

BC109 9p* MPU131 35p*

BC109C 15p* ORP12 55p*

BC147 12p* TIP41A 60p*

BC148 12p* TIP42A 65p*

BC149 12p* TIP2955 60p*

BC157 15p* TIP3055 50p*

BC158 15p* TI543 35p*

BC159 15p* 2N2646 39p*

BC167 10p* 2N2905 22p*

BC168 11p* 2N2926Y 10p*

BC169 12p* 2N3053 16p*

BC177 18p* 2N3055 45p*

BC178 16p* 2N3614 1p*

BC179 18p* 2N3702 9p*

BC182 10p* 2N3704 9p*

BC183 10p* 2N3706 9p*

BC184 10p* 2N3819E 18p*

BC212 12p* 2N3820 38p*

BC213 12p* 2N3904 15p*

BC214 12p* 2N3906 15p*

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HY5 Pre-amplifier

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

FEATURES: complete pre-amplifier in single pack, multi-function equalisation low noise low distortion high overload, two simply combined for stereo.

APPLICATIONS: hi-fi, mixers disco guitar and organ public address

SPECIFICATION: Inputs—magnetic pick-up 3mV, ceramic pick-up 30mV tuner 100mV microphone 10mV, auxiliary 3-100mV input impedance 47k Ω at 1kHz Outputs—tape 100mV, main output 500mV R M S Active Tone Controls—treble \pm 12dB at 10kHz, bass \pm 12dB at 100Hz Distortion—0.1% at 1kHz signal noise ratio 68dB Overload—38dB on magnetic pick-up Supply Voltage— \pm 16-50V

Price £6.27 + 78p VAT, P. & P. free

HY5 mounting board B.1. 48p + 6p VAT, P. & P. free



HY30 15W into 8 Ω

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

FEATURES: complete kit, low distortion short, open and thermal protection easy to build

APPLICATIONS: updating audio equipment guitar practice amplifier test amplifier, audio oscillator

SPECIFICATION: Output Power—15W R M S into 8 Ω Distortion—0.1% at 15W Input Sensitivity—500mV Frequency Response—10Hz-16kHz -3dB

Price £6.27 + 78p VAT, P. & P. free

HY50 25W into 8 Ω

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

FEATURES: low distortion integral heatsink only five connections 7 amp output transistors no external components

APPLICATIONS: medium power hi-fi systems low power disco guitar amplifier

SPECIFICATION: Input Sensitivity—500mV Output Power—25W R M S into 8 Ω Load Impedance—4-16 Ω Distortion—0.04% at 25W at 1kHz Signal Noise Ratio—75dB Frequency Response—10Hz-45kHz -3dB Supply Voltage— \pm 25V Size—105 x 50 x 25mm

Price £8.18 + £1.02 VAT, P. & P. free



HY120 60W into 8 Ω

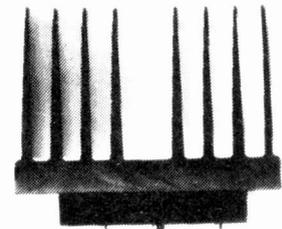
The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design

FEATURES: very low distortion integral heatsink load line protection thermal protection five connections, no external components

APPLICATIONS: hi-fi high quality disco public address monitor amplifier guitar and organ

SPECIFICATION: Input Sensitivity—500mV Output Power—60W R M S into 8 Ω Load Impedance—4-16 Ω Distortion—0.04% at 60W at 1kHz Signal Noise Ratio—90dB Frequency Response—10Hz-45kHz -3dB Supply Voltage— \pm 35V Size—114 x 50 x 85mm

Price £19.01 + £1.52 VAT, P. & P. free



HY200 120W into 8 Ω

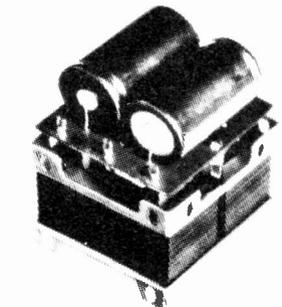
The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown very low distortion load line protection integral heatsink no external components

APPLICATIONS: hi-fi disco monitor power slave industrial public address

SPECIFICATION: Input Sensitivity—500mV Output Power—120W R M S into 8 Ω Load Impedance—4-16 Ω Distortion—0.05% at 100W at 1kHz Signal Noise Ratio—96dB Frequency Response—10Hz-45kHz -3dB Supply Voltage— \pm 45V Size—114 x 50 x 85mm

Price £27.99 + £2.24 VAT, P. & P. free



HY400 240W into 4 Ω

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

FEATURES: thermal shutdown very low distortion load line protection no external components

APPLICATIONS: public address disco power slave industrial

SPECIFICATION: Output Power—240W R M S into 4 Ω Load Impedance—4-16 Ω Distortion—0.1% at 240W Input Sensitivity—500mV Size—114 x 100 x 85mm

Price £38.61 + £3.09 VAT, P. & P. free

POWER SUPPLIES: PSU36—suitable for two HY30s £6.44 + 81p VAT, P. & P. free. PSU50—suitable for two HY50s £8.18 + £1.02 VAT, P. & P. free. PSU70—suitable for two HY120s £14.58 + £1.17 VAT, P. & P. free. PSU90—suitable for one HY200 £15.19 + £1.21 VAT, P. & P. free. PSU180—suitable for two HY200s or one HY400 £25.42 + £2.03, VAT, P. & P. free.

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AS226	0-45	BF182	0-45	OC41	0-50
AS227	0-50	BF183	0-45	OC42	0-50
AS215	1-25	BF184	0-39	OC43	1-50
AS216	1-25	BF185	0-37	OC44	0-50
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AS220	0-75	*BF195	0-11	OC71	0-45
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BA145	0-15	*BF224	0-20	OC75	0-80
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BA155	0-12	BF258	0-42	OC81	0-75
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BAX16	0-07	*BF338	0-55	OC84	0-80
BC107	0-12	BF521	2-27	OC122	1-50
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*BC117	0-22	BFX85	0-41	OC200	1-00
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*BC159	0-13	BTY79/400R	3-19	*R2010B	2-25
*BC167	0-13	*BU205	2-25	T1C44	0-36
*BC170	0-16	*BU206	2-25	T1C226D	1-30
*BC171	0-14	*BU208	2-50	T1L209	0-25
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*BC173	0-15	BY126	0-45	*T1P30A	0-80
BC177	0-19	BY127	0-15	T1P31A	0-82
BC178	0-18	BZX61	0-20	T1P32A	0-75
BC179	0-20	Series		T1P33A	1-00
*BC182	0-11	BZY88	0-13	T1P34A	1-20
*BC183	0-11	Series		T1P41A	0-70
*BC184	0-12	CRS1/05	0-45	T1P42A	0-90
*BC212	0-14	CRS1/40	0-80	T1P2955	1-00
*BC213	0-14	CRS3/05	0-45	T1P3055	0-50
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*BC308	0-20	GMO378A	1-50	*ZTX107	0-11
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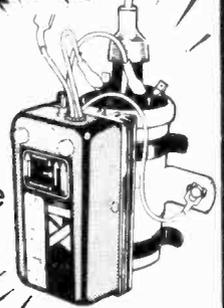
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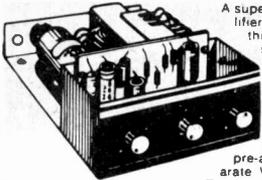
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2N1890	0.30	2N2925	0.19	2N3901	0.30	2N4924	1.15	2N5469	0.55	AF109	0.52	BC188E	0.13	BC549W	0.15	BD244V	0.93	BF203	0.41	BFY70	0.27	MJ541	0.50
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2N1897	0.30	2N2930	0.17	2N3906	0.28	2N4929	0.80	2N5474	0.55	BC107E	0.16	BC177E	0.22	BC212E	0.18	BC309E	0.16	BD242	0.44	BDY24	1.10	BFY03	0.54
2N1898	0.30	2N2931	0.17	2N3907	0.28	2N4930	0.80	2N5475	0.55	BC107F	0.16	BC177F	0.22	BC212F	0.18	BC309F	0.16	BD243	0.44	BDY25	1.10	BFY04	0.54
2N1899	0.30	2N2932	0.17	2N3908	0.28	2N4931	0.80	2N5476	0.55	BC107G	0.16	BC177G	0.22	BC212G	0.18	BC309G	0.16	BD244	0.44	BDY26	1.10	BFY05	0.54
2N1900	0.30	2N2933	0.17	2N3909	0.28	2N4932	0.80	2N5477	0.55	BC107H	0.16	BC177H	0.22	BC212H	0.18	BC309H	0.16	BD245	0.44	BDY27	1.10	BFY06	0.54
2N1901	0.30	2N2934	0.17	2N3910	0.28	2N4933	0.80	2N5478	0.55	BC107I	0.16	BC177I	0.22	BC212I	0.18	BC309I	0.16	BD246	0.44	BDY28	1.10	BFY07	0.54
2N1902	0.30	2N2935	0.17	2N3911	0.28	2N4934	0.80	2N5479	0.55	BC107J	0.16	BC177J	0.22	BC212J	0.18	BC309J	0.16	BD247	0.44	BDY29	1.10	BFY08	0.54
2N1903	0.30	2N2936	0.17	2N3912	0.28	2N4935	0.80	2N5480	0.55	BC107K	0.16	BC177K	0.22	BC212K	0.18	BC309K	0.16	BD248	0.44	BDY30	1.10	BFY09	0.54
2N1904	0.30	2N2937	0.17	2N3913	0.28	2N4936	0.80	2N5481	0.55	BC107L	0.16	BC177L	0.22	BC212L	0.18	BC309L	0.16	BD249	0.44	BDY31	1.10	BFY10	0.54
2N1905	0.30	2N2938	0.17	2N3914	0.28	2N4937	0.80	2N5482	0.55	BC107M	0.16	BC177M	0.22	BC212M	0.18	BC309M	0.16	BD250	0.44	BDY32	1.10	BFY11	0.54
2N1906	0.30	2N2939	0.17	2N3915	0.28	2N4938	0.80	2N5483	0.55	BC107N	0.16	BC177N	0.22	BC212N	0.18	BC309N	0.16	BD251	0.44	BDY33	1.10	BFY12	0.54
2N1907	0.30	2N2940	0.17	2N3916	0.28	2N4939	0.80	2N5484	0.55	BC107O	0.16	BC177O	0.22	BC212O	0.18	BC309O	0.16	BD252	0.44	BDY34	1.10	BFY13	0.54
2N1908	0.30	2N2941	0.17	2N3917	0.28	2N4940	0.80	2N5485	0.55	BC107P	0.16	BC177P	0.22	BC212P	0.18	BC309P	0.16	BD253	0.44	BDY35	1.10	BFY14	0.54
2N1909	0.30	2N2942	0.17	2N3918	0.28	2N4941	0.80	2N5486	0.55	BC107Q	0.16	BC177Q	0.22	BC212Q	0.18	BC309Q	0.16	BD254	0.44	BDY36	1.10	BFY15	0.54
2N1910	0.30	2N2943	0.17	2N3919	0.28	2N4942	0.80	2N5487	0.55	BC107R	0.16	BC177R	0.22	BC212R	0.18	BC309R	0.16	BD255	0.44	BDY37	1.10	BFY16	0.54
2N1911	0.30	2N2944	0.17	2N3920	0.28	2N4943	0.80	2N5488	0.55	BC107S	0.16	BC177S	0.22	BC212S	0.18	BC309S	0.16	BD256	0.44	BDY38	1.10	BFY17	0.54
2N1912	0.30	2N2945	0.17	2N3921	0.28	2N4944	0.80	2N5489	0.55	BC107T	0.16	BC177T	0.22	BC212T	0.18	BC309T	0.16	BD257	0.44	BDY39	1.10	BFY18	0.54
2N1913	0.30	2N2946	0.17	2N3922	0.28	2N4945	0.80	2N5490	0.55	BC107U	0.16	BC177U	0.22	BC212U	0.18	BC309U	0.16	BD258	0.44	BDY40	1.10	BFY19	0.54
2N1914	0.30	2N2947	0.17	2N3923	0.28	2N4946	0.80	2N5491	0.55	BC107V	0.16	BC177V	0.22	BC212V	0.18	BC309V	0.16	BD259	0.44	BDY41	1.10	BFY20	0.54
2N1915	0.30	2N2948	0.17	2N3924	0.28	2N4947	0.80	2N5492	0.55	BC107W	0.16	BC177W	0.22	BC212W	0.18	BC309W	0.16	BD260	0.44	BDY42	1.10	BFY21	0.54
2N1916	0.30	2N2949	0.17	2N3925	0.28	2N4948	0.80	2N5493	0.55	BC107X	0.16	BC177X	0.22	BC212X	0.18	BC309X	0.16	BD261	0.44	BDY43	1.10	BFY22	0.54
2N1917	0.30	2N2950	0.17	2N3926	0.28	2N4949	0.80	2N5494	0.55	BC107Y	0.16	BC177Y	0.22	BC212Y	0.18	BC309Y	0.16	BD262	0.44	BDY44	1.10	BFY23	0.54
2N1918	0.30	2N2951	0.17	2N3927	0.28	2N4950	0.80	2N5495	0.55	BC107Z	0.16	BC177Z	0.22	BC212Z	0.18	BC309Z	0.16	BD263	0.44	BDY45	1.10	BFY24	0.54
2N1919	0.30	2N2952	0.17	2N3928	0.28	2N4951	0.80	2N5496	0.55	BC107A	0.16	BC177A	0.22	BC212A	0.18	BC309A	0.16	BD264	0.44	BDY46	1.10	BFY25	0.54
2N1920	0.30	2N2953	0.17	2N3929	0.28	2N4952	0.80	2N5497	0.55	BC107B	0.16	BC177B	0.22	BC212B	0.18	BC309B	0.16	BD265	0.44	BDY47	1.10	BFY26	0.54
2N1921	0.30	2N2954	0.17	2N3930	0.28	2N4953																	

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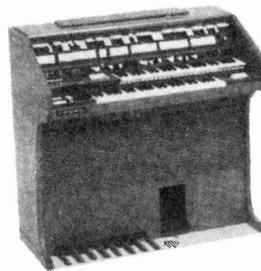
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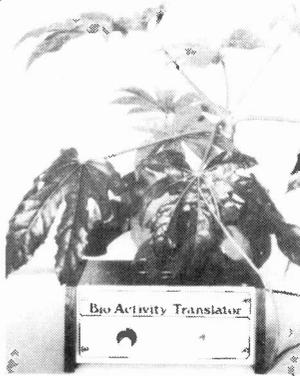
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THE COMPONENT CENTRE

7 LANGLEY ROAD - WATFORD - HERTS - WD1 3PS

Phone Watford 45335 Callers welcome 9.30-5.30 Mon-Sat. EC. Wed.

TRANSISTORS

AC126	21p	BC547	14p	MJ2955	99p
AC127	21p	BC548	14p	MJE340	64p
AC128	21p	BC549	14p	MJE2955	99p
AC176	21p	BC557	14p	MJE3055	68p
AC187	23p	BCY34	74p	OC25	108p
AC188	23p	BCY70	17p	OC35	108p
AD149	65p	BCY71	20p	OC71	19p
AD161	50p	BCY72	17p	OC84	46p
AD162	50p	BD115	59p	TP29	50p
AF114	30p	BD124	97p	TP30	52p
AF115	27p	BD131	47p	TP31	59p
AF116	25p	BD132	47p	TP32	59p
AF117	23p	BD135	43p	TP33	107p
AF118	30p	BD136	50p	TP34	60p
AF124	32p	BD137	50p	TP35	253p
AF125	32p	BD138	51p	TP36	389p
AF126	32p	BD139	51p	TP41	59p
AF239	40p	BD140	52p	TP42	59p
BF239	45p	BF173	30p	TP2955	126p
BC107	9p	BF179	37p	TP3055	64p
BC108	9p	BF180	37p	ZTX108	12p
BC109	9p	BF181	37p	ZTX300	12p
BC147	10p	BF182	37p	ZTX500	12p
BC148	10p	BF183	37p	2N1305	12p
BC149	10p	BF194	13p	2N1306	39p
BC157	11p	BF195	13p	2N1711	21p
BC158	11p	BF196	13p	2N2219	21p
BC159	11p	BF197	13p	2N2904	26p
BC168	12p	BF200	36p	2N2905	26p
BC169	12p	BF224	16p	2N2906	20p
BC171	12p	BF257	37p	2N2926G	9p
BC172	12p	BF258	40p	2N2926F	9p
BC173	12p	BF259	44p	2N2955	99p
BC177	16p	BF339	30p	2N3053	17p
BC178	16p	BF328	36p	2N3054	54p
BC179	16p	BF330	38p	2N3055	54p
BC182L	13p	BFX84	29p	2N3702	10p
BC183L	13p	BFX85	29p	2N703	10p
BC184L	13p	BFX86	31p	2N3704	12p
BC212L	13p	BFX87	31p	2N3705	12p
BC213L	13p	BFX88	29p	2N3706	12p
BC214L	14p	BFY50	17p	2N3708	12p
BC238	14p	BFY51	17p	2N3709	11p
BC303	30p	BSX20	21p	2N3711	10p
BC328	15p	BU105	191p	TI543	40p
BC338	15p	BU208	299p	2N2646	56p

S.C.R. THYRISTORS

1A/50V	28p	5A/400V	59p	10A/400V	70p
1A/200V	38p	5A/600V	75p	10A/600V	83p
1A/400V	40p	5A/800V	82p	10A/800V	129p
1A/600V	58p	7A/100V	59p	16A/100V	63p
3A/100V	36p	7A/200V	68p	16A/200V	67p
3A/200V	38p	7A/400V	120p	16A/400V	82p
3A/400V	51p	7A/600V	123p	16A/600V	115p

DIODES

BY127	16p	CA3011	86p
OA47	9p	CA3014	190p
OA70	9p	CA3018	86p
OA79	14p	CA3020	174p
OA81	15p	CA3023	186p
OA85	14p	CA3028	85p
OA91	7p	CA3030	129p
OA95	9p	CA3035	190p
OA200	9p	CA3036	115p
OA202	9p	CA3042	198p
IN914	4p	CA3045	275p
IN916	6p	CA3046	90p
IN4002	6p	CA3048	205p
IN4003	6p	CA3049	154p
IN4004	7p	CA3052	152p
IN4005	10p	CA3054	73p
IN4006	10p	CA3078	136p
IN4007	11p	CA3081	149p
3A-50V	16p	CA3086	47p
3A-100V	16p	CA3090	329p
3A-200V	18p	CA3130E	113p
3A-400V	20p	CA3140E	74p
3A-600V	25p	CA3160E	140p
10A-50V	25p	LM301	9p
10A-100V	25p	LM308	54p
10A-200V	28p	LM380	106p
10A-400V	36p	LM381	120p
10A-600V	42p	LM710	41p
1A-50V	22p	LM741	24p
1A-100V	24p	LM747	73p
1A-200V	27p	LM748	36p
1A-400V	30p	LM3900	73p
1A-600V	34p	MC1304	292p
2A-100V	35p	MC1310	197p
2A-200V	38p	MC1458	78p
2A-400V	42p	MC1496	78p
2A-600V	46p	NE555	33p
2A-100V	36p	NE556	76p
2A-200V	38p	NE561	385p
2A-400V	40p	NE562	385p
2A-600V	42p	NE565	138p
2A-100V	26p	NE566	129p
2A-200V	42p	NE567	175p
2A-400V	21p	SN76003	185p
2A-600V	50p	SN76013	185p
6A-100V	66p	SN76023	160p
6A-200V	66p	SN76033	259p
6A-400V	81p	TAA621	257p
10A-100V	68p	TAA681	175p
10A-200V	100p	TBA540	236p
10A-400V	133p	TBA641	281p
10A-600V	133p	TBA800	102p
10A-400V Plus	130p	TBA810	113p
		TBA820	90p

BRIDGE RECS

1A-50V	22p	LM3900	73p
1A-100V	24p	MC1304	292p
1A-200V	27p	MC1310	197p
1A-400V	30p	MC1458	78p
1A-600V	34p	MC1496	78p
2A-100V	35p	NE555	33p
2A-200V	38p	NE556	76p
2A-400V	40p	NE561	385p
2A-600V	42p	NE562	385p
2A-100V	26p	NE565	138p
2A-200V	42p	NE566	129p
2A-400V	21p	NE567	175p
2A-600V	50p	SN76003	185p
6A-100V	66p	SN76013	185p
6A-200V	66p	SN76023	160p
6A-400V	81p	SN76033	259p
10A-100V	68p	TAA621	257p
10A-200V	100p	TAA681	175p
10A-400V	133p	TBA540	236p
10A-600V	133p	TBA641	281p
10A-400V Plus	130p	TBA800	102p
		TBA810	113p
		TBA820	90p

TRIACS

2A-100V	26p	SN76003	185p
2A-200V	42p	SN76013	185p
2A-400V	21p	SN76023	160p
6A-100V	66p	SN76033	259p
6A-200V	66p	TAA621	257p
6A-400V	81p	TAA681	175p
10A-100V	68p	TBA540	236p
10A-200V	100p	TBA641	281p
10A-400V	133p	TBA800	102p
10A-600V	133p	TBA810	113p
10A-400V Plus	130p	TBA820	90p

C.-MOS

4000	16p	7400	13p
4001	18p	7401	15p
4002	18p	7402	16p
4006	110p	7403	17p
4007	20p	7404	22p
4008	20p	7405	22p
4010	62p	7406	44p
4011	19p	7407	44p
4012	20p	7408	22p
4013	20p	7409	23p
4014	108p	7410	16p
4015	97p	7411	24p
4016	59p	7412	24p
4017	99p	7413	38p
4018	99p	7414	66p
4019	99p	7415	33p
4020	119p	7416	33p
4021	99p	7417	18p
4022	94p	7418	28p
4023	21p	7419	20p
4024	83p	7420	28p
4025	20p	7421	29p
4026	190p	7422	74p
4027	59p	7423	74p
4028	96p	7424	123p
4029	118p	7425	123p
4030	62p	7426	102p
4031	249p	7427	130p
4032	108p	7428	19p
4033	157p	7429	39p
4034	130p	7430	28p
4035	130p	7431	28p
4036	117p	7432	39p
4037	70p	7433	33p
4038	24p	7434	48p
4039	22p	7435	46p
4040	22p	7436	91p
4041	22p	7437	36p
4042	22p	7438	36p
4043	22p	7439	36p
4044	22p	7440	36p
4045	22p	7441	36p
4046	22p	7442	36p
4047	22p	7443	36p
4048	22p	7444	36p
4049	22p	7445	36p
4050	22p	7446	36p
4051	22p	7447	36p
4052	22p	7448	36p
4053	22p	7449	36p
4054	22p	7450	36p
4055	22p	7451	36p
4056	22p	7452	36p
4057	22p	7453	36p
4058	22p	7454	36p
4059	22p	7455	36p
4060	22p	7456	36p
4061	22p	7457	36p
4062	22p	7458	36p
4063	22p	7459	36p
4064	22p	7460	36p
4065	22p	7461	36p
4066	22p	7462	36p
4067	22p	7463	36p
4068	22p	7464	36p
4069	22p	7465	36p
4070	22p	7466	36p
4071	22p	7467	36p
4072	22p	7468	36p
4073	22p	7469	36p
4074	22p	7470	36p
4075	22p	7471	36p
4076	22p	7472	36p
4077	22p	7473	36p
4078	22p	7474	36p
4079	22p	7475	36p
4080	22p	7476	36p
4081	22p	7477	36p
4082	22p	7478	36p
4083	22p	7479	36p
4084	22p	7480	36p
4085	22p	7481	36p
4086	22p	7482	36p
4087	22p	7483	36p
4088	22p	7484	36p
4089	22p	7485	36p
4090	22p	7486	36p
4091	22p	7487	36p
4092	22p	7488	36p
4093	22p	7489	36p
4094	22p	7490	36p
4095	22p	7491	36p
4096	22p	7492	36p
4097	22p	7493	36p
4098	22p	7494	36p
4099	22p	7495	36p
4100	22p	7496	36p
4101	22p	7497	36p
4102	22p	7498	36p
4103	22p	7499	36p
4104	22p	7500	36p

T.T.L.

D.I.L. SOCKETS

8 pin	10p	16 pin	14p
14 pin	13p	28 pin	30p
TIL209	Red		
TIL209	Yellow		
TIL209	Green		
	Red		
	Yellow		
	Green		
TIL209 Clip			
	2		
	Clip		

LOUDSPEAKERS

1 1/2 in	8Ω	72p
1 in	8Ω	72p
2 in	8Ω	72p
2 1/2 in	8Ω	64p
2 in	8Ω	64p
2 1/2 in	8Ω	72p
1 1/2 in	8Ω	76p
2 1/2 in	8Ω	118p

TRANSFORMERS

Mains prim 220-240V

NEONS

U.K. RETURN OF POST MAIL ORDER SERVICE also WORLDWIDE EXPORT SERVICE

R.C.S. 10 WATT AMPLIFIER KIT



This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductor components. The stereo kit uses 22 semiconductor components. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms. 7W into 15 ohms. Response 20c/s to 30kc/s input 100mV, high imp. Size 9 1/2 x 3 x 2 1/2 in. A/C mains operated.

Mono kit **£12.50** Stereo kit **£20.45p**
Easy to build Full instructions supplied



ELAC SPEAKER 10 inch £4.95

Large ceramic magnet 50-16,000 c/s. Bass resonance 55 c/s. 10W. 8 ohm impedance.

RCS STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp. per channel, with volume control and P.C. Board. Can be ganged to make multi-way mixers.

£2.95 Post 35p

MAINS TRANSFORMERS ALL POST 75p each

250-0-250V 70mA, 6 3 2A **£3.45**
250-0-250 80mA, 6 3V 3 5A, 6 3V 1A or 5V 2A **£4.60**
350-0-350 80mA, 6 3V 3 5A, 6 3V 1A or 5V 2A **£5.80**
300-0-300 120mA 2 x 6 3V 2A C.T. 6 3V 2A **£8.50**
220V 45mA, 6 3V 2A **£1.75**
HEATER TRANS. 6 3V 3A, £1.45, 1/2 amp **£1.00**
GENERAL PURPOSE LOW VOLTAGE Tapped outputs at
2A 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V **£5.30**
1A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£5.30**
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£8.50**
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£14.50**
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£14.50**
5, 8, 10, 16V 1/2A £2. 12V 100mA £1. 12V 300mA £1.

12V 750mA **£1.30**, 40V 2A tapped 10V or 30V **£2.95**,
10-0-10V, 2A **£2.50**, 40V 2A **£2.95**, 30V 5A 34V 2A ct. **£3.75**,
2 x 18V 6A **£5.12**, 0-12V 2 amp **£2.95**,
20-0-20V 1A **£2.95**, 30V 1 1/2A **£2.75**, 20V 1A **£2.20**,
9V 3 amp **£2.75**, 60V, 40V, 20V or 20-0-20V, 1A **£3.50**,
30-0-30 2A **£7.95**, 250mA **£1.30**, 30V 2 amp **£3.**
AUTO TRANSFORMERS: 115V to 230V or 230V to 115V
150W **£5**; 250W **£6**; 400W **£7**; 500W **£8**.
CHARGER TRANSFORMERS: Input 200/250V for 6 or 12V
1 1/2A **£2.75**; 3A **£4**; 4A **£5.20**.
FULL WAVE BRIDGE CHARGER RECTIFIERS, 6 or 12V outputs
1 1/2A 55p; 4A **£1.25**. HALF WAVE 12V 1 1/2A 25p.

GOODMAN'S COMPACT 12in BASS WOOFER



Standard 12in diameter fixing with cut sides 12 x 10in. 14,000 gauss magnet. 20 watt rms. 4 ohm impedance. Bass resonance 30 c.p.s. Frequency response 30-8,000 c.p.s. **£9.95** each. Post **£1.00**.

10 WATT PER CHANNEL STEREO AMPLIFIER Ready made in chassis form. Mains operated. Volume balance, treble and bass slider controls. Pick up and tape inputs. Recording output. Socket. Front panel size: 16 1/2 x 1 1/2 in. Chassis size: 13 x 15 in. Bargain **£18.50** Post 30p Made by Rank.

HEATING ELEMENTS WAFER THIN

Size 10 1/2 x 8 1/2 x 3/4 in. Operating voltage 200-250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters etc. Must be clamped between two sheets of metal or asbestos. ONLY **40p** EACH (FOUR FOR **£1.50**) ALL POST PAID—Discounts for quantity

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

With tweeter. And crossover.

10W Model **£7.95** Post 45p
State 4 or 8 ohm.
15W model **£10.50** Post 65p
8 ohms
20W model **£11.50** Post 75p
State 8 or 15 ohms.

TEAK VENEER HI-FI SPEAKER CABINETS

MODEL "A" 20 x 13 x 12in. For 12in. dia. or 10in. speaker. Illustrated **£14.50** Post **£1.60**
MODEL "B" BOOKSHELF For 13 x 8in. EMI Loudspeakers. **£8.50** Post **£1**

R.C.S. BOOKSHELF complete with speakers. Size 14 x 9 x 6in. approx. Response 50 to 14,000 cps. 12 watt rms 8 ohms **£19 pair** Post **£1.50**
ACOUSTIC WADDING 18in. wide, **20p** ft.

MONO PRE-AMPLIFIER

A mains operated solid state pre-amplifier unit designed to compliment amplifiers without low level phono and tape input stages. This free standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. Power ON/OFF, PHONO/TAPE switches and pilot lamp are on the front panel; phono socket input and output are rear located. AC mains 240V. Size 6 x 3 1/2 x 2in. Post 50p

£4.50 ea. - 2 for £8.



BAKER MAJOR 12 INCH £16.88



30-14,500 c/s 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 4 or 8 or 16 ohms available

Module kit, 30-17,000 c/s with tweeter, crossover baffle, 19 x 12 1/2 in. instructions As illustrated **£20.52** Please state 4 or 8 or 16 ohms Post **£1.60**

"BIG SOUND" BAKER SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups and discos. Useful response 30-13,000 c/s. Bass Resonance 55 c/s

GROUP "25"

12in 30W **£12.96** Post **£1**
4, 8 or 16 ohms

GROUP "35"

12in 40W **£15.12** Post **£1**
4, 8 or 16 ohms

GROUP 50/12in

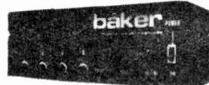
12in 60W **£22.68** Post **£1.60**
4 or 8 or 16 ohms with aluminium presence dome

GROUP 50/15in

15in 75W **£34.00** Post **£1.60**
8 or 16 ohms with aluminium presence dome. Post **£1.60**

Discos. Group - PA Cabinets in stock. Send for Leaflet. Covering Plittings, Handles, Corners, Feet, Cabinet Material all in stock.

BAKER 150 WATT ALL PURPOSE TRANSISTOR AMPLIFIER



Ideal for Groups Disco P.A. and Musical Instruments. 4 inputs speech and music. 4 way mixing. Output 4/8/16 ohm. a.c. Mains 240V. Separate treble and bass controls. 100 volt line model £10 extra. **£85** Carr **£1.50**

NEW "DISCO 100 WATT" £59

ALL TRANSISTOR AMPLIFIER CHASSIS Carr **£1**. 2 inputs 4 outputs separate volume treble and bass controls. Ideal disco or slave amplifier chassis. Made by Jennings

R.C.S. SOUND TO LIGHT DISPLAY MK II

Complete kit of parts with R.C.S. printed circuit. Three 1000W channels. Will operate from 200mV signal source. CABINET extra **£4**. KIT = **£17.00**

GOODMANS CONE TWEETER

£18,000 c/s 25W 8 ohm. Price **£3.25**
3 WAY CROSSOVER WITH TREBLE & MID RANGE CONTROLS. 50 WATT. **£5** POST **£1**.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS



Professional model. Four inputs. Treble, Bass, Master Volume Controls. Ideal disco, P.A. or groups. SAE for **£99** details. 5 speaker outputs 3 or 8 or 15 ohm. 100V line to order. Suitable carrying case **£16.50**. plus **£2.50** carr

LOW VOLTAGE ELECTROLYTICS
1 2 4 5 8 16 25 30 50 100 200mF 15V 10p. 500mF 12V 15p;
25V 20p; 50V 30p. 1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p;
2000mF 6V 25p; 25V 42p; 2500mF 50V 82p; 3000mF 25V 47p;
50V 85p. 3900mF 100V £1.60. 4700mF 63V £1.20. 5000mF 6V 25p;
12V 42p; 25V 75p; 35V 85p; 5600mF 76V £1.60; 1200/76V 80p.

HIGH VOLTAGE ELECTROLYTICS

8/350V 22p	8+8/450V 50p	50+50/300V 50p
16/350V 30p	8+16/450V 50p	32+32/450V 75p
32/500V 75p	16+16/450V 50p	100+100/275V 65p
50/350V 50p	32+32/350V 50p	150+200/275V 70p

ROBUST BLACK PLASTIC BOX Size 6 1/2 x 3 1/2 x 2in with brushed aluminium facia. Ideal for constructional projects. **£1.50** Post 30p

R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS

All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer. Input 200/240V a.c. Output voltages available 6 or 7.5 or 9 or 12V d.c. up to 100mA or less. Size 3 x 2 1/2 x 1 1/2 in. Please state voltage required. **£2.95** Post 45p

ELECTRO MAGNETIC PENDULUM MECHANISM 95p

1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays. Teaching electro magnetism or for metronome, strobe etc.

BSR AUTOCHANGER

Plays 12in, 10in or 7in records Auto or Manual. A high quality unit backed by BSR reliability with 12 months guarantee. a.c. 200/250V. Size 13 1/2 x 11 1/2 in. Above motor board 3 1/2 in. Below motor board 2 1/2 in.

With STEREO/MONO CARTRIDGE **£12.95** All Post 75p
BSR P182 SINGLE PLAYER. Snake Arm Flared Turntable Ceramic Cartridge **£19.95**
GARRARD AUTOCHANGER plays all records **£14.95**
BSR P163 BELT DRIVE DECK, less cartridge **£27.50**
GARRARD AP76 Single Player less cartridge **£27.50**

BSR DE LUXE AUTOCHANGER

Features balanced arm, cueing device, stylus pressure gauge, 3 speed - plays all size records. Fitted with stereo ceramic cartridge. Size: 13 x 12ins. Post **£1**.
Or with Sonotone V100 "magnetic cartridge" **£21.50**



R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop, stereo compatible cartridge. Baseplate. Size 11 x 8 1/2 in. Turntable. Size 7in diameter. a.c. mains 220/250V. 3 speeds plays all size records. Post **£1**.
Two for **£15**, Post 75p. **£7.95** 45p

HEAVY METAL PLINTHS

With P.V.C. Cover. Cut out for most BSR or Garrard decks. Silver grey finish. Model A Size 12 1/2 x 14 1/2 in. Post **£1.50**
Model B Size 16 x 13 1/2 x 7in **£7.50**.
Extra Large Plinth and Cover. For transcription decks. Size 20 x 17 1/2 x 9in. uncut board. Shop callers only **£18.50**.

TINTED PLASTIC COVERS ONLY

Sizes: 14 1/2 x 12 1/2 x 4 1/2 in. **£3**, 17 1/2 x 14 x 4 in. **£4.50**,
16 1/2 x 14 x 4 in. **£4**, 15 1/2 x 13 1/2 x 4 in. **£3.75**,
15 x 13 1/2 x 3in. **£3.50**, 17 1/2 x 9 1/2 x 3 1/2 in. **£3**,
14 1/2 x 14 1/2 x 2 1/2 in. Rosewood sides **£4**.
Ideal for record decks, tape decks, etc. Post **£1**.

BAKER HI-FI SPEAKERS

HIGH QUALITY—BRITISH MADE

SUPERB £24.75 Post **£1.60**
12in 25 watt

Quality loudspeaker low cone resonance ensures clear reproduction of the deepest bass. Special copper drive and concentric tweeter cone. Full range reproduction with remarkable efficiency in the upper register.
Bass Resonance 25 c/s
Flux Density 16 500 gauss
Useful response 20-17,000 c/s
8 or 16 ohms models

AUDITORIUM £22.68 Post **£1.60**
12in 35 watt

A full range reproducer for high power Electric Guitars, public address, multi speaker systems electric organs. Ideal for Hi-Fi and Discotheques.
Bass Resonance 35 c/s
Flux Density 15,000 gauss
Useful response 25-16,000 c/s
8 or 16 ohms models

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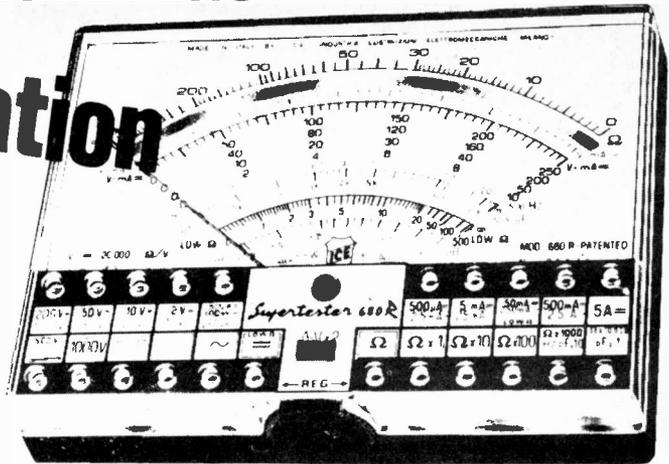
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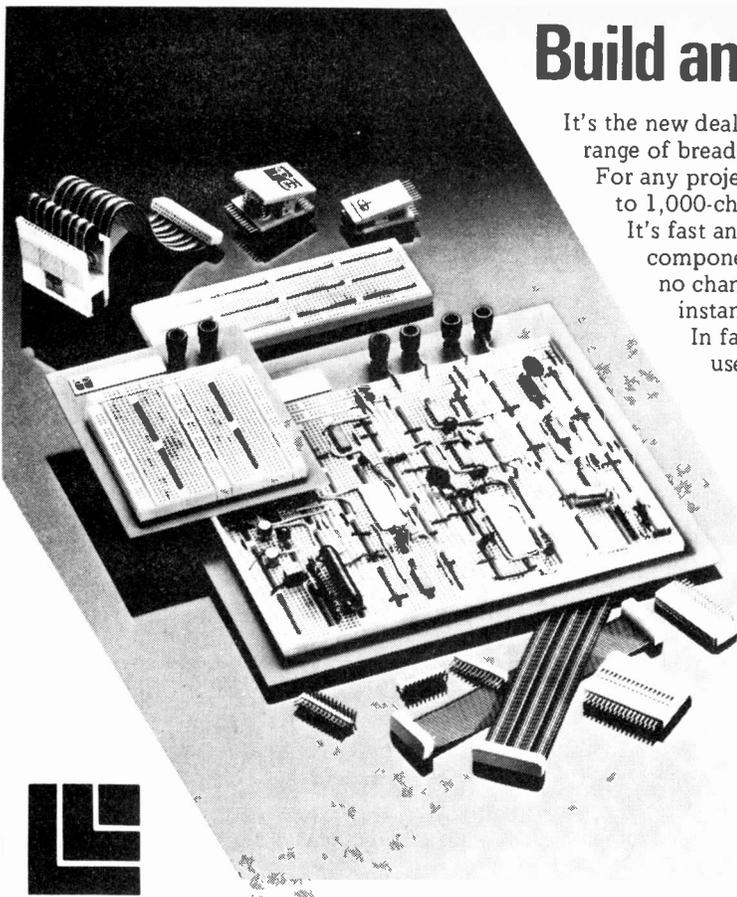
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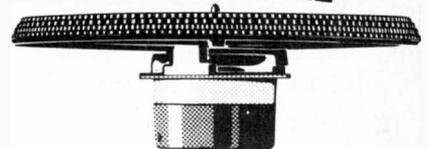
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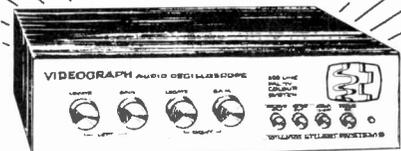
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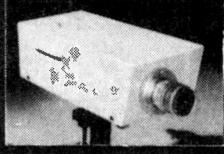
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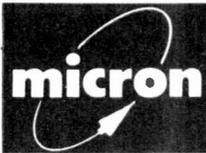
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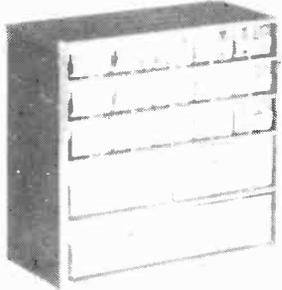
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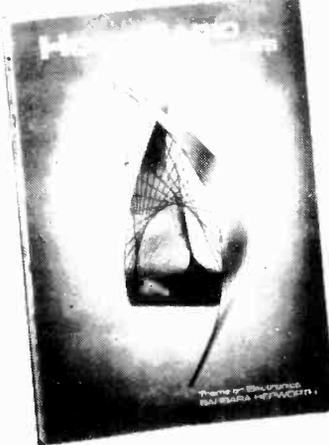
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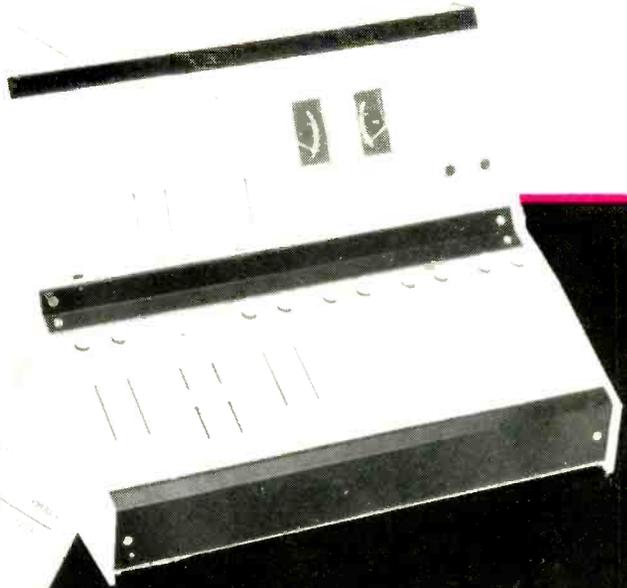


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7405	18p	74122	48p	74403	225p	9313	165p	4020	100p	*AVS-1320	320p	*BC147/8	9p	*BU105	190p	TIP305	70p	2N4058/9	12p	*0491	9p	*2A 100V 35p	
7406	32p	74123	55p	74404	225p	9314	165p	4021	110p	*CA3019	80p	BU108	10p	BU108	250p	TIP305	70p	2N4060	12p	*0495	9p	*2A 400V 45p	
7407	32p	74125	55p	74405	225p	9315	165p	4022	100p	*CA3046	70p	BU205	220p	*BU205	220p	TIP305	70p	2N4061/2	12p	*0495	9p	*3A 200V 60p	
7408	19p	74126	60p	74406	225p	9316	165p	4023	100p	*CA3048	70p	*BC159	12p	*BU208	200p	*TIP300	75p	2N4061/2	12p	*0495	9p	*3A 500V 72p	
7409	19p	74128	75p	74407	225p	9317	165p	4024	65p	*CA3080E	72p	*BC169C	12p	BU406	145p	*TIP300	75p	2N4061/2	12p	*0495	9p	*4A 100V 95p	
7410	15p	74132	75p	74408	225p	9318	165p	4025	20p	*CA3089E	175p	*BC172	12p	*E300	60p	*TIP305	70p	2N4061/2	12p	*0495	9p	*4A 400V 100p	
7411	24p	74138	75p	74409	225p	9319	165p	4026	130p	*CA3090AD	375p	BC178/9	17p	*E308	55p	TIP305	70p	2N4427	20p	*0495	9p	*6A 50V 90p	
7412	20p	74141	70p	74410	225p	9320	175p	4027	50p	*CA3130S	100p	*BC181/3	10p	*MJE181	175p	TIP48	75p	*2N4574	25p	*1N4118	4p	*5A 100V 100p	
7413	30p	74142	200p	74411	225p	9321	175p	4028	80p	*CA3140E	70p	*BC182/3	10p	MJ491	200p	2N696	35p	*2N6087	27p	*1N4012	10p	*6A 100V 100p	
7414	60p	74145	90p	74412	225p	9322	175p	4029	100p	*CA3160E	100p	*BC184	11p	MJ2501	200p	2N697	25p	*2N6089	27p	*1N4003/4	6p	*10A 400V 200p	
7416	27p	74147	190p	74413	225p	9323	175p	4030	55p	F2029	750p	BC187	30p	MJ2955	100p	2N698	45p	*2N6172	27p	1N4005	6p	25A 400V 400p	
7417	27p	74148	190p	74414	225p	9324	175p	4031	200p	ICL7106	925p	*BC212/3	11p	MJ3001	225p	2N708A	20p	*1N5412/3	7p	TRIACS			
7420	17p	74150	100p	74415	225p	9325	175p	4032	180p	ICL7106	925p	*BC214	12p	*MJE340	65p	2N708A	20p	1N5412/3	7p	PLASTIC			
7421	40p	74151A	70p	74416	225p	9326	175p	4033	200p	ICL7106	925p	BC241	36p	MJE2955	100p	2N918	45p	2N5194	40p	3A 400V 60p			
7422	22p	74153	70p	74417	225p	9327	175p	4034	110p	LM311	190p	*BC247/8	30p	MJE3055	100p	2N930	18p	*2N5245	40p	3A 600V 65p			
7423	34p	74154	100p	74418	225p	9328	175p	4040	100p	LM318	200p	*BC517/8	15p	*MPS10/4	40p	2N131/2	20p	*2N5298	55p	3A 500V 65p			
7425	30p	74155	90p	74419	225p	9329	175p	4041	80p	LM324	70p	*BC519C	18p	*MPS10/6	40p	2N1613	25p	*2N5401	50p	5A 400V 70p			
7426	40p	74156	90p	74420	225p	9330	175p	4042	80p	LM338	70p	*BC549C	18p	*MPS10/6	40p	2N1711	25p	*2N5457/8	40p	6A 500V 88p			
7427	34p	74157	70p	74421	225p	9331	175p	4043	90p	LM348	95p	*BC557C	18p	*MPSA06	30p	2N1202	60p	*2N5459	40p	8A 400V 75p			
7428	35p	74159	190p	74422	225p	9332	175p	4044	90p	LM377	175p	*BC559C	18p	*MPSA06	30p	2N1210	60p	*2N5460	40p	8A 500V 95p			
7430	17p	74160	130p	74423	225p	9333	175p	4045	180p	LM380	160p	*BC561	18p	*MPSA06	30p	2N1219	20p	*2N5461	40p	12A 400V 85p			
7432	30p	74161	100p	74424	225p	9334	175p	4046	150p	LM381AN	150p	*BC562	18p	*MPSA06	30p	2N2222A	20p	*2N6027	48p	12A 500V 105p			
7433	40p	74162	100p	74425	225p	9335	175p	4047	150p	LM389N	140p	*BC563	18p	*MPSA06	30p	2N2369A	16p	2N6247	19p	16A 400V 110p			
7437	35p	74163	100p	74426	225p	9336	175p	4048	40p	LM709	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	16A 500V 130p			
7438	35p	74164	100p	74427	225p	9337	175p	4049	40p	LM710	50p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7440	17p	74165	90p	74428	225p	9338	175p	4050	40p	LM710	50p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7441	70p	74166	140p	74429	225p	9339	175p	4051	40p	LM710	50p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7442A	60p	74167	200p	74430	225p	9340	175p	4052	80p	LM741	22p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7443	112p	74170	240p	74431	225p	9341	175p	4053	80p	LM747	70p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7444	112p	74172	220p	74432	225p	9342	175p	4054	80p	LM747	70p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7445	100p	74173	220p	74433	225p	9343	175p	4055	125p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7446A	93p	74174	93p	74434	225p	9344	175p	4056	135p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7447A	70p	74175	80p	74435	225p	9345	175p	4057	135p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7448	80p	74176	90p	74436	225p	9346	175p	4058	60p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7450	17p	74177	90p	74437	225p	9347	175p	4059	60p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7451	17p	74178	160p	74438	225p	9348	175p	4060	115p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7453	17p	74180	90p	74439	225p	9349	175p	4061	115p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7454	17p	74181	200p	74440	225p	9350	175p	4062	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7455	17p	74182	90p	74441	225p	9351	175p	4063	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7470	36p	74184A	150p	74442	225p	9352	175p	4064	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7472	30p	74185	150p	74443	225p	9353	175p	4065	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
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7475	36p	74191	100p	74446	225p	9356	175p	4068	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7476	35p	74192	100p	74447	225p	9357	175p	4069	120p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7480	50p	74193	100p	74448	225p	9358	175p	4070	30p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7481	100p	74194	100p	74449	225p	9359	175p	4071	22p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7482	84p	74195	95p	74450	225p	9360	175p	4072	22p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7483A	90p	74196	95p	74451	225p	9361	175p	4073	22p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			
7484	100p	74197	80p	74452	225p	9362	175p	4074	22p	LM748	35p	*06242	25p	OC28	130p	2N2484	30p	2N6254	130p	12A 100V 120p			

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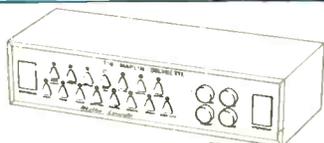
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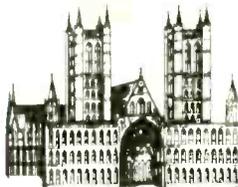
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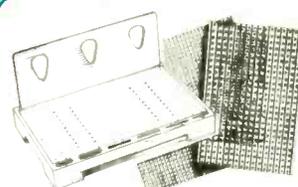
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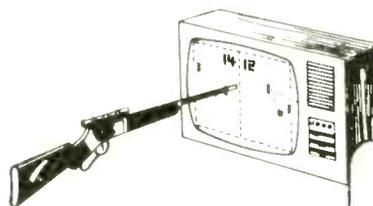
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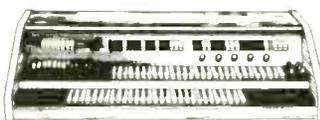
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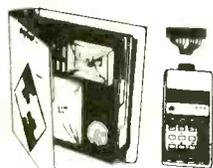
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