

PRACTICAL

ELECTRONICS

DECEMBER 1979

55p

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SOLID STATE

CAR INSTRUMENTS

AS SEEN IN
P.E. AUGUST, SEPTEMBER
OCTOBER 1979

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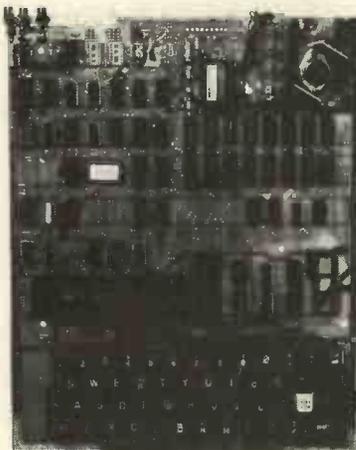
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WITH EXTENDED
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- ★ Video output and UHF Highgrade modulator (8Mz Bandwidth) which connects direct to the aerial socket of your T.V. Channel 36 UHF
- ★ Fully stabilised 5V power supply including transformer on board.
- ★ Standard KANSAS city tape interface providing high reliability program storage — use on any standard domestic tape or cassette recorder.
- ★ 4K user RAM expandable to 8K on board £49 extra.
- ★ 40 line expansion Interface socket on board for attachment of extender card containing 24K RAM and disk controller. (Ohio Scientific compatible).
- ★ 6502 machine code accessible through powerful 2K machine code monitor on board
- ★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.
- ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.



Simple Soldering due to clear and concise instructions compiled by Dr. A.A. Berk, BSc.PhD

NO EXTRAS NEEDED JUST HIT 'RETURN' AND GO.

Build, understand, and program your own computer for only a small outlay.

KIT ONLY **£219** + VAT including RF Modulator & Power supply. Absolutely no extras.

Available ready assembled and tested, ready to go for **£269** + VAT

*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print. SPECIAL CHARACTERS

@ Erases line being typed, then provides carriage return, line feed.

CR Carriage Return — must be at the end of each line.

• Separates statements on a line. CONTROLIC Execution or printing of a list is interrupted at the end of a line.

"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.

CONTROLIO No outputs occur until return made to command mode. If an input statement is encountered, either another CONTROLIO is typed, or an error occurs.

? Equivalent to PRINT

FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)

FRE(X)	INT(X)
SGN(X)	SIN(X)
USR(I)	

STRING FUNCTIONS

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$,I)
RIGHT\$(X\$,I)		STR\$(X)	
LEN(X\$)	MID\$(X\$,I,J)		
VAL(X\$)			

COMMANDS
CONT LIST NEW NULL RUN
STATEMENTS
CLEAR DATA DEF DIM END FOR
GOTO GOSUB IF.GOTO IF.THEN INPUT LET
NEXT ON.GOTO ON.GOSUB POKE PRINT REAC
REM RESTORE RETURN STOP
EXPRESSIONS
OPERATORS
+ * / % ^ NOT.AND.OR. >< <> >= <= RANGE 10⁻³² to 10⁺³²
VARIABLES
A,B,C...Z and two letter variables
The above can all be subscripted when used in an array
String variables use above names plus \$.e.g. A\$

COLOUR ADD-ON CARD AVAILABLE SOON

Enables you to choose your foreground the background colour anywhere on the screen. Flash any character on the screen at will. Full documentation and parts in kit form.

THE ATARI VIDEO COMPUTER SYSTEM £138 + VAT



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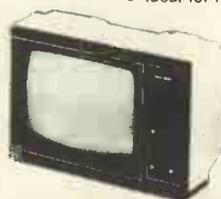
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100V: 10nF, 15n, 22n 24p; 33n, 47n 41p; 68n 48p; 1µF 64p; 2.2µ 82p.
160V: 10nF, 12n, 33n, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1µF 22p; 2.2µF 32p; 4.7µF 36p.
1000V: 10n, 15n 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1µF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n 5p; 33n, 47n, 68n, 100n 7p; 150n 9p; 220n, 330n 13p; 470n 12p; 680n 18p; 1µ 22p 13p; 2.2µ 34p.
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TAG-END TYPE: 450V: 100µF 180m; 70V: 4700 165p; 64V: 2500 98p; 3300 130p; 50V: 2200 99p; 3300 105p; 40V: 15,000 399p; 4700 120p; 4000 92p; 3300 93p; 2500 85p; 2200 85p; 2000 + 2000 120p; 30V: 4700 90p; 25V: 6400 105p; 4700 85p; 3300 80p; 2200 60p.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8, 8.2V: 1.5, 10, 20V: 1.5µ, 16V: 10µF 13p each.
16V: 15µ, 22 25p; 47, 100, 220 40p.
100V: 15µ, 22, 33, 50µF; 100 35p; 6V: 47, 68, 100 30p; 33, 50µ 20p.

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100V: 0.001, 0.002, 0.005, 0.01, 0.01µF 6p
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0.1µF, 0.2 10p. 50V: 0.47µF 12p

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Range: 0.5pF to 10nF 4p
15nF, 22nF, 33nF, 47nF 5p 100nF 6p

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2.5pF, 3-10pF;
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1250pF 58p

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AC107	28	BC327	15	8FY51	P	TIP35C	P	2N1671B	215
AC125	20	BC328	15	8FY52	P	TIP36A	220	2N2219A	22
AC126	20	BC329	15	8FY56	45	TIP36C	256	2N2204A	26
AC127	20	BC331	15	8FY64	40	TIP41A	66	2N2221A	23
AC128	20	BC332	15	8FY71	20	TIP41B	66	2N2222A	23
AC141	24	BC337	25	8FY81	90	TIP42A	64	2N2369A	15
AC142	24	BC351E	48	85X20	18	TIP42B	82	2N2646	48
AC187	24	BC517	48	85X29	45	TIP142	195	2N2784	55
AC188	24	BC547	12	85Y95A	18	TIP147	199	2N2904	22
AC176	40	BC548	12	85Z26	78	TIP295E	65	2N2905A	22
ACY17	40	BC549C	12	85Z35	140	TIP305	75	2N3422	146
ACY18	40	BC557	15	BU205	190	TIS44	34	2N2907A	22
ACY19	40	BC558	20	BU208	225	TIS55	45	2N2826G	10
ACY20	40	BC559	20	MD8001	158	TIS45	45	2N3052	20
ACY21	35	BC570	18	MJ491	160	TIS88A	40	2N3054	55
ACY28	40	BC572	20	MJ255	105	TIS90	20	2N3055	48
ACY39	78	BD121	78	MJ340	54	TIS91	24	2N3056	48
AD149	70	BD121	78	MJE370	58	TIX07	12	2N3504	55
AD161	42	BD123	98	MJE371	60	ZTX108	12	2N3663	26
AD162	42	BD124	115	MJE2955	105	ZTX109	14	2N3702	11
AF114	50	BD131	45	MJE3055	70	ZTX122	28	2N3703	11
AF115	50	BD132	45	MPF102	68	ZTX300	13	2N3704	11
AF116	50	BD133	43	MPF103	36	ZTX301	25	2N3705	11
AF117	50	BD135	38	MPF104	36	ZTX302	20	2N3706	11
AF118	65	BD136	36	MPF105	36	ZTX303	25	2N3707	11
AF139	35	BD137	36	MPF106	40	ZTX304	24	2N3708	11
AF149	70	BD138	50	MPSA05	25	ZTX314	24	2N3709	11
8C107	10	BD139	40	MPSA06	25	ZTX320	30	2N3710	16
8C107B	12	BD140	30	MPSA12	40	ZTX311	40	2N3711	16
8C108	12	BD144	198	MPSA55	25	ZTX312	20	2N3822	130
8C108B	12	BD145	198	MPSA56	25	ZTX500	15	2N3771	233
8C108C	12	BD205	110	MPSU02	58	ZTX501	15	2N3772	195
8C109	12	BD378	65	MPSU05	50	ZTX502	19	2N3773	288
8C109B	12	BD517	65	MPSU06	58	ZTX503	15	2N3819	22
8C109C	12	BD517	65	MPSU07	65	ZTX504	25	2N3820	45
8C140	35	BD695A	65	MPSU55	55	ZTX511	25	2N3823	95
8C142	30	BD696A	65	MPSU56	60	ZTX520	25	2N3866	90
8C143	30	BDV56	156	OC23	170	40250	85	2N3903	20
8C144	30	BDV115	34	OC26	170	40251	97	2N3904	18
8C147B	10	BF172	20	OC28	150	40311	60	2N3905	18
8C148	8	BF177	24	OC30	150	40312	60	2N3906	18
8C148B	10	BF178	25	OC35	130	40315	55	2N4037	52
8C148C	10	BF179	30	OC41	48	40316	85	2N4058	17
8C149	8	BF180	35	OC42	48	40317	52	2N4061	17
8C150	11	BF194	12	OC43	55	40319	71	2N4062	17
8C151	11	BF195	12	OC44	55	40320	56	2N4063	17
8C152	27	BF196	12	OC45	28	40407	52	2N4922	55
8C157	10	BF197	14	OC70	28	40406	65	2N4829	65
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8C169C	14	BF244B	30	OC82	50	40494	90	2N5179	60
8C170	18	BF256	50	OC83	44	40595	98	2N5180	80
8C171	11	BF257	50	OC84	44	40603	65	2N5191	70
8C172	11	BF258	50	OC85	44	40604	65	2N5192	70
8C173	12	BF259	30	OC110	110	40594	90	2N5306	40
8C177	18	BF274	18	OC170	85	40595	98	2N5307	40
8C178	16	BF336	35	OC200	85	40636	125	2N5459	32
8C179	18	BF354	40	TIP29	43	40673	65	2N5485	35
8C181	21	BF359	38	TIP29A	44	40697	25	2N5642	750
8C182	9	BF360	38	TIP29B	44	40698	25	2N5777	45
8C183	9	BF369	25	TIP29C	66	40699	54	2N5778	40
8C184	9	BF370	25	TIP30	47	40706A	18	2N6109	50
8C182L	11	BF441	28	TIP30A	50	40708	19	3N128	112
8C183L	10	BF479	28	TIP30B	64	40714	32	3N140	112
8C184L	28	BF480	28	TIP30C	65	40716	27	40715	795
8C187	28	BF481	28	TIP30D	62	40718	40	40719	280
8C212	10	BF482	105	TIP31C	85	40719	22	40720	280
8C212L	11	BF483	105	TIP31D	58	2N1132	22	40721	280
8C213	12	BF484	26	TIP32C	75	2N1303	50	40722	280
8C213L	12	BF485	26	TIP33A	85	2N1304	50	40723	280
8C214	13	BF486	28	TIP33C	105	2N1305	28	40724	280
8C214L	13	BF487	28	TIP33D	115	2N1307	50	40725	280
8C307B	20	BF488	28	TIP34C	115	2N1308	46	40726	280
8C308B	20	BF500	20	TIP35A	185	2N1670	50	40727	280

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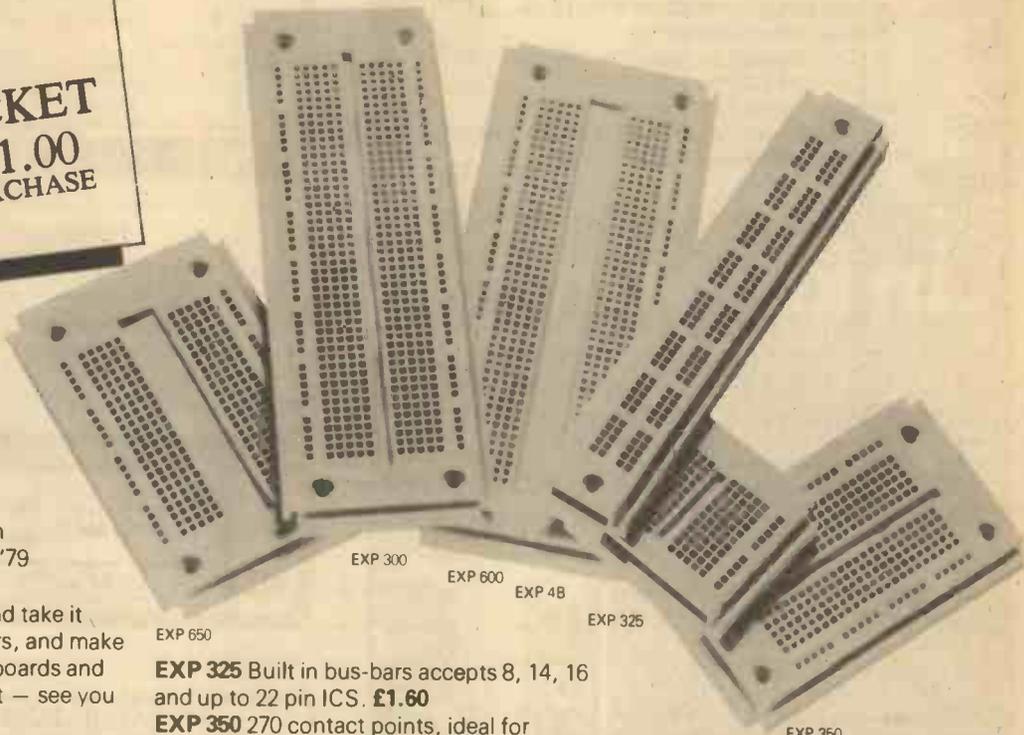
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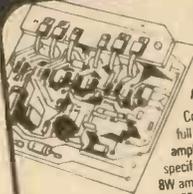
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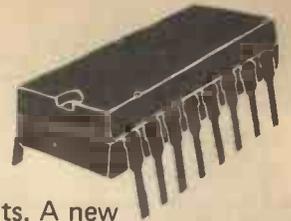
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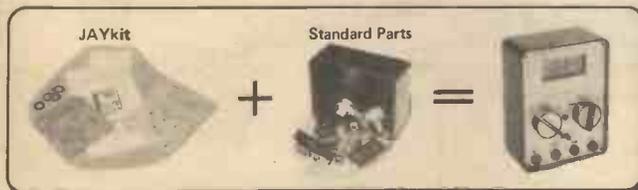
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PCB**



- Compact size, 5" x 7"
- Complete with power and video plugs, plus leads
- Scan coil assembly as standard supplied
- Transformers, tubes, and surrounds available
- 15v Mains or 12v DC power
- Ideal for O.E.M. use

self contained **10"**
MONITOR



- Totally enclosed
- All transistorised
- Suitable for analogue signals or alphanumeric
- Operable on 220v Mains or 12v DC power
- Comparable to wire frame monitors

ONLY **£35.50** ONLY **£85.00**

EX VAT AND P&P

Crofton Electronics

Crofton Electronics Limited, 35 Grosvenor Road,
Twickenham, Middlesex. Tel.: 01 891 1923



20 x 20 WATT STEREO AMPLIFIER
 Viscount IV unit in teak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder, DIN speaker and input sockets 20 x 20 watts RMS 40 x 40 watts peak for use with 8 to 15 ohm speakers. Size 14 1/2" x 3" x 10" approx. **NEW** feature—units now includes a built in four channel stereo sound facility. **£31.90** p&p £3.00

30x30 WATT AMPLIFIER IN KIT FORM
 For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output. 60x60 watts peak For use with 4 to 15 ohms speakers. **£31.50** p&p £3.00

SPECIAL OFFER
30 x 30 WATT AMPLIFIER KIT with BSR P200 belt drive deck and Shure M75 cartridge. **£57.00** + p&p £6.00

EMI SPEAKER BARGAIN
 Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround. 2 1/2" approx. Audaux tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS 20 watts max 8 ohm impedance. **£18.25** Per stereo pair £3.65 p&p

BSR P200
 Belt drive chassis turntable unit semi-automatic, cueing device. **£25.50** p&p £2.60
 A.D.C. QLM 30 Mk III Magnetic Cartridge to suit. **£7.95**

BSR Manual single play record deck with auto return and cueing lever. fitted with stereo ceramic cartridge 2 speeds, with 45 r.p.m. spindle adaptor ideally suited for home or disco use. **OUR PRICE £11.25** £2.75

GARRARD DECK MODEL CC 10A
 Record changer with cueing device fitted with stereo ceramic cartridge ready to fit into your own plinth. **£8.15** p&p £2.05 Size 12" x 8 1/2"

UNIT AUDIO STAND
 Can be used with TV too! Finish in chrome with decorative wood spacer fitted with 4 Kenrick Mini Meteor castors. **£3.95** £2.25 p&p 24" x 12 1/2" x 11 1/2" approx.

BARGAIN FOR PERSONAL SHOPPERS ONLY
Altone UA4 Stereo System
 Features 8 watt total output. Full size BSR manual turntable with cueing and auto return. Socket for tape in and out and stereo headphones complete with speakers. **£35.75**

Micro Cassette Recorder
 Pocket size—home or office use or when travelling. **£14.25**

Battery operated fluorescent camping lamp.
 Runs off 8 U2 batteries. **£4.80**

Mullard

AUDIO MODULES IN BARGAIN PACKS
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PRICE £ AT OVER 25 PER PACK

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1 PACK 1. 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input. **OUR PRICE £5.00** p+p £1.00

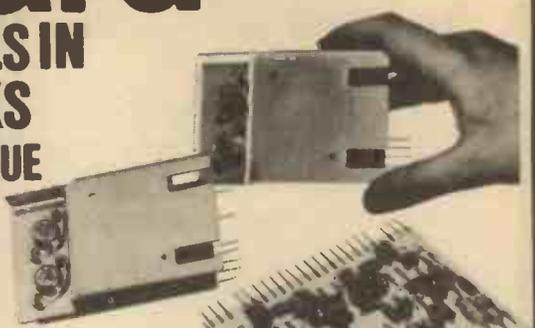
2 PACK 2. 2 x LP1173 10w RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs. **OUR PRICE £7.65** p+p £1.00

10 + 10 AMPLIFIER KIT

An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit. Size approximately 9 1/4" x 8 1/4" x 4" **OUR PRICE £12.25** p&p £2.25



ACCESSORIES ARE ONLY AVAILABLE TO THOSE CUSTOMERS WHEN BUYING OUR BARGAIN PACKS.



ACCESSORIES

Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance **£3.00** plus £1.50 p&p

Two Way Speaker Kit
 Comprising of two 8" x 5" approx 4 ohm bass and two 3 1/2" 15 ohm mid-range tweeter with two cross-over capacitors **£4.05** per stereo pair plus £1.55 p&p

AVAILABLE ALSO TO PURCHASERS OF THE 10 + 10 AMPLIFIER KIT.

BARGAINS FOR PERSONAL SHOPPERS

LCO Solar 5 function with backlite stainless steel finish case and strap **£7.40**

LCO Solar Chrono 9 function with backlite stainless steel finish case and strap **£9.55**

Chrono stop watch 9 function with back lite stainless steel finish case and strap. **£8.95**

Solar Alarm LCO stainless steel case and strap. **£21.95**

AM/FM DIGITAL CLOCK RADIO Accurate 4 Digit Electronic Clock with 1/2" LED display Buzzer and snooze timer **£12.20**

100 Watt Power Amp Module **£14.25**

Mains power supply for above unit **£3.60**

OECCA 20w Stereo speaker kit comprising 2 8" approx bass units + 2 3A" approx tweeter inc crossovers **£20.45**

VIDEOMASTER Super Score TV Game with pistol mains operation **£15.95**

PORTABLE RADIO/CASSETTE RECORDER, AM/FM with clock, LW, MW, SW, VHF mains/battery operation **£42.90**

ISP Radio Cassette recorder Mains/Battery AM/FM built in mic auto stop. **£24.50**

100 WATT MONO DISCO AMP

Size approx 14" x 4" x 10 1/4"
 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 (PFL) lets YOU hear next disc before fading it in VU meter monitors output level. Output 100 watts RMS 200 watts peak **OUR PRICE £66.45** p&p £4.05

50 WATT MONO DISCO AMP

£30.60 p&p £2.70
 Size approx. 13 1/4" x 5 1/4" 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.

FOR PERSONAL SHOPPERS ONLY

DUO II SPEAKERS

Attractive teak finish, modern design, incorporating 2 speaker units—8" approx woofer and 2 1/2" approx tweeter 45 to 1800 Hz Impedance 8 ohms Power 15 watts RMS 18 1/2" x 13 1/2" x 7 1/4" Per stereo pair approx **£16.50**

FOR PERSONAL SHOPPERS ONLY

STEREO RADIOGRAM CABINET

Finished in a natural teak veneer with opening top. Easily modified to accommodate stereo equipment of your choice. **Price £10.95**
 Size approximately 47" x 15 1/2" x 15"



323 EDGWARE ROAD, LONDON W2
 21B HIGH STREET, ACTON W3 6NG

ACTON: Mail Order only. No callers

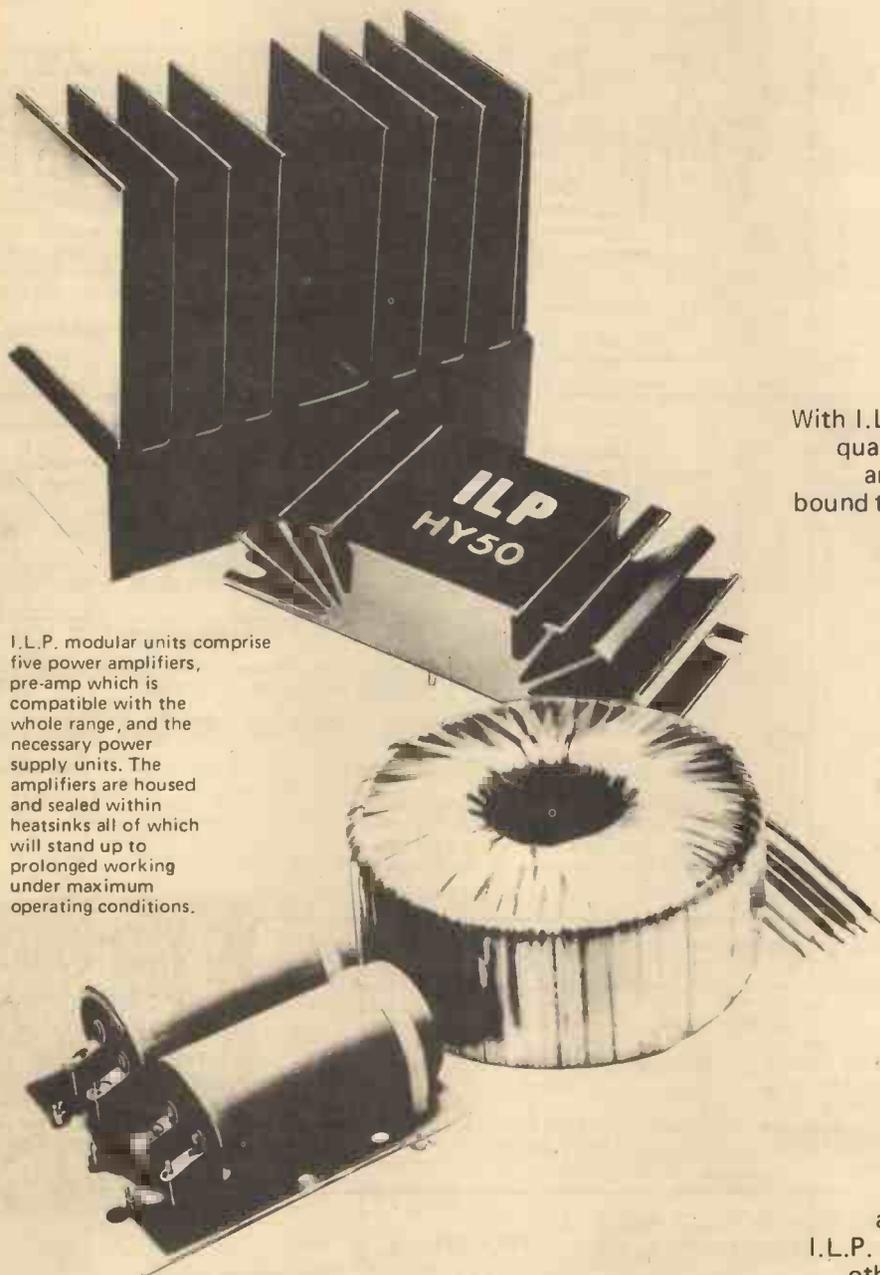
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ILP'S NEW GENERATION OF HIGH



I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance

— and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain

— the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance.

These have stood the test of time far longer than normally expected from

ordinary commercial modules. So we have concentrated on

improvements whereby our products will meet even more stringent demands such, for example, as

those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of

which can prove merciless to an indifferent amplifier system.

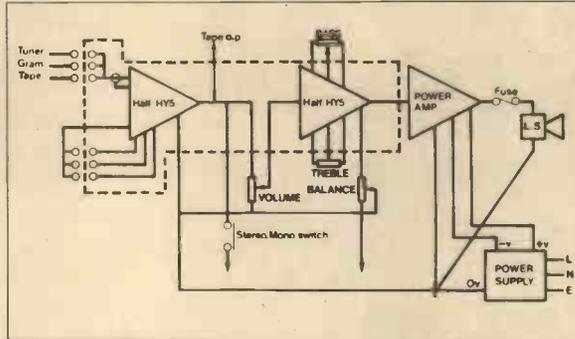
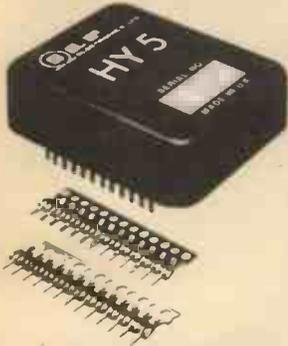
I.L.P. modules are for laboratory and other specialised applications too.

**PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS
IN ELECTRONIC MODULAR DESIGN**

and staying there

PERFORMANCE MODULAR UNITS

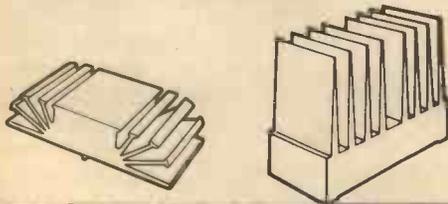
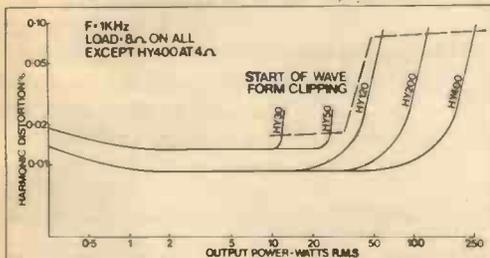
HY5 PRE-AMPLIFIER



The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz-0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

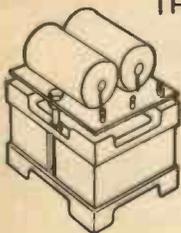
THE POWER AMPLIFIERS



Model	Output Power R.M.S. into 8 Ω	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W	0.02%	80dB	-20 -0 +20	105x50x25	155	£6.34 + 95p
HY50	30 W	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W	0.01%	100dB	-35 -0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W	0.01%	100dB	-45 -0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W	0.01%	100dB	-45 -0 +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4 - 16 Ω
 Input sensitivity - all models 500 mV
 Input impedance - all models 1.00 KΩ
 Frequency response - all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms - one with circuit panel mounted on conventionally styled transformer the other with toroidal transformer having half the weight and height of its conventional laminated types.

PSU 36	for 1 or 2 HY30's	£8.10 + £1.22 VAT
PSU 50	for 1 or 2 HY50's	£8.10 + £1.22 VAT
PSU 70	with toroidal transformer for 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU 90	with toroidal transformer for 1 HY200	£13.61 + £2.04 VAT
PSU180	with toroidal transformer for 1 HY400 or 2 x HY200	£23.02 + £3.45 VAT
PSU 30	± 15V at 100ma to drive up to: five HY5 pre-amps	£4.50 + 68p VAT

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1000W lighting per channel, max. A 3 channel sound to light unit housed in a robust metal case, with a sensitivity control for each channel i.e. Bass, middle and treble. Full instructions make this unit easy to connect to your present amplifier. S.A.E. for spec. sheet. Still only £20.00 + £3 VAT.

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Dims:- 60 x 47 x 33mm.
Require 38mm dia. cut out

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T23 0-500µA
T24 0-1 M/A
T25 0-5 M/A
T26 0-10 M/A
T27 0-50 M/A
T28 0-100 M/A
T30 0-1 AMP
T31 0-2 AMP
T36 VU Meter
T43 0-30 V.DC
T35 "S" Meter
£5.50 + 83p VAT.



SWR50

SWR/POWER METER £21

+ £3.15 VAT Measures SWR and power.

SWR:- 1:3 1:1
Power:- 0-1KW ± 20%
Impedance:- 52 ohms
Frequency range:- 3.5 to 150 MHZ
Dims:- 145 x 75 x 57mm



SWR9

SWR and FS METER

£12.50 + £1.87 VAT

For antenna adjustment. Has convenient relative field strength meter built-in.
SWR:- 1:1 3:1
Accuracy:- 5%
Impedance:- 50 ohms
Frequency range:- 3-150 MHZ
Dims:- 120 x 50 x 55mm



SIRENS

S1 Siren. 125mm diameter gold coloured horn with fixing plate. Emits high-pitched wailing note of varying frequency - 16 cyc. per minute. 12 volts DC.
S2 As above but rapid noise frequency change - 160 cyc. per minute.
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PL258 Double ended female coupler.	£1.30p
M358 "T" connector female/male/female	80p
NC563 Double in-line male adaptor (PL259 x 2)	£1.20p
M369 Right angle coupler. PL259/S0239	£1.20p

'P&P' orders up to £5. Add 30p.

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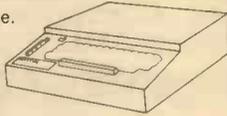
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- Single board
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- Basic in eprom
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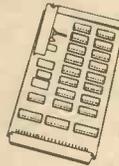


8 SLOT
Uses standard 64-way DIN CON.

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8K RAM CARD

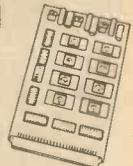
Triton 8k static Ram card. Kit uses 2114 Low power 4k. Static Rams. On board regulation, memory jump select. PCB only **£16** Rams **£5.50** each. Kit less Rams **£35** incl. all sockets & components.



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Triton 8k Eprom card kit. Designed to take up to 8x2708 Eprom (1kx8)



PCB only **£15**
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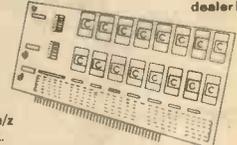
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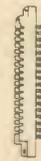
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Triton resident assemble language package. Links via the L6-1 monitor and new scientific basic to make Triton a stand alone development system. Trap is an 8k package in EPROM and resides on our EPROM card. Set of 8x2708 only **£80** including document.

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- DISASSEMBLER
- SYMBOL TABLE
- CREATE
- BREAKPOINT
- SINGLE STEP
- TRACE
- PROGRAMME LOAD
- MONITOR

See catalogue for further details.

COMPONENTS 74LSXX

SN74LS00N	10	SN74LS40N	25	SN74LS113N	44	SN74LS165N	170	SN74LS248N	136
SN74LS01N	10	SN74LS42N	70	SN74LS114N	44	SN74LS166N	176	SN74LS249N	130
SN74LS02N	20	SN74LS47N	85	SN74LS122N	70	SN74LS168N	185	SN74LS251N	145
SN74LS03N	10	SN74LS48N	85	SN74LS123N	90	SN74LS169N	195	SN74LS252N	125
SN74LS04N	20	SN74LS49N	100	SN74LS124N	150	SN74LS170N	250	SN74LS257N	140
SN74LS05N	20	SN74LS54N	21	SN74LS125N	85	SN74LS173N	220	SN74LS258N	85
SN74LS08N	20	SN74LS55N	21	SN74LS126N	85	SN74LS174N	115	SN74LS259N	145
SN74LS09N	22	SN74LS56N	150	SN74LS127N	75	SN74LS175N	105	SN74LS260N	38
SN74LS10N	10	SN74LS57N	35	SN74LS128N	38	SN74LS176N	275	SN74LS261N	350
SN74LS11N	20	SN74LS58N	40	SN74LS129N	40	SN74LS177N	175	SN74LS262N	38
SN74LS12N	25	SN74LS59N	40	SN74LS130N	40	SN74LS178N	175	SN74LS263N	185
SN74LS13N	55	SN74LS60N	35	SN74LS131N	120	SN74LS179N	120	SN74LS264N	220
SN74LS14N	80	SN74LS61N	35	SN74LS132N	175	SN74LS180N	175	SN74LS265N	175
SN74LS15N	25	SN74LS62N	115	SN74LS133N	85	SN74LS181N	189	SN74LS266N	180
SN74LS16N	20	SN74LS63N	110	SN74LS134N	80	SN74LS182N	185	SN74LS267N	180
SN74LS17N	20	SN74LS64N	40	SN74LS135N	160	SN74LS183N	120	SN74LS268N	180
SN74LS18N	20	SN74LS65N	40	SN74LS136N	125	SN74LS184N	120	SN74LS269N	220
SN74LS19N	80	SN74LS66N	125	SN74LS137N	120	SN74LS185N	120	SN74LS270N	180
SN74LS20N	35	SN74LS67N	80	SN74LS138N	125	SN74LS186N	125	SN74LS271N	220
SN74LS21N	20	SN74LS68N	80	SN74LS139N	125	SN74LS187N	125	SN74LS272N	180
SN74LS22N	20	SN74LS69N	80	SN74LS140N	220	SN74LS188N	220	SN74LS273N	180
SN74LS23N	20	SN74LS70N	80	SN74LS141N	190	SN74LS189N	220	SN74LS274N	180
SN74LS24N	20	SN74LS71N	80	SN74LS142N	190	SN74LS190N	220	SN74LS275N	255
SN74LS25N	20	SN74LS72N	175	SN74LS143N	185	SN74LS191N	220	SN74LS276N	255
SN74LS26N	30	SN74LS73N	30	SN74LS144N	210	SN74LS192N	210	SN74LS277N	135
SN74LS27N	20	SN74LS74N	30	SN74LS145N	210	SN74LS193N	210	SN74LS278N	135
SN74LS28N	20	SN74LS75N	30	SN74LS146N	210	SN74LS194N	210	SN74LS279N	135
SN74LS29N	20	SN74LS76N	30	SN74LS147N	210	SN74LS195N	210	SN74LS280N	135
SN74LS30N	20	SN74LS77N	30	SN74LS148N	210	SN74LS196N	210	SN74LS281N	135
SN74LS31N	20	SN74LS78N	30	SN74LS149N	210	SN74LS197N	210	SN74LS282N	135
SN74LS32N	20	SN74LS79N	30	SN74LS150N	210	SN74LS198N	210	SN74LS283N	135
SN74LS33N	20	SN74LS80N	30	SN74LS151N	210	SN74LS199N	210	SN74LS284N	135
SN74LS34N	20	SN74LS81N	30	SN74LS152N	210	SN74LS200N	210	SN74LS285N	85
SN74LS35N	20	SN74LS82N	30	SN74LS153N	210	SN74LS201N	210		
SN74LS36N	20	SN74LS83N	30	SN74LS154N	210	SN74LS202N	210		
SN74LS37N	20	SN74LS84N	30	SN74LS155N	210	SN74LS203N	210		
SN74LS38N	20	SN74LS85N	30	SN74LS156N	210	SN74LS204N	210		

MEMORY AND SUPPORT CHIPS (Prices exclude VAT)

SUPPORT	220	TMS8011	5.00	4118	20.00	LINEARS	LM748CN-8	45	7815K	1.50	1M56011	6.00
8212	2.20	81LS95	1.80	280P10	10.00	LM301AH	LM748CN	45	7824K	1.50	MC14411	12.00
8216	2.28	81LS98	1.80	280 CTC	10.00	LM301AH-8	LM1458N	72	7905K	1.10	MC14412	12.90
8224	2.80	81LS97	1.80	280A P10	14.00	(Min Dip)	LM1458N-8	40	7912	1.10	95364	10.95
8226	2.20	81LS98	1.80	280A CTC	14.00	LM309K	LM14880	05	7915	1.10		
8228	4.20	RAMS				LM309K	LM1490	05	7924	1.10	CPU'S	
8238	4.20	2101	2.32	1702	6.00	(TOS)	LM1490AD	1.25	7905K	1.00	8080	6.33
8245	11.00	2102L-4	1.20	5204	6.00	LM311N	LM1495N-14	05	7912K	1.00	6800	10.00
8246	11.00	2111	2.32	5204	6.00	LM318N	LM1332N	05	7915K	1.50	280	10.00
8251	5.00	2112	2.46	2709	6.00	LM323K	LM1340N	05	7924K	1.89	280A	15.00
8253	11.00	2114	2.80	2516	28.00	LM324N	LM1390N	05	7924K	1.89	280B	12.85
8255	5.00	5810	4.08	2718	22.80	LM339N	LM1390N	54	DIL SOCKETS		6805	6.00
8257	11.00	8154	1.10			LM555N	75 TL080CP	1.40	8 DIL	14	SCM711	10.00
8259	12.50	2114	5.50			LM555N	75 TL081CP	05	18 DIL	17	6802	13.85
8264	11.00	2102L-3	1.50			LM555N	75 TL082CP	1.85	18 DIL	24	9900	30.00
8265	11.00	74C920	11.00	74S267	4.00	LM7080N	75 TL083CP	1.80	20 DIL	27		
8267	4.50	74C921	11.00	74S472	12.00	LM7090N	75 TL084CP	1.80	20 DIL	27	W/WRAP SKTS	
8268	4.50	74C922	11.00	74S473	12.00	LM7230N	75 TL085CP	1.80	28 DIL	30	8 DIL	20
8269	4.80	74C923	11.00	74S474	12.00	LM7230N	75 TL086CP	1.80	28 DIL	30	14 DIL	35
8271	5.50	4027	6.00	74S473	12.00	LM7230N	75 TL087CP	1.80	28 DIL	30	14 DIL	42
8272	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL088CP	1.80	28 DIL	30	14 DIL	42
8273	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL089CP	1.80	28 DIL	30	14 DIL	42
8274	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL090CP	1.80	28 DIL	30	14 DIL	42
8275	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL091CP	1.80	28 DIL	30	14 DIL	42
8276	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL092CP	1.80	28 DIL	30	14 DIL	42
8277	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL093CP	1.80	28 DIL	30	14 DIL	42
8278	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL094CP	1.80	28 DIL	30	14 DIL	42
8279	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL095CP	1.80	28 DIL	30	14 DIL	42
8280	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL096CP	1.80	28 DIL	30	14 DIL	42
8281	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL097CP	1.80	28 DIL	30	14 DIL	42
8282	5.50	4027	6.00	74S474	12.00	LM7230N	75 TL098CP	1.80	28 DIL	30	14 DIL	42
8283	5.5											

Quality audio modules and accessories for

S450

STEREO FM TUNER
Fitted with phase lock-loop

£26.73
+ 40p p&p



FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3.0 µV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22.5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The S450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage, Vari-Cap diode tuning, Switched AFC LED Stereo Indicator.

Stereo 30

COMPLETE AUDIO CHASSIS

£22.06
+ 66p p&p



7 + 7w R.M.S.

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 × 130mm × 33mm

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

£5.39 + 35p p&p



25w R.M.S.

OUTPUT POWER	25 Watts RMS
SUPPLY	30-50 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

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
35 Watts RMS

£8.54 + 35p p&p



35w R.M.S.

OUTPUT POWER	35 Watts RMS
SUPPLY	40-60 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

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

£20.49 + 76p p&p



125w R.M.S.

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%

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

£4.36 + 35p p&p



10w R.M.S.

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 × 63mm × 28mm

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

SPM80

STABILISED POWER SUPPLY
£5.06 + 35p p&p



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 × 63mm × 30mm

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

PA100

STEREO PRE-AMPLIFIER

£18.46
+ 46p p&p



FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .07%)
SENSITIVITY	1. TAPE 100 mV/100 K ohms } For an 2. RADIO TUNER 100 mV/100 K ohms } output 3. MAGNETIC P.U. 3.5 mV/50 K ohms } 250 mV
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 × 90 × 33mm (less controls)

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.

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER



£3.43

+ 35p p&p

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 × 50 × 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER



£8.95

+ 35p p&p

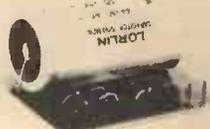
The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

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	-85 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450, etc.
Transformer T538.

Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 × 43 × 26mm.



£1.73

+ 35p p&p.

BP124 SIREN ALARM MODULE

American Police siren powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.



ONLY £4.03

+ 35p p&p.

5 WATTS —

STA15 STEREO AMPLIFIER KIT

Build your own top quality amplifier, save yourself pounds. The STA15 kit comprises the following BI-kits modules, 2x AL60 amps, 1x PA100 pre-amp, 1x SPM80 stab. power supply, 1x BMT80 transf. giving 15 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 £40.68 + 62p p&p.

STA15 ACCESSORY 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, Nuts, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £21.94 + 86p p&p. Order No. 2240.

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3.68 + 55p p&p.
T2050 For use with Stereo 30
Order No. 2050 Price: £3.74 + 55p p&p.
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £6.21 + £1.00 p&p.
BMT250 For use with AL250
Order No. 2035 Price: £7.30 + £1.10 p&p.
2040, For use with AL60
Order No. 2040 Price: £5.98 + 80p p&p.
2041, For use with AL80, AL120 and AL250
Order No. 2041. Price: £7.82 + 86p p&p.

CASES

TEAK 30, 32 × 23 × 8cm, designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. £6.27, p&p 70p.

TEAK 60, 42 × 29 × 9cm, for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve — has no front or back panel. o/n 140. £8.63, p&p 85p.

Professionals and Enthusiasts from BI-PAK

AL120

AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection).

£13.74

+ P. & P. 35p

Introduced to fulfill the demand for a fully protected power amp., capable of driving high quality speaker systems at up to 50w., with distortion levels below 05%. Ideal for domestic use. Discos, P.A. systems, electronic organs etc. The generously rated components ensure continuous operation at high output levels.



50W
R.M.S.

OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	05% Max. (Typically 02%)
FREQUENCY RESPONSE	±1dB 25Hz-20KHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP	45 deg. C
DIMENSIONS	192 x 89 x 49 mm

SPM120

STABILISED POWER SUPPLIES

SPM120/45
SPM120/55
SPM120/65

£6.67

+ P. & P. 35p



AC INPUTS	
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV 2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A., operates direct from a mains transformer requiring only the addition of 2 electrolytic capacitors to complete the s/c protection.

GE100 Mk2.

10 CHANNEL MONOGRAPHIC EQUALISER

£23.00

+ P. & P. 35p



Control Range	±12dB
Dynamic Range	110dB
Maximum Output	+15dB
Frequency Response	30Hz-20KHz (±1dB)
Power Supply	15-0-15v.
Voltage Handling Input	3v R.M.S.
T.H.D.	-.05%

Only 155mm x 65mm x 50mm including the 10 x 10K 1in slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12dB with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, P.A. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power Supply for GE100, o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£8.74

+ P. & P. 35p



AC Input Maximum	25v
Voltage Regulation	2-30v
Regulated Current	0-2A
Incorporating short circuit protection	

This NEW variable Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v-30v, with a current limiting range of 0-2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 20331, 0-1ma (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899), it can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££!

PA200

STEREO PRE-AMPLIFIER

£18.61

+ P. & P. 40p



FREQUENCY RESPONSE	20Hz to 20kHz x 1dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically .70%)
SENSITIVITY	1. TAPE 100mV/100 K ohms For an output 500mV
INPUTS	2. RADIO TUNER 100mV/100 K ohms
	3. MAGNETIC P.U. 3.5mV/50 K ohms
EQUALISATION	Within ±1dB from 20Hz to 20kHz
BASS CONTROL RANGE	±15dBs at 75Hz
TREBLE CONTROL RANGE	+10-20dBs at 15kHz
SIGNAL/NOISE RATIO	Better than 65dBs (All inputs)
INPUT OVERLOAD	Better than 26dBs (All inputs)
SUPPLY	35 to 70V
DIMENSIONS	300 x 90 x 33mm (less controls)

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

HEADPHONES

A top quality headphone with cushioned earpads and headband. Separate balance/volume controls. Stereo or Mono switch. Impedance: 8 ohms. Frequency: 30-18,000Hz. o/n 884. £10.01. p&p 70p.

A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi. Impedance 8 ohms. Frequency: 30-15,000Hz. o/n 885. £6.06. p&p 50p.

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity: 100 0 1000UA. Dimensions: 23 x 22 x 26mm. o/n 1318. £2.24. p&p 35p.



Balance and Tuning Meter
Clear view edge-wise meter. Centre zero application. Sensitivity: 100 0 1000UA. Dimensions: 45 x 22 x 34mm. o/n 1319. £2.30. p&p 35p.



Miniature Level Meter
Moving coil, for accurate level indication for tape recorders, amplifiers etc. Neat design, rugged construction will withstand five times rated value. Sensitivity FSD 200UA OdB 130UA Dimensions: 23 x 22 x 26mm. o/n 1320. £3.22. p&p 35p.



Vu Meter
Calibrated 20 to +3 and 0 100%, making it suitable for use as a recording level meter or as a power output indicator. Sensitivity 130UA. Dimensions: 40 x 29mm. o/n 1321. £2.30. p&p 35p.



ADAPTORS

AC-DC enables a large range of battery powered radios, recorders, calculators to be run off the mains. (220-240v AC). Switchable for 3-6-9-12 volts. Current rating 300mA. Polarity reversing switch. Universal plug incorporated. o/n 137. £4.14. p&p 35p.

DC-DC for use in all cars, boats etc., with pos. or neg. earth for a regulated output of 6, 7.5 or 9 volts DC at 300mA. For radios, recorders etc. o/n 138. £3.22. p&p 35p.

CROSSOVER NETWORKS

2-WAY channels for high and low frequencies to correct speakers - high to tweeters, low to woofers. Complete with instructions. Frequency: 3,000Hz. o/n 1904. £1.73. p&p 35p.

2-WAY for 8 ohm speakers up to 30 watts. Frequency: .3KHz. o/n 1905. £2.65. p&p 35p.

3-WAY for 8 ohms speakers up to 30 watts. Frequency: 800Hz and 4.5KHz. o/n 1906. £4.60. p&p 35p.

MICROPHONES

DYNAMIC CASSETTE

For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/Off switch, 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance: 200 ohms. Sensitivity: 90dB. Frequency: 90-10,000Hz. Size: 20mm dia x 120mm. o/n 1326. £1.84. p&p 35p.

DYNAMIC MICROPHONE

Superior quality portable cassette recorder mike built-in remote control switch and lead fitted with 5-pin 240F DIN plug (remote switch) and 3-pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance: 200 ohms. Freq. response: 100 to 10,000Hz. Sensitivity: 79dB at 1,000Hz. o/n 1327. £3.05. p&p 35p.

RE-317 DYNAMIC MICROPHONE

Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/Off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000 ohms. Freq. response: 100 to 12,000Hz. Sensitivity: (-7dB at 1,000Hz). o/n 1336. £6.29. p&p 35p.

OMNIDIRECTIONAL CARDIOID

Powered by a 1 1/2 battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/Off switch. Also with "Busby" type windshield. "U" bracket and stem and extremely supple cable. Consumption: 0.2mA from 1 1/2 battery providing approx. 8-10,000 hours continuous life. Impedance: 600 ohms. Sensitivity: 70dB. Frequency: 30-16,000Hz. Size: 23mm dia x 267mm. o/n 1328. £14.72. p&p 35p.

UNIDIRECTIONAL CARDIOID

Dual imp. 600 and 50,000 ohms. Response 50 to 14,000Hz. Sensitivity 54dB at 50K/ohms. Size 1 1/2" dia x 6 1/2" long. Weight approx., 190gm. o/n 1328. £12.69. p&p 35p.

STANDS

GOOSENECK CHROME FLEXIBLE HOLDERS

Length 320mm. o/n 1333. £2.99. p&p 35p.

Length 515mm. o/n 1334. £4.03. p&p 35p.

FLOOR STAND Heavy chrome. Stow-away feet with rubber ends for maximum stability. Draws to a height of 5' maximum. o/n 1335. + £12.31. p&p 85p.

BOOM ARM for use with the above stand. Heavy chromed metal. It gives 30" reach from the stand. o/n 1337. £10.58. p&p 70p.

WINDSHIELD COVERS

o/n 1331. Medium per pair £1.38. p&p 35p. o/n 1332. Large per pair £2.30. p&p 35p.

AUDIO LEADS

- 107 FM Indoor Ribbon Aerial £0.09
- 113 5mm Jack plug to 3.5mm jack plug Length 1.5m £0.86
- 114 5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m £0.98
- 115 5 pin DIN plug to 3.5mm. Jack connected to pins 1&4 Length 1.5m £0.98
- 116 Car aerial extension. Screened insulated lead. Fitted plug & socket £1.44
- 117 AC mains connecting lead for cassette recorders & radios. 2 metres £0.78
- 118 5 pin DIN phono plug to stereo headphone jack socket £1.21
- 119 2 - 2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m £1.04
- 120 Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions. £0.89
- 123 6.5m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK £1.73
- 124 3 pin DIN plug to 3 pin DIN plug Length 1.5m £0.86
- 125 5 pin DIN plug to 5 pin DIN plug Length 1.5m £0.86
- 126 5 pin DIN plug to Tinned open end. Length 1.5m £0.86
- 127 5 pin DIN plug to 4 Phono Plugs. £1.80
- 128 All colour coded. Length 1.5m £1.92
- 129 5 pin DIN plug to 5 pin DIN socket. Length 1.5m £1.21
- 130 5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m £1.21
- 131 2 pin DIN plug to 2 pin DIN inline socket. Length 5m £0.78
- 131 5 pin DIN plug to 3 pin DIN plug 1&4 and 3&5. Length 1.5m £0.95
- 132 2 pin DIN plug to 2 pin DIN socket. Length 10m £1.13
- 133 5 pin DIN plug to 2 phono plugs. Connected pins 3&5 Length 1.5m £0.86
- 134 5 pin DIN plug to 2 phono sockets. Connected pins 3&5 Length 2.3cm £0.78
- 135 5 pin DIN socket to 2 phono plugs. Connected pins 3&5 Length 2.3cm £0.78
- 136 Coiled stereo headphone extension lead. Black Length 6m £2.01
- 178 AC mains lead for calculators etc. £0.54

All prices are inclusive of VAT. Barclaycard & Access accepted. Giro A/C No.: 3887006

BI-PAK
DEPT. PE12, P.O. Box 6,
13 Baldock Street, Ware, Herts.

Just a little bit more...

NASCOM-2

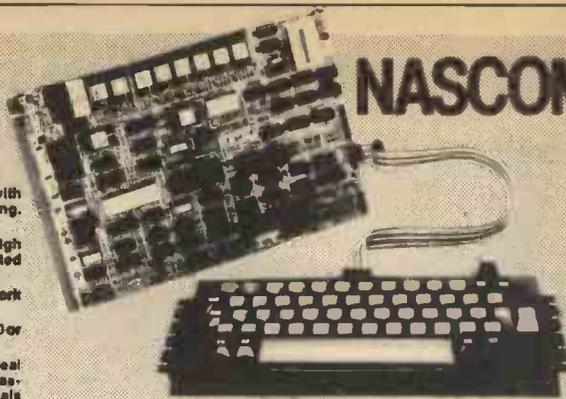
Compare its features:

- * Z-80A 4MHz CPU: The most powerful 8-bit processor on the market.
- * 8K Basic: resident on board, MICROSOFT Basic, the industry standard, with extensions for on-screen editing, graphics, machine code interfacing. Optimised for speed (see benchmarks below).
- * Full 57 Key Ucon solid state keyboard: switch mechanisms are contactless, high reliability professional units for long trouble free life. Keyboard is mounted separately to avoid straining main P.C.B.
- * Total of 20K on-board memory: 2K monitor (Nas-Sys 1), 1K Video RAM, 1K Work space RAM, 8K Microsoft Basic, 8K user RAM.
- * Kansas City cassette interface: for reliable storage of programs and data at 300 or 1200 baud, with full checksum error detection.
- * Nas-sys monitor: A powerful 2K machine code monitor provides an ideal environment for learning about and developing machine code programs. Nas-sys uses a blinking non-destructive cursor, with 22 commands. ASCII terminals are fully supported via the serial interface; users can add their own I/O drivers via the system I/O vector table to support other devices.

Nas-sys commands are:

- | | |
|-------------------------------------|-----------------------------|
| A—Hex arithmetic | N—return to normal |
| B—set breakpoint | O—Output to P.I.O. |
| C—Copy | Q—Query input port |
| E—Execute | R—Read tape |
| G—Generate | S—Single step |
| H—Operate as half duplex, terminal. | T—Tabulate memory |
| I—Intelligent copy | U—activate user I/O drivers |
| J—Execute at FFA | V—Verify tape |
| K—set keyboard options | W—Write tape |
| L—load from tape | X—set external device |
| M—Memory modify | Z—execute at FFD |

- * On board P.I.O. — An uncommitted P.I.O. (MK 3881) giving 18 programmable I/O lines with handshake.
- * On board RS-232C Will Interface directly into any standard teletype — allowing use of BASIC or Nas-sys from the teletype.
- * Full on-screen editing: a complete screen editor with cursor movement (UP, DOWN, LEFT, RIGHT), insert and delete, backspace etc.
- * Screen display of 16 lines x 48 characters: Stable, clear display to British television standards. Full 128 ASCII character set; option for further 128 graphics characters.
- * Fully buffered NASBUS compatible: Well defined bus structure with a range of expansion cards; including (shortly) a floppy disc system with CP/m — the industry standard operating system.



	Nett	Val	Total
Nascom-2	295.00	44.25	339.25
Power supply	24.50	3.68	28.18
10 C15 cassettes	4.44	0.66	5.10
Z-80 Programming manual (Mostek)			4.50
Z-80 Microcomputer handbook			6.95
Practical microcomputer programming the Z-80			20.00
Sargon-8K Z-80 Chess program (book)			9.50

PERSONAL COMPUTER WORLD BENCHMARK TESTS

	APPLE II		RM. 380Z	PET
BM 1	1.5	1.1	1.4	1.7
BM 2	3.2	5.4	6.5	9.9
BM 3	7.3	11.1	13.2	18.4
BM 4	7.2	11.6	13.9	20.4
BM 5	8.9	12.6	15.0	21.7
BM 6	16.6	19.3	22.3	32.5
BM 7	28.2	27.6	31.8	50.9
BM 8		5.2	6.2	12.3



25 Brunswick Street, Liverpool L2 0BJ
Tel: 051-236 0707 (Mail Order) 051-227 2535 (All other Depts)

What's new from Heathkit?



IM 2212—Auto Ranging DMM



IO 4105—Single Beam 5 MHz Oscilloscope



IM 5217—Portable Multimeter

Plus

- * GD 1290—VLF Metal Locator
- * HX 1681—CW Transmitter
- * IR 5201—XY Recorder
- * CI 1525—Car Temperature Indicator

These brand new self-assembly kits are designed to the highest specification. The step-by-step instructions make them easy to build at your leisure in your own home.

And first class quality makes them excellent value for money.

Details of the full Heathkit range are available in the Heathkit catalogue. Send for your copy now.



IM 2215—Hand-held DMM

To: Heath (Gloucester) Limited, Dept. (PE 12), Bristol Road, Gloucester, GL2 6EE.
Please send a copy of the Heathkit catalogue. I enclose 20p in stamps.

Name _____

Address _____

N.B. If you are already on the Heathkit mailing list you will automatically receive a copy of the latest Heathkit catalogue without having to use this coupon.

Soldering Iron offer FREE

When you receive your catalogue you will get details of this free offer.



There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (0452 29451).



THE COUNTRY

EVEN in the face of a Government paper, which basically reports that the microprocessor revolution will create more employment in the foreseeable future, and the recent Labour Party commitment to microelectronics at its conference, some bodies are still spreading gloom over the electronics industry and the country. Even if there are sound arguments behind such pessimistic views, we are pleased to report that at last we are beginning to stop procrastinating and get on with the job in hand.

Many component distributors have been reporting an increase of up to 60 per cent in sales, this increase started back in August—normally a quiet month in the industry. The boom is generally attributed to the employment of m.p.u.s in new designs and equipment causing a market expansion, especially in demand for memories. The problem is that we are now years behind the Americans and our industry has been so slow to react to the new technology that a very high percentage of the newly developed equipments are being imported because, as yet, there are no British competitors.

It seems to us that, as a nation, we excel at the investigation and discussion of possible social problems and both management and workers—usually for very different reasons—are initially set against the speedy introduction of new techniques and technology. Both the lengthy strikes at *The Times* and ITV have had much to do with new technology. Unless our basic attitudes to progress change we will suffer a lower standard of living and new technology *will* cause unemployment—because we refuse to allow it to be used. We must all be prepared to change our views and retrain ourselves if necessary; if we do and if we move quickly we will ultimately all prosper.

THE HOBBYIST

Unfortunately the present buying spree by industry is creating component supply problems and once again we suspect the hobbyist is beginning to suffer. There has been a world shortage of ROMS and this has affected the supply of parts for home computers. Delivery dates are again lengthening and sometimes being broken by manufacturers, so have some sympathy

with your component retailer if he is out of stock and says it could be a month or two before a certain device is again available—very often he can only pass on information from the manufacturer and that information has, in the past, sometimes proved to be unreliable.

These problems also have a bearing on the projects we bring you. Recently we have been investigating the possibility of publishing a constructional design for one of the latest devices, only to discover that no mask-programmed single chip processors, suitable for our purpose, were available in less than six months. Steps are now being taken to circumvent the problem with the use of a PROM—this alternative will cost slightly more but the six months gained will be worth it. However, the supply of PROMS and RAMS is now under some strain so we must also watch that position carefully. The time problem is not because we are small hobbyist buyers—we have been discussing a device costing about £6,000 to get into production with one of the world's largest suppliers.

Mike Kenward

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David Shortland PROJECTS EDITOR

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to one published project only.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £3.75 each to UK or overseas addresses, including

postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10.60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perryment Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

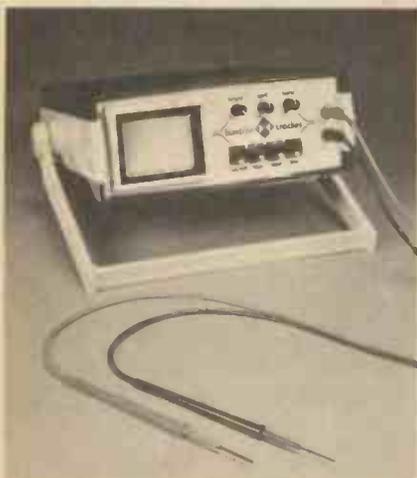
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by
**Alan
Turpin**

and
**David
Shortland**

HUNTRON TRACKER

The Huntron Tracker is a versatile instrument for trouble-shooting solid state circuits. The unit is capable of in-circuit testing of a number of discrete components: i.c.s, transistors, FETs, diodes, l.e.d.s, Zeners, UJT's, electrolytic capacitors and gate controlled devices.



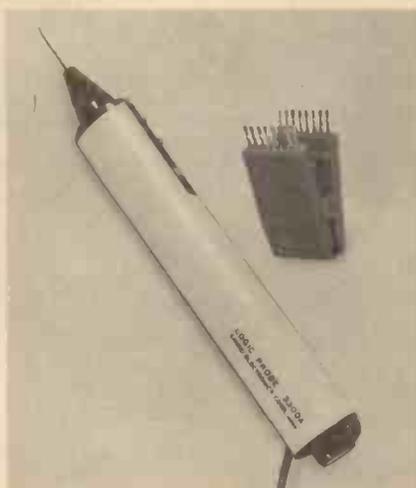
The Tracker uses a scope display, two non-polarised leads and three impedance ranges. The scope display show the condition of the device under test indicating "shorts", "opens" and "leaks". Both the forward and reverse response of the component can be displayed on the scope screen.

The price of the Tracker will be around £500. MTL Microtesting Limited, 1-15 Butts Road, Alton, Hants. GU34 1EN (0420 88022).

DTL/TTL, CMOS PROBE

The 3300A logic probe which has a 1 Megohm input impedance is supplied with two i.c. clips (a single pole and a 16 pole), carrying case and operating instructions.

The instrument operates on voltages from 5V to 18V d.c. and is protected against reverse p.s.u. connections and input over voltage.



Two l.e.d.s are used to detect high and low logic levels with the TTL threshold being $2.2V \pm 0.2V$ for logic '1' and $0.6 \pm 0.2V$ for logic '0'. The CMOS threshold is 70 per cent of the supply voltage $\pm 0.5V$ (logic '1') and 30 per cent of the supply voltage $\pm 1.0V$ (logic '0').

The price of the 3300A is £14.50 plus VAT and p&p. Watford Electronics, 33/35 Cardiff Road, Watford, Herts. WD1 8ED (9023 40588).

NEW CASES

Three new cases have been added to Vero Electronics range of moulded enclosures.

A desk top case (228 x 216mm) which is ideal for control equipment and keyboards is available in two versions, one with a raised top unit for digital readouts, encoders and other switches. Both have a base section moulded with an integral rear panel to accommodate connectors and plugs. Six mounting bosses are also provided in the base with holes to take self-tapping screws. Top and base sections screw together and the kit comes complete with aluminium front panels and fixing screws.



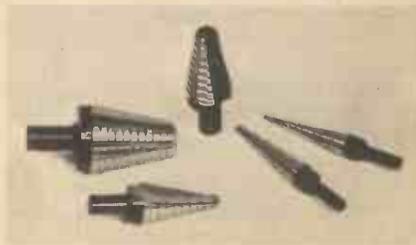
The other case, 150 x 85 x 45 mm high, has a front panel for identification and controls, which is protected by a raised edge all round. Assembly of components and connections to the front panel is simple as, with the case cover removed, components are accessible from all sides. The front panel is connected to the base by moulded posts and retained by the case cover. P.c.b. mounting pillars are moulded into the base, and a raised end surface is provided for cable grommets or components.

The price of the three cases are £9.50, £7.60 and £4.60 respectively.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants SO5 3ZR (042 15 69911).

DRILL AND DE-BURR

The step configuration of these Unibits allows drilling and simultaneous de-burring of a range of holes with one bit. Five bits cover holes from 4mm to 34mm in 1mm or 2mm



steps. Unibits are said to cope with sheet steel, brass, aluminium, copper, plastic and wood. Price from £7.38 inc. VAT, exc. p&p.

Toolrange Ltd., Upton Road, Reading RG3 4JA (0734 29446).

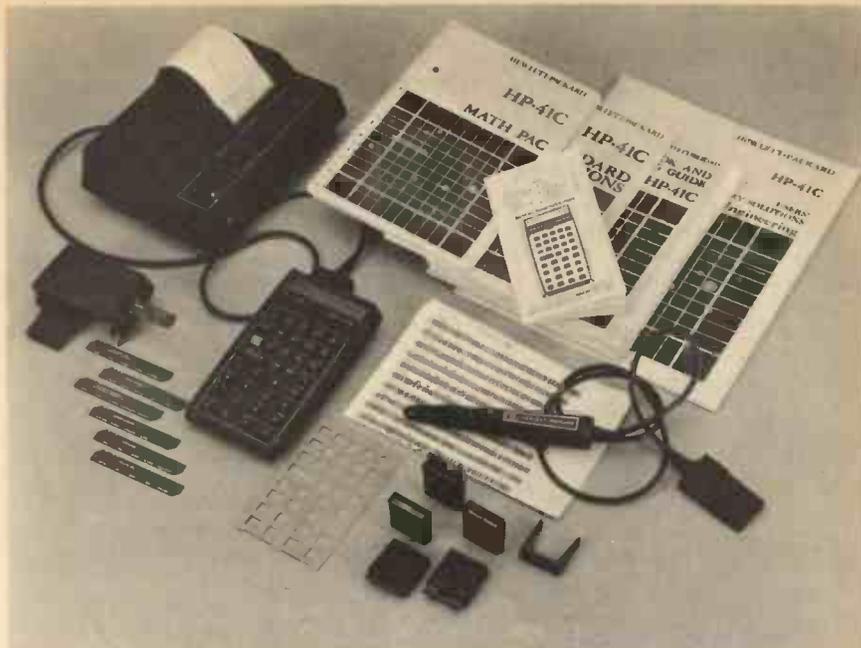
HP-41C

The latest programmable calculator from Hewlett Packard has a 12-character liquid crystal display, alpha-numeric keyboard and a memory which can retain data and programs after the calculator has been switched off. The type of memory can be selected from 448 bytes or 63 data storage registers or any blend of bytes and registers required.

The HP-41C has a total of 130 mathematical, scientific and statistical functions which are identified on the keyboard or can be used by either spelling the name of the function or assigning it to a particular key replacing a function which is not needed in the calculation. Two overlays are provided to enable users to re-label the keyboard with the functions they use most.

For problems in specialised areas such as engineering, aviation, finance, surveying etc. plug in modules are available together with handbooks. Any created programs should be assigned a name and then keyed in and whenever the program name is entered the program is automatically carried out.

Peripheral devices available for use with the HP-41C include: memory modules, magnetic card readers, plotting printer and an optical reader for bar codes. The card reader can be used to record programs which on replay become part of the calculator's memory. The programs on the card can also be instructed



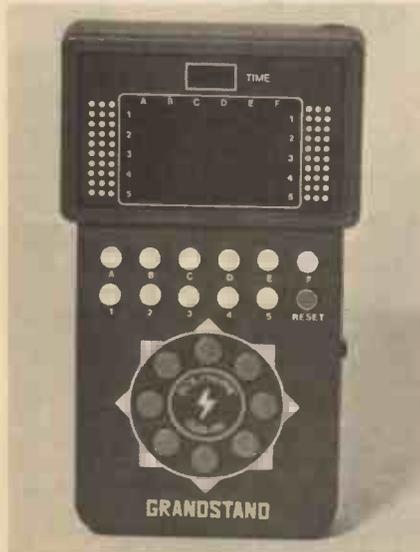
only to execute the program and not allow alterations. The thermal printer can print numbers, letters (upper and lower case), special characters, graphics and produce high resolution plots from data of programs.

The price of the HP-41C is £190, the card reader £135 and the printer £260 plus VAT and p&p.

Hewlett-Packard Ltd., King Street Lane, Wokingham, Berks. (0734 784774)

US CRAZE

As one of the latest crazes in the US at the moment is hand held computer games you won't be surprised to hear that many manufacturers are predicting this Christmas



as the start of the "craze" period for these games over here. Tempus are offering a range of games which includes Digits, a variation of Mastermind or Codebreaker where the player must guess a hidden number in as few attempts as possible.

Amaze-A-Tron which is a maze game for two players who must find their way through a maze using coloured pegs on a 25 key matrix board. There are eight game variations and over one million different mazes available.

The U.F.O. Master Blaser Station is a game in which you shoot down as many U.F.O.s as

possible before they reach your station. The U.F.O.s can change course, disappear or descend in pairs and you can increase the difficulty by increasing the speed of descent.

A hand held version of Solitaire is also available in which you must clear all the lights except one on the display panel by process of elimination. Each game is timed and two speeds are available.

The price of these games vary from £13.95 to £22.50 ex. VAT and p&p. Tempus 19-21 Fitzroy Street, Cambridge CB1 1EH.

PLUG-IN TIMERS

A new range of plug-in timers introduced by Adonis Instruments can be used to time intervals between 1 sec and 100 hours.



Both "delay on energise" or "interval delay" types are available and all types have the facility for "external start" from a remote signal. A range of voltage types are stocked, varying between 12V and 240V with each timer having 2-pole changeover contacts rated at 10A/250V.

Protection against mains transients and reverse polarity connection are built into the

timers and the time period can be set either with the control on top of the case, or fixed and adjusted with an external control.

Each timer fits into standard octal or 1-pin bases and are compatible with many existing types. The price range of the timers is from £15.50 to £18.00 excluding VAT and p&p.

A.I., 70 Broomfield Road, Chelmsford, Essex CM1 1SW (0245 68459).

3½ DMM

The latest DMM from Lascar Electronics is claimed to be the first l.c.d. multimeter with an indefinite "digital hold" facility.

The instrument which is housed in an ABS case with an adjustable carrying handle will give over 2000 hours life from a single battery.



The 0.5 l.c.d. has a built-in battery low indicator.

With a basic accuracy of 0.1 per cent the DMM features 10 voltage, 10 currents and 5 resistance ranges with resolutions of 0.1 mV, 0.1µA and 0.1 ohms. Inputs are via 4mm connectors which are protected against overloads and transients.

The multimeter is supplied complete with battery and operating instructions at a cost of £69.00 plus VAT and p&p.

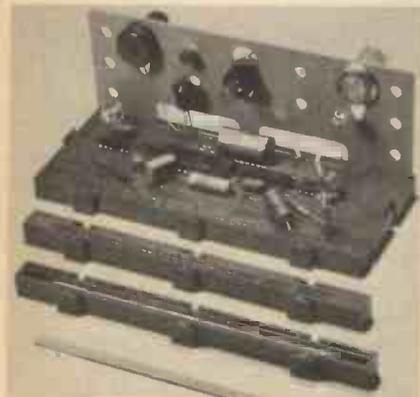
Lascar Electronics Limited, Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex, SS13 1LH (0268 727383).

CRYSTAL SET

For anyone trying to find a Christmas present suitable for young children that will be both educational and interesting then the answer could be a crystal set. Many of us had our first introduction to electronics through such a set and Home Radio are hoping they will be able to addict youngsters to the hobby with their crystal set which is easy to build and requires no soldering. The price of the set is £2.50 including VAT and p&p. **Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey CR4 3HD (01-648 8422).**

BIMBOARD BUS-STRIP

To augment their existing range of 0.1in breadboards, Boss Industrial Mouldings have introduced a 2 line Bus-Strip for use where two existing integral rails of a Bimboard are



insufficient for a particular circuit design. The price of the bus is £1.92 excluding VAT and p&p. **Boss Industrial Mouldings Ltd., 2 Herne Hill Road, London SE24 0AU.**

OPTOELECTRONIC SHORTFORM

Optron, the US specialist manufacturer of optoelectronic devices whose products are handled exclusively in the UK by Norbain Electro-Optics Division has just brought out a new shortform catalogue giving details of its latest optoelectronic emitters and sensors. They range from phototransistors, infrared light emitting diodes, and matched emitting diodes and phototransistors to photodarlingtons and photodiodes.

Norbain, Electro-Optics Division, Norbain House, Arkwright Road, Reading, Berkshire RG2 0LT (0734 864411).

NEOSID

Neosid Limited have recently established a new outlet to cater for the amateur constructor.

A broad selection of the parent company's products are included in their new Small Order Catalogue, which covers a full range of ferrite components i.e. beads, screw cores, rods, E, I and U cores, also coil assemblies, plastics formers and trimming tools.

The catalogue is available free of charge from **Neosid Small Orders, P.O. Box 86, Welwyn Garden City, Herts, AL7 1AS.** (Please send stamped addressed envelope.)

PANEL TIME

Have you ever wanted an l.c.d. clock to mount on the front panel of a project, amateur transceiver, teletext control box?

Ambit International are now stocking a miniature panel clock that can display time,



day and date. The unit is quartz controlled, has a back light, and an alarm function to drive a bleeper or other indicator. Running consumption is 6µA, accuracy is within ± 2.5 minutes per year, and height of the characters is up to 0.5in. The display shown has a character height of 0.25in. Price is £10.60 inc. VAT and p&p.

Ambit International, 2 Gresham Road, Brentwood, Essex, CM14 4HN.

FREQUENCY SYNTHESISER

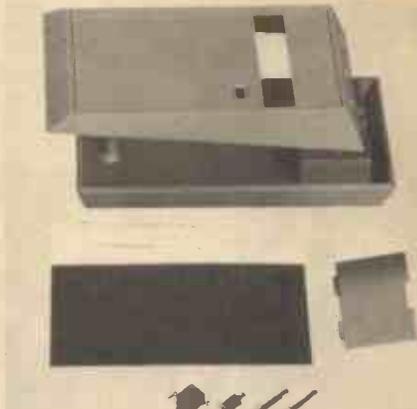
The FS-1B is a frequency synthesiser control unit module, comprising input prescalers, swallow counter, programmable divider, switchable filters and clock buffer.

It is programmed from a three line connection (clock/data/enable) with a 15 bit word that determines the reference frequency and output frequency of the VCO connected in the phase locked loop.

Frequencies in the range 20kHz to 200MHz may be programmed in conjunction with either discrete switch entry, hardwiring or simple computer control. A simple BASIC program

CSC CASE

The new hand-held case from CSC has been designed to house small, portable electronic systems such as calculators, counters, remote control units, communications devices and portable meters etc.



Measuring 76 x 152 x 38mm the case comes complete with assembly screws, antenna connector, red plastic front fascia panel, sub-miniature jack connected to a battery snap connector and a battery compartment. There is sufficient room for keyboards, speakers, microphones or controls on the front panel.

The price of the case is £3.00 ex. VAT and p&p. **CSC, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.**

exists to provide facilities for LF/MF/HF/VHF tuning options, so that owners of NASCOM, PET and similar systems may readily operate the module in conjunction with a voltage tuned radio having a buffered local oscillator output.

Various reference frequencies are available, both in conjunction with an on-board selection in the data control, and the use of different frequency crystals.

Priced at £24.95 in one-off quantities, the FS-1B is available from **Ambit International, 2 Gresham Road, Brentwood, Essex CM14 4HN (0277 227050).**

PE AT BREADBOARD

'79

**DECEMBER 4th-8th AT ROYAL
HORTICULTURAL HALLS, ELVERTON ST.,
WESTMINSTER**

We will be exhibiting a range of projects and hope to include: Ultrasonic Alarm; Solid State Car Instruments; EPROM Programmer; Ultrasonic Cleaner; Teletext; Digital Frequency Meter; Compukit UK101 with peripherals; Short Range Communication Transmitter and Receiver; Modem; Pushbutton Car Radio; PE Diamatic and perhaps a few more forthcoming attractions. Interested? Then come along and see for yourself.



A computer range from £500

The number one micro-computer in Britain today, selling more than 1,000 per month!

The Commodore Pet computer range is versatile and affordable. Programs can be written in Basic, the easiest computer language to learn. There is also machine language accessibility for professionals.

The Pet is a fully expandable system, peripherals being available for many specialist applications, (peripherals such as dual drive floppy discs and printers).

There are already over 300 standard programs,

tested and in use in commercial, scientific, educational and many other applications throughout Britain. The Pet is a portable and professional computer that operates by plugging into a normal 13 amp mains. Service and advice is readily available through the nationwide network of dealer outlets.

For a demonstration contact your local dealer—some of whom are shown here. In case of difficulty contact Consumer Information Dept (PE2),



commodore
We made small computers big business.

Commodore Systems,
360 Euston Road,
London NW1.

Associated Commodore dealers:

BIRMINGHAM

Camden Electronics 021-773 8240
CPS (Data Systems) 021-707 3866
Taylor Wilson Systems Knowle 6192

BOLTON

B & B Consultants 0204-26644

BOURNEMOUTH

Stage One Computers 0202-23570

BRADFORD

Ackroyd Typewriter & Adding
Machine Co 0274-31835

BRENTWOOD

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LONDON W5

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LONDON WC1

Euro Calc 01-405 3113

LONDON WC2

TLC World Trading 01-839 3893

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Cytek (UK) 061-832 7604

Executive Reprographic

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Sumlock Elec Svs 061-834 4233

MATLOCK

Lowe Electronics 0629-2817

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Yorkshire Elec Svs 0532-522181

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Thistle Computers Kirkwall 3140

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ATARI VCS - £159.95
21 Game Program £14.95 each
MATTEL INTELEVISION
builds into Computer £179.95
Cartridges - £15.95 each



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BANK**

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Monthly calendar display
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Semiconductor UPDATE...

FEATURING

Z8000

7110

AY-3-1350

R. W. Coles

CAPTAIN ZILOG

Zilog would like to draw your attention to their brand new microprocessor, the 16 bit Z8000.

Interesting electronics engineers or hobbyists in yet another new microprocessor will probably be difficult, and the fact that a comparable device from Intel, the 8086, has been around for several months won't make things any easier.

Technically, the Zilog Z8000 is a big leap forward, with the power of a minicomputer and an address range of up to 8 megabytes. It is probably more powerful than the Intel competition, but it seems that it will soon itself be upstaged by an even more powerful device from Motorola, the 68000. All this has put Zilog in the awkward position of not being the first and not being the best either, a situation which called for an expensive publicity campaign to broadcast the news about the Z8000 before all those sockets are gobbled up by other 16 bit devices.

Now, one way to tackle the publicity task would be to commission some technical articles and advertisements extolling the virtues of the Z8000 architecture, but Zilog wanted to get all electronics engineers interested and there's only one way to do that, isn't there? Yes of course, they gave the Z8000 its very own comic book! Enter Captain Zilog, alias systems designer Nick Stacey, who is given the gift of "Zilog power" by an extra terrestrial being who hauls him bodily through his VDU screen.

Moulded in the fine tradition of Superman and Captain America, Captain Zilog hurls himself into adventures such as "The doom of Doctor D" and "Battle beneath the architecture" in a desperate (and of course successful) attempt to foil the dastardly plans of Doctor Diabolicus who intends to conquer Earth with the aid of his super main-frame computer. Liberally laced with comments such as: "Stick it in your Index Register Diabolicus" or "Dancin' data" and "Leapin' logic", the new Zilog comic book is a must, if you can get one!

This is certainly a novel way to publicise a new device, being less distracting than the "sex" alternative, and much less boring than a ten page sheet! I found after reading the comic book that I knew quite a lot about the Z8000.

BIG BUBBLE

The future bulk memory requirements of the Zilog Z8000 and all the other fourth generation microprocessors will probably not be satisfied by present floppy disc systems because their electro-mechanical

technology is bulky, fragile, and likely to get more expensive rather than less as time goes by. The advantages of solid-state memory are self evident, and the bulk memory requirement will soon be satisfied by magnetic bubble memory chips which are compact and have no moving parts.

Bubble memories rely on the non-volatile storage and propagation of magnetic domains within a synthetic garnet substrate, and are thus quite different in their operation to conventional semiconductor RAM devices. Despite the differences in operation, bubble memories are made using the same basic techniques which have been developed for the other LSI technologies, and this has attracted many of the biggest semiconductor manufacturers including Intel, Texas Instruments, Rockwell, and Plessey in the UK.

Bubble memories are essentially serial in operation (like shift registers) rather than parallel (like RAM devices) and the speed at which the bit domains can be moved is limited to a few tens of kilohertz. Together, these factors make the access time to a particular location very much larger than the few hundred nanoseconds of today's RAM chips, but this is more than made up for by the huge amounts of data which can be stored by a single device. One of the latest bubble memory chips, the 7110 from Intel, stores 1 megabit, or looked at another way, 128 kilobytes, just think how many RAM chips you would need to handle that!

To speed up the access to any particular location, the 7110 is organised internally as 4096 separate shift registers, each of 256 bits. Two registers are used together to form a 512 bit page and on-chip processing treats each page as 64 8 bit bytes to achieve an average random access time of 40 milliseconds. That may be a lot slower than a conventional RAM but it's faster than a floppy disc and a lot more compact and reliable. A single 7110 could replace a complete mini-floppy drive in many applications.

RING-A-DING-DONG

A new single-chip tunes synthesiser, which can be programmed to generate up to 28 different tunes, has been introduced by General Instrument Microelectronics Limited.

Designated the AY-3-1350, the 28-lead NMOS device operates from a single 5V power supply, and is suitable for use in toys, musical boxes, doorchimes and other "novelty" products.

The standard circuit is pre-programmed with 25 short tunes plus 3 simple chimes,

but this may be altered to suit the application. It is possible for instance, to program just a single tune consisting of up to 251 notes. The chip does offer great flexibility to designers, as it can also generate tunes from data held in external PROMs.

In addition to its programming options, the AY-3-1350 may operate in a number of different modes, making it suitable for a wide variety of different applications. In a doorchime for instance, it can be connected to play any one of 25 pre-selected tunes from the front door bell push, with one of 5 tunes from the back door. In addition a third bell push can be wired to play a simple chime. All the tunes would be selected by switches or matrix board inside the chime cabinet.

A further possibility is to connect the circuit to a number of different bell pushes on each door. This might be useful for telling which different tradesmen are calling, or which member of the family is required at the door. Mother, father, brothers and sisters could each have their own particular "call" tune. In addition further variations could be made for back door, side door, or even a bell push for alarm purposes in an apartment used by an elderly relation.

Applications exist in low cost paging systems, where key personnel are each allocated one tune. A brief tune played over loudspeakers in a noisy factory would be much easier to recognise than a spoken name.

The circuitry may be connected so that there is virtually no power consumption when in the stand-by condition. When any bell push is activated the circuit plays a tune and then automatically powers down again to conserve batteries—even if the visitor keeps his finger on the bell push. Releasing the button and repressing would cause either the same tune to play again, or the next tune to be selected, depending on the precise operational mode of the device. Alternatively, the circuit may be wired to replay tunes over again until the button is released.

With the addition of an external ROM or PROM the standard AY-3-1350 will play almost any tune or tunes desired. These could be 28 tunes averaging 8 notes each or one tune of up to 251 notes. This would provide about 1-2 minutes worth of music.

The pitch, tone and speed of tunes played may be independently set by simple external components. These may be either preset or brought out as potentiometers as a user control. Either switch closures may be used to trigger the device or a capacitive touch switch using a few external interface components.

EPROM PROGRAMMER

PART 1

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

THE EPROM programmer is a memory-mapped peripheral for the 2708 family of Erasable Programmable Read Only Memories (EPROM's) and programs at about the maximum possible speed (around 2 minutes). The p.c.b. contains its own power supply giving +12V, -5V, +27V, and only requires +5V and a 9-0-9 volt transformer. On board, there is 1K of RAM for storing information to be transferred to the EPROM. The EPROM may be read before or after programming for verification, and used *in-situ* as a normal 1K block of Read Only Memory. The programmer thus effectively expands the host system by 2K of memory (1K of EPROM and 1K of RAM), with the added facility of being able to reprogram the EPROM section. Connection of the machine is simple and almost identical to the PE VDU connections.

Eleven Address Bus Lines (A0-A10), eight Data Bus Lines (D0-D7), a Read/Write line and some address decoding logic is all that is required. Interface to the COMPUKIT UK 101 and many other machines requires just a couple of d.i.l. plugs. The COMPUKIT would allow the necessary routines to be written in BASIC. A minimal MPU system containing the machine is shown in Fig. 1.

Use of the programmer is restricted to writing the desired target program or data into the 1K of on-board RAM, running and checking it, and then switching on the programmer which then takes around two minutes to copy the RAM contents onto EPROM. The machine automatically hands EPROM and RAM back to the MPU system.

EPROM THEORY

Each individual cell within the 2708 contains a "floating gate", which is able to collect a charge from a "pumping" pulse-train produced by a programmer. When sufficient charge has been accumulated within this completely insulated storage element, the cell, initially showing a "one", will return a "zero" along its data line when read.

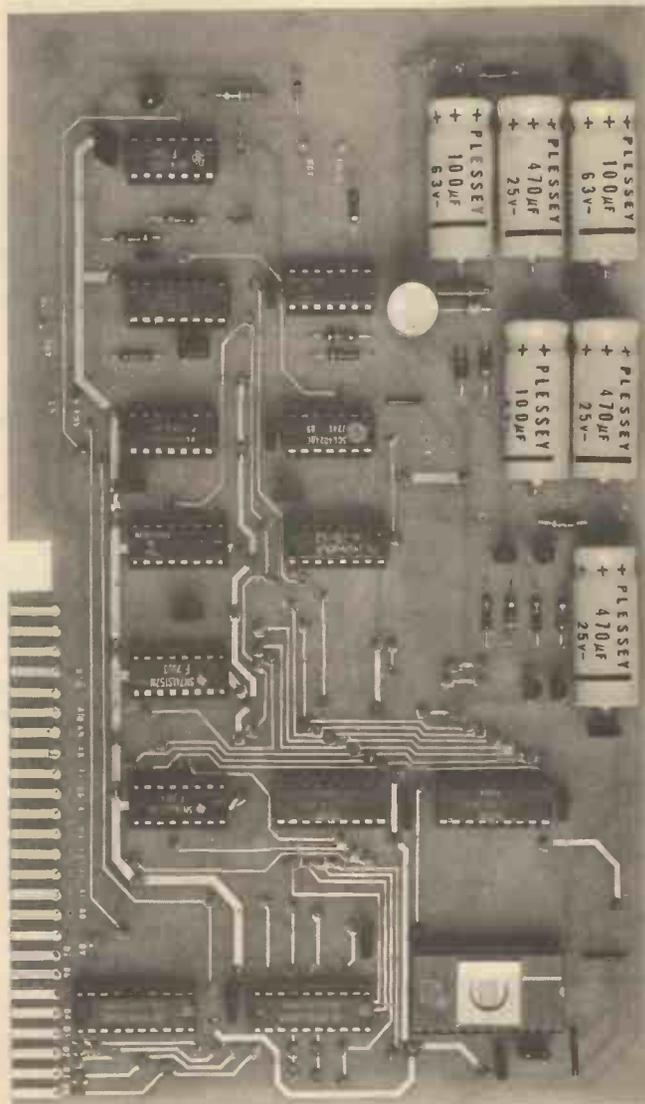
The 2708 family members have a quartz window in the upper surfaces of their packages. Through this, a strong ultra-violet light may penetrate to knock the electrons in the storage elements out of their shallow energy levels and allow them to leak away via the substrate.

This clears the cell back to a "one". The organisation of the 2708 causes 8 cells (one byte) to be read and programmed at a time, hence requiring normal Address and Data lines.

To program the EPROM, the programmer produces a succession of addresses along A0-A9, and, for each, presents the data to be programmed along D0-D7. The EPROM thus starts, after erasure, with FF (8 "ones") in each location.

The requirements of the 2708 family demand that *all* locations be presented with data a large number of times during the programming sequence. The number of such complete addressing cycles is determined by the speed of operation.

The Block and Connections diagram shows a typical Read Only Memory device with the addition of a Programming pin. This pin is pulsed up to +27 volts during programming.



The \overline{CS}/WE pin is a normal chip select except when programming, when it is held at +12 volts. The timing Diagram (Fig. 3), shows the signals necessary to program the 2708. It should be emphasised that the programming cycle consists of cycling through all 1024 memory locations *N* times and presenting the data to be stored over and over again. The sequence is as follows. \overline{CS}/WE is switched to +12V, the first address and data are presented and $>10\mu S$ later, pin 18 is pulsed up to +27V. These conditions are held for 0.1 to 1ms (0.5ms for the machine presented here) and then pin 18 drops to zero and the next address and data loaded. The cycle from address 0 to address 1023 thus takes a little more than half a second.

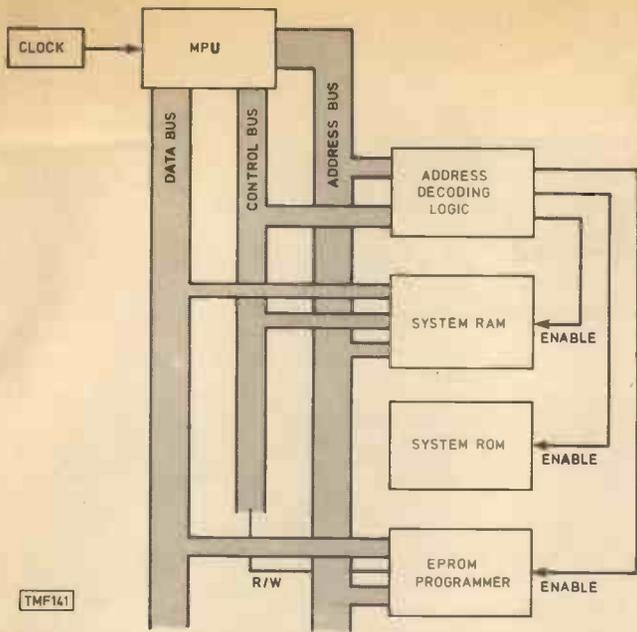


Fig. 1. Minimal system containing EPROM Programmer

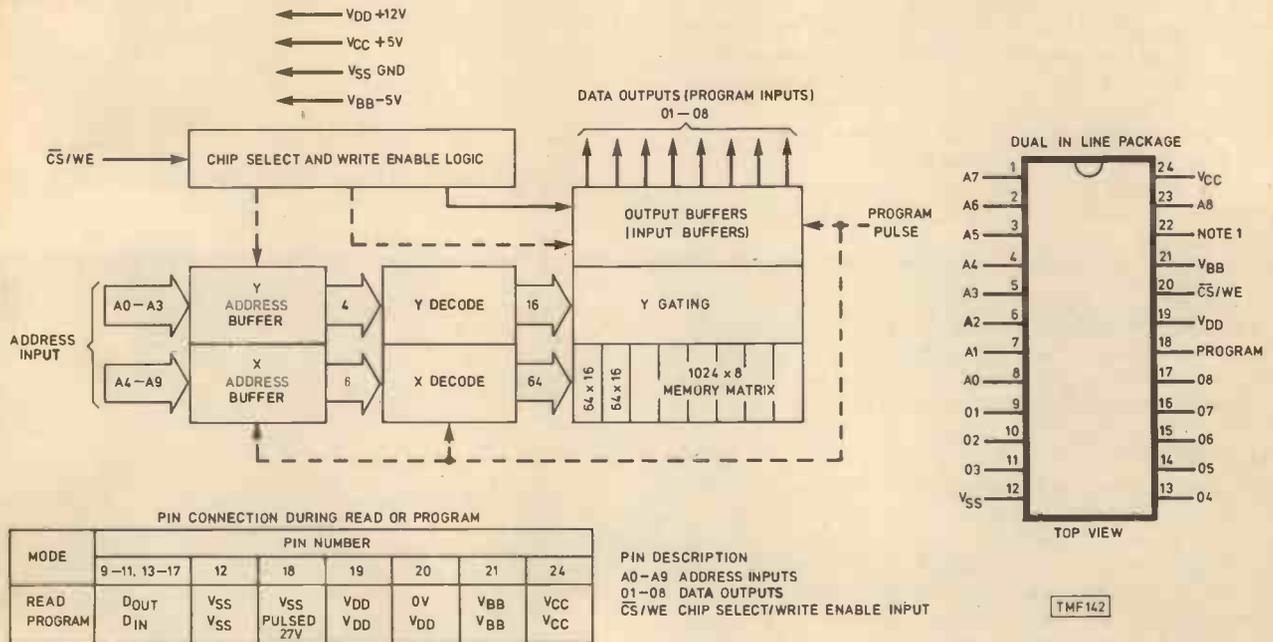
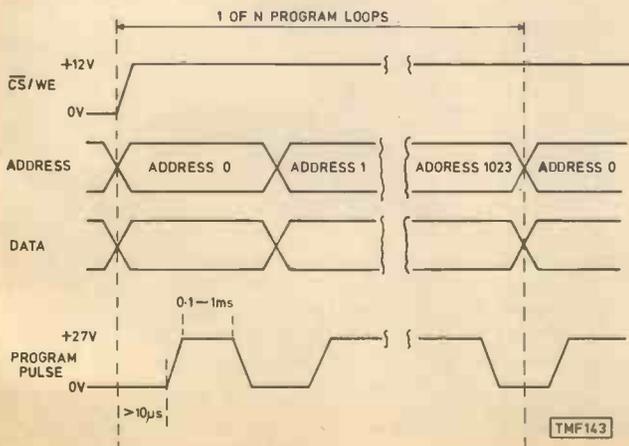


Fig. 2. The 2708 EPROM

Fig. 3. Program timing diagram



TMF143

This entire sequence is then repeated a number of times. The total number, N , of such loops is between 100 and 1000 (possibly more) depending upon the width (t_p) of the program pulse (+27 volts). The formula for determining N is: $N \times t_p > 100\text{ms}$. Thus, for 0.5ms, N is a minimum of 200. The total programming time for this number is slightly over 100 seconds.

The EPROM starts with its locations containing FF, thus if the programmer presents just FFs to the EPROM, it will retain its "erased" state. Even though each memory location must be accessed during programming (many times in fact), those presented with FF will remain untouched. Thus, a block of the EPROM may be programmed selectively without affecting the rest of the device. In fact, this is true of an EPROM already containing any other block of information. Contents of that block, whatever they may be, remain unaffected by the programming procedure as long as FF is presented to each of its locations during the cycles.

Indeed, a single bit in any given location can be set to zero selectively by presenting 1's everywhere else during programming.

It should be noted that the machine described here is *not* suited to the *single supply* 2716, nor types of EPROM other than 2704, 2708 and the multi-supply 2716. The reason for this is that the cycle-timing diagram requirements are quite unique to this family.

Fig. 4 shows the hardware set-up of the programmer. The heart of the device is in the timing control block. It is here that the cycles of sequentially presented addresses are produced, as well as the correct repetition rate and number of complete loops necessary.

The counter-produced addresses are switched over to the RAM and EPROM by the Address Bus switch after a Program Request signal is received. A Ready line, and i.e.d. on the p.c.b., signals when the programming cycle is in progress.

The RAM is held in the READ state, and the Counter addresses RAM and EPROM sequentially. The RAM (which holds the desired program) places the data on the Data Bus and hence onto the input pins of the EPROM. The timing control then waits a few microseconds and switches the 27 volt level on to the Program pin of the EPROM for 0.5ms.

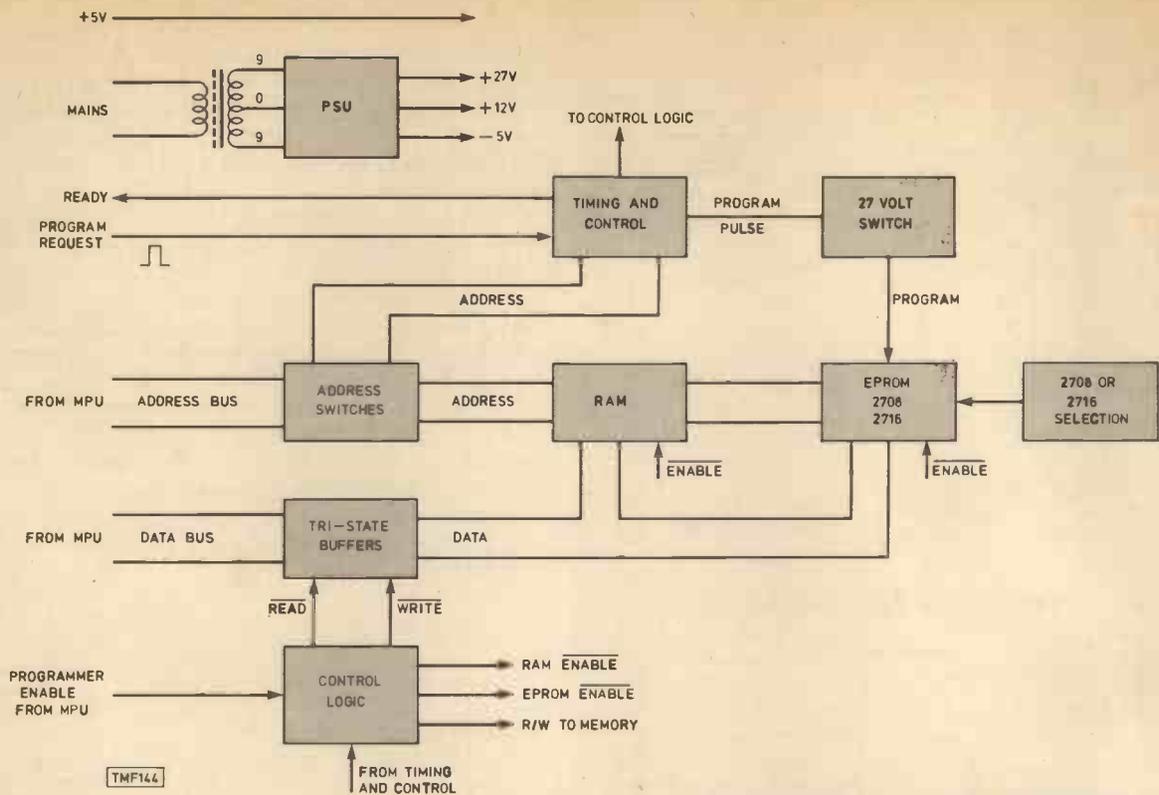


Fig. 4. Block diagram of EPROM Programmer

COMPONENTS . . .

Resistors

R1	1k ½W
R2	1k
R3	47
R4	150
R5	100
R6, R9	2k2 (2 off)
R7	15k
R8	8k2
R10, R12	10k (2 off)
R11	33k

All resistors ¼W 5% unless otherwise stated.

Capacitors

C1, C2, C4	470µF/25V elect (3 off)
C3, C5, C6	100µF/63V elect (3 off)
C7	1n ceramic
C8	100n ceramic
C9	10n ceramic
C10	33µ elect
C11 upwards	100n Supply decoupling

Transistors and Diodes

D1-D4	1N4004 (4 off)
D5, D6	1N914 (2 off)
D7	27V/1W Zener
D8	Any i.e.d.
TR1, TR3	BC549 (2 off)
TR2	BC559

Integrated Circuits

IC1	7474
IC2	4024
IC3	4040
IC4	2708 or 2716 EPROM
IC5, IC6	2114 (2 off)
IC7, IC14	74LS244 (2 off)
IC8, IC13	7400 (2 off)
IC9	74123
IC10-IC12	74LS157 (3 off)
IC13	79L05
IC14	78L12

Sockets

14 pin	4 off
16 pin	5 off
18 pin	2 off
20 pin	2 off
24 pin	1 off

Miscellaneous

T1	Mains transformer. Sec. 9-0-9V at 1A
S1	Double pole single throw
	Pins for through-board connection
	Double sided 0.156in. pitch 50-way edge socket
	Printed circuit board

Constructor's Note

Kit of parts, including double-sided, drilled and tinned p.c.b. (not plated-through), is available from: **Modus Systems Ltd., Dept. EP, 29a East Cheap, Letchworth, Herts. SG6 3DA. £37.30 VAT + p.p. inc. P.c.b. £8.45 inc.**

The kit excludes T1, S1, IC4 and edge socket, but sockets are included for all i.c.s.

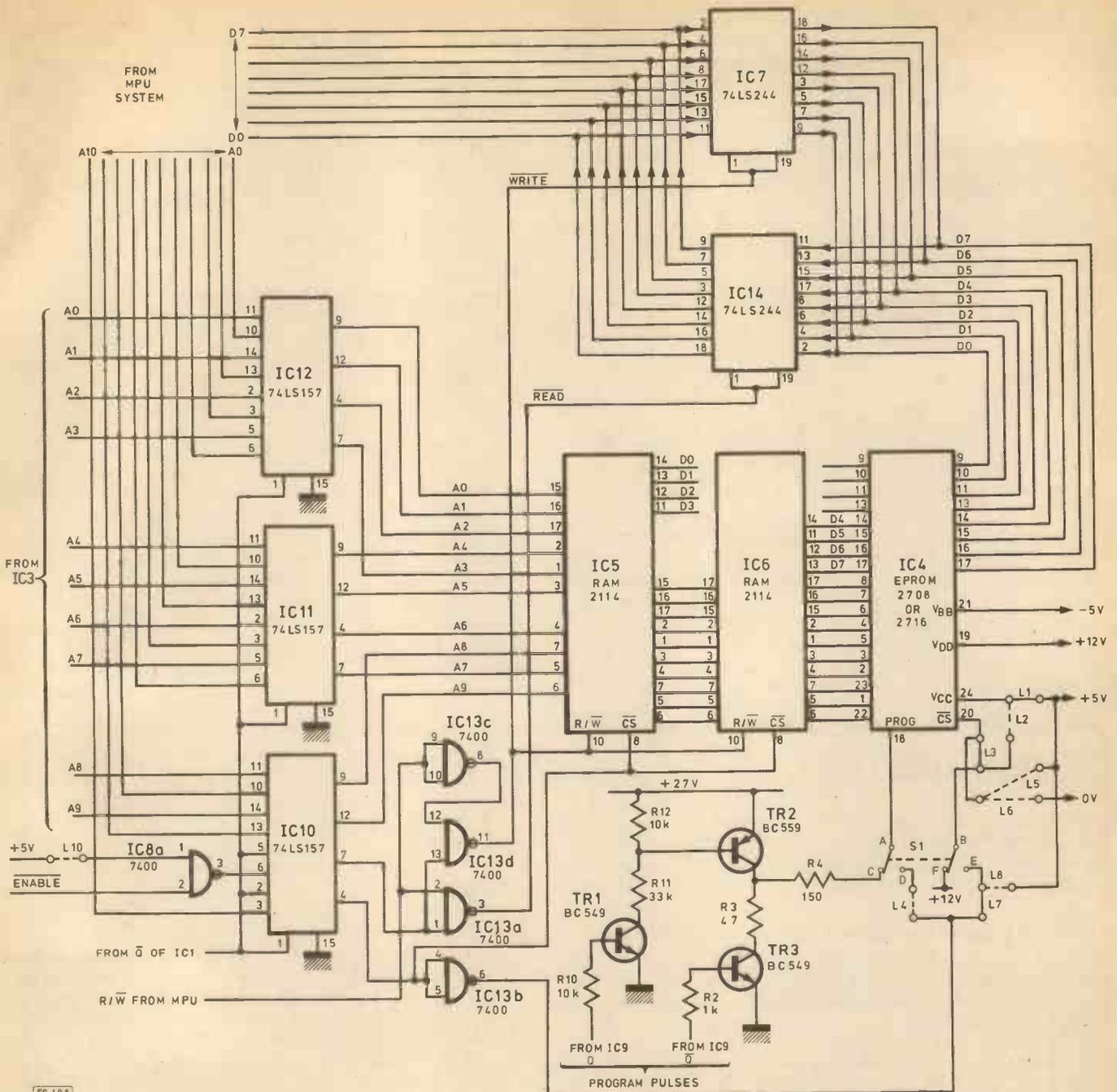


Fig. 5. Memory and switching of the Programmer. S1 is in the "Program" position. Links are shown connected for 2708

The cycles continue until complete and the EPROM and RAM are then handed back to the MPU system for normal use.

It should be clear then, that the role of the MPU system hosting the process is to provide for the RAM, programs or data to be "burned" into EPROM. To this effect, the RAM should be filled with FFs beforehand, so that any unused RAM space does not affect the EPROM.

The RAM and EPROM form a normal part of the MPU's address map, such that programs and data may be stored in either or both for running and use *in-situ*. The only time the memory is not available to the MPU is *during* programming. When the tri-state buffers are switched off, the data Bus of the MPU system is disconnected from the machine.

Last month, in the final part of the COMPUKIT UK 101 article, "plug-in" methods of expanding the machine utilising the upper part of the 2114 memory were described. This is the most convenient method of attaching a programmer and is described next month.

POWER SUPPLY

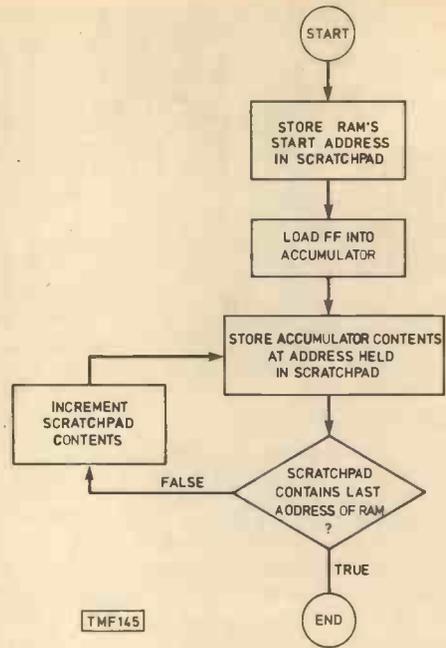
The Power Supply Unit (Fig. 6) gives all necessary power levels except for the +5V which is usually available from the MPU system. An external transformer with a secondary of 9-0-9 volts at 1 Amp is necessary for the PSU and may be purchased from Modus Systems Ltd., who can also supply the p.c.b. and full kit.

As a final note on the above, it is possible to perform the setting of RAM to FF by hardware. All the facilities for stepping through memory exist on the programmer, and it is just a question of keeping the EPROM disabled, the RAM in the write-state, the Bus buffers tri-state and all Data lines to a logic "one". This will fill the RAM with 1s as IC3 cycles through once.

Next month, the final part covers the rest of the hardware, p.c.b. layout, construction and hardware interfacing to your system.



Fig. 8. Flow diagram to fill the RAM with FFs



The EPROM Programmer may be run from the UK101

Countdown

Organisers: Please send details of exhibitions, club open days and other events to Mike Abbott at least six weeks in advance. Inclusion will be subject to space etc.

- Electronics 79**—Nov. 20-23. Olympia, London. ☎ 021 705 6707.
- Video Rights 79** (conference)—Nov. 26, 27. Cafe Royal, London. Details: Nord Media ☎ 01-629 9381.
- Breadboard 79**—Dec. 4-8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. ☎ 0822 4671.
- IBM Hardware Selection**—Dec. 5, 6. Skyline Hotel, London Airport. Details: Online.
- BEX** (Business Equipment Exhibition)—Feb. 6-7. Queens Hall, Leeds. Details: Douglas Temple Studios. ☎ 0202-20533.
- BEX**—Feb. 20-21. The Pavilion, Bournemouth. Details: Douglas Temple Studios.
- IEA/Electrex**—Feb. 25-29, 1980. National Exhibition Centre, Birmingham. Details: Industrial and Trade Fairs Ltd. ☎ 021-705 6707.
- Viewdata '80**—March 26-28. Wembley Conference Centre, London. Conference and exhibition. Details: Online Conferences Ltd. ☎ Uxbridge (0895) 39262.
- Computer-Aided Design** (conference and exhibition)—March 31-April 2, 1980. Metropole, Brighton. Details: Organisers, CAD 80. ☎ 0483 31261.
- Seminex**—April 14-18. Dept. Physics, Imperial College, London.

- Communications '80**—April 14-18. National Exhibition Centre, Birmingham. Details: ITF Exhibitions. ☎ 021-705 6707.
- Electronic Test and Measuring Instrumentation**—April 22-24, 1980. Wythenshaw Forum, Manchester. Details: Trident.
- International Conference On The Electronic Office**—April 22-25, 1980. London Penta Hotel. Organised principally by the Institute of Electronic and Radio Engineers. 99 Gower St., London WC1E 6AZ.
- All-Electronics Show (1980)**—April 29-May 1, Grosvenor House, Liverpool. Exhibition and seminars, with the co-operation of Liverpool.
- The Mersey Micro Show**—April 30, May 1, 2, 1980. Adelphi Hotel, Liverpool. Exhibition and seminars, with the cooperation of Liverpool University. Details: Online.
- The 1980 Microcomputer Show**—July 10-12. Royal Lancaster Hotel, London. Details: Online.
- IBC 80**—Sept. 20-24. Metropole Centre, Brighton. Details: Secretariat, IEE, Savoy Place, London WC2R 0BL.

POINTS ARISING

SIX CHANNEL MIXER (September 1979)

Switch S3b, terminal 4, should be connected to terminal 4 of switch S3a and not to 0V.

DIGITAL TEMPERATURE CONTROLLER (October 1979)

The values for C8 and C9 should be transposed in the circuit and components list.

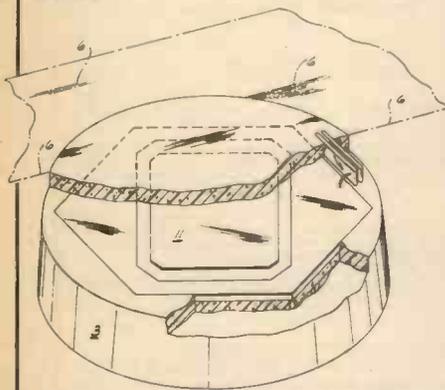
PATENTS REVIEW...

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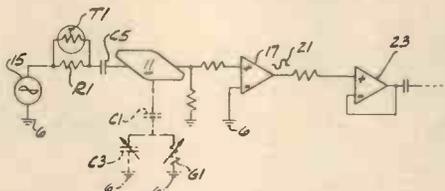
PRECIPITATION SENSOR

British patent application 2010486 from Surface Systems Inc. of Missouri, USA (applied for under the new laws and dating back to December 1977) describes a module for automatically sensing wet and icy conditions on a road or airport runway surface.



The module can trigger a visible or audible alarm, for instance light up a danger sign, when a surface becomes slippery and dangerous; or a series of sensors can provide air traffic control with a continuous readout of airport runway conditions.

A block 3 of epoxy resin material, with silica glass or sand filler for strength and resistance to wear, is embedded in the surface 6 to be monitored. A square electrode 11 of metallic foil is encapsulated in the block thereby providing both capacitance and conductance paths to surface 6.



In the circuit diagram the capacitance path is represented by phantom capacitors C1 and C3, and the conductance path by phantom resistor G1. A constant-voltage oscillator 15 and capacitor C5 supply electrode 11 with a sine wave signal at a

frequency of around 5kHz. The signal is applied via resistor R1 and thermistor T1 to compensate for any small change in the value of capacitor C1 caused by temperature. Because a relatively low frequency sine signal is used, oscillator 15 can be placed up to 500 feet from sensor electrode 11 without significant loss.

Whenever there is water or ice precipitation the sensor surface is connected capacitively and conductively to the surface 6. This causes a significant loss of current from electrode 11 to surface 6. The amplitude of the signal appearing at the input of amplifier 17 is thus a function of the change in the capacitance and conductance between sensor electrode 11 and surface 6. The output of amplifier 17 therefore decreases as precipitation accumulates on the sensor. Precipitation circuit 23 provides an indicator or alarm trigger signal when the output signal 21 of amplifier 17 falls to a predetermined level.

In one modification of the invention a delay circuit is incorporated to ensure that the temporary removal of ice or water from the sensor block by passing vehicles does not affect the overall reading.

LIQUID MAGNET

British patent application 2009414 from the French company Societe Nationale D'etude et de Construction de Moteurs D'aviation was filed under the new patent laws and dates back to November 1977.

Although the invention is concerned primarily with a magnetic means of measuring the thickness of passageways inside gas turbine blades, it is clear that the principle described has much wider applications. The specific aim of the invention is to check that

the cooling passages inside a turbine blade are accurately formed, with adequately thick walls. To achieve this the passages are temporarily filled with ferro-magnetic fluid.

This material, which was developed (like so many others) for use in space, is a suspension of magnetic particles in liquid which behaves like a fluid magnet. Because ferro-magnetic fluid is expensive, it is introduced into the passageways and withdrawn after use by a simple piston and cylinder arrangement.

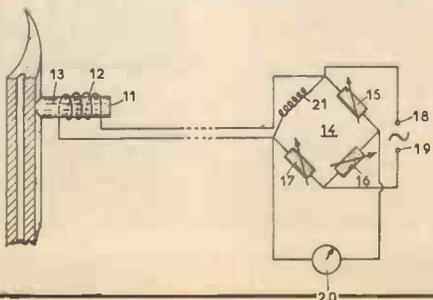
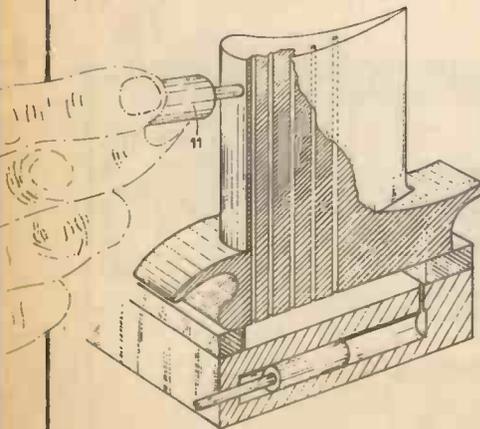
A probe 11, like a metallic pencil, is wound with a coil 12 on a core 13. This coil forms one branch of an a.c. bridge 14, of which the other branches are formed by potentiometers 15, 16 and 17. The bridge is supplied at a first diagonal by a.c. from generator supply 18, 19 and a measuring

apparatus 20, for instance a meter, is connected across a second diagonal to read any dis-equilibrium of the bridge. Compensation winding 21 is identical to, and in parallel, with the winding 12, but wound in the opposite direction.

Equilibrium of the bridge is achieved with the probe against the part to be measured. When the probe is subsequently moved over the part, any irregularities in the passages containing the fluid cause a visible change at the meter 20 because the fluid governs the impedance of winding 12.

It is interesting to note in passing that the American firm Teledyne Acoustic Research already has what appears to be a master patent on use of ferro-magnetic fluid to fill the gap between the voice coil and magnet of a loudspeaker. Indeed many Acoustic Research loudspeakers now have fluid filled gaps of this type. The claimed advantage is that the fluid helps conduct heat away from the voice coil to the magnet pole piece in the manner of a heat sink and provides friction-free radial support for the coil former.

The Acoustic Research patent was granted under the old British laws (BP 1542266) and cites US patents 3612630 and 3734578 as describing basic forms of ferro-magnetic fluid *per se*.



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STAR CHESS - £56.09 + VAT. PLAY CHESS AGAINST YOUR PARTNER.

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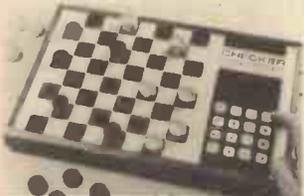
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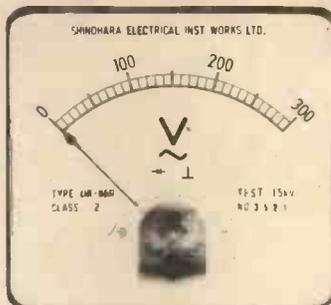
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DC 5mA			

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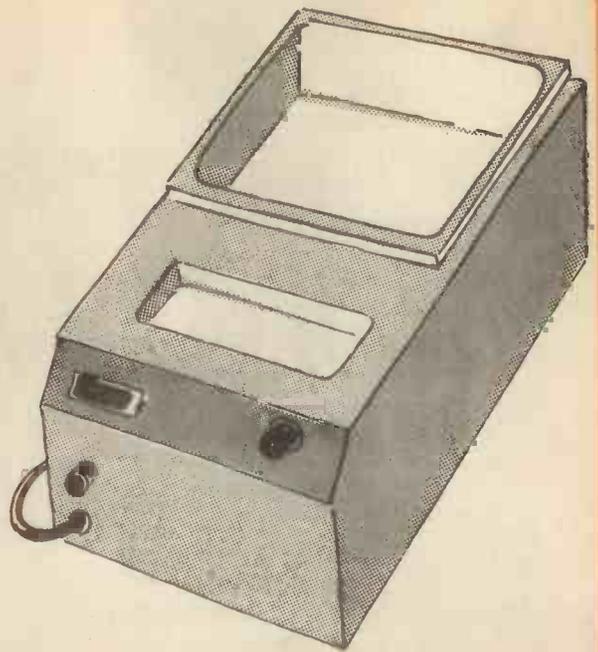
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SOFTY *Review*

Softy is a general development tool for MPUs and next month our contributor, Dr. A. A. Berk, reviews this new line in the micro scene.

PRACTICAL ELECTRONICS

JANUARY ISSUE ON SALE FRIDAY DECEMBER 14

Ultrasonic BURGLAR ALARM

GILBERT DAVIES

THIS ultrasonic burglar alarm is a two unit system: a Movement Detector and a Control Unit. The Movement Detector, which contains the ultrasonic transmitter (X1) and receiver (X2), will detect movement within a room and then send an alarm signal to the control board. The Control Unit contains the keyswitch for on/off control of the system, the delay circuits, and the relay for controlling the alarm as well as the battery back up circuit in case of mains failure.

which can be higher or lower than 40kHz); these will combine to produce a beat note. The frequency of this audio or sub-audio beat note will be the difference between the two ultrasonic frequencies. This beat frequency is then amplified, filtered and used to operate the alarm.

MOVEMENT DETECTOR

The circuit diagram of the Movement Detector is shown in Fig. 1. If constructors wish to use the Detector Unit on its own the relay RLA and D15 (shown in the shaded area) should be fitted and the value of C13 increased to 22 micro farads. If both units are to be used the two wire links shown on the Movement Detector board should be fitted. The 18V output from the transformer (T1) is fed to the bridge rectifier formed by D11 to D14, smoothing capacitor C15 and the voltage regulator (IC2) to obtain a stabilised 12V supply.

The 555 timer (IC3) is connected as a variable square wave generator the output of which (pin 3) is fed to the ultrasonic transmitter (X1). The transmitted signal from X1 is

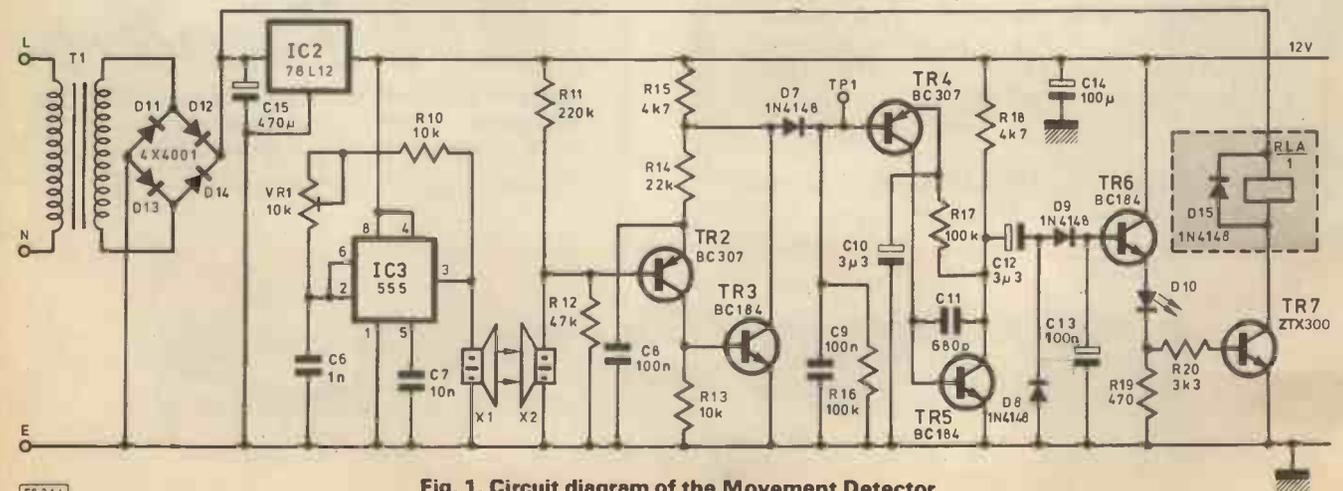
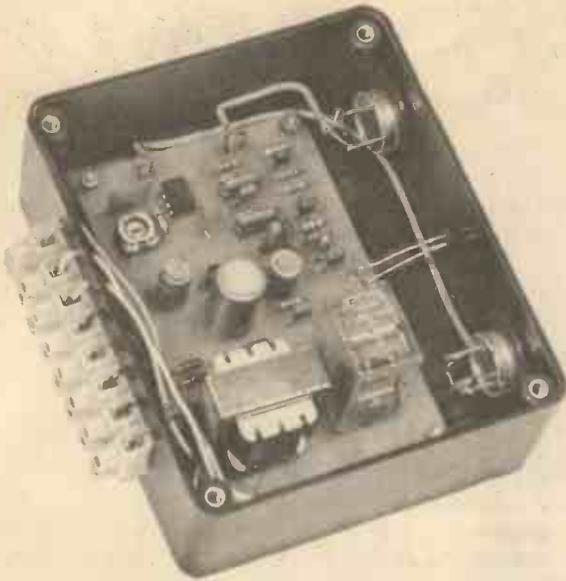


Fig. 1. Circuit diagram of the Movement Detector

picked up by the receiver X2 and amplified by TR2 and TR3 with resistor R14 providing 100 per cent feedback making this stage very stable. The a.c. gain of the stage is determined by C8 which shunts the high frequency signals in the feedback path therefore increasing the gain of the stage 50 times the input voltage at 40kHz.

As only the positive going signal is required at the output of this stage the bias is offset from the normal half supply rail to provide a better operating working voltage for the diode detector as well as a greater overload margin for the input stage.



Internal view of the Movement Detector. Note that the relay RLA has been included

The output from TR3 collector passes through the envelope detector D7 and the CR network C9, R16 which removes the 40kHz signal. The signal from TR3 collector varies the d.c. level across C9 and provides both the bias and the signal for the next stage. This stage is basically the same as the first stage with the exclusion of the load resistor for TR4 collector.

SPECIFICATION

- 0.5 sec alarm function test at switch on.
- 2 sec delay to suppress invalid movement.
- 20 sec delay at switch on — to prevent alarm operation on leaving room.
- 20 sec delay on entry — to allow the alarm to be cancelled.
- 2 min alarm before cancelling (alarm is pulsed at 2 Hz).
- Quiescent current 25µA at 12V d.c.
- 18V battery back up in the event of a mains failure.

The capacitor C11 limits the HF response by applying negative feedback to TR5 so that the ultrasonic component of the signal is not amplified. R17 and C10 were chosen to provide a suitable bandwidth for Doppler shift frequencies.

The output from TR5 is fed to the diode pump network (D8, D9) via C12 which rectifies the signal and charges C13 to convert the beat note to a steady voltage. When the voltage across C13 reaches 2.6V, TR6 turns on and the l.e.d. (D10) is illuminated. TR7 is also turned on via R20 and the collector voltage of TR7 falls to zero. This fall in collector

voltage is passed to the control unit via the wire link and the common output of RLA on the Movement Detector Board.

However if the relay RLA is used the falling collector voltage of TR7 is used to energise the relay from the un-stabilised 18V supply, whilst D15 suppresses any spikes generated by the relay coil. The collector of TR7 remains low until C13 discharges through TR6 turning off both TR6 and TR7 and switching the collector voltage of TR7 high.

COMPONENTS . . .

Resistors

R1, R3, R7, R14	22k (4 off)
R2, R11	220k (2 off)
R4, R5	2M2 (2 off)
R6	10M
R9, R10, R13	10k (3 off)
R8	470k
R12	47k
R15, R18	4k7 (2 off)
R16, R17	100k (2 off)
R19	470
R20	3k3

All resistors ¼W 10% carbon

Potentiometers

VR1	10k min. hor.
-----	---------------

Capacitors

C1, C4	4µ7 25V tant (2 off)
C2, C3, C5	10µ 25V tant (3 off)
C6	1n ceramic
C7	10n ceramic
C8, C9	100n polyester (3 off)
C10, C12	3µ3 16V tant (2 off)
* C13	100n or 22µ 16V elect
C11	680p ceramic
C14	100µ 16V elect
C15	470µ 25V elect

Semiconductors

D1 to D6, D7 to D9, D15	1N4148 (10 off)
D11 to D14	1N4001 (4 off)
D10	TIL 209
TR1, TR7	ZTX300 (2 off)
TR2, TR4	BC307 (2 off)
TR3, TR5, TR6	BC184 (3 off)
IC1	4093
IC2	78L12
IC3	NE555

Miscellaneous

X1	Transmitter MA 40 LIS
X2	Receiver MA 40 LIR
T1	Transformer 18V 75 mA
* RLA	Varley VP2 700 ohms
RLB	12V 1640Ω open type (RS 349 — 131)
B1, B2	Battery PP9 (2 off)
S1	Keyswitch
P.c.b.s.	(2 off)
Battery clips	(2 off)
ABS case 115 x 95 x 45mm	(2 off)
Grommets	
Terminal block	
Keyswitch	
* Piezoelectric transducer	1TT U2 — 50 RHA
* See text	

Constructor's Note

Printed circuit boards and other components are available from **G.J.D. Electronics, 105 Harper Fold Road, Radcliffe, Manchester.**

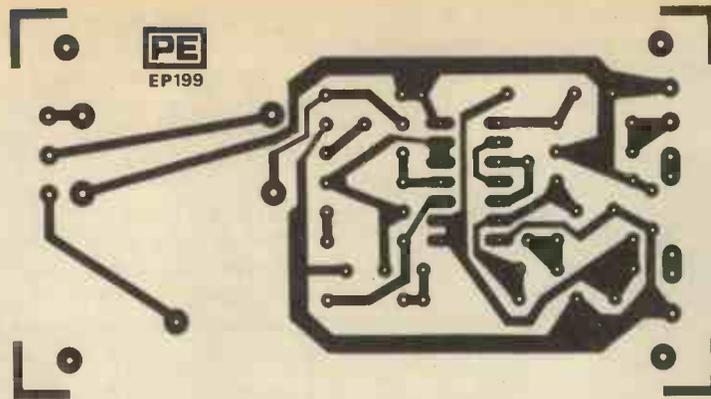


Fig. 5. P.c.b. design for the Control Unit

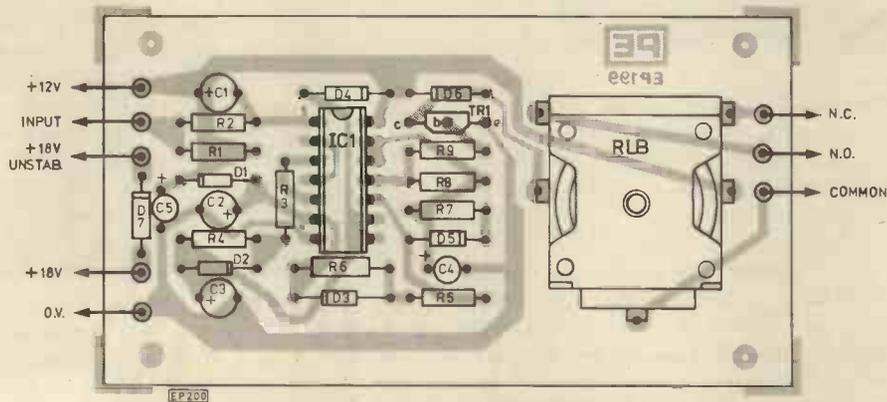


Fig. 6. Component layout of the Control Unit

for 0.5 sec to provide an alarm test every time the system is switched on.

When movement is present for more than 2 secs the input of gate "a" goes low setting the bistable with the output of gate "a" going high charging C3 through R3, R4. This allows the input to gate "c" to go high and its output low releasing the input of gate "d". Gate "d" forms a 2Hz Schmitt oscillator, the frequency being determined R8, C4. The output from gate "d" passes through R9 driving TR1 and energising RLB. D6 suppresses the back e.m.f. from the relay coil.

The output of gate "c" also discharges C2 which after 2 mins resets the bistable and cancels the alarm. D1 and D4

discharge C2 and C3 at switch off.

Diode D7 has the battery voltage connected to its anode and the un-stabilised 18V to its cathode. Because the un-stabilised voltage will be higher the diode is turned off. When the main voltage falls the diode will conduct and the battery voltage will be applied to the system. When the main supply is re-established the diode D7 automatically switches off the battery voltage.

CONSTRUCTION

In the prototype system the movement detector and the control unit were mounted into two separate ABS boxes.

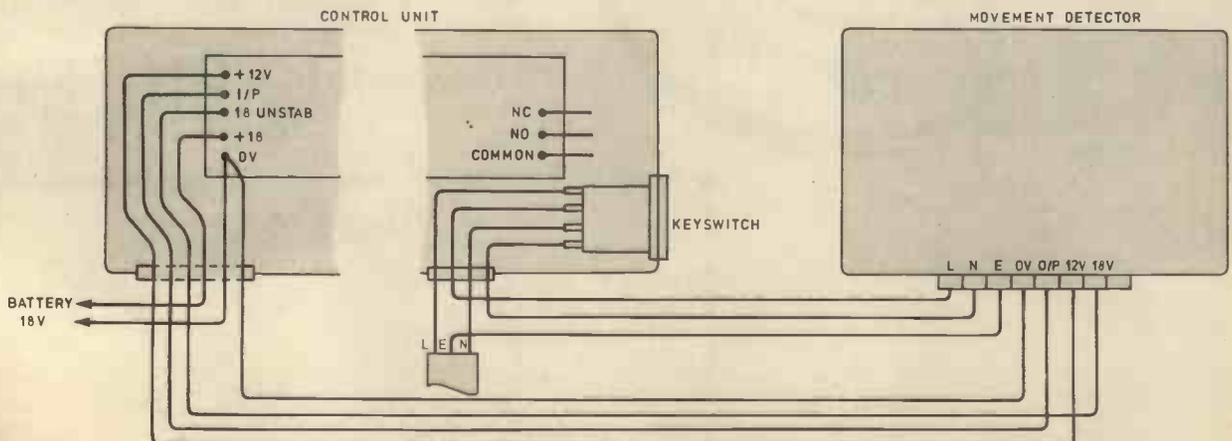
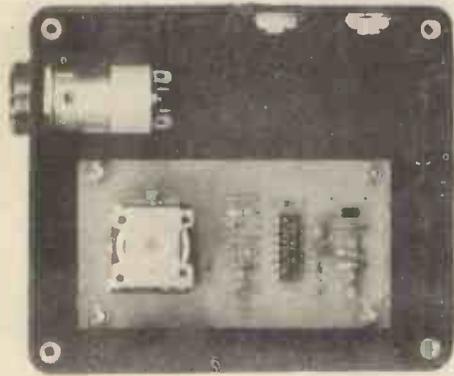


Fig. 7. Wiring interconnections for the two units

The transducers are mounted inside grommets on the front panel with the indicator l.e.d. mounted mid way between them. If the l.e.d. is not required on the front panel it can be placed inside on the p.c.b.



Internal layout of the Control Unit

The p.c.b. design for the Movement Detector is shown in Fig. 3 with the component layout in Fig. 4. After the board has been soldered and checked it can be mounted into the case and connected to the terminal block. The transducers should be soldered to the board using screened leads.

The p.c.b. design and component layout for the Control Unit are shown in Figs. 5 and 6. After soldering and checking, the p.c.b. should be mounted into the case together with the keyswitch. The two PP9 batteries were mounted outside the case on the prototype although if a larger case is used they could be mounted inside. The two units should be wired together as shown in Fig. 7.

ALARM OPTIONS

The system can be fitted with an external piezo electric transducer which can directly replace RLB and D6, driven from the collector of TR1.

If an external alarm is used it can be connected via the contacts of RLB and either a mains or 12V d.c. buzzer used.

INSTALLATION

The detector is prone to both vibration and air currents therefore the points shown in Table 1 should be observed to avoid false triggering of the alarm.

TABLE 1	
a)	Do not place the unit on a vibrating surface.
b)	Close doors and windows.
c)	Do not point the unit at a wall with a radiator or convector heater.
d)	Objects should not be placed within 5 feet of the unit as this will limit its sensitivity.
e)	The external alarm should be far enough away from the unit so as not to produce vibration.
f)	Cats, dogs and other household pets should be taken into consideration.
g)	If more than one unit is used care should be taken to ensure the two ultrasonic "fields" do not interact the alarm to trigger.

SETTING UP

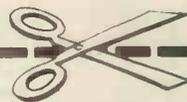
The variable resistor VR1 should be adjusted for the maximum d.c. level at TP1. The sensitivity of the unit can be checked by moving in front of the ultrasonic transmitter and receiver and noticing the l.e.d. movement indicator. Finely adjust VR1 until the maximum sensitivity is obtained ★

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FRANK W. HYDE

THE LARGEST INFRA RED TELESCOPE

A triumph of engineering skill has added a fourth member to a group of telescopes on the summit of Mauna Kea on the big island of Hawaii. The United Kingdom Infra Red Telescope (UKIRT) was inaugurated by His Royal Highness the Duke of Gloucester on the 10th of October.

In recent years there has been a very considerable expansion of activity in the field of Infra Red Astronomy, indeed it could now be said that it has paralleled advances made in other areas of the spectrum. New sources of radiation have been recorded and new mechanisms have been posed to account for physical processes that are taking place in remote regions of the Universe. For example it has been discovered that the nuclei of galaxies radiate an unexpectedly large amount of infra red energy. As yet the extent of the power involved is unknown.

There are massive clouds of interstellar dust and gases which appear to be the site of galaxy and star formation. These cradles of creation may hold the clues relating to the origin of the Universe. Solid matter in these areas provide the surfaces needed for hydrogen and other molecules to form. Of the different types of molecule identified, more than 50, all have specific emission or absorption at the infra red and radio frequencies. The extent of the complexity involved in the molecular processes was unsuspected a decade ago.

It may be possible now to set up a galactic distance scale using techniques involving magnitudes and measured velocity dispersions. At millimetre wavelengths the infra red telescope is the only means of studying the cosmic background radiation at 2.7 degrees. This is the temperature at which there should be remanent radiation from the processes that were in operation at the formation of the Universe.

Two British firms were involved in the development and construction of the 3.8 metre UKIRT. They are Grubb Parsons who have had so much experience in the design and development of telescopes over many decades and are now a unit of Northern Engineering Industries, together with Hadfields Ltd., famous for their original work on the 250ft diameter radio telescope at Jodrell Bank, Hadfields are now part of the Lonrho Group.

The UKIRT was commissioned by the Science Research Council in 1975. The contract went to the Special Projects Division of Hadfields Limited. Work commenced in the spring of 1975.

Modern telescopes and other instruments in use for astronomical purposes are now very much concerned with electronics. Control systems abound and astronomy cannot be seen now as an isolated activity for it is, by reason of the space industry involved, not only in the scientific experiments but in all systems involving navigation and the practical guidance of space vehicles. The infra red telescope by its very nature covers a wide field of technology. The mechanics are concerned with the elements such as control of a surface which is so sensitive that just tilting on its axis can set the mirror in a condition of distortion. Such conditions not only affect the performance of individual tasks but have long term possibilities in ageing and deterioration of the materials used. This is primarily where the control system depends on electronics.

The mirror was to be 3.8 metres in diameter and 29 centimetres in thickness. Now apart from the very critical parameters involved in the manufacture of such a mirror, its performance at all angles is prodigious. The final result must be such that distortion must be held to an almost impossible low level. The contours of the surface of the primary mirror is held by a special support of three rings with a total of eighty pneumatic cylinders. These are electronically controlled. The result has been to achieve subarc second performance under all normal operating conditions.

The material of the mirror is a glass ceramic called Cer-Vit. Normal glass would not be suitable for a mirror of this size and nor would it be able to resist thermal distortion which is one of the great hazards with large mirrors. Cer-Vit is not subject to this defect and indeed is almost unaffected by thermal changes. It should be noted here that even a minute distortion of the surface can result in a confused image at the focus and thereby nullify measurements.

The rest of the optical system consists of smaller mirrors all made of Cer-Vit. One of them is a plane mirror used in the Coudé beam. This has a major axis of 1.5 metres and a thickness of 3 centimetres. The mirror blanks were purchased from Owen's of Illinois and figured by Grubb Parsons.

The principle of operation is in a number of modes. Two of these will be described.

The primary mirror is at the "bottom" of the main structure. This receives the radiation from the sky and directs it on to a secondary mirror at the "top" of the structure. The radiation is then again returned toward the primary mirror. Different secondaries may be

used. In one case the radiation passes from the secondary mirror through a hole in the centre of the primary mirror to a point about one metre behind the primary. This is the Cassagrainian focus. At this point the radiation is recorded by instruments mounted on the frame of the telescope. Thus all instruments in a similar mode have to be mounted on the telescope since it traverses the sky and the instruments must follow. The amount of such instrumentation has a limiting factor. To overcome this, where the equipment for examining the radiation is large, another mode is adopted. By the use of plane mirrors another focus independent of the position of the main axis of the telescope is achieved. This is called the Coudé focus. By means of plane mirrors the beam from the system can be diverted so that it remains independent of the motion of the telescope itself. This enables large and bulky apparatus to be accommodated in a basement below the telescope.

The remainder of the telescope apart from the optical systems was designed and constructed by Hadfields of Sheffield. The whole completed telescope was built, tested, dismantled and conveyed to the final site there to be erected and put into operation by that Company under the guidance of the Royal Observatory Edinburgh.

COMPUTER CONTROL

Many of the mechanical and control systems are new concepts in control. A high proportion of this innovative design is found in the unique electronic control systems and computer control. The control computer is physically coupled systems employing the European CAMAC standard interface which provides almost unlimited expansion facilities. The control computer is of unique design due to Hadfields and provides time dependent data for telescope motions without frequency synthesis. This technique has been developed into an advanced form by software engineers from Imperial College, London and the Royal Observatory of Edinburgh.

In operation the telescope has a special device not used on ordinary optical telescopes. To be effective an infra red device must be able to separate the radiation from the body or area under study from the background radiation. This is provided by a special "rocking" secondary mirror. This allows the telescope to "see" the sky and the object alternately. The mirror is rocked at a rate of up to 30 cycles per second. The detector is therefore presented with a varying signal which the electronics record. Any British astronomer may apply for time to use the telescope. Application must be made to the Royal Observatory, Edinburgh who are responsible for the administration of their project.

SHUTTLE SCHEDULE

The first space shuttle schedule shows that between 1981 and 1984 all thirty-eight flights are already fully booked.

The customers are US business enterprises, foreign Governments, many departments of the US Government in which no less than 12 spacelabs are required each having many experiments aboard.

PE

DIAMATIC

Programmable Audio Visual Unit

PART 2 — J.R.W. Ames B.Sc. W.L.Blyth B.Sc.

In this final part board construction together with interwiring and final setting up will be detailed.

CONSTRUCTION

The authors' projectors are made largely of plastic with a metal lamp house which gets very hot so there is no suitable heatsink surface for the triacs. To get round this problem the prototype system, shown in the photographs, was built in two boxes. One houses the majority of the electronics while the other, which also doubles as a heatsink, is for the triacs. Two boxes were used so that the high current connections to the triacs could be kept short whilst leaving the control box free to be positioned in a convenient position when making a recording. Connection to each projector is via a short length (approx. 400mm) of heavy duty mains cable while a screened multi-core cable connects the triac drivers to the control box. Other constructors may have projectors with exposed cool metal surfaces in which case the triac housing can be eliminated and the projectors connected directly to the control box.

The price of the multi-way connectors used in this arrangement amounts to nearly £18—one third of the cost of the whole unit. Many constructors may therefore prefer to mount a heatsink on the side of their plastic bodied projectors thereby eliminating the need for expensive connectors. The connection from each projector to the control unit then comprises 5 light current signal leads plus earth so a DIN audio connector can be used, reducing the cost of connectors to no more than £2.

TRIAC HOUSING

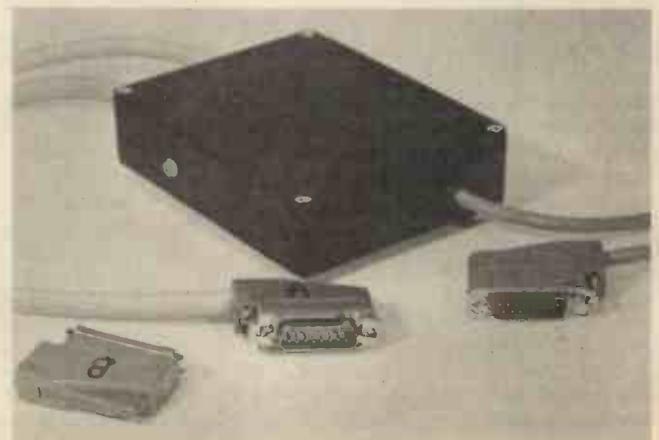
Fig. 1 shows the circuit that is contained within this housing. Straight-through connections are provided for the slide change and power supply connections to each projector while additional inputs from the main control box trigger each triac. The connections to the control box carry only small currents and are made by a multi-core screened cable (to reduce radiation from the triac trigger pulses) terminated by a 15-way D-type plug and socket (PL2, SK2). D-type plugs and sockets are also used for the connections to the projectors. Each way of these connectors can carry a maximum of 5A and in this arrangement four pins are connected in parallel for each of the two load carrying connections.

The circuit is housed in an aluminium die-cast box which should be painted with matt black spray paint after drilling. Before mounting the triacs on the inside of the box make sure that all paint is removed from the area and apply a thin

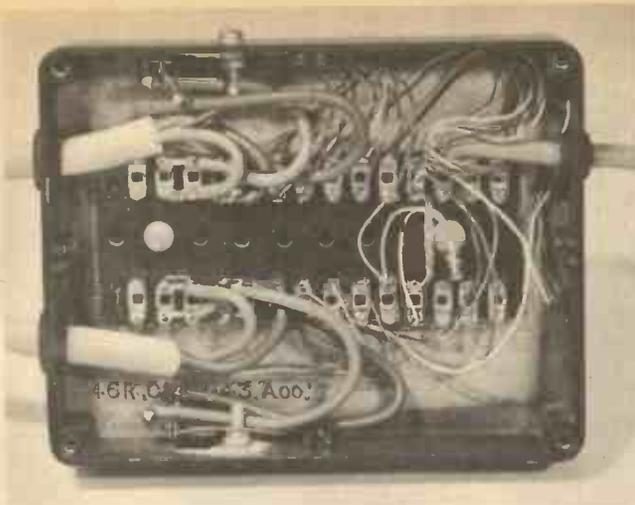
film of heatsink compound to the mating surfaces. The specified triac has a mounting tab which is electrically isolated from all of its terminals. When using a substitute device without an insulated tab it will be necessary to mount it by means of a nylon nut and bolt and to use a mica insulating washer.

Fig. 14 shows the layout inside the box and the details of the connections to the plugs, shown from the solder side of each plug. It will be necessary to shorten the specified group-boards a little before they will fit in the box. About 400mm of 3 core 13A mains cable is used to connect the housing to each projector plug. The third core of the cable can be pulled out leaving a hole large enough to take the four 0.4mm dia. wires that connect to the slide change mechanism, the power supply and earth. Inside the box the conductors from each composite cable are connected to tags on the group-board. From the group-board stout wires are connected to the T_1 and T_2 connections of each triac while the cores of the multi-way connection to the control box are also terminated on the appropriate tags. Make sure that the earth wire from each of the projectors is connected through to the chassis tag and that the screen of the multi-core cable is connected to this tag also.

It is not easy to solder the thick conductors of the load carrying cable to the pins of the projector plugs and it may be helpful to make the parallel connections between pins first using a piece of stiff wire (a resistor lead, for example). The heavy duty cable cores are then stripped back for only a short distance (approx. 4mm) and fanned out a little before



Triac housing



Interior wiring

being butt jointed to the stiff wire link which provides a large enough area to form a good soldered joint.

MAIN CONTROL CIRCUIT

The whole of the electronics is mounted on a single printed wiring board whose layout and component overlay are shown in Figs. 19 and 15. As a result the circuit is very easy to assemble even for the beginner or for someone whose main interest lies in photography! Installing a few components at a time work from one side of the board inserting the components and bending back their leads so that they do not drop out when the board is inverted. When a group of components have been fixed in this way invert the board and solder carefully using a clean miniature iron and miniature resin-cored solder. Apply only the minimum amount of solder to make a sound joint and then cut off the

component leads before repeating the operation. Continue in this way mounting all the wire-ended discrete components before others are inserted. R4, the power supply dropper resistor, gets fairly hot and should be stood away from the board by putting a U-bend in its leads.

Mount the skeleton preset potentiometers and sockets for the integrated circuits making sure that they are held securely home whilst soldering.

The specified cermet preset potentiometers should not be replaced by the cheaper s.r.b.p.-based types which have inferior mechanical and electrical characteristics. Use of sockets for the i.c.s is not a luxury—it is very difficult indeed to unsolder all 14 or 16 leads of a suspect "chip" without damaging the device or the board (or both), and it is very discouraging to undertake the task only to discover that it was not the i.c. that was causing the problem. Sockets allow easy substitution tests as well as ensuring that the devices are not damaged by excessive heat during soldering.

Finally, insert pins from the copper side of the board into the holes provided for off-board connections and push them firmly home using a hot soldering iron before fixing them with a small quantity of solder. In the same way that i.c. sockets are not essential to the project these pins can be omitted, but they make it much easier to make connections to the board without causing damage, and they make it possible to attach and remove external wires once the board is firmly mounted in the box.

TRANSFORMER

The pulse transformers, T101 and T102, are very easy to make and should not deter anyone from undertaking the project. Wind 100 turns of 38 swg wire on to one half of the sectionalised bobbin and twist the free ends of the wire together for a short distance to prevent them from unwinding. Repeat the operation for the secondary winding using 10 turns of 28 swg wire in the other half of the bobbin.

Now put the bobbin into one half of the pot core, line the other half of the core up on top and clip the whole assembly to the mounting board with the ring and clips as shown in Fig. 18. Solder the protruding wire ends to the pins on the base according to the layout in Fig. 15—the sense of the windings is not important as the triac will turn on with either positive or negative pulses applied to its gate. To prevent vibration and noise from the transformer when in use dip the whole assembly into household polyurethane varnish, giving it a good shake to remove surplus fluid on removal, and leave it to dry for 24 hours. Finally give the windings a check for d.c. continuity and insert the transformer into the printed wiring board before carefully soldering it into place.

THE BOX

First mount the two sockets SK1 and SK2 at the back of the box after carefully making the cut-outs.

The DIN socket SK1 is used to interconnect with the



Relative sizes of Diamatic pair

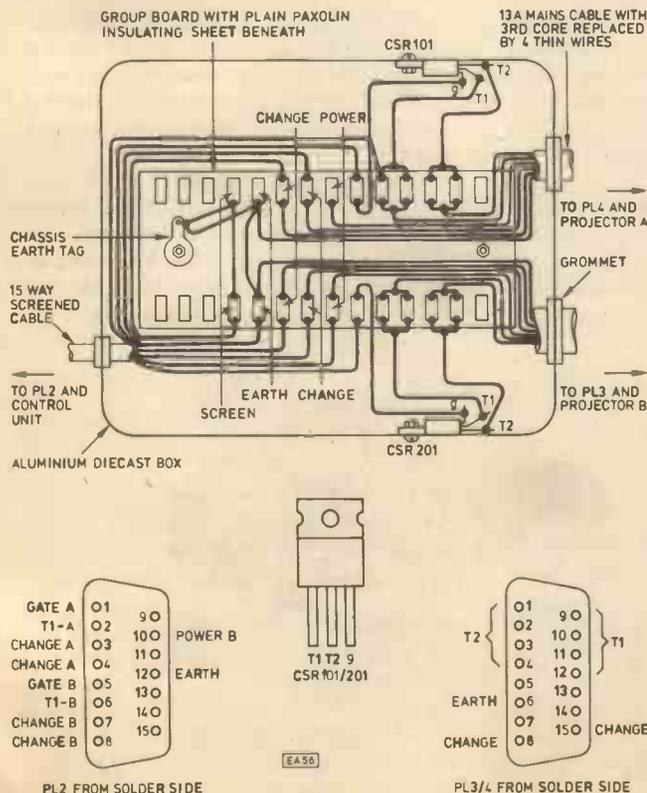


Fig. 14. Layout and plug connection

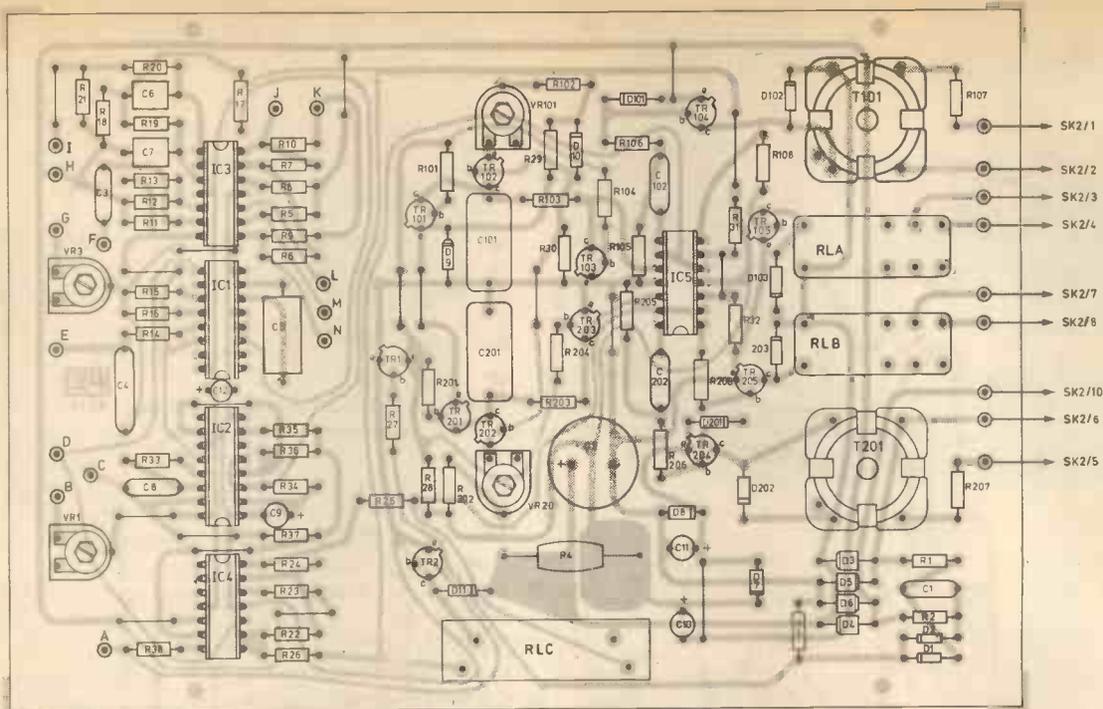


Fig. 15. Board component layout

tape recorder while the multi-way D-type socket, SK2, carries the connections to the triac housing. Fig. 20 shows the numbering of the socket connections from the interior of the box to assist in wiring. Solder leads of suitable lengths to the socket pins before mounting the printed wiring board in the box using four 3mm holes drilled to align with the mounting holes on the board. Group the wires neatly together and solder them to the appropriate pins on the board making sure that you leave enough wire to allow the board to be removed from the box to assist with later fault finding and debugging.

Fig. 16 shows the drilling details for the front panel. Mount the components where shown being careful not to damage the front surface of the panel and wire up the controls as shown in Fig. 17.

Group the wires from the front panel together remembering to leave enough wire to allow the panel to be removed for access.

When all the soldering is complete insert IC1-5 in their sockets noting that they do not all lie the same way round. It is very easy to insert an i.c. the wrong way round or to trap a pin underneath it so check carefully to avoid some tricky fault finding later.

AUDIO LEADS

The correct terminations for the DIN plug connection to the tape recorder are shown in Fig. 20 in which the left hand channel of the stereo pair has been chosen to carry the dissolve control tone. The connections to the plugs at both ends of the lead are identical. For right hand channel operation wire up the plug using pins 4 and 5 in place of

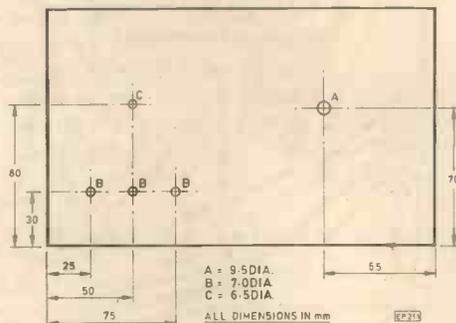


Fig. 16 Drilling detail of control panel

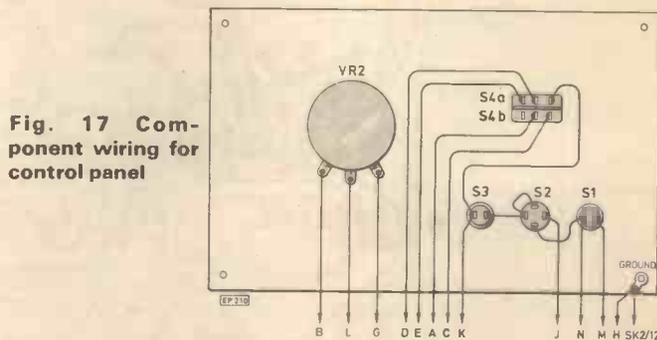


Fig. 17 Component wiring for control panel

1 and 3 respectively. If phono connections to the tape recorder are required wire up one DIN plug as shown and terminate the two free wires at the other end with standard phono plugs.

MODIFYING THE PROJECTORS

There are probably as many variations on the basic electrical circuit of a projector as there are manufacturers of this type of equipment so it is not possible to give modification instructions in great detail. We show in Fig. 21 the circuit diagram of a typical projector together with the modifications needed to enable it to work under control from the slide dissolve unit.

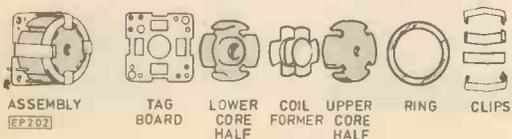


Fig. 18. Exploded detail of pulse transformer

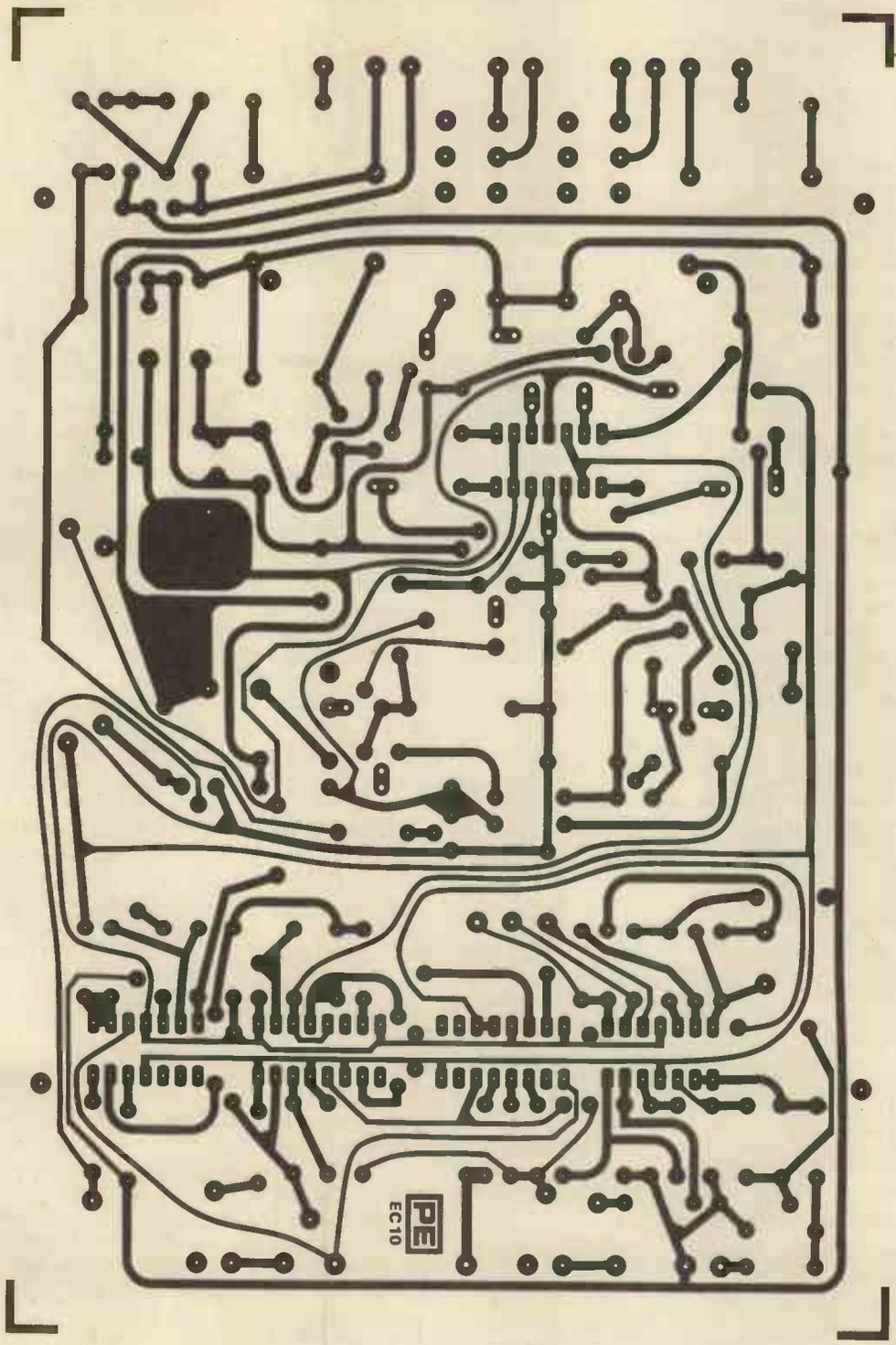


Fig. 19. Printed circuit board for Diamatic

The first and most obvious of the modifications involves interrupting the lamp circuit and bringing it out to a suitably placed D-type socket for connection to the triac housing. Also brought out to the socket is a connection in parallel with the slide change switch and a connection to the transformer secondary which completes the power supply circuit for the control electronics.

Not so obvious are the suppression components shown connected across the two solenoids. The change solenoid (SOL1) operates every time the change relay contacts make in the control unit and the slide direction solenoid (SOL2) will also operate if the direction switch on the projector remote control is set to "reverse". On release of the change relay the back e.m.f. across both of the solenoids causes arcing across the relay contacts which can interfere with the audio channel and disturb the operation of the control circuit. Suppression components are fitted across the coils of both the solenoids to prevent this problem.

First it is necessary to establish whether the solenoids involved (in many projectors there will be only one) are powered from an a.c. or d.c. supply. In the example shown (which is of a real projector) SOL1 is d.c. operated while SOL2 is powered by unrectified a.c. Across the d.c. solenoid we may connect a normally reverse biased rectifier diode that will conduct during the reverse swing of the back e.m.f. thereby preventing an arc from developing. This treatment is not possible for an a.c. solenoid so in this case a series combination of R/C is used to damp the back e.m.f. and reduce the intensity of the arc.

For operation as a normal projector without the dissolve control unit in circuit a dummy plug which shorts together the interrupted lamp connections is inserted in the multi-way socket and slide change is controlled in the usual way from the projector remote control.

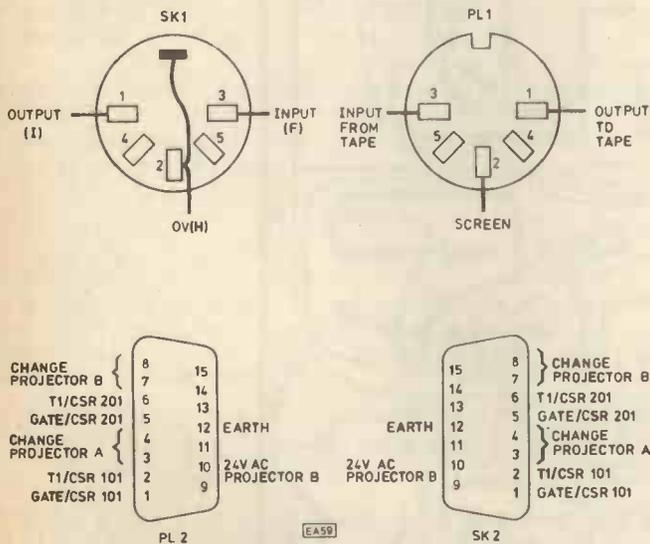


Fig. 20. Plug and socket connections

Constructors who build the triac into their projectors can revert to normal operation by connecting a resistor in series with a switch between T_2 and gate of the triac. With the switch open operation of the lamp circuit is controlled by the triac trigger pulses but when the switch is closed the triac is held in its conducting state and the lamp remains at full brightness.

SAFETY

An earth connection is shown in the circuit diagrams which connects the OV rail and all metalwork to mains earth via the projectors. It is important that this connection is

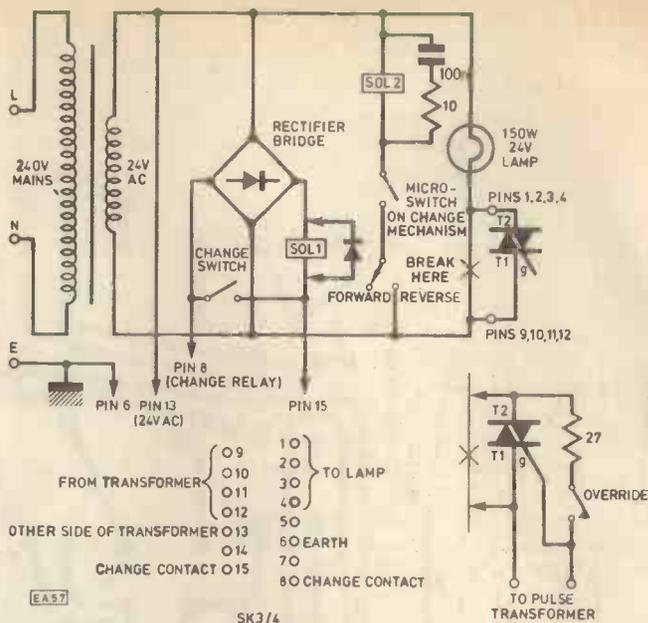


Fig. 21. Circuit diagram of projector with mods

made even if the projectors are double-insulated and do not have a ground connection because the control circuits and hardware are not protected by the double-insulation and could therefore become live in the event of a fault in either projector. If a two-core mains lead is fitted to either or both of the projectors replace it with a three-core 3A cable and connect the earth lead through to the control equipment via the multi-way connector as shown in the diagrams.

Do not rely on an earth connection made via audio equipment—if a hum loop results when separately earthed audio equipment is used remove the connection between the board (pin H) and the DIN connector (SK1, pin 2) to alleviate the problem but remember to replace it if isolated equipment is used at a later date.

ADJUSTMENTS

Only four adjustments are needed before the unit can be used. The object is to adjust the control circuit of each projector so that the lamp is just extinguished at one extreme of the range of the dissolve control knob and just at maximum brilliance at the other. This ensures that there is no "dead space" at either end of the control and that maximum brightness is achieved with no annoying residual image on the screen at the other extreme. Referring back to Fig. 3 we see that a projector is at maximum brilliance when its control voltage just reaches the bottom of the ramp signal (approximately $-2V$). The lower extreme of the ramp is fixed for both projectors by the common bias (set by R29/D9) to which C101 is discharged. Because this level is fixed it is necessary to adjust the control voltage at each end of its range to make certain that the bright projector is just at its brightest point. This adjustment is made with VR1 and VR3 which set the voltage seen by the wiper of VR2 at each end of its travel (Fig. 6).

Having set up the bright end of the range for each projector it is necessary to ensure that they just turn off at the other extreme of their range. A projector lamp is just extinguished when its maximum control voltage just exceeds the positive tip of the ramp. As we have already fixed the two extreme values of the voltage we must now adjust the peak value of the ramp at the dark end of the range for each projector. The adjustment is made by VR101 (VR102) which

varies the current generated by the source which charges C101 (C201) and therefore affects the slope of the ramp.

SETTING UP

The setting up procedure is as follows. First connect the two projectors to the triac housing via the heavy duty cables. It does not matter which projector is connected to each of the two cables as, although power is drawn from only one of the two projectors, both are wired up to supply power when connected to the appropriate lead. Next plug the multi-core connection from the triac housing into the control box, which should be switched to record with all preset adjustments set to mid range, and switch on the projectors. Check that operation of the dissolve control fades from one projector to the other although the adjustment of the lamps at each end of the range will almost certainly be wrong. With the control to the extreme of its travel at which projector A should be bright adjust the preset VR3 anti-clockwise until the projector will go no brighter and then reduce its setting until the lamp dims just perceptibly. Now increase the setting a little to reach maximum brightness. Set the dissolve control to its other extreme (B bright) and repeat the procedure using VR1 for the other projector. The adjustments of VR1 and VR3 interact so it will be necessary to repeat this sequence of events with the control set alternately at each end of its travel three or four times until no perceptible difference is found from one adjustment to the next.

When the bright end of the range is correct set the dissolve control to make A dark and adjust the current source preset VR101 until A is just extinguished. The best way of making this adjustment is to project a slide onto a screen in a darkened room and to adjust the preset until the image can just no longer be seen. When the setting is made in this way the projector lamp will be left with a dull orange glow which keeps it warm and speeds its response to rapid changes. Repeat the adjustment for projector B using VR201; the current source presets do not interact so it is only necessary to make one adjustment for each projector at opposite extremes of the dissolve control.

When the adjustments are complete check that the slide change control works at both ends of the dissolve control range, that the "twinkle" control swaps over the states of the two projectors and that the "superimpose" button forces them both to illuminate at half power. Finally, with the dissolve control set to either end of its range and with no audio input switch to play and check that the signal loss detector operates forcing both the projectors to switch on as if the "superimpose" button had been pressed.

You are now ready to make your first slide dissolve programme.

FREQUENCY SETTING

The adjustments already described are all that are required if the same unit is to be used both to record and to play your audio-visual presentations. Because the same VCO is used both during recording and during playback no adjustment of the VCO output frequency is needed. If, as may happen in a club for instance, different units are used for recording and playing back it is necessary to ensure that all the VCOs have the same brightness/frequency characteristic.

R15 and R16 control the frequency of the VCO at the upper and lower extremes of its control range. In order to make several units compatible with one-another it will be necessary to replace these resistors with pre-set potentiometers, possibly mounted so as to be accessible through the rear of the box.

In order to set up a group of units they should first be adjusted individually in the manner described in the previous section. One of the units is then nominated as "master" and its variable R15 and R16 set to mid-range. The output of this unit is then connected to each of the "slave" units in turn so as to carry out the adjustment of their VCO frequencies. With the "master" set to record and the "slave" set to play the master control potentiometer is set to the end of its range at which projector A is bright. R16 of the "slave" is then adjusted until its A projector is just at full brightness. R15 is next adjusted to set the brightness of "slave" projector B with the "master" control at the other extreme. The whole procedure must be repeated three or four times until no variation between successive adjustments is detected as the frequency setting controls will interact with one-another.

MAKING A RECORDING

The best recording technique to use will depend on the type of tape recorder involved. The output from the dissolve unit occupies one complete track of an audio tape recorder so those readers who, like the authors, do not possess a multi-track machine, will have to use one track of their stereo tape deck and record only mono sound. This is a limitation of course but the impact of a fully synchronised dissolve programme more than makes up for a lack of accompanying stereo sound.

Using a two-head machine (many cassette recorders are of this type) it will be necessary to record both the sound and the slide control tone simultaneously. The sound will first be assembled on an auxiliary tape machine if a number of sources (e.g. disc, tape, microphone) are to be mixed together and then played into the master recorder while the slide sequence controls are operated. With a relatively simple sound programme (e.g. disc only) it is possible to record sound and vision directly without the need for an extra tape recorder.

Three-head machines often allow you to play the contents of one track whilst recording on the other. In this case the sound programme can first be built up on one track, from a number of sources if required, and the visual control signal can later be added to the other track whilst listening to the sound.

Before making a recording it is vital to draw up a script indicating exactly how the intended sequence of dissolves, twinkles, etc. relates to the sound track. It is also helpful to practice by running through the programme several times



to check on timings and to learn to anticipate the operation of the controls.

To make a recording arrange the projectors so that their images are superimposed and load the slides alternately into each magazine with a black slide as the first in each set so that the screen is dark whichever projector is illuminated. With the black slide in each projector gate switch to record and adjust the dissolve control so that the projector that will show the first slide is *dark*, the other fully illuminated. Now switch on the tape recorder at least 30s before the first slide is due to appear and after about 15s press the slide change button to remove the black slide from the gate and replace it with the first one to be projected. When the slide is to appear fade it in with the dissolve control and as soon as it is fully illuminated press the change button to bring the second slide into the gate of the dark projector. Continue in this way alternately operating the dissolve control and the change button until the sequence is completed. It will probably be necessary to insert a black slide as the last in each projector so that the screen remains dark at the end of the presentation.

REPLAY

A smooth, efficient and unruffled beginning to a show adds greatly to the overall effect that it has on even the most uncritical of audiences so fumbling with projectors, wires and controls is best done before the viewers arrive.

The signal loss detector helps by allowing you to superimpose the images from the two projectors at half power simply by switching to "play" without an audio input applied. When the images are set correctly load the slides into the two projectors (making very sure that the right magazine

has been loaded into each projector) and bring the first (black) slide into the gate of each. Wind the tape to a position just after the beginning of the slide control tone and connect the output of the recorder to the control unit which is switched to "play".

When the moment arrives switch on the projectors and turn off the room lights. Now start the tape recorder and enjoy the show which will begin by first bringing a slide into the gate of the dark projector and then fading it up on to the screen.

We apologise for the omission of joint authorship and qualifications in Part 1. ★



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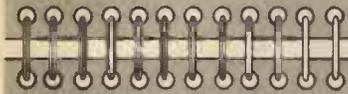
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INDUSTRY NOTEBOOK

By Nexus



Energy Saving

Among all the claims and counterclaims for energy saving systems, sane or crazy, it is refreshing to find a few hard facts and figures based on actual field experience.

The Italian company Telettra has recently published some details of a 2,000 mile national route network of microwave links they have engineered in co-operation with the New Guinea PTT Administration. The first links went in seven years ago and, taking advantage of the newest technology which allowed an extremely low power consumption of only 30W, the equipment was originally powered from dry cells needing replacement every six months. There was therefore no need for mains supply power lines or expensive diesel generation and, as New Guinea has a benign climate, no air conditioning was required. Despite the low power consumption of the repeater stations the capacity is 960 telephone channels plus TV.

Later expansion of the system also brought an up-date and the repeaters are now powered from solar cells with a secondary cell float. The system still demands a visit from a technician every six months to service the secondary cells and clean the solar panels, but over a five year period the cost of ten replacement sets of dry batteries is saved.

Drawing on this experience together with the falling cost of solar cells Telettra now say that the capital cost of a solar powered system breaks even with a diesel generator installation for local power up to 100W. In service the savings come from a nil fuel bill and no maintenance costs for diesel equipment. One of the great advantages of independent local power is that the equipment cabins can be sited anywhere. No approach roads are needed as would be the case for regular delivery to the site of diesel fuel, or the provision of overhead power lines or both.

Fine! But how about locations where temperature variations are such that the equipment needs an air conditioned environment? Conventional air-conditioning burns up more power than the equipment itself. Telettra says the answer lies in a new form of shelter exploiting the thermal characteristics of the materials from which it is constructed and the few watts of heat dissipation in the equipment itself. There are no moving parts and by changing the materials a passively conditioned shelter can be made to iron out temperature fluctuations in either tropical or arctic environments. For large installations the conditioning can be enhanced by natural circulation of fluids in a closed circuit.

Note the three-pronged systems approach. First, getting the power needs lower for a given function, second the development of a non-energy consuming conditioned shelter, third the timely application of solar cells as soon as the cost became economical. Telettra see a huge market for this type of equipment all over the world but especially in the vast undeveloped areas.

Augustine's Law

Norman R. Augustine, vice president technical operations, Martin Marietta Aerospace Corporation, following the example of Professor Parkinson, has established his own set of Laws. Augustine's are based on observation of trends in his own industry and projecting them into the future. The US defence budget increases yearly but so does the cost of tactical aircraft, the latter at a much greater rate. Extrapolating the figures Augustine suggests that by the year 2054 the total defence budget of the United States will buy only one tactical aircraft. Similarly, that before the tricentennial the US Government will employ more government workers than there are workers. Nonsense, of course, but with just that little grain of truth which makes you sit up and think.

Augustine ruefully reflects that in World War 2 all the technology was developed, built and applied and the war was won in just half the time it takes to develop a new military system today.

How Big?

GEC may be Britain's largest private employer (about 184,000 employees) as well as one of the best managed and consistently profitable. And annual turnover is now a healthy £2,500 million. But, as GEC management point out to their staff, there are much bigger fish in the sea. US General Electric (no connection) has nearly four times the turnover and Siemens of West Germany over three times. Matsushita and Toshiba of Japan are both much larger in turnover than GEC while French Thomson-Brandt and Brown Boveri of Switzerland and Germany are nudging from behind only barely short of GEC's sales performance.

Direct comparisons are, however, difficult because such conglomerates (including

GEC) have different interests. GEC, for example, unlike US GE, does not make aero engines or own coal mines. A more valid comparison is to try to separate out the various activities. Yet when we do this there is another shock. The whole of GEC's activities in electronics, automation and telecommunications accounts for only one fifth of group turnover. Take out the business in traffic lights, telephone exchanges and industrial automation and you might guess that in 'pure' electronics GEC is about level on turnover with Racal whose business is almost totally in professional electronics.

This is not to disparage GEC, clearly a powerful force in electronics world-wide, but it does impress on us the problem of comparability and that, after all, from this perspective some of the smaller British firms are relatively larger than we imagined.

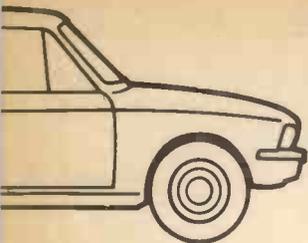
It is now ten years since GEC swallowed up English Electric and AEL. Turnover was then less than £900 million. Today's £2,500 million turnover is achieved with 50,000 fewer employees, reflecting a mix of factory productivity gains and price inflation. Annual salary per employee is now averaging nearly £4,000, not far short of four times the 1970 figure which worked out, by present standards, at a lowly £21.80 per week—but you got more for your money in those days.

BPO Split

Apart from predictable adverse comment from union spokesmen on the postal side of the business, the Government's decision to split the present BPO into two corporations was generally welcomed. PO telecommunications can now romp ahead doing their own thing, and doing it well. Most people, users only of the domestic network, are unaware of the international aspects of the business, or of the immense capital sums involved.

Two recently announced projects are examples. TAT 7, due in service by 1983, will provide another 4,200 submarine cable channels between the UK and the USA. Britain has a 22 per cent share of the £100 million cost and ST&C will manufacture in the UK 2,700 miles of the cable at a cost of £30 million. Another £100 million project is INMARSAT providing by the mid-80s marine satellite communications for shipping. The BPO has an 11 per cent share in the project which will have its HQ in London. Yet another dish aerial is to be constructed at the Goonhilly complex to accommodate the new service. The BPO of course also has a major share in INTELSAT and is pressing ahead with international sales of the Prestel viewdata service.

Under the new arrangement, home and business subscribers will be able to use terminal equipment of their own choice provided it has no adverse technical effect on the public network. With the BPO monopoly of supply broken, there will be intense competition for the business providing a real challenge for home producers to exercise initiative. They have about two years in which to prepare. Failure means handing the bulk of the business to the Far East.



SPECIAL SUPPLEMENT

SOLID STATE CAR INSTRUMENTS

Ammeter - Engine Temperature Dwell Meter

Michael Tooley B.A. David Whitfield B.A. M.Sc.

No. 3 AMMETER

CONVENTIONAL moving iron ammeters usually offer poor calibration, whilst transient response is severely impaired due to the damping needed to prevent overshoot. These ammeters are often difficult to install since they require heavy duty leads (30A or more) from the battery.

The instrument described overcomes these limitations and provides linear response over a range of typically $\pm 25A$. Furthermore, the displayed current range is adjustable, thus permitting the user to preselect the actual range of indication to suit his particular needs. The module is basically a voltage measuring device with a high input impedance.

PRINCIPLE OF OPERATION

The usual arrangement of connections to a vehicle battery is shown in Fig. 1(a). A heavy duty copper braid links the negative terminal of the battery to the vehicle chassis. This earth strap has a very low resistance, typically 0.002Ω or less. The equivalent circuit of the battery connection, showing the earth strap resistance, is given in Fig. 1(b). The voltage drop developed across the earth strap resistance, R , is directly proportional to the current flowing in it. Furthermore, the polarity of this voltage will change according to whether the battery is being charged or discharged. The obvious disadvantages are that the resistance of the earth strap will vary from car to car, and the voltage developed is very small, typically 20mV for a current of 10A. Hence, in order to interface with the standard LM3914 display circuit, additional amplification is required, and the gain must be made variable to allow for variation in earth strap resistance from one vehicle to the next.

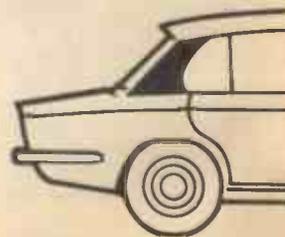
The obvious solution is to use a simple operational amplifier arrangement. There is, however, a problem associated with the fact that the input voltage (developed across the earth strap) varies in polarity about 0V (chassis potential). This is overcome by using a FET as a common source amplifier. See Fig. 2. The output voltage developed

No. 1 Battery Voltage Indicator, including a description of the LM3914, and No. 2 Rev' Counter appeared in *October* and *November*. This supplement incorporates the remaining three, plus details of warning and cascading.

across the drain load resistor, R_D , depends upon the drain current, I_D , and Fig. 3 shows how the drain current varies with the gate-source voltage, V_{GS} . By suitable choice of source resistor, R_S , the drain current will increase and decrease about a steady value according to whether the battery is being charged or discharged. Again, by appropriate choice of values, the drain voltage is made to be approximately half the supply voltage, and thus it will interface correctly with the operational amplifier stage which follows. The effects of supply voltage and temperature variations are reduced by using a balanced differential arrangement as shown in Fig. 4. An input protection circuit is necessary in the event of the earth strap ever becoming disconnected, since the excessive gate-source voltage would damage TR1. VR1 allows the circuit to be balanced and compensates for any difference in FET characteristics.

The complete circuit of the Ammeter is shown in Fig. 5. Input protection is provided by R3 and D1-D2. This ensures that the maximum input voltage excursion at the gate of TR1 is 600mV in either polarity. R5 and D13 provide a regulated supply for the differential stage and VR2 sets the voltage gain of the operational amplifier stage. D14 is used to remove the d.c. level from the output of the operational amplifier and allows correct interfacing with the display driver, which requires a 0 to 5V input signal. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible signal at the input of IC2 over the desired current range.

NO HEAVY GAUGE WIRES
FAST RESPONSE
CLOSER CALIBRATION



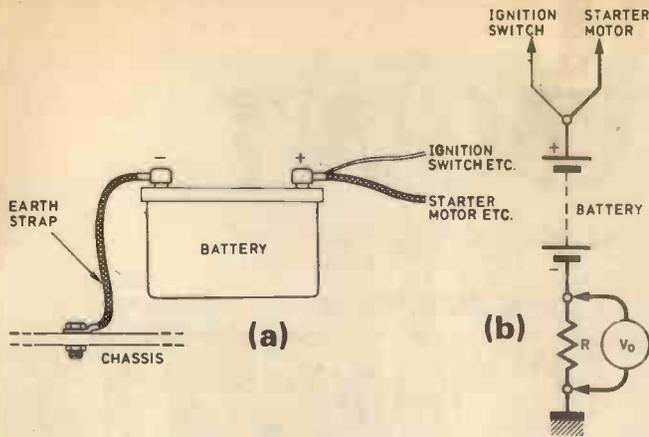


Fig. 1. (a) Conventional car battery connections; (b) Equivalent circuit of the battery earth strap

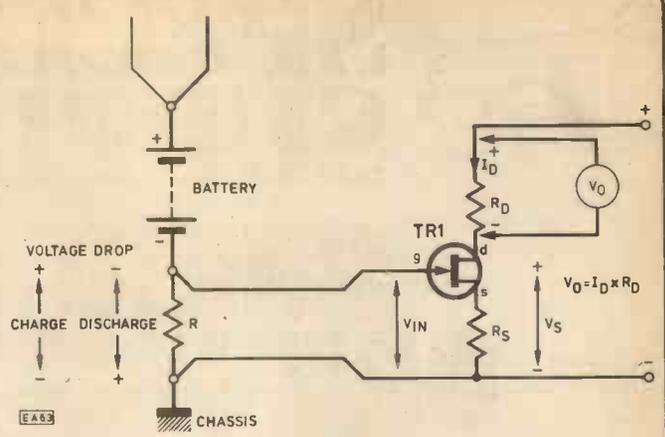


Fig. 2. Simple common source amplifier using an n-channel FET

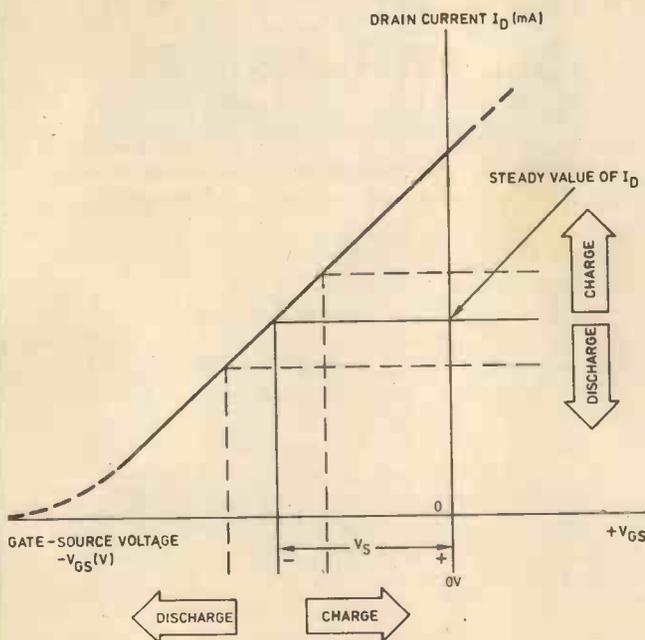


Fig. 3. Mutual characteristics $I_D/(V_{GS})$ of an n-channel depletion mode FET

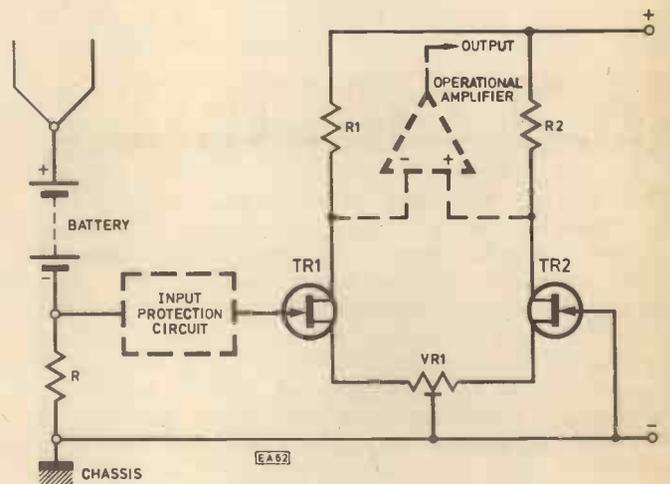
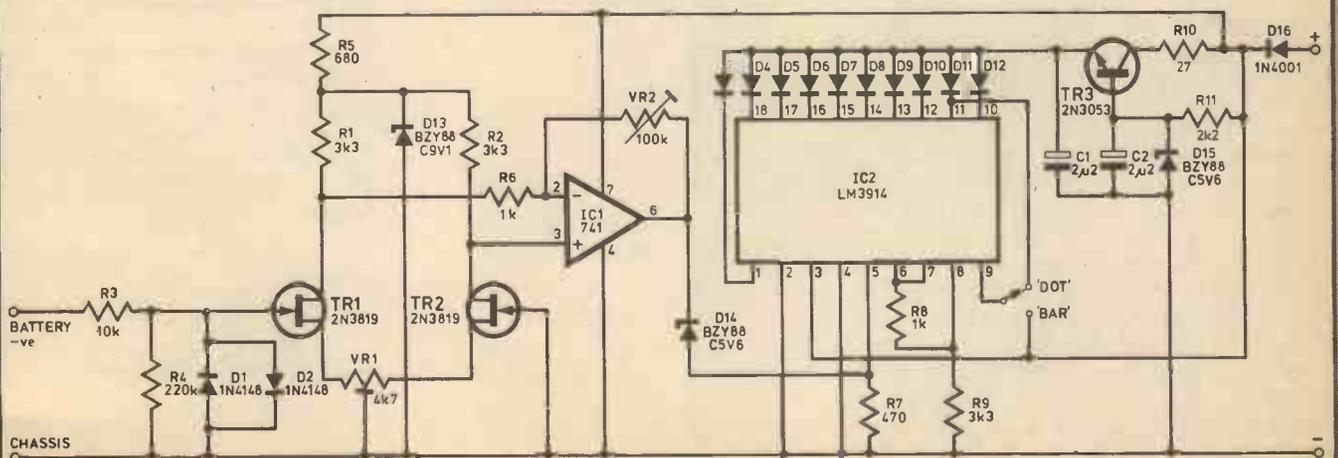


Fig. 4. Practical realisation of Fig. 2

Fig. 5. Circuit diagram of the Ammeter



CONSTRUCTION

Two constructional examples are described. Individual constructors will most likely exercise their own preference as to the mechanical assembly of the instrument. The p.c.b. pattern is shown in Fig. 6 with the corresponding component layout given in Fig. 7. The printed circuit board is recommended for use when the instrument is for dashboard mounting in a rectangular "instrument pod". An alternative layout which uses 0.1 inch matrix stripboard is shown in Fig. 8. This method of construction is more appropriate when the instrument is to be of the hand-held type.

The pod mounted version uses standard 0.2 inch I.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The MODE link in both layouts has been shown in the recommended DOT display position. The I.e.d.s may be colour coded to suit the constructor's preference and suggested colours are red for the five left-hand diodes (indicating discharge) and green for the five right-hand diodes (indicating charge).

TESTING AND CALIBRATION

Before installation it is recommended that the instrument is "bench checked" using the circuit in Fig. 9. This provides a variable input voltage of up to 100mV of either polarity. It thus simulates the approximate range of voltages that will appear across the earth strap, and constructors can check

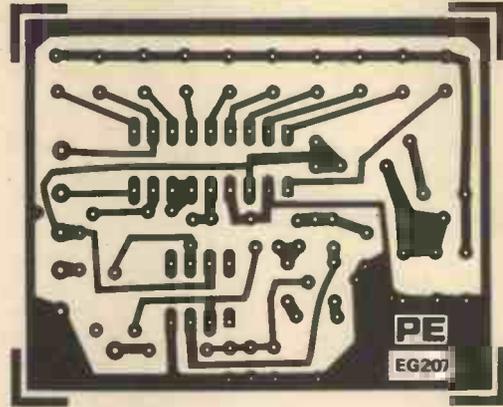
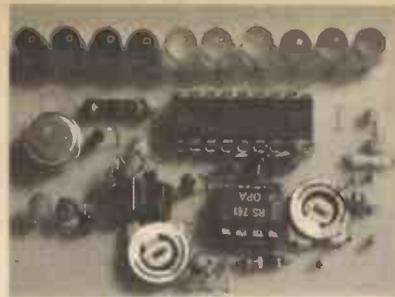


Fig. 6. Printed circuit layout (actual size)

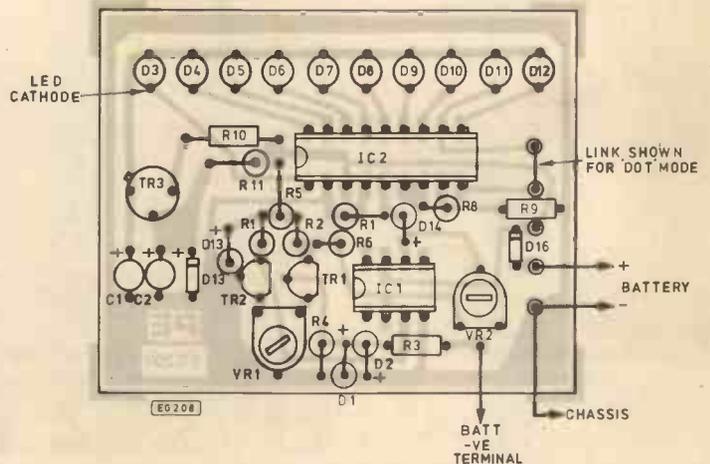


Fig. 7. Component layout

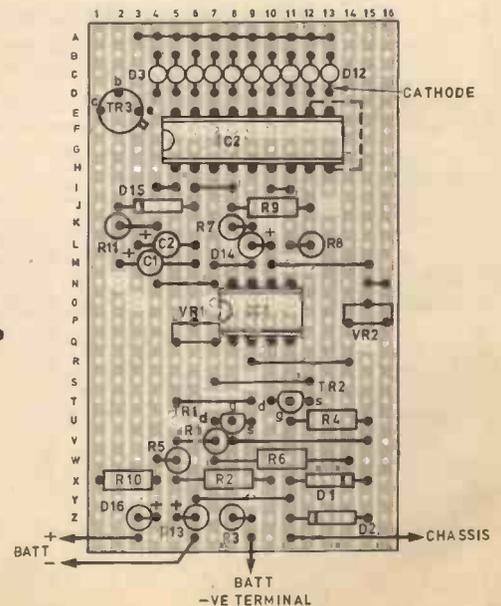


Fig. 8. Alternative stripboard layout

COMPONENTS . . .

Resistors

R1, R2, R9	3k3 (3 off)
R3	10k
R4	220k
R5	680
R6, R8	1k (2 off)
R7	470
R10	27 $\frac{1}{2}$ W 5%
R11	2k2
All resistors $\frac{1}{4}$ W 5% unless otherwise stated	

Potentiometers

VR1	4k7 miniature skeleton pre-set
VR2	100k miniature skeleton pre-set (Use horizontal pre-sets for PCB mounting, vertical for Veroboard mounting.)

Capacitors

C1, C2	2 μ 2 25V tantalum (2 off)
--------	--------------------------------

Transistors and Diodes

TR1, TR2	2N3819 (2 off)
TR3	2N3053
D1, D2	1N4148 (2 off)
D3-D12	10 off I.e.d.s—size and colour to suit
D13	BZY88 C9V1
D14, D15	BZY88 C5V6 (2 off)
D16	1N4001

Integrated Circuits

IC1	741
IC2	LM3914

Miscellaneous

Printed circuit board or stripboard
Moulded case as appropriate

that the circuit functions correctly before wiring to the vehicle. With the 1k variable resistor set to mid-position, VR1 should be adjusted so that D7 just extinguishes and D8 just becomes illuminated. Moving the variable in one direction should cause the green l.e.d.s (D8 to D12) to illuminate successively and in the other direction the red l.e.d.s (D3 to D7) should illuminate successively. VR2 should be adjusted so that the whole range is covered.

The instrument can now be fitted to the vehicle. Care should be taken to connect the input leads correctly (otherwise a reverse indication will result) using a length of two core cable which terminates at either end of the earth strap. Calibration in the vehicle can then follow, but it will first be necessary to know the power or current requirements of one or more items connected to the vehicle's electrical system.

With no electrical accessories operating and the ignition off, VR1 should be adjusted for centre zero indication as before. Now assume, for example, that two headlamps, each rated at 60W, are illuminated together with side lights and rear lights accounting for a further 60W. The total power from the battery (assuming that the engine is not running and no other accessories are connected) will be 180W which corresponds to a current of 180/12 or 15A. (In the example we have assumed that the battery is man enough to stand up to this load—in practice the terminal voltage of the battery would probably fall a little from the nominal 12V.) It is now merely a question of adjusting VR2 so that the third

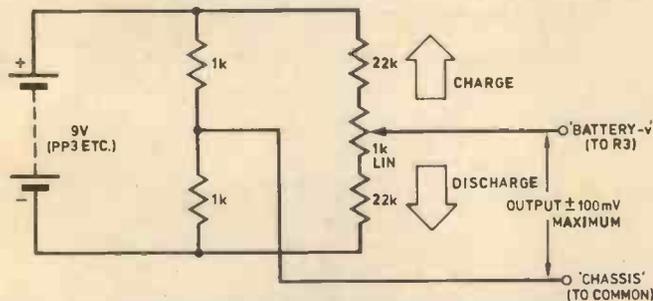


Fig. 9. Circuit for bench-checking the Ammeter

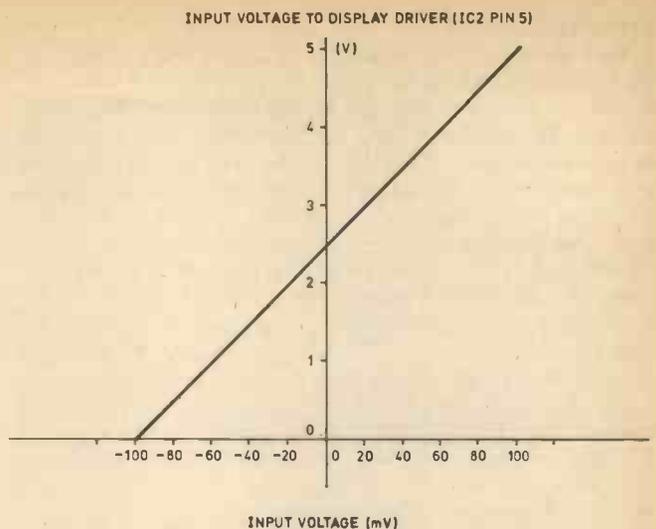


Fig. 10. Earth strap voltage versus display module input voltage — typical

red l.e.d. from the centre, D5, is illuminated (assuming calibration is 5A/LED or $\pm 25A$). If a different calibration is required it is simply a matter of adjusting VR2 accordingly. The setting of VR1 should now be checked once again and the car started. A momentary full scale discharge indication will be given as the starter motor is engaged. The charging indication should be checked. On most cars this will be between 5 and 15A. The following table gives a rough guide of the current consumption of various items:

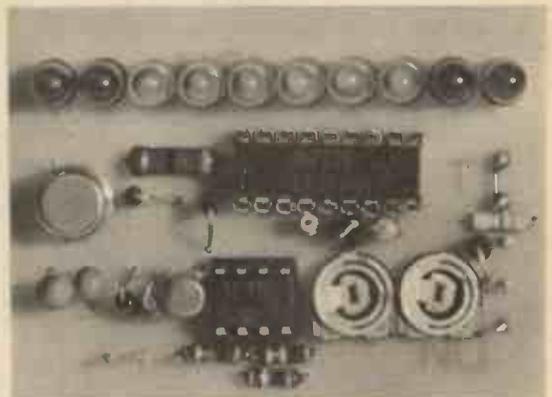
Sidelights	3A
Rear stoplamps	5A
Rear screen heater	10A
Radio/cassette	less than 1A
Fan	3A
Interior light	$\frac{1}{2}$ A

No. 4 ENGINE TEMPERATURE

THE instrument described overcomes the accuracy limitations of conventional temperature gauges, and provides a linear response over a range of typically 0°C to 100°C. In addition, the response time is faster than with conventional gauges, and the displayed temperature range is adjustable, thus permitting the user to select a range of indication to suit his particular needs.

PRINCIPLE OF OPERATION

The transducer used is a general purpose silicon transistor. The base-emitter junction voltage, V_{BE} , which although normally quoted as approximately 600mV, varies with the junction temperature. Although the voltage change produced is rather small, it is a linear function of temperature and lies in the range from -2.0 to -2.5 mV/°C (ie, V_{BE} falls as the temperature increases). Over the desired 100°C temperature range the total change in V_{BE} will be approximately 225mV and, since the display module requires an input voltage of 0 to 5V, some additional amplification is necessary.



The basic temperature sensing arrangement is shown in Fig. 1. The base-collector voltage is fixed; a resistor is included in the emitter lead and, provided that the supply and bias voltages remain constant, V_{BE} gives an indication of the temperature of the transistor junction. An improved arrangement is shown in Fig. 2 where two transistors are connected

in a differential configuration. This is important in reducing the effects of supply voltage variation which in a vehicle can be as much as 25%. If the circuit is exactly balanced, with R_1 equal to R_2 and identical transistors, the output voltage will be zero, provided that the two transistors are at the same temperature. Any difference in temperature will cause an imbalance in the circuit and a corresponding output voltage. Ideally TR2 should be closely maintained at a constant temperature, however in practice the interior temperature of a vehicle is usually regulated to a comfortable and fairly constant level (between 20 and 25°C) by the driver. The temperature sensor, TR1, is mounted at some convenient point on the engine block and thus is kept at the working temperature of the engine.

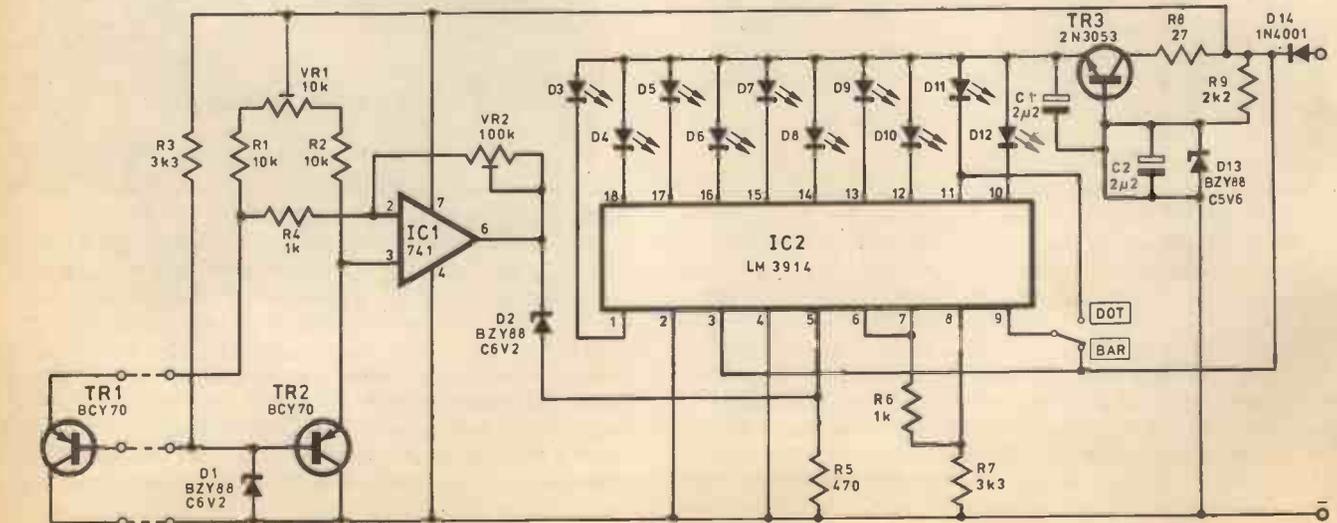
Fig. 3 shows the practical realisation of Fig. 2. A Zener diode is used to stabilise the base-collector voltages of TR1 and TR2. The emitters of TR1 and TR2 are connected to the differential inputs of an operational amplifier. This responds to the difference in the two base-emitter voltages. The operational amplifier also provides the additional voltage gain necessary for interfacing with the display module. VR1 provides a means of balancing the circuit and compensating for any mismatch in transistor characteristics.

The complete circuit of the engine temperature indicator is shown in Fig. 4. The gain of the operational amplifier stage is made adjustable by means of VR2 and, since the output of the stage is at about half-supply potential (approximately 5V), a Zener diode, D2, is used to remove the d.c. level before the signal is applied to the display driver, IC2. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible 0 to 5V signal at the input of IC2 over the desired temperature range.

CONSTRUCTION

As with the other instruments in this series, two constructional examples are described. Fig. 5 shows the printed circuit track pattern and Fig. 6 the corresponding component layout recommended for use in a dashboard instrument for mounting in a rectangular instrument pod. The alternative layout using 0.1 inch matrix stripboard which is suitable for a hand-held instrument is shown in Fig. 7. The pod mounted version uses standard 0.2 inch l.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The wire MODE link in both layouts has been shown in the recommended Dot display mode. The l.e.d.s. may be colour coded,

Fig. 4. Circuit diagram of Engine Temperature Gauge. Note: D2 should be BZY88 C4V7



EG2.13

Fig. 1. Base-emitter voltage varies with temperature of transistor junction

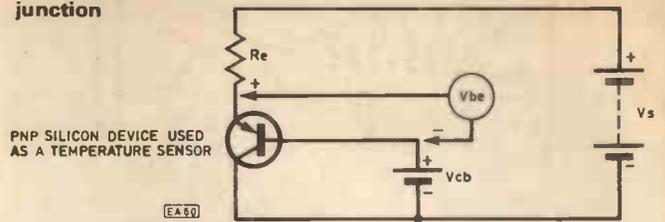


Fig. 2. Differential configuration to reduce the effects of supply and bias voltage variations

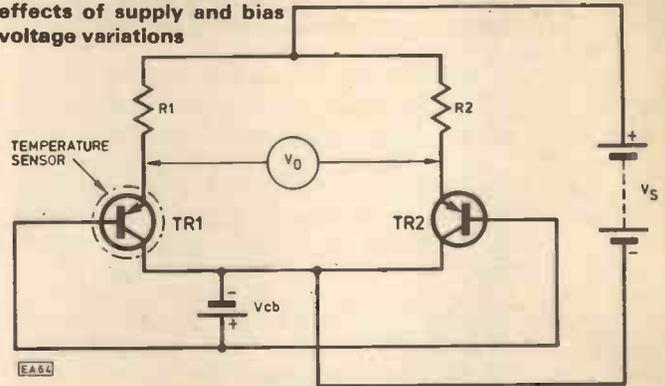
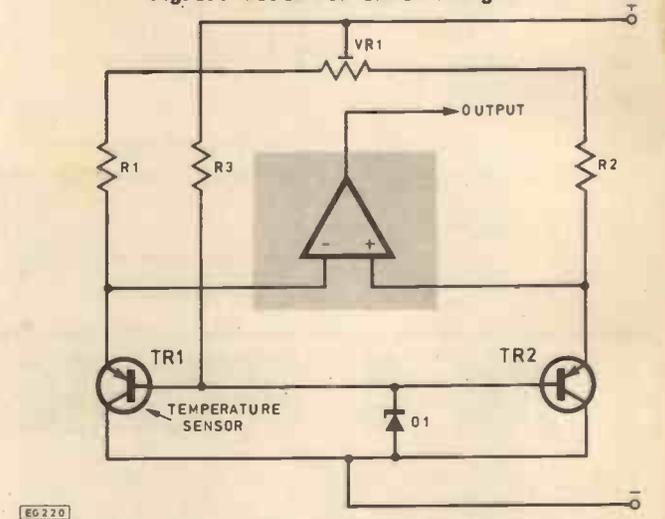


Fig. 3. Practical realisation of Fig. 2



EG2.20

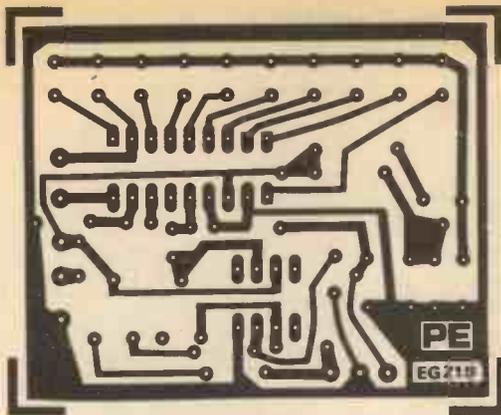


Fig. 5. Printed circuit layout (actual size)

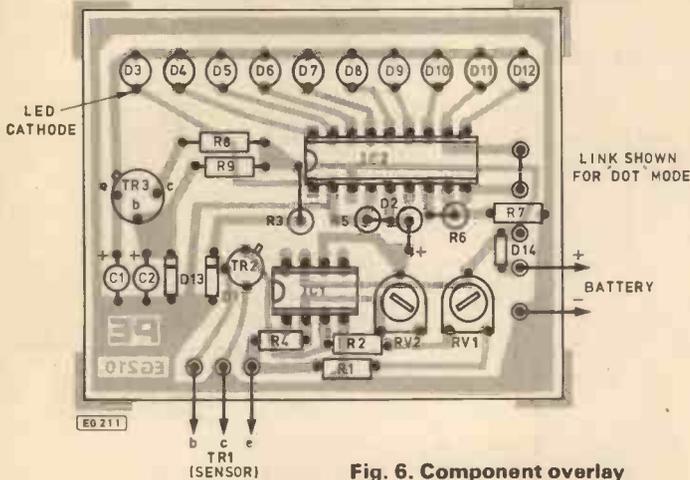


Fig. 6. Component overlay

sensor, TR1, should be placed in the ice taking care not to immerse the leads. VR1 is then adjusted until the extreme left hand i.e.d., D3, just extinguishes (leaving the rest of the display blank). TR1 should then be placed in a cupful of water that has just been boiling, again taking care not to immerse the leads. This will produce a temperature of around 90 to 95°C. (Do not use a kettle since the steam produced can cause condensation around the transistor leads.) VR2 is then adjusted so that the extreme right hand i.e.d., D12, is illuminated. The procedure should be repeated, again adjusting VR1 at one end of the range and VR2 at the other. The calibration can, of course, be checked using an accurate thermometer if available. Having completed the calibration, the instrument is ready for fitting to the vehicle.

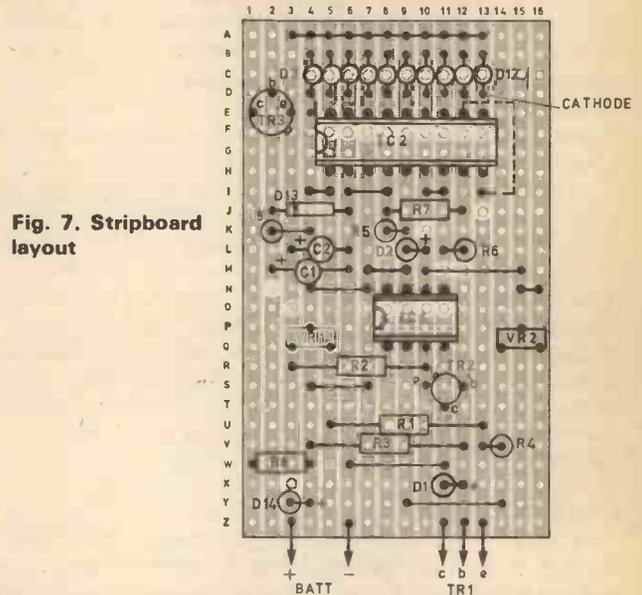


Fig. 7. Stripboard layout

COMPONENTS . . .

Resistors

R1, R2	10k (2 off)
R3, R7	3k3 (2 off)
R4, R6	1k (2 off)
R5	470
R8	27 ½W
R9	2k2
All resistors ½W 5% except where stated	

Potentiometers

VR1	10k	min. skel. pre-set
VR2	100k	min. skel. pre-set
(Use hor. pre-sets for p.c.b. mounting, vert. for stripboard mounting.)		

Capacitors

C1, C2	2µ2 25V tantalum
--------	------------------

Transistors and Diodes

TR1, TR2	BCY70
TR3	2N3053
D1	BZY88 C6V2
D2	BZY88 C4V7
D3-D12	i.e.d.s to suit (10 off)
D13	BZY88 C5V6
D14	1N4001

Integrated Circuits

IC1	741
IC2	LM3914

Miscellaneous

Printed circuit board or 63 x 40mm of 0.1 inch strip-board
Moulded case as appropriate

and suggested colours are red for the two i.e.d.s on either extreme and yellow for the others. Hence a red "warning indication" will be given when the engine temperature is outside the range 20°C to 80°C.

CALIBRATION

Calibration is quite simple and, if necessary, can be carried out without the aid of a thermometer. VR1 should be used to set the low temperature indication of the display and VR2 to adjust the range of display. An approximate calibration temperature of 0°C can be obtained using a cupful of crushed ice which is just on the point of melting. The temperature

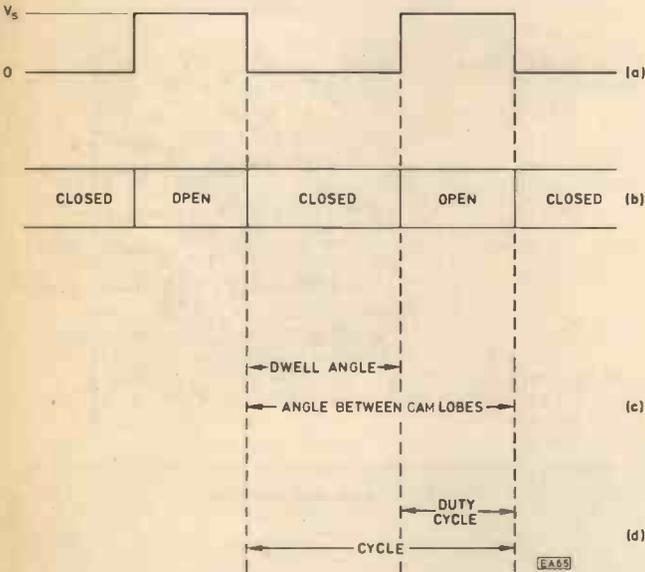
CONNECTION TO THE VEHICLE

The temperature sensor, TR1, should be either bonded to the engine block using epoxy adhesive or held in place by a small metal clamp. The metal case of the transistor is connected to the collector and may thus safely be earthed to the chassis of the vehicle. Care should be taken to insulate the transistor leads and ensure a sound mechanical termination. A short length of three-core cable should be used to connect the temperature sensor to the instrument pod. Alternatively a length of two-core screened cable may be used in which case the earth/collector connection is the screen itself. ★

No. 5 DWELL METER

THE dwell angle of the contact breaker cam is of great importance to engine performance, particularly at higher rev's. The dwell angle is the angle through which the cam turns while the contact breaker points remain closed and depends upon the angular separation of the cam lobes on the distributor shaft, and the maximum gap between the points. It must be sufficiently large to enable the soft iron core of the ignition coil to become magnetically saturated to provide a good spark, yet not so large as to cause over-dissipation. Too small a dwell angle will result in a low spark voltage, and poor combustion. This may be caused by:

- (a) The contact breaker gap being too large.
- (b) The cam being excessively worn.
- (c) The cam and shaft bearings being excessively worn.



Large dwell angles will result in overloading of the capacitor and burning of the contact breaker points at low speeds. Too large a dwell angle is usually due to the gap of the contact breaker being set too small.

The correct dwell angle for a particular vehicle will be found in the workshop manual. Generally, the dwell angle is usually slightly less than two-thirds of the angle between the cam lobes. In a 6-cylinder distributor, for example, the cam lobe separation is 60 deg and the dwell angle is about 36 deg (comparable figures for a 4-cylinder unit are 90 deg and 52 deg, respectively).

MEASUREMENT OF DWELL ANGLE

Measurement of the contact breaker dwell angle is most easily accomplished by observation of the voltage waveform across the contact breaker points. An idealised representation of this waveform is shown in Fig. 1(a).

A straightforward method of measuring dwell angle requires only a moving coil d.c. voltmeter and a calculator. The mean value of the waveform in Fig. 1(a) is given by:

$$V_{mean} = V_s \times \frac{\text{Angle between cam lobes} - \text{Dwell angle}}{\text{Angle between cam lobes}}$$

Fig. 1. (a) Breaker points voltage waveform. (b) Points condition; (c) Timing angles; (d) Duty cycle

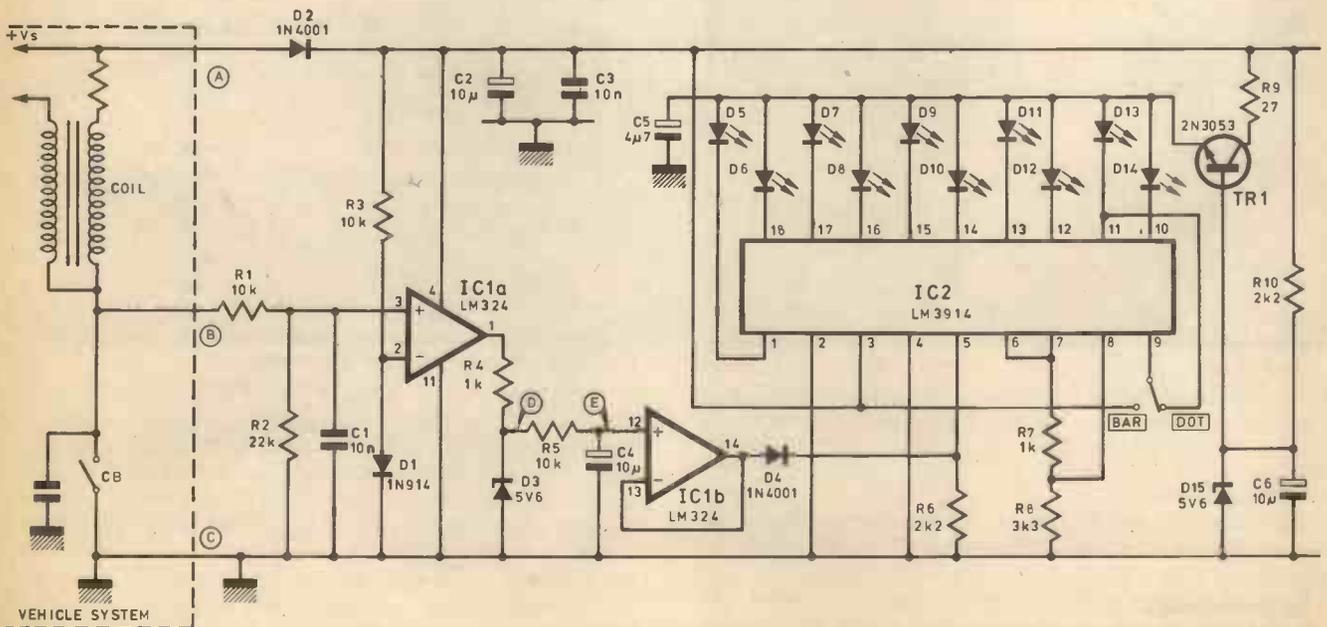


Fig. 2. Circuit diagram

The values of V_{mean} and V_s may be measured at the two ends of the ignition coil primary winding. The moving coil movement will average the waveform and the dwell angle may then be found from:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{V_s - V_{mean}}{V_s}$$

This technique is tedious when repeated measurements are required.

Ideally, dependance upon the variable value of V_s should be eliminated, allowing a simple scaled meter to be used, whereby the *duty cycle* of the waveform, rather than the *voltage* is measured. The dwell angle is then:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{100\% - \text{Duty cycle}}{100\%}$$

The calibration now depends only upon the angle between the cam lobes. This meter works on duty cycle and displays dwell on a scale which may be calibrated to 90 deg, 60 deg or 45 deg for distributors with 4, 6 or 8 cam lobes, respectively.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 2. The contact breaker voltage waveform is sampled at point "B", and then filtered by R1, C1 and R2. The filtered signal is applied to the non-inverting input of op. amp. IC1a, which is arranged as a voltage comparator. The combination of R3 and D1 sets the switching threshold such that the voltage at point "B" must exceed approximately 1 volt to cause the output of the comparator to go "high".

COMPONENTS ...

Resistors

R1, R3, R5	10k (3 off)
R2	22k
R4, R7	1k (2 off)
R6, R10	2k2 (2 off)
R8	3k3
R9	27 1/2W
All 1/4W 5% unless otherwise stated	

Capacitors

C1, C3	10n ceramic (2 off)
C2, C4, C6	10µ/16V elect (3 off)
C5	4µ7/10V elect

Transistors and Diodes

D1	1N914 or similar
D2, D4	1N4001 (2 off)
D3, D15	BZY88 C5V6 Zener (2 off)
D5-D14	L.e.d.s to suit physical requirements (10 off)
TR1	2N3053, BFY50 or similar

Integrated Circuits

IC1	LM324
IC2	LM3914

Miscellaneous

Stripboard or p.c.b. Moulded case

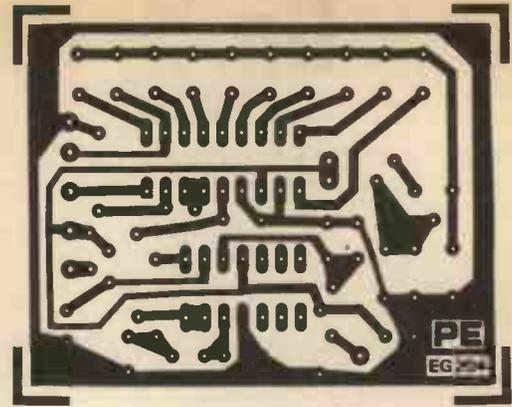


Fig. 3. Printed circuit layout (actual size)

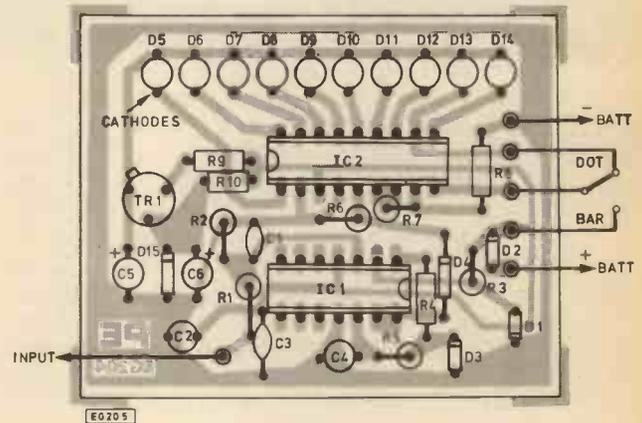


Fig. 4. Component overlay

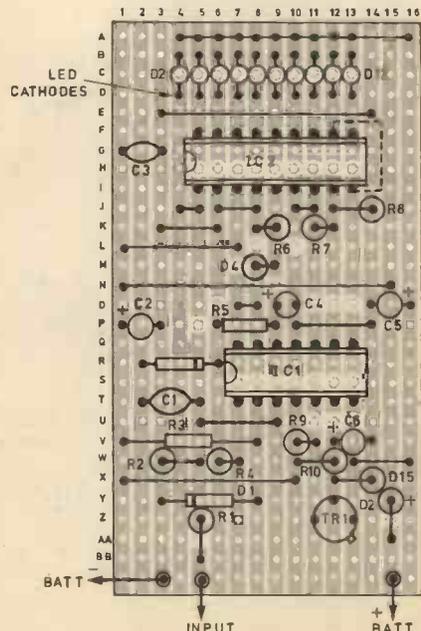


Fig. 5. Alternative stripboard layout

The comparator output is a rectangular waveform limited to the output saturation levels of the op. amp., which in this application are approximately 600mV and $(V_{\text{supply}} - 1.2)$ volts for the "low" and "high" states respectively. The dependence of the "high" level on the supply voltage is eliminated by the clipper circuit, R4 and D3, and the result is a signal between the levels of 600mV and 5.6 volts.

The average value of the signal at point "D" varies linearly between 600mV and 5.6 volts as the duty cycle varies between 0 and 100%. This average value is developed at point "E" by the integrator formed by R5 and C4, and is subsequently buffered by IC1d to minimise loading effects. The 600mV d.c. offset is removed by D4, and the voltage across R6 varies from 0 to 5V as the duty cycle at the input varies from 0 to 100 per cent to correspond to dwell angles from maximum (angle between the cam lobes) to zero, respectively.

The time constant of the display response is determined

by the integrator circuit of R5 and C4. The remainder of the circuit comprises the standard display module.

PRACTICAL DETAILS

The constructional details for the dwell meter closely follow those outlined for the earlier instruments in the series. A p.c.b. design is shown in Fig. 3, with a corresponding component layout in Fig. 4. A stripboard layout for a hand-held test instrument is shown in Fig. 5.

Both instrument variants are shown wired for dot mode display. The display scale should be calibrated $90^{\circ}-0^{\circ}$, $60^{\circ}-0^{\circ}$, $45^{\circ}-0^{\circ}$ for 4, 6, 8-cylinder distribution units respectively. The connections for use are the same as those for the tachometer (November), and are summarised again in Fig. 2. A higher resolution display of the dwell angle may be obtained by the use of additional display driver devices, described later.



HAZARD WARNING & CASCADING...

THERE are many occasions when it is imperative that the driver receives an immediate warning that all is not well under the bonnet. The two techniques described below illustrate methods of producing hazard warnings in sharp contrast to the normal indication given by the instrument concerned. The examples provided should enable constructors to modify any of the instruments previously described in the series for added hazard warning indications. The enthusiastic constructor will doubtless wish to further exploit the many features of the LM3914 and, in this case, the suggestions given will merely provide a starting point.

MODE SWITCHING

An obvious method of attracting the driver's attention to an instrument operating in Dot mode is to change the display to Bar mode whenever a pre-determined level is exceeded. In practical terms this involves switching the display mode input (pin 9 of the LM3914) electronically, and since the particular l.e.d. illuminated relates to the input level, it is possible to sense the voltage across the l.e.d. concerned and use this to activate an electronic changeover switch. If the voltage at the input of the standard display module (pin 5 of the LM3914) were to be increased slowly from 0 to 5V, and the last l.e.d. used for setting the display into Bar mode, then the display would operate in the normal Dot mode until the last l.e.d. became illuminated, at which level the display would change to Bar mode. In practice any one of the l.e.d.s could be used for determining the changeover point. For most applications it is suggested that either l.e.d. No. 8 or l.e.d. No. 9 is used to provide the changeover (corresponding respectively to 80% and 90% of full range).

Fig. 1 shows a simple practical arrangement which may be used in conjunction with the standard display module. The display mode is changed from Dot to 'bar' whenever D8 is illuminated. A reference voltage is provided by means of R3 and D9. This sets the potential at the emitter of TR1. When D8 is extinguished the voltage at pin 12 of the LM3914 is "high" and base current flows through R1, effectively saturating TR1 and thereby reducing the collector voltage and the mode input voltage at pin 9 of the i.c. to a low value. The display then operates in Dot mode. When D8 is illuminated the voltage at pin 12 of the LM3914 is

low (approximately 3V), and thus the base-emitter junction of TR1 is no longer forward biased. TR1 is therefore held off and the voltage at its collector rises to be almost equal to the supply (12V). Hence the mode input is made approximately equal to the supply voltage and the display operates in Bar mode. It is important to note that, if the display indication falls back below the hazard threshold determined by the particular l.e.d. selected, the display then reverts to the normal Dot mode of operation.

TR1 can be almost any n.p.n. silicon transistor having a current gain of 100 or more. A 3.3V Zener diode of at least 250mW rating should be used for D9. The additional components can readily be mounted on a small piece of stripboard and wired to the existing circuitry.

FLASHING BAR DISPLAY

Where a Bar mode display is used (as would normally be the case with a rev. counter, for example) an alternative technique for gaining the driver's attention must be used. In this case, probably the most dramatic method is to make the entire display flash on and off whenever a safe level is exceeded. Since the current drawn from the reference output (pin 7 of the LM3914) determines the brightness of the l.e.d.s in the display it is possible to turn off the display by reducing this current to zero. The circuit of Fig. 2 shows a simple arrangement for flashing the display whenever D8 is illuminated. The falling potential at the cathode of D8 when it first becomes illuminated is applied, by means of C1 and R2, to the reference output of the display driver. R3 is included to ensure that D8 becomes extinguished along with the other l.e.d.s in the display when the display is momentarily turned off. The LM3914 is programmed to produce a constant current in each of its l.e.d. loads and hence the additional resistor in series with D8 does not affect its brilliance. With the component values given the circuit operates at a rate of approximately 90 flashes per minute with a duty cycle of around 30%. It is important to note that, because the reference output is used to modulate the display, the top end of the resistive divider chain which feeds the non-inverting inputs of the ten comparators within the LM3914, must be supplied from a separate regulated supply. This can conveniently be derived from the supply rail which feeds the l.e.d.s (nominally 5V) however, since Bar

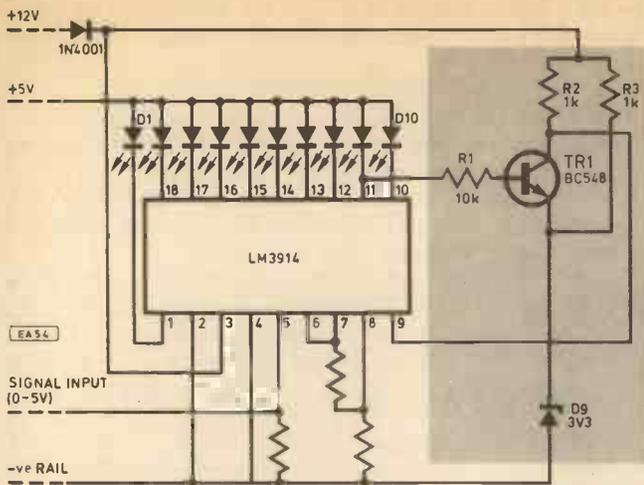


Fig. 1. Circuit to provide Dot-to-Bar mode changeover triggered by I.e.d. 8

mode is employed and a relatively high current is drawn from this rail, it is recommended that the simple discrete component series transistor regulator used with the standard display module be replaced with a conventional 5V integrated circuit regulator.

Where the flashing circuit is to be fitted to an existing circuit board it is recommended that the extra components are assembled using a small piece of stripboard. The regulator should be fitted with a suitable heatsink (19°C/W should be adequate) and capacitors C2 and C3 should be fitted as close as possible to the pins of the regulator. The existing transistor series regulator arrangement should be disabled by removing the transistor and associated components from the board. It will also be necessary to modify the board

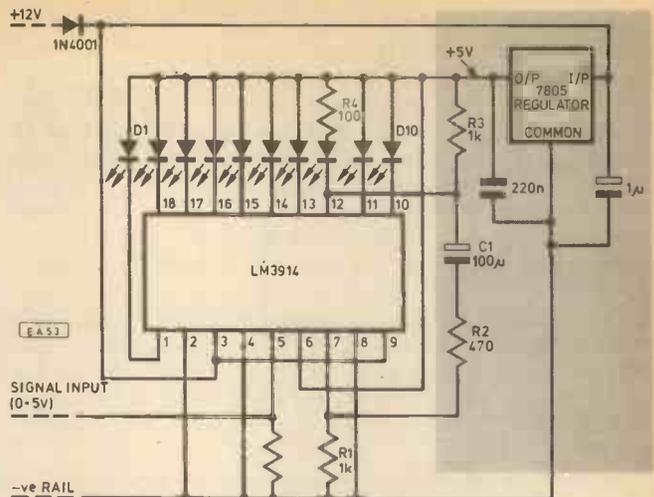


Fig. 2. Circuit to provide flashing bar display triggered by I.e.d. 8

wiring around pins 6 and 7 of the LM3914. R1 and R4 can conveniently be incorporated on the existing board and five connecting wires will be necessary.

DISPLAY RESOLUTION ENHANCEMENT

The basic display module described in this series makes use of a display consisting of 10 I.e.d.s. It is often desirable, however, to know the value of the measured parameter to finer limits than can be read from the basic display module. This means that a greater number of I.e.d.s must be used, for example, to display 0-6000 r.p.m. in steps of 200 r.p.m. requires 30 I.e.d.s.

The design of the LM3914 integrated circuit means that the display is conveniently increased in multiples of 10

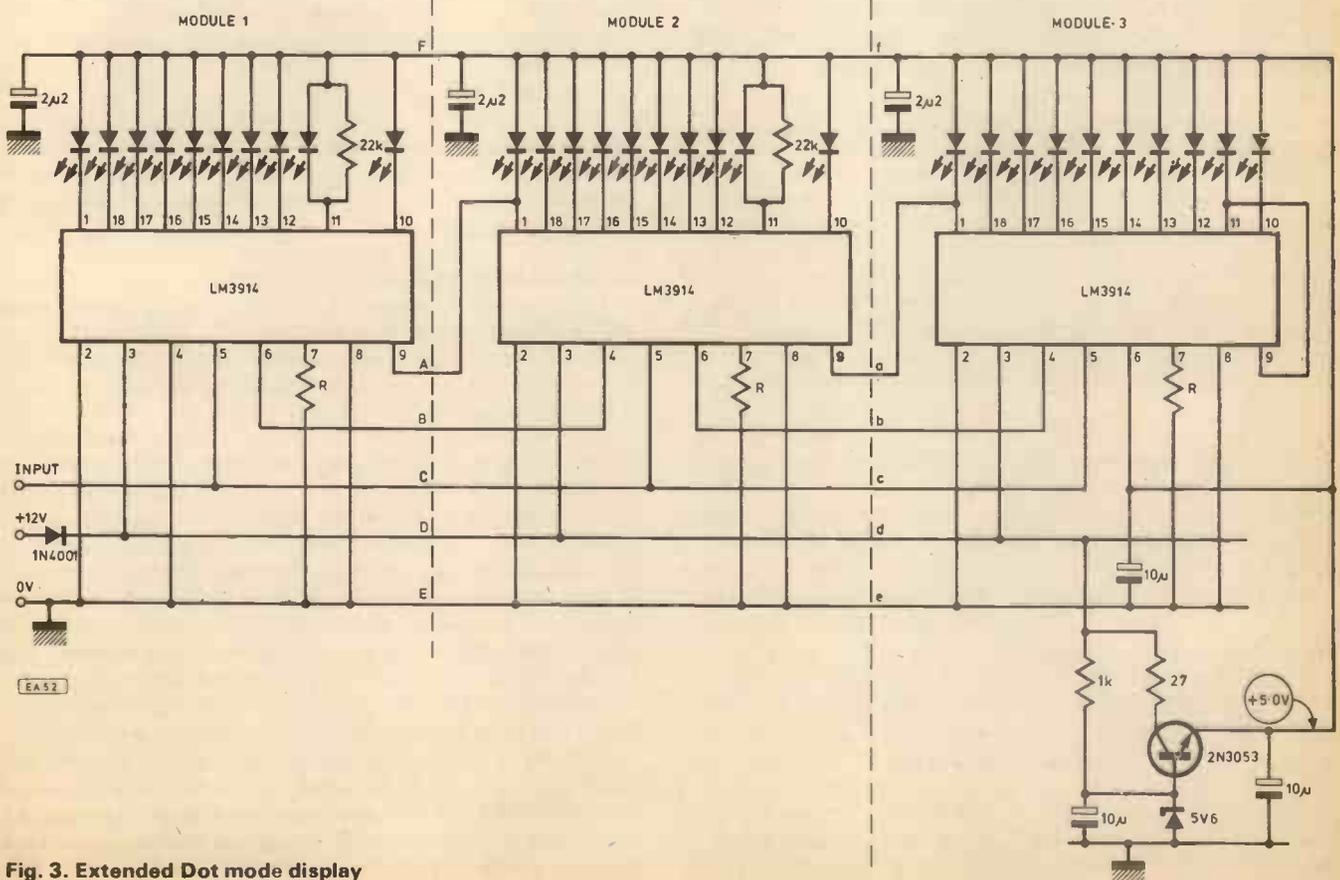


Fig. 3. Extended Dot mode display

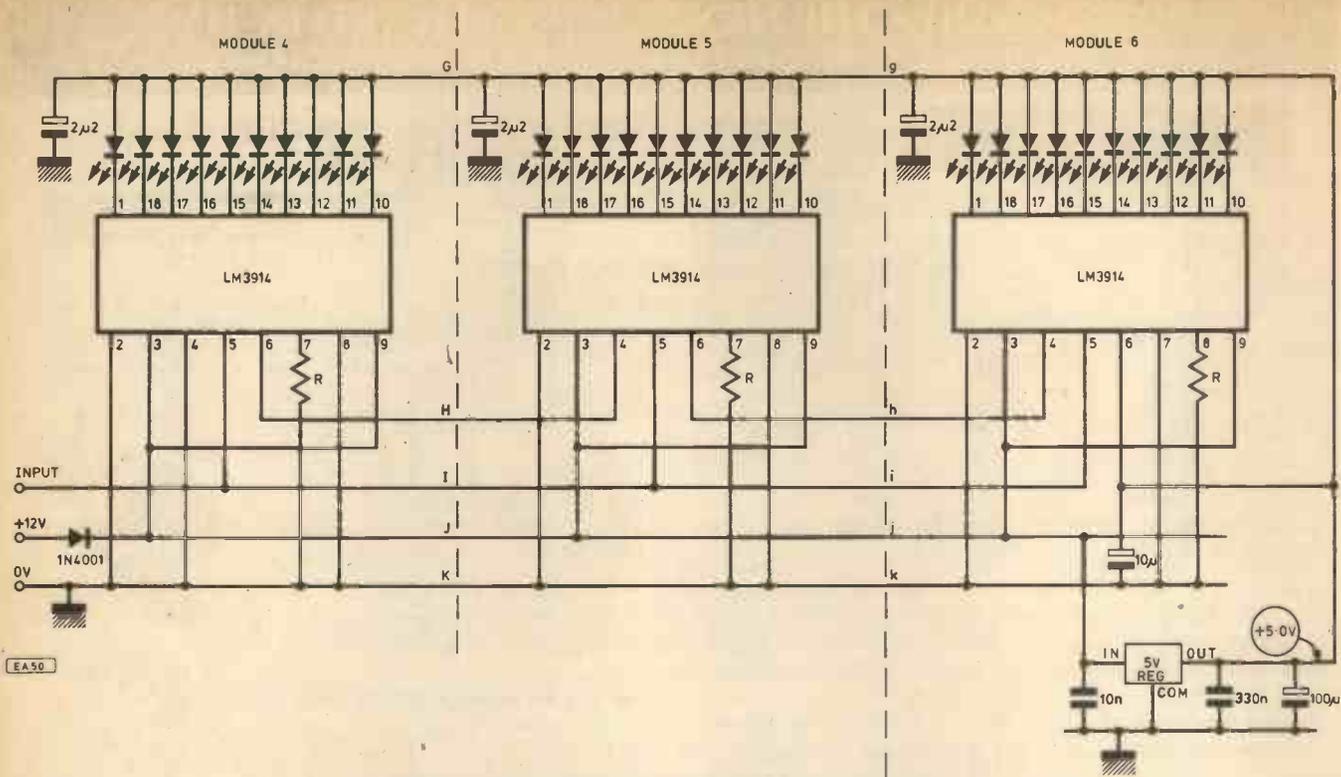


Fig. 4. Extended Bar mode display

I.e.d.s; with the precise circuit details varying slightly depending upon the choice of Dot or Bar mode for the display format. In this way the display may be extended up to 100 I.e.d.s.

EXTENDED DOT MODE DISPLAYS

The "chaining" of display devices to provide an extended Dot mode display employs some as yet unused characteristics of the Mode Select Amplifier in the LM3914. The Mode Select Amplifier looks at three inputs to decide whether to show a Dot display, a Bar display, or a Dot display using multiple LM3914 devices. The three inputs to the Mode Select Amplifier are from pin 9 (mode), pin 3 (V+), and from pin 11 (D9); the last two being connected internally.

Holding the mode pin to within 20mV of the voltage at pin 3 will cause a bar graph to be displayed. A dot mode display will appear if pin 9 is 200mV or more below the voltage at pin 3. If the mode pin is 900mV below the voltage at the anodes of the I.e.d.s, D10 will be turned off. This last feature is exploited in the extended dot mode displays to be discussed and is used to turn the last I.e.d. of one LM3914 off when the first I.e.d. of the next device up the chain is turned on.

The circuit diagram for a 30-I.e.d. dot mode display module is shown in Fig. 3. The I.e.d. current is set by the value of the resistors R, to a value given by:

$$I \approx \frac{12.5}{R} \text{ (R is typically 1 k}\Omega\text{)}$$

The full-scale calibration of the display module shown depends on the exact value of the 5 volt rail, i.e. the full-scale value is set by the voltage at pin 6 of the LM3914 in

module 3. A 22k resistor is also required in parallel with D9 in modules 1 and 2 to ensure correct operation of the Mode Select Amplifiers.

A 20-I.e.d. display may be constructed by omitting module 2 from the circuit of Fig. 3, and making direct connections A-a, B-b, C-c, D-d, E-e, and F-f. Alternatively, the display may be extended beyond 30 I.e.d.s. by breaking the links at A, B, C, D, E, and F, and inserting additional modules of type 2 as required.

EXTENDED BAR MODE DISPLAYS

Bar graph displays of 20 or more I.e.d.s are relatively simple to build. All that is required is that the mode pin of each LM3914 is connected to pin 3 of the same LM3914. The circuit diagram for a 30-I.e.d. bar graph display module is shown in Fig. 4.

As with the extended dot mode display, the full-scale input voltage for the module is set by the voltage at pin 6 of the LM3914 in module 6. The power dissipation of the regulator for the anode supply to the I.e.d.s requires careful consideration. A stable 5.0 volt output is required, with the regulator capable of dissipating the surplus power associated with a full-scale display. For example, a 100-I.e.d. display with $R = 1\text{ k}\Omega$ would involve a regulator dissipation of 8.75 watts when operated from 12V supply, (the individual I.e.d. current would be 12.5mA). It is recommended, therefore, that an integrated circuit regulator be used as shown in Fig. 4, and that adequate heat-sinking arrangements be made.

Displays of 20 I.e.d.s should omit module 5 from the circuit given in Fig. 4, and links should be inserted at G-g, H-h, I-i, J-j and K-k. For displays of more than 30 I.e.d.s, the links should be broken at G, H, I, J, and K, and additional modules of type 5 inserted as required.



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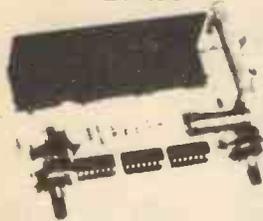
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readout

... 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.

Compukit

Sir—Some time ago I think you asked for reader comments and I would like to say that in my view *PE* has improved very considerably over the years and particularly in recent times.

But I have a moan! The Compukit articles, who are they aimed at, the expert or the amateur? Right at the start the writer lists the amateur as a potential user, but the articles are written using computer jargon (the writer says as much in one place) which is pretty well unintelligible to the beginner in the computer world, however expert he may be in general electronics. In saying, this I am not referring to the BASIC dialect but to words such as "string function" (on page 43 of the pull-out, it is stated that a string can be 0 characters long which seems to have no meaning, and whence 255?), "the memory defaults", "arrays", "truncated integers", etc., and does the average amateur know his Boolean algebra?

With reference to the pull-out itself, does this refer particularly to the Compukit or to BASIC in general?

May I refer to the "Microprocessor Evaluation System" article in the May issue of *PE* in which the writer states several times that 377 octal is 255 binary, but 377 octal is equivalent to 255 decimal, there are no 2s and 5s in the binary system. As the writer makes the statement several times he presumably means something by it, but what? Lastly, to the beginner in the computing world (and that includes me) the charts on pages 20, 21 of the same article, are unintelligible in the form given.

The small booklet that you issued in May 1978 is not much use with reference to the above points, what about a reissue?

I was initially filled with enthusiasm for the Compukit but this is rapidly turning to frustration. Is there any chance of a short glossary being published as an addendum to the last article of the series?

A. Bray,
Potters Bar.

Thank you for your comments. This is a difficult area for PE because we have to optimise between encumbering every computer based article with the same mass of fundamental explanations, or keeping to the point but losing the beginner. This is why, in the Compukit article, we refer the reader to our Learn BASIC article which, we hope, will put the newcomer in the picture.

However, to briefly answer your questions: A string (\$\$) is a string of alphabetic characters. i.e. You may state A = 123 but not A = CAT, for this must be a string A\$ = "CAT". A

string of no characters is a null string, i.e. A = "". The maximum of 255 char's is governed by the highest number 8 binary bits may record.

When the machine is said to default to something, it is assuming a preset value in the absence of information to the contrary.

An array is a subscripted variable i.e. A(1) to A(10) is a dimensioned array with ten possible values.

Truncated Integer. This is to round-down, i.e. 2.76 becomes 2 etc.

To revise Boolean algebra is a prerequisite for any amateur embarking on computer work, and the pull-out describes the BASIC which Compukit is capable of only.

With reference to the binary and octal numbers in the Microprocessor Evaluation System article, the statement is technically incorrect. The number 255 represents the individual digits of the b.c.d. equivalent, not the strict binary equivalent—Ed.

Schottky

Sir,—In "Semiconductor Update" in September's issue of Practical Electronics, R. W. Coles states "There will be other new TTL families from manufacturers such as Fairchild..."

A few months ago Texas Instruments announced their AS and ALS range of advance TTL families. To date, only one part is obtainable, the 74ALS74.

One year ago, Fairchild announced fast: "Fairchild Advanced Schottky TTL". This range was not only announced several months before competing products: it is also considerably easier to obtain. Already the simple SSI building blocks are available, and MSI multiplexers, registers, counters and bus drivers are either available or will shortly be announced.

Fast is fast: 3ns per gate at one fifth the power of high speed standard Schottky.

A technical description of fast technology has already been published in *Electronics*, March 1979, pp. 111.

J. Summers,
Fairchild.

Recompense!

Sir—Re. your correspondence page in October issue and the article on CB. There is no doubt in my mind that most, if not all of this, is triggered off by people who wish to flog 27MHz imports. I have had a life-long interest in radio and have made no concerted effort to study, and yet recently I saw a paper used at the May RAE exam and could have passed it. This would give me access to equipment

designed for 144MHz costing less than the £260 quoted in Mark Sawicki's article. Study Morse for a few weeks and I can transmit world-wide! Much more interesting and just as useful in emergencies as CB probably is. In the States, I am told, it (CB) is abused more than used.

I suppose that the Government will eventually give in, they usually do, but if they take the soft option, 27MHz, then they are morally bound to recompense modellers financially, who have to change their equipment. I am not, by the way, an RC modeller.

T. D. Ray,
Derby.

Champ

Sir,—In the conclusion of the CHAMP series you mentioned possible further articles on programming or hardware designs, but nothing has been printed yet.

There must be many PE readers who have constructed CHAMP and have information to exchange.

I would be glad to exchange with any CHAMP enthusiasts hardware ideas, problems and even the occasional program.

J. Coyne,
BFPO 17.

CHAMP has been rather overtaken by new technology but it is not our intention to neglect those who have built it and we would welcome small programmes and hardware ideas for publication and for exchange to other CHAMP users—Ed.

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	470n	0.47μF
	47n	0.47μF
	4p7	4.7pF
Inductance	3H4	3.4H
	800m	800mH
	2m6	2.6mH
	1m	1mH

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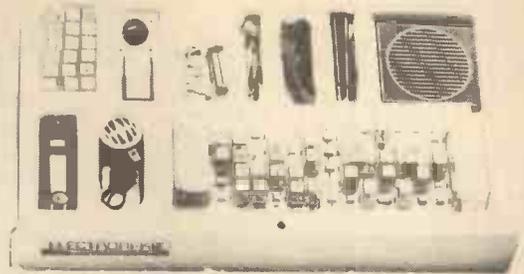


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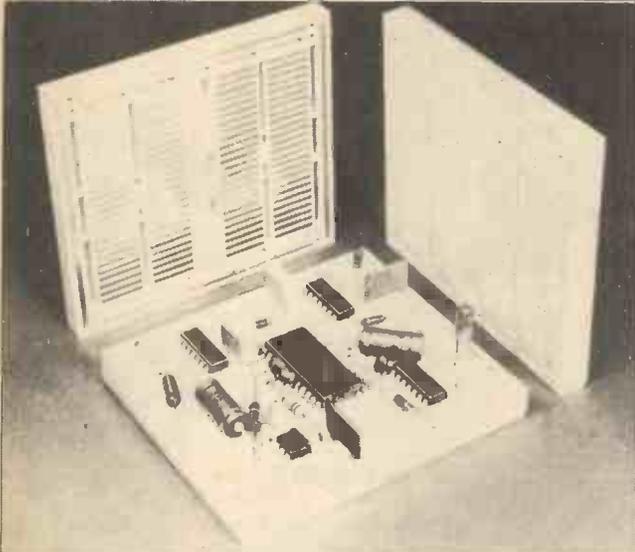
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COST • A • CALL

A.P. DONLEAVY

Calculator

Can be used to cost several calls

THE unit to be described will display directly the cost of a telephone call, taking into account the time of day, distance called, and length of time of a call. The unit can also be used to total the cost of several calls.

At the time of writing, the Post Office charges three pence for each unit of time of the duration of a telephone call. For a long distance call (over 56km) at peak rate, each ten seconds will cost three pence. A local call at peak rate costs three pence for two minutes. Table 1 gives the current rates (cost codes) presently charged by the Post Office.

For example with the instrument set to cost code (a) it will add three pence to the display every ten seconds.

CIRCUIT

Fig. 1 gives a block diagram of the system used. The period timer is a monostable with a timing period set for the appropriate cost code—10s, 15s, etc. The negative edge of the output pulse is fed to both the unit timer, which is also a monostable, and, in turn, the cost oscillator. The timing pulse of this is used to gate the cost oscillator.

The duration of this pulse and the frequency of the oscillator are chosen such that only thirty oscillations occur before the gating pulse stops the oscillator. These thirty pulses are fed to the counter/display system, and cause a 3 to be displayed. The unit timer pulse is also fed back to re-trigger the period timer, and start again the sequence of events.

IC1 contains two monostable oscillators (Fig. 2). IC1a is used to provide the period timing pulse. The length of this depends on which resistor R3—R11 is switched into the circuit and on the value of C3. VR1 is used to provide a control voltage to pin 3 which is used to make a fine adjustment to the timing pulse period. The length of this pulse is altered by VR2.

The output pulse is then fed to pin 12 of IC2. This is a four NAND gate CMOS chip. Three of these gates are connected as an oscillator. The oscillations are fed to pin 9, and only emerge at pin 11 of the gate if pin 12 is at logical 1, which is for the duration of the unit timer pulse.

Table 1: Cost Codes
Time in secs. for 3p. Costcode is in brackets

	Peak Rate	Standard	Cheap
Local	120 (f)	180 (g)	480 (h)
Up to 56km	30 (c)	45 (d)	180 (g)
Over 56km	10 (a)	15 (b)	60 (e)

The negative edge of the pulse is fed back via C5 to re-trigger IC1a. C4, R13 and C5, R12 are used to provide short input triggering pulses, since these must be of shorter duration than the output pulse, which would not be the case if the pulses were fed directly to the inputs.

S2 is a double pole switch arranged such that S2a is on when S2b is off. In this mode pin 4, the reset of IC1 is grounded and the output pin 5 is low. Switching S2b on immediately gives a negative pulse to pin 8 IC1b which triggers the monostable so that the instrument immediately displays the first unit of cost, and then proceeds to cost the rest of the call.

TIMING PERIODS

The values of C3 and R3—R11 are chosen to give a timing period of 10 seconds per 100k (using VR1 for a final calibration). Therefore to obtain the timing periods 10, 15, 30, 45, 60, 120 and 180 seconds, resistors of 100k, 150k, 300k, 450k, 600k, 1.2M and 1.8M, respectively are required.

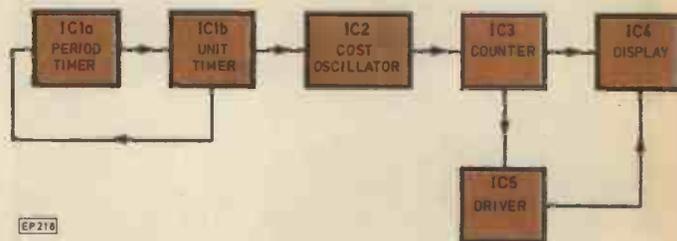


Fig. 1. Block diagram

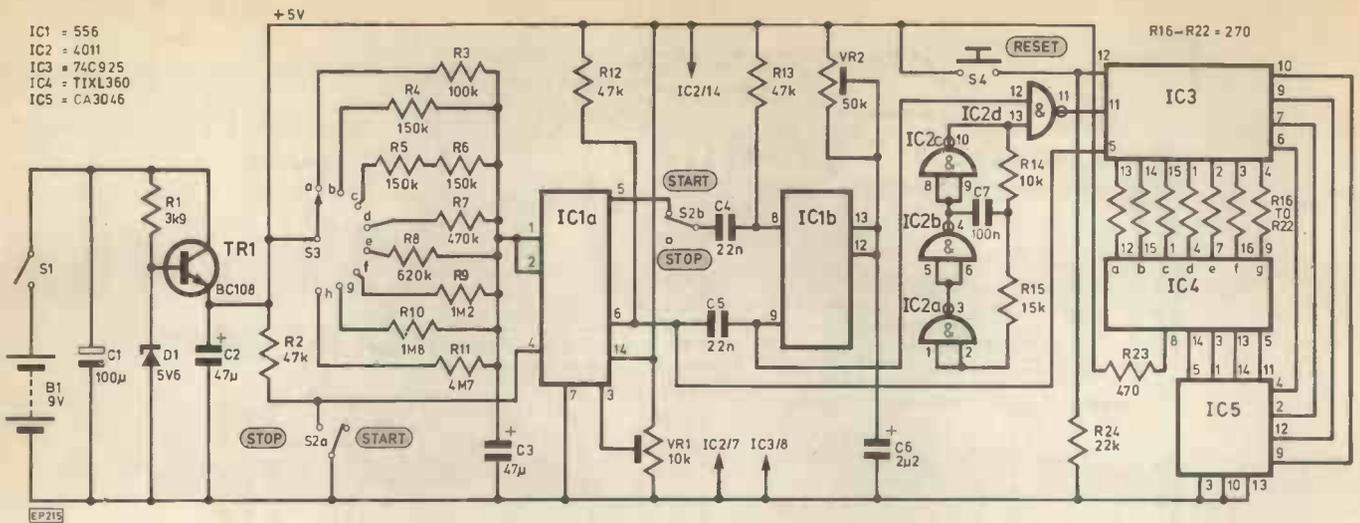


Fig. 2. Circuit diagram

300k resistor is obtained by two 150k in series and a 470k resistor is used instead of a 450k resistor, leading to a 5 per cent error in this timing interval. However, for domestic use this is not significant. Also R8 will need to be 620k. Varying VR1 changes all timing periods by the same percentage.

In the event of changes in telephone charges VR2 will recalibrate the unit cost of a call. Any changes in this period costing may be done with VR1, or else resistor changes may be required. This however is a simple job.

IC3 is a National CMOS MM 74C925 four digit counter/latch/driver, internally multiplexed. IC5 is a CA3046 chip containing five identical transistors, four of which are used to drive the display digits. The display is a TIXL306 calculator display with either four or six digits. Only four are used in this project.

The pulses from the oscillator are clocked into pin 11 of IC3 where they are then counted and displayed on IC4. S4 is depressed to zero the reading on the display.

The power supply regulation circuit is fairly simple and straightforward giving a line voltage of about five volts.

COMPONENTS

IC5 may be substituted by an LM3086, which is a pin for pin equivalent. IC4 may be substituted by any display if the appropriate adjustments are made to the printed circuit board. All that is required is that the segments a-g and digits be connected to IC3 as shown. Individual 0.3 in. displays may be used also. Again the constructor will need to make his own modifications.

The specified display fits into a 16 pin DIL socket making the mounting simple. It is recommended that DIL sockets be used for all the i.c.s, especially for the 74C925. Being CMOS it can be easily damaged by static electricity.

CONSTRUCTION

Figs. 3 and 4 give the printed circuit board and component layout. The display is mounted in a DIL 16 pin socket arranged on its edge, such that the display is perpendicular to the board. Bend the socket pins round 90° and solder them into the holes drilled in the board. Stiff wire is used to connect the remaining pins of the display to the board.

Drill the front panel of the case to take the switches. Cut a window in this panel suitable for viewing the display. Red clear plastic can be used as a filter. This can be glued to the inside of the panel.

S3 is mounted on the lid of the box. R3-R11 are soldered directly onto the terminals of this switch. The battery, if used, is stuck on the underside of the lid using a double sided sticky mounting tab. The printed circuit is held to the base using two screws into the mounting studs. The lettering on the box can be done using Letraset. To avoid extra circuitry for controlling the decimal points, the unwanted decimals are blanked off using a felt tipped pen.



COMPONENTS . . .

Semiconductors

D1	RZY88-5.6 Zener 400mW
TR1	BC108
IC1	556
IC2	4011
IC3	74C925
IC4	TIXL360
IC5	CA3046

Resistors

R1	3.9k
R2	47k
R3	100k
R4	150k
R5	150k
R6	150k
R7	470k
R8	620k
R9	1M2
R10	1M8
R11	4M7
R12	47k
R13	47k
R14	10k
R15	15k
R16-22	270
R23	470
R24	22k
All 1/4W 10% carbon	

Capacitors

C1	100µ elect 25V
C2	47µ tantalum
C3	47µ tantalum
C4	22n
C5	22n
C6	2.2µ tantalum
C7	100n

Switches

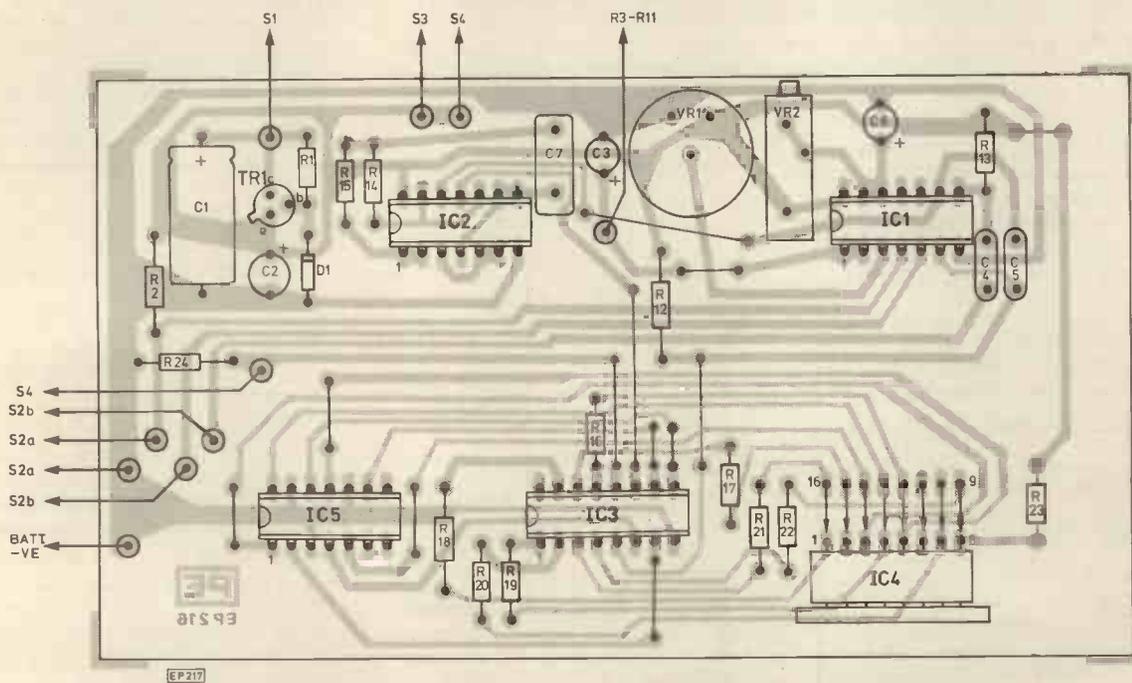
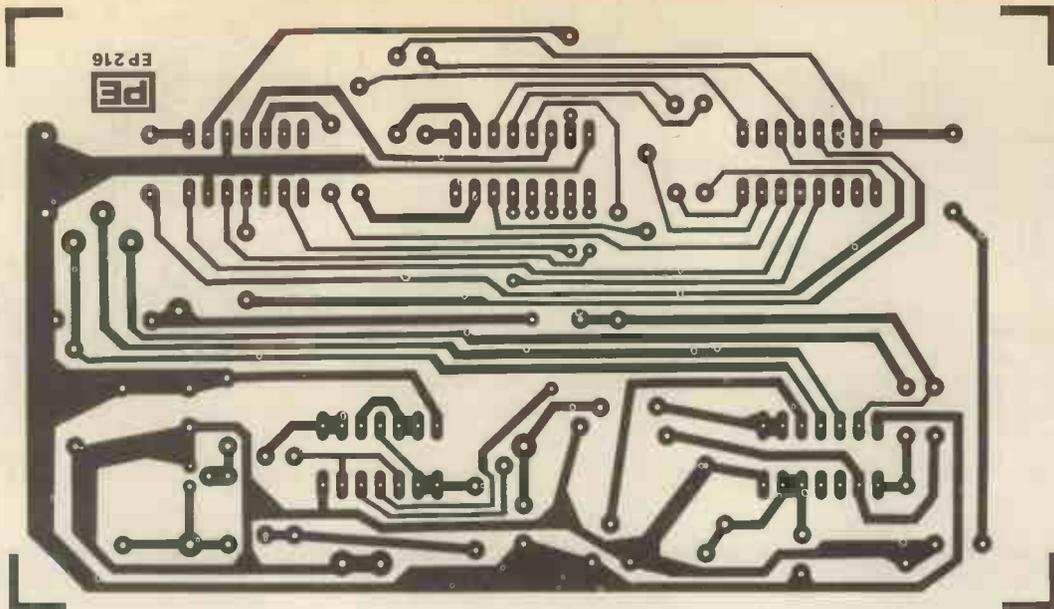
S1	On-off toggle
S2	Double pole double throw
S3	Single pole eight way rotary
S4	Press switch

Variable resistors

VR1	10k linear
VR2	50k multitrn trimpot

Miscellaneous

Verobox	153 x 84 x 39.5mm
---------	-------------------



Figs. 3 and 4. P.c.b. and component layout. Arrows refer to display pin connections. For these see circuit

CALIBRATION

VR2 must first be adjusted so that the display increments by thirty each time. Switching S2 from stop to start will increment the display and speed up the calibration process.

Switch to cost code a, and adjust VR2 until the counter increments every 10 seconds. This roughly calibrates the period timer. Then switch to position g, and readjust VR2 so that the counter increments every three minutes. The unit is now calibrated.

TROUBLE SHOOTING

If the unit doesn't work on switching on, check power supply voltage and wiring. Also check the i.c.s are inserted the right way round.

If the four digits of the display light and S4 will zero any random number displayed when the instrument is turned on, then IC3, IC4, IC5 will be functioning. Attention can then be

turned to the remaining circuitry. Remove IC1 and the display should count continuously. Switching on/off may be necessary to start the oscillations. If the oscillator is working, attention can then be turned on IC1. Make sure that VR1 is not set to either end of its travel, and check the voltages on the various pins of the i.c.

USING THE INSTRUMENT

Switch on, set cost code. Put S1 to stop, press S4, then put S1 to start when the call starts. At the end of the call put S2 to stop.

The cost will then be displayed. If another call is to be made do not turn off the instrument. Press to start and the cost of this call will be added to the last call. The instrument could be permanently left on if required to total the cost of all calls (up to a limit of £9.99). However, a mains adaptor would be imperative in this case. ★

how the Mk14s display can be multiplexed from a user program. It displays a nine-letter message, making use of the ninth digit wired up as described above. The routine works by repeatedly copying the nine segment codes for the message to the addresses for the nine display digits; P1 points to the display and P2 to the message bytes, and the extension register is used as an offset. The routine formed part of a cassette interface system, submitted by *Colin C. Tredwell of London*, which displayed a file name after a program was loaded from tape; unfortunately there is not space to publish the whole program here.

AUTOMATIC OFFSET CALCULATOR

As anyone who has programmed a SC/MP micro will know, the hardest part of "hand

In the example of a program which loops around, decrementing a counter the address of the program to be processed (0F20 in this example) is put in 0FF9, 0FFA so that the monitor will set up P1 for us. Then the offset calculator program is run from 'ENTER', and will stop when it encounters 'A0'. It will have altered the program to:

```
0F20 B8FE
0F22 90FC
and the program is now ready to run."
```

PROGRAM OPERATION

"The SC/MP instruction set can be divided into three basic types:

- 1) Single byte instructions
- 2) Double-byte immediate or indexed instructions
- 3) Double-byte instructions with displacement.

```

; OFFSET CALCULATOR FOR SC/MP
0000      ; -OPRA
0F9A C501 ALTER: LD @1(1) ;SKIP 2-BYTE INSTRUCTION
0F9C C501 ENTER: LD @1(1) ;START EXECUTION HERE
0F9E 94FC JF ENTER ;NO CALCULATION
0F00 940F ANI OF ;ENDS IN ZERO
0F02 981E JZ NDO ;ENDS IN ZERO
0F04 C1FF LD -1(1) ;ENDS IN ZERO
0F06 D40F ANI OF ;ENDS IN ZERO
0F08 E808 XRI 08 ;ENDS IN EIGHT
0F0A 9821 JZ NDB ;ENDS IN EIGHT
0F0C C1FF LD -1(1) ;JFFZ
0F0E E494 XRI 074 ;JFFZ
0F10 9804 JZ JUF ;JUF
0F12 E408 XRI 08 ;NOT INZ.
0F14 9C64 JZ ALTR ;NOT INZ.
0F16 31 JUMP XPAL 1
0F18 01 XAE
0F1A 40 LDE
0F1C 31 JUMP 1 ;RESTORE P1
0F1E C501 LD @1(1) ;GET SECOND BYTE
0F20 02 CCL ;STORE DISPLACEMENT
0F22 78 CAE ;CONTINUE
0F24 C9FF ST -1(1) ;STORE DISPLACEMENT
0F26 90DA JNB ENTER ;CONTINUE
0F28 C1FF NDC: LD -1(1) ;STORE DISPLACEMENT
0F2A E490 XRI 090 ;STORE DISPLACEMENT
0F2C 982E JZ JUMP ;JMPZ
0F2E E43D XRI 03D ;JMPZ
0F30 9C07 JZ INC ;JMPZ
0F32 3F XPC 3 ;STOP AT A0 BYTE.
0F34 C1FF NDC: LD -1(1) ;STORE DISPLACEMENT
0F36 E198 XRI 098 ;JMPZ
0F38 98E3 JZ JUMP ;JMPZ
0F3A 8800 INC: ILD (1) ;MEMORY REFERENCE
0F3C 90DF JNB JUMP ;NO CALCULATION
0000      .END

```

Fig. 4. SC/MP program automatically calculates offsets for program-counter relative instructions

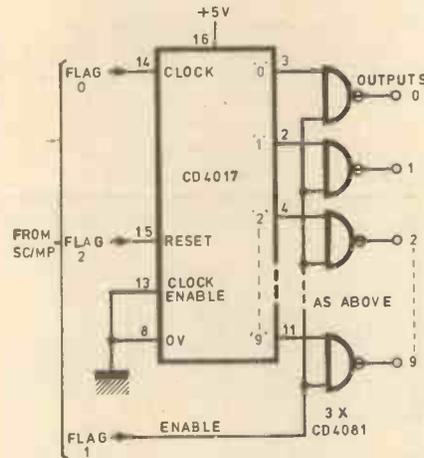


Fig. 5. Circuit uses a decade counter to add ten outputs to a SC/MP micro

gates provide control of the selected output.

"A small subroutine, Fig. 6, is run to address any particular output. Once addressed, the output can then be controlled on and off by the operation of flag 1. The contents of 0F27 determine which output will be enabled. If the addressed output is changed the original output will be disabled, but if necessary latches could be added to store the states of the outputs. The circuit was originally developed to connect a small robot to an Mk14."

SC/MP SUBROUTINE STACKER

"One of the problems of programming with SC/MP is how best to use the three 16-bit pointer registers. These can be used as stacks, subroutine addresses, or to address data, etc. but when you need to switch from one use to another it is easy to get into a mess."

```

; OUTPUT ADDRESSING ROUTINE
0006      ; OUTPUT = 6 ; OUTPUT 1 TO 10
0000      ;
0000      ; -OPIF
0F1F COUNT: LD -1 ;COUNT
0F20 C404 BEGIN: LD 04 ;PULSE RESET
0F22 07 CAS ;
0F24 C400 LD 00 ;
0F26 C406 LD ;
0F28 C8F6 ST ; WHICH OUTPUT?
0F2A C401 LOOP: LD 01 ;PULSE CLOCK
0F2C 07 CAS ;
0F2E D400 LD 00 ;
0F30 B8EE DLD ;
0F32 9CF6 JNZ COUNT ;FLAG PULSED
0F34 C402 LD 02 ; 'OUTPUT' TIMES?
0F36 07 CAS ;ENABLE OUTPUTS
0F38 3F XPC 3 ;RETURN
0000      .END

```

Fig. 6. Routine which selects an output—in this case 6—with Fig. 5

```

; SC/MP SUBROUTINE STACKER
0000      ;
0B00 3F EXIT: XPC 3 ; -OB00
0B01 01 ENTRY: XAE ;
0B02 C9FD ST -3(1) ;STORE ENTRY VALUE OF B
0B04 C280 LD 2(2) ;GET SUBROUTINE ADDS. HIGH
0B06 3F XPAH 3 ;
0B07 CDFP ST 0-1(1) ;RETURN ADDS. HIGH TO STACK
0B09 02 CCL ;INCREMENT E:
0B0A C401 LD 1 ;
0B0C 70 ADE ;
0B0D 01 XAE ;
0B0E C280 LD 2(2) ;SAME FOR LOW ADDS. BYTE
0B10 33 XPAL 3 ;
0B11 CDFP ST 0-1(1) ;
0B13 C1FF LD -1(1) ;RESTORE ORIGINAL E VALUE
0B15 01 XAE ;
0B16 90E8 JNB EXIT ;
0B18 C501 ENTRY2: LD 0+1(1) ;RETURN ADDS. LOW
0B1A 33 XPAL 3 ;
0B1B C501 LD 0+1(1) ;RETURN ADDS. HIGH
0B1D 3F XPAH 3 ;
0B1E 90E0 JNB EXIT
0000      .END

```

Fig. 7. Program implements a stack to simplify the use of subroutines

assembling" programs is calculating the offsets for program-counter relative jumps and addressing operations. The "offset calculator" program of Fig. 4, submitted by *Mr D. Love of Swansea*, eliminates the need to make these calculations by hand.

"The 'offset calculator' makes all the calculations automatically in one pass, thus speeding up writing programs and making them more likely to be free of errors. To use the offset calculator, programs are written as usual except that where instructions require a displacement, the low byte of the destination address is inserted as the second byte of the instruction instead of the displacement. The offset calculator makes the calculation when it passes over the program.

So writes *Mr N. E. H. Feilden of Suffolk*, and to remedy the situation he has written a routine for SC/MP to simulate the JSR and RTS instructions of other micros such as the 6502; see Fig. 7.

"A list of the subroutine addresses is stored in memory pointed to by P2. The appropriate one is selected by the value received in the accumulator by the stacker routine. Thus the calling program contains: 'LDI n, XPPC 3' (C4 nn 3F) as the equivalent of 'jump to subroutine'. The subroutine address is taken from locations P2+n (high byte) and P2+n+1 (low byte). The calling address is saved in a stack using P1, which should initially point to the top of a free area of RAM. Return is achieved using 'JMP 17(3)' (93 17) which causes a jump to the stacker routine at 'ENTRY 2'.

Pointer P3 should be set to the address 'EXIT' (0B00 in this case) before use. The routine is fully relocatable, so it can be put anywhere convenient in memory without modification. This version is fairly simple; it does

```

0F1F      COUNTER
0F20 B81F LOOP: DLD COUNTER
0F22 9020 JMP LOOP
0F24 A0 STOP CHARACTER
FOR OFFSET
CALCULATOR

```

EXTRA OUTPUTS FOR SC/MP

The basic SC/MP micro has three "flag" outputs which can be controlled from programs. The circuit of Fig. 5, sent in by *Steve Stamps of Avon*, shows a simple way of extending the number of outputs by using a CMOS decade counter, clocked by one of the flags, to select one of ten outputs. The AND

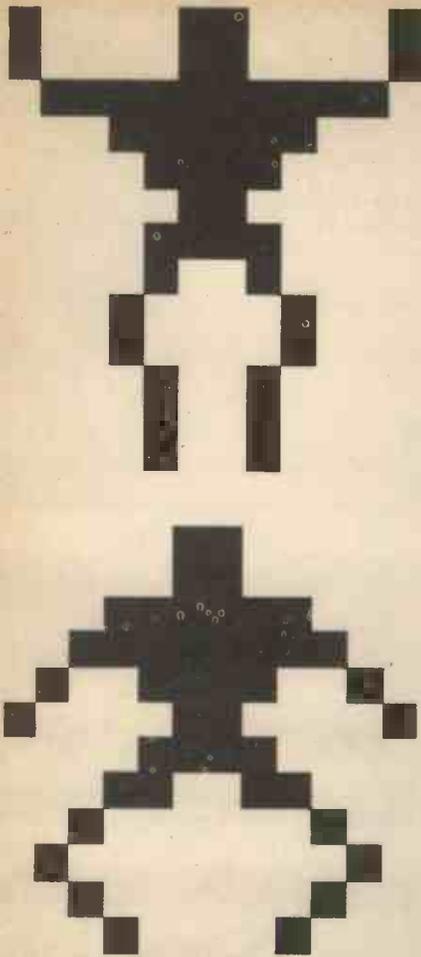


Fig. 8. Graphics generated by the falling-man program

```

; FALLING MAN DISPLAY
)
OF00 RAM = OF00 ;FOR VARIABLES
OB00 DESP = OB00 ;DISPLAY MEMORY
)
0002 J RAM OFFSETS:
0003 CNT = 3 ;COLUMN
0004 ROW = 4 ;COUNTER
;ROW COUNT

0000
0F20 C40F ENTER: LDI H(RAM)
0F22 37 XPAH 3
0F23 C400 LDI L(RAM)
0F25 33 XPAL 3 ;P3 TO VARIABLES
0F26 C40B BEGIN: LDI H(DISP)
0F28 35 XPAH 1
0F29 C406 LOOP: LDI 6
0F2B C802 ST COL(3)
0F2D 31 NEMMAN: XPAL 1 ;BEGIN NEW MAN
0F2E C40F LDI H(MAN)
0F30 36 XPAH 2
0F31 C47D LDI L(MAN)
0F33 32 XPAL 2 ;P2 TO MAN PATTERN
0F34 C413 LDI 19
0F36 C803 ST CNT(3)
0F38 C40F COPY: LDI 15 ;ROWS PER PICTURE
0F3A C804 ST ROW(3)
0F3C C401 NEMROW: LD 0(2)
0F3E C001 ST 0(1)
0F40 C601 LD 0(2)
0F42 C007 ST 0(1)
0F44 B804 DLD ROW(3) ;POINT TO NEXT ROW
0F46 9CF4 JNZ NEMROW ;PICTURE DONE?
0F48 C4B2 LDI 0-30(2) ;RESET P2
0F4A C590 LD 2-112(1) ;RESET P1 1 ROW DOWN
0F4C 8F40 DLY 040 ;WAIT...
0F4E B803 DLD CNT(3)
0F50 E404 XRI 4 ;4 SWEEPS TO GO?
0F52 9618 JI LAND ;YES = CHANGE PICTURE
0F54 E404 XRI 4 ;RESTORE CNT
0F56 9CE0 JNZ COPY ;FRESH SWEEP?
0F58 8FF7 DLY OFF ;LEAVE MAN STANDING
0F5A B802 DLD COL(3) ;NEXT MAN?
0F5C B802 DLD COL(3) ;SUBTRACT 2
0F5E 94CD JP NEMMAN ;ALL DONE?
0F60 C500 LDI 1 ;CLEAR SCREEN
0F62 31 CLEAR: ST 1
0F63 C400 LDI 0 ;BLANK
0F65 C001 ST 0(1)
0F67 31 XPAL 1
0F68 9CF8 JNZ CLEAR ;MORE TO DO
0F6A 908A JMP START ;REPEAT FOR EVER.
0F6C C43C LAND: LD 0+2(2) ;P2 TO STANDING MAN
0F6E 90C8 JMP COPY ;CONTINUE.

; BIT-PATTERNS FOR FALLING MAN
0F70 0000 MAN: .DBYTE X'0000,X'1308,X'4308
0F72 3FFD .DBYTE X'3FF0,X'0F00,X'0750
0F74 0300 .DBYTE X'0300,X'0780,X'0480
0F76 0840 .DBYTE X'0840,X'0840,X'0480
0F78 0480 .DBYTE X'0480,X'0480,X'0000

; BIT-PATTERNS FOR STANDING MAN
0F8E 0300 .DBYTE X'0300,X'0300,X'0FC0
0F90 1FED .DBYTE X'1FED,X'2790,X'4308
0F92 0780 .DBYTE X'0780,X'0C00,X'1020
0F94 2010 .DBYTE X'2010,X'1020,X'0840
0F96 0000 .DBYTE X'0000,X'0000

0000 .END

```

Fig. 9. Animation program for use with a Science of Cambridge VDU module

preserve the E register, but not the S. It could be adapted to handle interrupts since an 'XPPC 3' will always go to the stacker from anywhere outside the stacker. More complex schemes with two levels of indirection may be used to perform multiple tasks, for instance, in controllers."

FALLING MAN DISPLAY

The last in this month's series of applications for the Mk14 is a program donated by *Nick Toop*, designer of the Science of Cambridge VDU Module, to demonstrate some of the graphics possible with this VDU. The program generates a display of a man falling through space with his arms raised, and then landing with his arms lowered; see Fig. 8. He is then joined by three similar men, and the cycle repeats indefinitely. The animation is generated in half of the screen, 32 of the 64 possible rows, and uses the Mk14's extra RAM at OB00 for the display area. This memory is mapped to the display in rows of 64 dots, 8 bytes per row.

PROGRAM OPERATION

The falling-man program, Fig. 9, makes clever use of auto-indexing to keep it as short as possible. The bit patterns for the two positions of the man are stored after the program at "MAN". Each row of the man consists of 16 dots, specified by two bytes, and the whole man comprises 15 rows. The program writes the man to the display a total of 19 times, each time shifting the man down by one row to give the appearance of falling. For the first 15 sweeps of the man the picture of the falling man is used, and for the last 4 sweeps the standing man is used.

The resulting animation is pleasingly realistic, and should inspire owners of suitable systems to attempt more ambitious displays, such as a man walking across the screen.

EIGHT EIGHTS WINNERS

The winners of the Eight Eights competition, presented in the August Micro-Bus, were:

Mr D. Caballero of Ramsgate, Mr J. M. Brinton of Cheltenham and Mr E. Vyncke of Allur, Belgium.

News Briefs

PRESTEL TESTING THE INTERNATIONAL MARKET

BUSINESSMEN in seven countries will soon be able to take part in an international trial of Prestel, the British Post Office's world-leading viewdata system which gives users access to computer information banks by means of a simple TV type display terminal.

Invented at the Post Office Research Centre this system has already put Britain ahead of any other country in the mass marketing of electronic information. Now following the start of the world's first public viewdata service in London on March 27 Britain will score another world first when it begins experiments with an international viewdata service later this year.

The trial is designed to identify the kind of information today's

globe-trotting businessman, or government official, needs to know but which is often difficult to get quickly. With a Prestel international service it will be instantly available, literally at the user's fingertips.

The trial will be open to selected users in the UK and up to six countries—Australia, German Federal Republic, the Netherlands, Sweden, Switzerland, and the United States. It will offer a wide variety of up-to-the-minute business information drawn from many parts of the world—prices in the world's premier stock markets, currency exchange rates, schedules for the world's major airlines, the latest shipping news, as well as a variety of specialist information such as commodity prices, economic analyses and company management information.

The decision to go ahead with the trial follows a six-month evaluation of the potential market for such a service carried out for the Post Office by Logica Limited. This firm has now been commissioned to assist in implementing the trial which is expected to last one year. During the trial, a decision will be taken regarding a full-scale service.

Already discussions are under way with firms who might provide information needed for an international databank, part of which could be multi-lingual. Parallel talks are due to start soon with TV set manufacturers about supplying the few hundred terminals needed for the trial. The telecommunications authorities of the other countries involved are being invited to discuss the Post Office's plans.

The trial service will be using a dedicated Prestel computer in London which will become available after the full public service goes live in London.

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4026	90p	4070	13p
4027	28p	4071	13p
4028	45p	4072	13p
4029	50p	4081	13p
4040	55p	4093	36p
4041	55p	4510	60p
4042	55p	4511	60p
4043	50p	4518	65p
4044	90p	4520	60p
4045	25p	4528	60p

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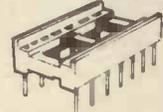
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7473	20p	74141	55p
7474	22p	74145	55p
7475	25p	74148	90p
7476	20p	74150	55p
7485	55p	74151	40p
7486	20p	74154	65p
7489	135p	74157	40p
7490	25p	74164	55p
7492	30p	74165	55p
7493	25p	74170	100p
7494	45p	74174	55p
7495	35p	74177	50p
7496	45p	74190	50p
74121	25p	74191	50p
74122	35p	74192	50p
74123	38p	74193	50p
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AD162	38p	BD140	35p	2N3055	50p
BC107	8p	BFY50	15p	2N3442	135p
BC108	8p	BFY51	15p	2N3702	8p
BC108C	10p	BFY52	15p	2N3703	8p
BC109	8p	MJ2955	98p	2N3706	9p
BC109C	10p	MPSA06	20p	2N3707	9p
BC147	7p	MPSA56	20p	2N3708	8p
BC148	7p	TIP29C	60p	2N3819	15p
BC177	14p	TIP30C	70p	2N3820	44p
BC178	14p	TIP31C	65p	2N3904	8p
BC179	14p	TIP32C	80p	2N3905	8p
BC182	10p	TIP2955	65p	2N3906	8p
BC182L	10p	TIP3055	55p	2N4058	12p
BC184	10p	ZTX107	14p	2N4557	32p
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		220				10p
			470			15p
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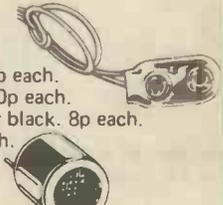
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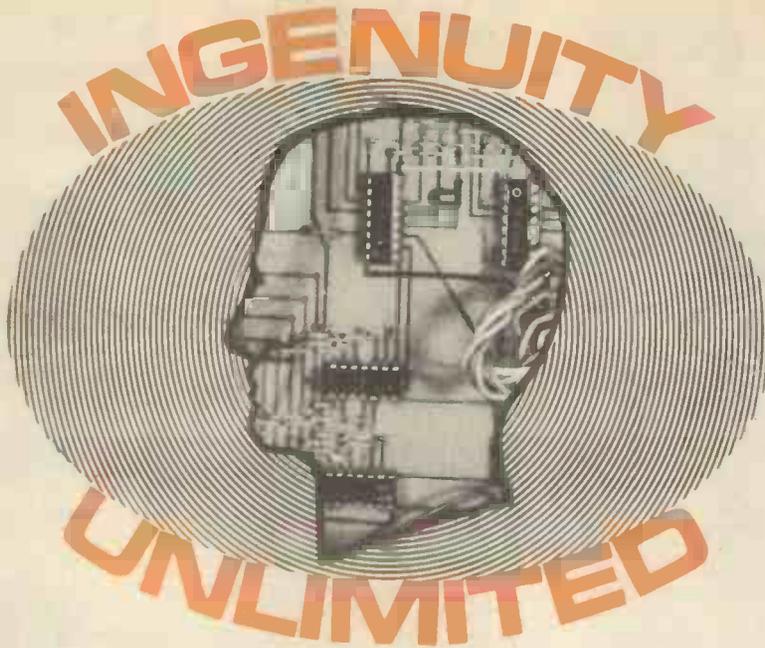
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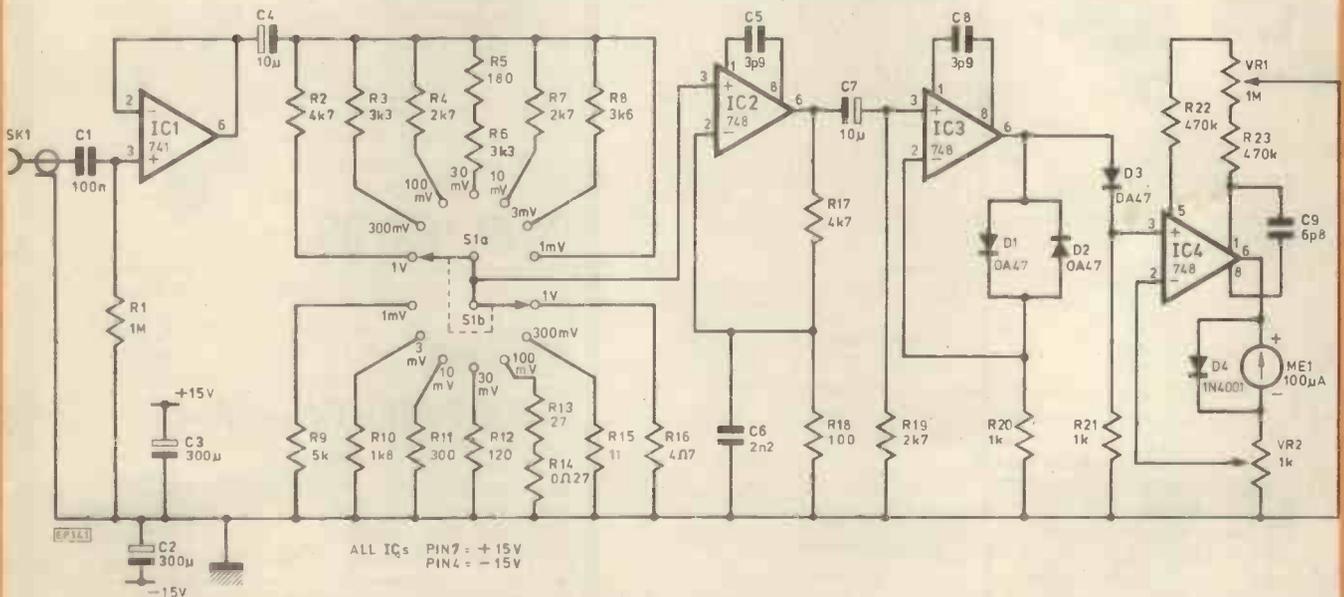
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AUDIO-MILLIVOLTMETER



HAVING constructed the audio-millivoltmeter featured in the June '76 edition of *PE*, I discovered that circuit noise and main's hum caused a permanent deflection on the meter that was unacceptably large on the lowest range. To cure this I devised this circuit.

IC1 has unity gain and acts as a buffer amplifier for the input signal across R1. The signal is then fed through one of the voltage-dividers to IC2, which amplifies it and provides frequency compensation. The signal then passes to IC3 which duplicates

it across R4 and so produces a low-distortion half-wave rectified signal across R5 (it is important that R20 = R21 and that D1, D2 and D3 are identical). The rectified signal is d.c. and is amplified by IC4 to drive the meter. The gain of this stage is varied by VR2, allowing calibration, and the meter is zeroed by VR1. D4 protects it from damage.

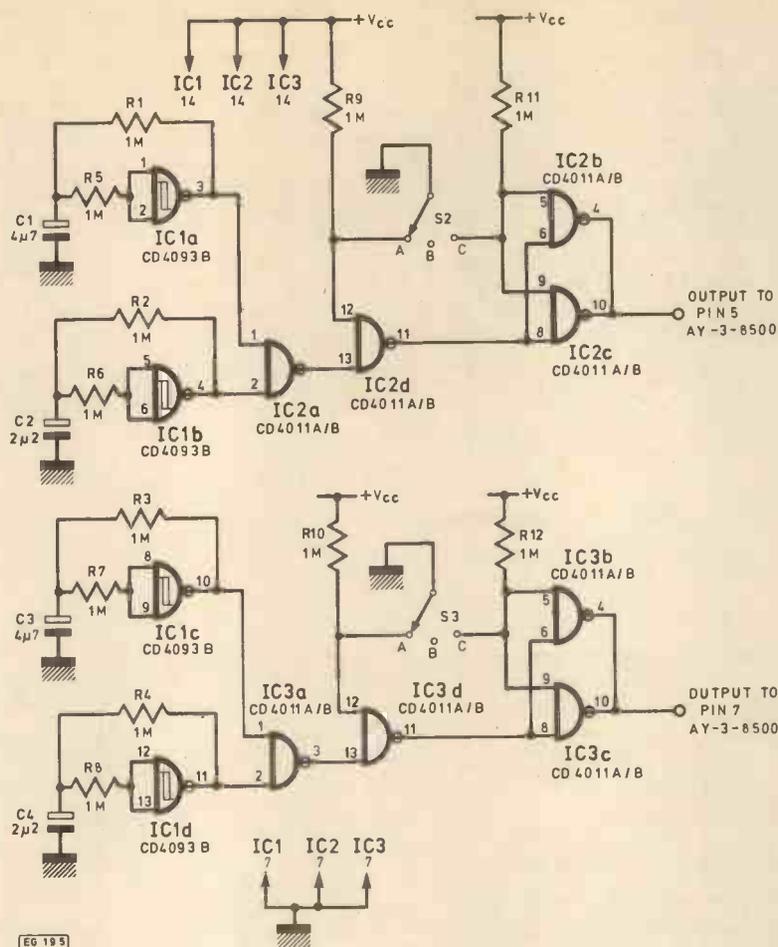
The input impedance of the circuit is governed by R1, one megohm was found to be satisfactory. The frequency response is virtually flat up to and beyond 100kHz,

depending on the value of C2 which affects the frequency compensation of IC2. The circuit measures a.c. signals from 1mV to 1V in seven ranges using a 100µA f.s.d. meter with 0-3 and 0-10 scales.

The circuit is very sensitive and care should be taken in its construction and housing; all signal carrying leads, the selector switch, the input socket, and any sources of main's hum should be properly screened.

Kevin Cameron,
Melrose,
Roxburghshire.

TELE-GAMES MOD



EG 193

THE introduction of the General Instruments, AY-3-8500 i.c. has produced a large number of almost identical tele-games circuits. It was while seeking some degree of variation from these circuits, while still maintaining the use of the AY-3-8500, that the following circuit was evolved, to introduce a certain amount of randomness to the game. In this way differences in ground texture (ball speed variation) and slight mis-hitting (angle at which the ball leaves the bat is uncertain) can be represented.

The circuit operation is very simple; consider the top section used for ball speed variation. Two slow oscillators are built around two NAND Schmitt triggers operated in the inverting mode. The speed of the oscillators is 0.3Hz and 1Hz using the quoted values. The resistor in series with the gate is to help protect the gate from

switch on surges. The two oscillators are then gated via IC2a to produce random pulses.

A SPDT centre off switch (S2) replaces the S2 in the original game. It can be seen that with S2 in position A the output of IC2c will be high, thus IC2bd will be low, giving a high ball speed. Similarly, with S2 in position C, IC2bd will be high, and so the ball speed will be low. However, with S2 in position B, both IC2c and IC2bd are enabled thus giving the random transitions at the output of IC2bd. The AY-3-8500 uses 100 kilohm pull up resistors, and although one gate drive will cope with the current drain, two may be used in parallel to ensure adequate speed.

An identical circuit is used to change the rebound options between 2 and 4 angles.

The circuit may be much simplified, by using only one oscillator and one drive gate, the circuit could then be built around one quad NAND Schmitt, but the full random nature is not available. It should also be possible to obtain speed changes every time a rebound occurs by using a monostable and latch on the sound output to alter the speed.

The connection to pins 5 and 7 of the AY-3-8500 may be made at the original switch points.

The oscillator gates must be Schmitt to ensure oscillation and the capacitors should be Tantalum types.

I. C. Lare,
Northwich,
Cheshire.

DC/DC VOLTAGE MULTIPLIER

SHOWN is an astable, symmetrical multivibrator working at about 1,000Hz. It has the special feature, that the ordinary collector resistors are replaced by *p.n.p.* silicon transistors. Even using small transistors, the output has a low impedance. When using supply voltages lower than 5-6 volts the base protection diodes may be omitted. It is advisable to use transistors with a nominal I_c maximum two or three times the input current; they need not match exactly.

The multivibrator has been tested with small power transistors BC328 as TR1-TR2; and BC338 as TR3-TR4. The base diodes are ordinary small signal silicon types.

The circuit works well with power transistors too: *p.n.p.* 2N2955, *n.p.n.* 2N3055

and base diodes 1N4001. With these it is necessary to decrease the base resistors and to keep the frequency, increase the capacitors proportionally.

It might seem unusual to use this type of converter instead of the popular transformer coupled type, which has somewhat higher efficiency, but this needs less space and is light weight. Thanks to the present cheap, high quality semiconductors, the total result is better than one might expect.

The circuits are interesting to the experimenter, and could certainly be improved.

The examples in the tables tell the rest of the story.

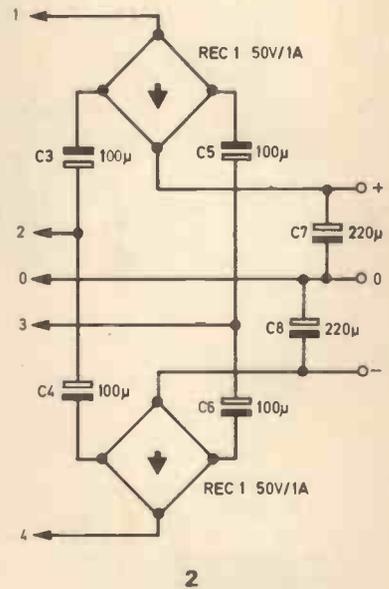
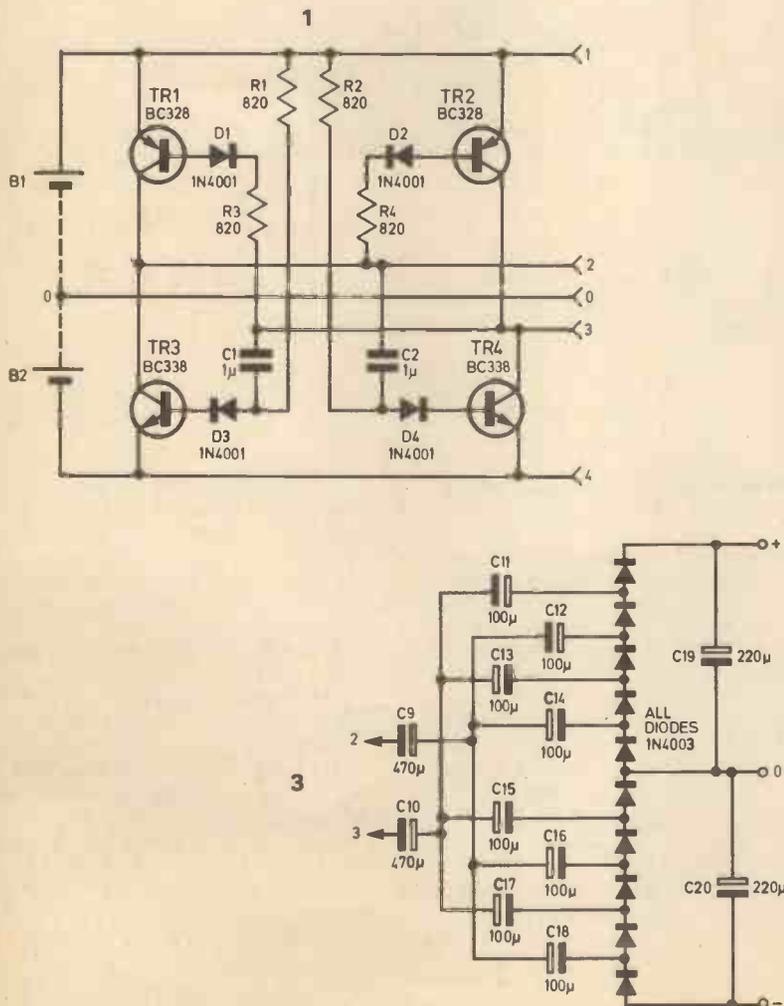
P. Poulsen,
Odense,
Denmark.

Circuit 1 + 2

Input:	1.5V 14mA	Output:	2-25V 2mA
	3.0V 50mA		3-0-3V 10mA
	6.0V 80mA		9-0-9V 20mA
	12.0V 250mA		16-0-16V 50mA

Circuit 1 + 3

Input:	3V 130mA	Output:	6-0-6V 15mA
	6V 100mA		23-0-23V 10mA
	6V 160mA		16-0-16V 15mA
	6V 280mA		15-0-15V 30mA
	6V 340mA		12-0-12V 50mA
	12V 680mA		28-0-28V 60mA
	12V 750mA		25-0-25V 80mA



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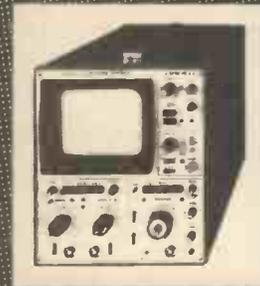
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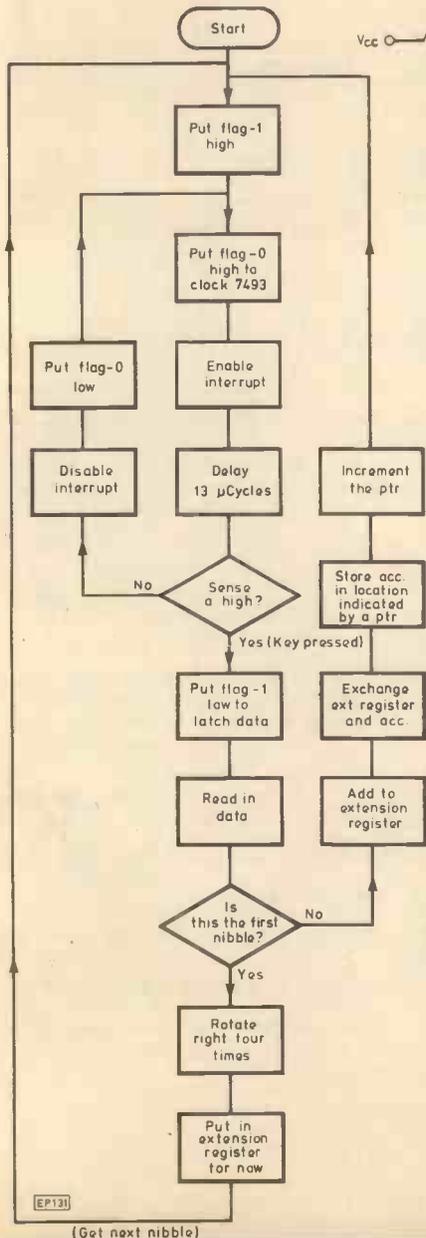
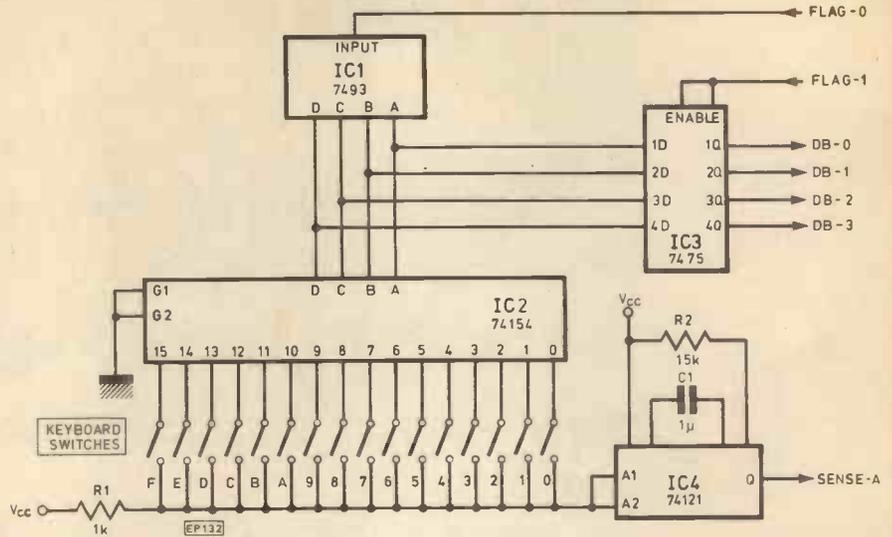


HEX

KEYBOARD

FOR

SC/MP



THIS circuit is for an experimental hexadecimal keyboard for use with National Semiconductor's SC/MP microprocessor. Using four popular TTL i.c.s it represents an interesting example of the hardware/software trade-off in MPU systems. If built with one of the surplus calculator-style keyboards advertised regularly in *P.E.*, total cost should be under £5. Use of 74LS series TTL is recommended.

It comprises a 7493 4-bit counter clocked by Flag-0 of SC/MP, feeding a 74154 4-16 line decoder. Outputs from this decoder go to the 16 keys of the keyboard, whose common line is debounced via a 74121 monostable.

SC/MP increments the counter by putting Flag-0 high. One of the 16 decoded lines corresponding to the resultant 7493 binary output now goes low. Suppose the key on that line is now depressed, causing the output of the 74121 to go high and an interrupt on the SC/MP. The MPU responds by halting the counting sequence, and by putting Flag-1 low to latch the 4-bit (hexadecimal) code using a 7475. Outputs of the 7475 are connected to the four least significant bits of SC/MP's data bus, which it now reads and stores after rotating right four times. The sequence is now repeated to get another hexadecimal character, which is added to the first to produce a single 8-bit byte. This can now be stored in a memory location pointed to by a Pointer Register; the Pointer Register is now incremented and the whole process is repeated to obtain the next byte.

A greater understanding of the above process may be obtained by studying the flowchart 2 shown left.

N. Rushton,
Northwood,
Kirkby.

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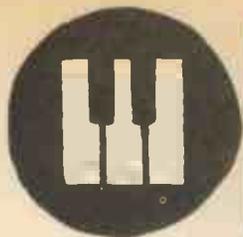
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12 or 24 hour format
all indicated continuously.
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for any selected month over
80 year period.
Memory bank function.
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can be stored in advanced.
2 year battery life.
Water resistant.
Metac Price



£79.50

M11

SEIKO Alarm Chronograph

With WEEKLY Alarm.
Hours, mins, secs, month,
date, day, am/pm.
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for every day at designated
time e.g. 8.30 am on Mon,
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above time of day.
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M10

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Chiming Alarm,
plus chrono.
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day, 24 hour alarm, 12
hour chronograph, 1/10th
secs, Laptime, Back light,
Stainless steel, mineral
glass.



METAC PRICE

£92.95

M19

SEIKO Calculator Watch

Full specification
calculator with
memory, plus multi
function watch.
Hours, mins, secs,
day, date, backlight.
Automatic calendar.
Long life battery.



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M27

CASIO CHRONO 95QS-3LB

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



£22.95

M22

CASIO LADIES 86CL-23B-1

Elegant slim line.
Stainless steel bracelet,
fully adjustable.
Hour, mins, 10 sec symbol
second by flash, am/pm.
Month, date, day.
Auto-calendar preprogrammed
for 28th day in Feb.
Accuracy per month 15 secs.
Battery life approx 15 months.



£29.95

M23

CASIO F-200 Sports Chrono

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



£14.95

M24

CASIO ALARM CHRONO 81CS-36B

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



£34.95

M25

BELTIME Chronograph

(9-Functions)
Hours, mins, secs,
day, date, month,
interchange feature,
automatic calendar,
backlight, Net
time/lap/time.
Stainless steel bracelet.
Battery life 1 year.



£14.95

M34

BELTIME Multi Alarm

29 Functions
Hours, mins, secs,
date, day.
Alarm, chronograph,
Light.
Watch 8 functions,
Alarm 4 functions,
chronograph 17
functions.
Stainless steel
bracelet.



£29.95

M35

CASIO F-8C 3 Year Battery life.

Hours, mins, secs,
am/pm, date, day.
Auto calendar set
28th Feb.
Stopwatch function.
Accuracy 15 secs per
month. 8 battery life
approx 3 years.



£9.95

M36

CASIO CALENDAR 200 47CS-23B-1 Black. Stainless steel.

Hours, mins, 10 second
symbol, second (by flash),
am/pm. Month, day, date.
Auto-calendar set from
1901 to 2009.
Full month calendar display,
Dual time function.
Accuracy 10 secs per
month. Battery life
approx 15 months.



£59.95 M37

MELODY Multi Alarm Chronograph

Hours, mins, secs,
Day, Date, Count-
down alarm,
Dual time zone,
1/100th sec
stopwatch.
Lap/split time,
1st and 2nd place
times, Melody test
function.



£26.95

M30

DUAL TIME-ALARM CHRONOGRAPH

Incorporating module
of world famous
Japanese watch
manufacture.
Hours, mins, secs,
days of week, month,
day and date,
24 hour alarm,
1/10th secs,
lap time, Back light,
stainless steel case
and bracelet,
Mineral glass,
Battery hatch,
long life battery.



£35.00

M12

PICOQUARTZ Microprocessor Alarm Chronograph

Multilanguage-day of
the week can be set
to English, French,
German, Italian or
Spanish.
Chime - every full
hour combined with a
response signal,
beeping at every
pressing of the
functions.
Can be switched off.
12-24 hour format.
Backlight.
Chrono - 1, full scale
chrono with lap,
counting hours upto
24 hrs. Mins, secs,
1/100th secs.
Two Alarm systems.
Two time zones.



£37.95

M32

SEIKO CHRONOGRAPH

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



£56.00

M33

Metac

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QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calendar, back-light, quality metal bracelet.

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Very slim, only 6mm thick.



M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.



M2

QUARTZ LCD 11 Function

SLIM
CHRONO

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



£10.65 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs., month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£12.65

Guaranteed same day despatch.



M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5



FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags. 22 functions. Constant display of hours and mins., plus optional seconds or date display. AM/PM indication, month, date. Continuous display of day. Stop-watch to 12 hours 59.9 secs., in 1/10 second steps. Split and lap timing modes. Dual time zones. Only 8mm thick. Back-light. Fully adjustable open bracelet.

£22.65

M6



SOLAR QUARTZ LCD Chronograph with Alarm

6 digits, 5 flags. 22 functions. Solar panel with battery back-up. 6 basic functions. Stop-watch to 12 hours 59.9 secs., in 1/10 sec., steps. Split and lap timing modes. Dual time zones. Alarm. 9mm thick. Back-light. Fully adjustable bracelet.



£27.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59.9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8



SOLAR QUARTZ LCD Chronograph

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

£13.65

Guaranteed same day despatch.

M9



QUARTZ LCD Ladies Day Watch

Only 25 x 20mm and 8mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£9.95

Guaranteed same day despatch.

M15



QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour. Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists. State colour preference.

£14.95

Guaranteed same day despatch

M17



QUARTZ LCD Ladies Cocktail Watch

Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins, secs, day, date, backlight and auto calendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

£19.95

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M18



HANIMEX Electronic LED Alarm Clock



Features and Specification:
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm). Weight: 1.43 lbs (0.65 kg). AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

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

£14.95

M60



MACY QUARTZ ANALOGUE

Automatic Calendar Day and Date infinite bracelet. This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21



Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

- OUTSTANDING FEATURES**
- DUAL TIME. Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
 - CALENDAR FUNCTIONS include the date and day in each time zone.
 - CHRONOGRAPH/STOPWATCH displays up to 12 hours, 59 minutes, and 59.9 seconds.
 - On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
 - ALARM can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!
- Guaranteed same day despatch. **M16**



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OUT NOW 50p

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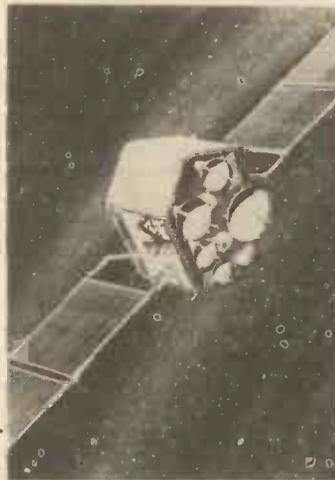
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COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits,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

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Set of text photocopies		£1.36

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A multivoiced string instrument synthesiser.

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P.E. JOANNA PLUS ORGAN VOICING

A modified version of the P.E. 5-octave piano that retains all the original facilities and also includes switchable organ voicing circuitry.

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"Sound Design" booklet		£1.00

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

5-octave set of basic components	KIT 80-6	£100.64
5-octave set of PCBs (as published)	KIT 80-7	£26.02
Additional 3-octave extension basic parts	KIT 80-5	£40.98
Additional 3 octave set of PCBs (as published)	KIT 80-8	£9.45
Set of text photocopies		£1.81

P.E. MINISONIC MK2 SYNTHESIZER

A portable mains operated miniature sound synthesiser with keyboard circuits. Although having slightly fewer facilities than the large Formant and P.E. synthesisers the functions offered by this design give it great scope and versatility.

Set of basic component kits (excl. KBD R's & tuning pots - see list for options available)	KIT 38-23	£67.05
Set of PCBs (incl. layout charts)	KIT 38-24	£9.87
"Sound Design" booklet		£1.00

P.E. SYNTHESIZER

The well acclaimed and highly versatile large scale mains operated synthesiser. Other circuits in our lists may be used with it to good advantage.

Main Unit basic component kits	KIT 23-27	£86.99
Main Unit set of PCBs & layout charts	KIT 23-28	£14.82
Keyboard Unit basic component kits	KIT 23-29	£52.07
Keyboard Unit set of PCBs & layout charts	KIT 23-30	£8.42
Main Unit set of text photocopies		£5.81
Keyboard Unit set of text photocopies		£2.30

ELEKTOR FORMANT SYNTHESIZER

A very sophisticated synthesiser for the advanced constructor who puts performance before price.

Set of basic component kits	KIT 66-12	£193.66
Set of PCBs (as published)	KIT 66-13	£53.92
Set of text photocopies		£7.83

P.E. GUITAR EFFECTS PEDAL

Modulates the attack, decay and filter characteristics of a signal from most audio sources, producing 8 different switchable effects that can be further modified by manual controls.

Basic parts with foot switches	KIT 42-1	£8.45
Basic parts with panel switches	KIT 42-2	£5.55
PCB & layout chart	PCB 43A	£1.57
Text photocopy		28p

ELEKTOR DIGITAL REVERB UNIT

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

Main unit basic component kit	KIT 78-1	£49.99
Main unit PCB (as published)	PCB 9913	£3.89
Extension unit basic component kit	KIT 78-2	£47.69
Extension unit PCB (as published)	PCB 78B	£1.16
Text photocopy		

ELEKTOR ANALOGUE REVERB UNIT

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

Main unit basic component set	KIT 83-1	£29.49
Additional Delay basic components	KIT 83-2	£20.07
PCB (as publ.) to hold both kits	PCB 9973	£4.31
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P.E. GUITAR MULTIPROCESSOR

An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments.

Set of basic component kits	KIT 85-3	£43.75
Set of PCBs & layout charts	KIT 85-4	£10.62
Set of text photocopies		£2.52

P.E. PHASER

An automatically controlled 6-stage phasing unit with integral oscillator.

Set of basic components, incl. PCB & chart	KIT 88-1	£10.14
Text photocopy		68p

ELEKTOR PHASING & VIBRATO UNIT

Includes manual and automatic control over the rate of phasing & vibrato, and has been slightly modified to also include a 2-input mixer stage.

Set of basic components	KIT 70-1	£19.11
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P.E. PHASING UNIT

A simple but effective manually controlled phasing unit.

Set of basic components incl. PCB & chart	KIT 25-1	£3.52
Text photocopy		28p

PHASING CONTROL UNIT

For use with Phasing Kit 25 to automatically control rate of phasing.

Set of basic components incl. PCB & chart	KIT 36-1	£5.21
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P.E. SWITCHED TONE TREBLE BOOST

Provides switched selection of 4 preset tonal responses.

Set of basic components, PCB & chart	KIT 89-1	£3.82
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P.E. TREBLE BOOST UNIT

A simple treble boost unit with manual control of depth.

Set of basic components, PCB & chart	KIT 53-1	£2.76
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ELEKTOR RESONANCE FILTER

Allows a synthesiser to produce a more realistic simulation of natural musical instruments.

Set of basic components	KIT 82-1	£16.61
PCB (as published)	PCB 9951	£3.29
Text photocopy		

P.E. GUITAR OVERDRIVE

Sophisticated versatile fuzz unit including variable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Can be used with other electronic instruments.

Set of basic components	KIT 56-1	£7.87
PCB & layout chart	PCB 56A	£1.78
Text photocopy		88p

P.E. FUZZ UNIT

A simple fuzz unit. Slightly modified from the original.

Set of basic components, PCB & chart	KIT 55-1	£2.25
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TREMOLO UNIT

A slightly modified version of the simple P.E. unit.

Set of basic components, PCB & chart	KIT 54-1	£3.23
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GUITAR FREQUENCY DOUBLER

A slightly modified and extended version of the P.E. unit.

Set of basic components, PCB & chart	KIT 74-1	£4.97
Text photocopy		39p

P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, foot switches, PCB & chart	KIT 75-1	£5.64
Basic components, panel switches, PCB & chart	KIT 75-2	£4.08
Text photocopy		38p

P.E. WAH-WAH UNIT

Can be controlled manually or by Integral automatic control.

Set of basic components, PCB & chart	KIT 51-1	£3.99
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P.E. AUTO-WAH UNIT

Automatically Wah or Swell sounds with each note played.

Basic components, foot switches, PCB & chart	KIT 58-1	£8.43
Basic components, panel switches, PCB & chart	KIT 58-2	£5.31
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ELEKTOR WAVEFORM CONVERTOR

Converts a saw-tooth waveform into sinewave, mark-space sawtooth, regular triangle, or square-wave with variable mark-space ratio.

Basic components, PCB & chart, but excl. sw's.	KIT 67-1	£9.24
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P.E. VOLTAGE CONTROLLED FILTER

Extracted from P.E. Minisonic project.

Set of basic components, PCB & chart	KIT 65-1	£7.88
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P.E. RING MODULATOR

Extracted from P.E. Minisonic project.

Set of basic components, PCB & chart	KIT 59-1	£6.05
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LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

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P.E. NOISE GENERATOR

Extracted from the P.E. Minisonic.

Set of basic components,

PCB & chart KIT 60-1 £4.00

WIND & RAIN EFFECTS UNIT

A slightly modified version of the original P.E. unit.

Set of basic components,

PCB & chart KIT 28-1 £4.68

Text photocopy 28p

P.E. ENVELOPE SHAPER WITHOUT VCA

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

Set of basic components,

PCB & chart KIT 44-1 £5.24

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Has an Integral Voltage Controlled Amplifier, and has full manual control over the A,D,S,R functions.

Set of basic components,

PCB & chart KIT 50-1 £7.34

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An ADSR envelope shaper without VCA, and additional providing Repeat-triggering enabling a synthesiser to be programmed for mandolin or banjo effects.

Set of basic components KIT 63-1 £5.13

PCB & layout chart PCB 63A £2.00

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Allows external inputs such as guitars, microphones etc., to be processed by synthesiser circuits.

Set of basic components,

PCB & chart KIT 81-1 £3.23

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Set of basic components,

PCB & chart KIT 62-1 £5.03

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A 5-digit counter for 1Hz to 55KHz with 1Hz sampling rate. Readout does not count visibly or flicker due to blanking.

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4011	17½p
4013	34p
4016	33p
4017	54p
4024	48½p
4046	96p
4049	37½p
4066	40½p
4069	18p
4081	16½p
4136	126p
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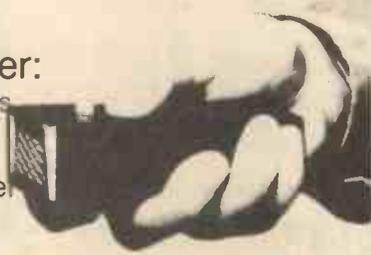
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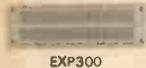
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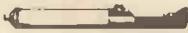
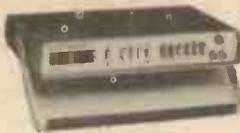
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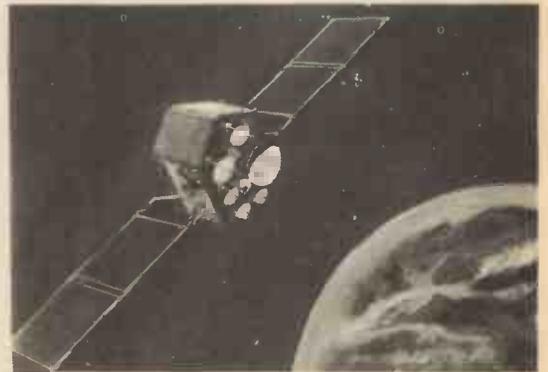


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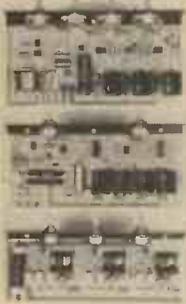
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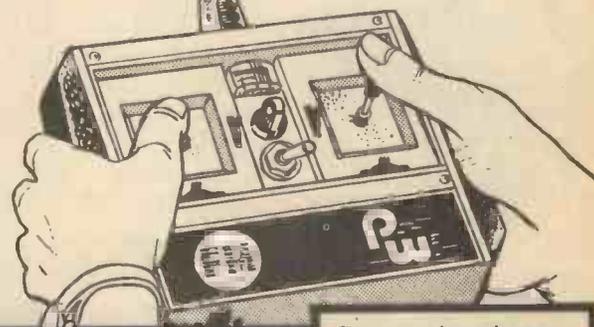
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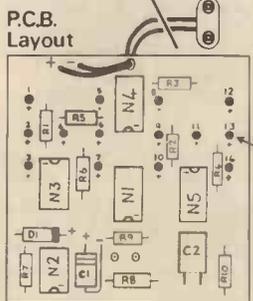
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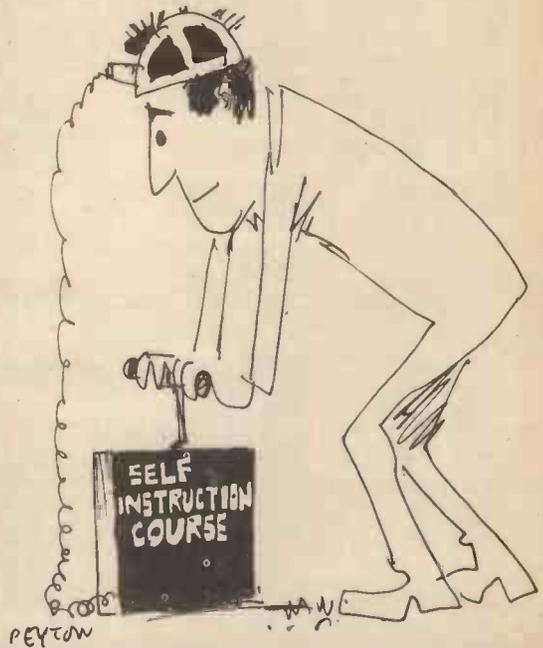
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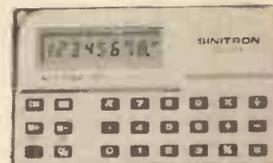
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207	500, 500	0-8-9, 0-8-9	3.05	0.85
208	1A, 1A	0-8-9, 0-8-9	3.88	0.90
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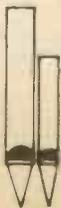
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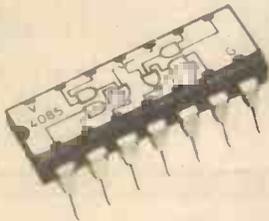
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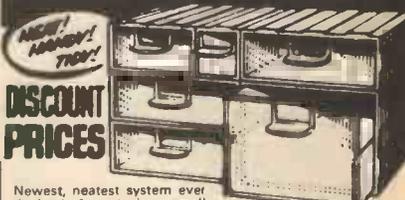
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7412 0.15	74107 0.24	74184 1.30	4038 0.95	4507 0.52	TAAS50B	0.32 0.300	3.50
7413 0.24	74109 0.32	74185A 1.30	4039 2.75	4508 2.50	TAA661B	0.88 1.000	3.25
7414 0.50	74110 0.38	74186 5.00	4040 0.68	4510 0.92	TBA120S	0.66 1.008	3.25
7415 0.23	74111 0.58	74188 2.70	4041 0.72	4511 0.82	TBA41A	1.50 1.8432	3.50
7416 0.23	74112 0.30	74189 0.88	4042 0.87	4512 0.92	TBA800	0.78 2.000	3.25
7417 0.23	74116 0.50	74191 0.88	4043 0.80	4513 1.85	TBA810S	0.75 2.097	3.25
7420 0.11	74118 0.80	74192 0.62	4044 0.80	4514 2.30	TBA820S	0.68 2.457	3.25
7421 0.20	74119 1.50	74193 0.62	4045 1.26	4515 2.80	TCA270SD	1.60 3.276	2.60
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7425 0.23	74122 0.38	74196 0.72	4048 0.48	4518 0.90	VOLTAGE	4.000	2.60
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7427 0.24	74125 0.32	74198 1.00	4050 0.40	4520 0.95	LM300H-T099	0.75 4.915	2.60
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7438 0.21	74136 0.52	74284 3.40	4086 0.48	4530 0.78	7905-T0220	0.78 6.553	2.60
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7446 0.60	74147 1.40	4001 0.15	4073 0.17	4541 1.05	LED's	0.25" 0.2"	
7447 0.48	74148 1.25	4002 0.15	4075 0.17	4543 1.50	RED	6.85 0.09	
7448 0.56	74150 0.68	4006 0.85	4076 0.84	4549 3.92	YELLOW	0.14 0.14	
7450 0.11	74151 0.48	4007 0.16	4077 0.21	4553 3.80	GREEN	0.14 0.14	
7451 0.11	74153 0.48	4008 0.78	4078 0.18	4564 1.25	YELLOW	0.14 0.14	
7452 0.23	74154 0.82	4009 0.40	4081 0.17	4555 0.75	LED clip	0.25 0.35	
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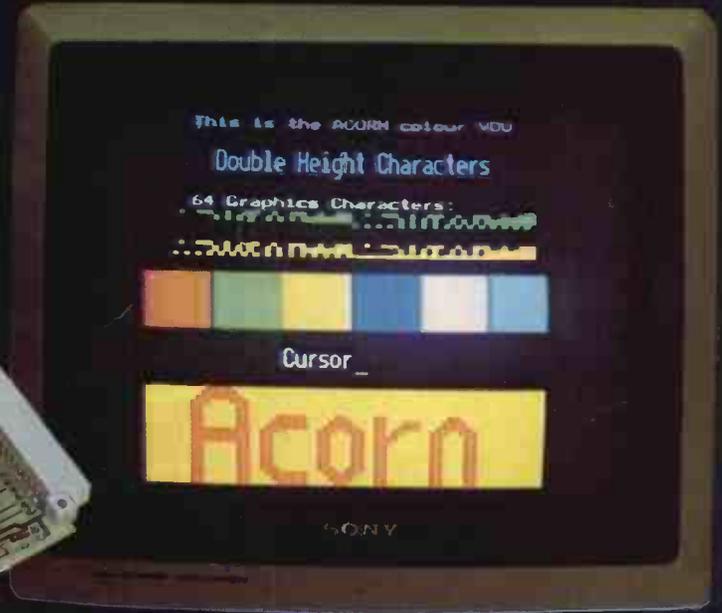
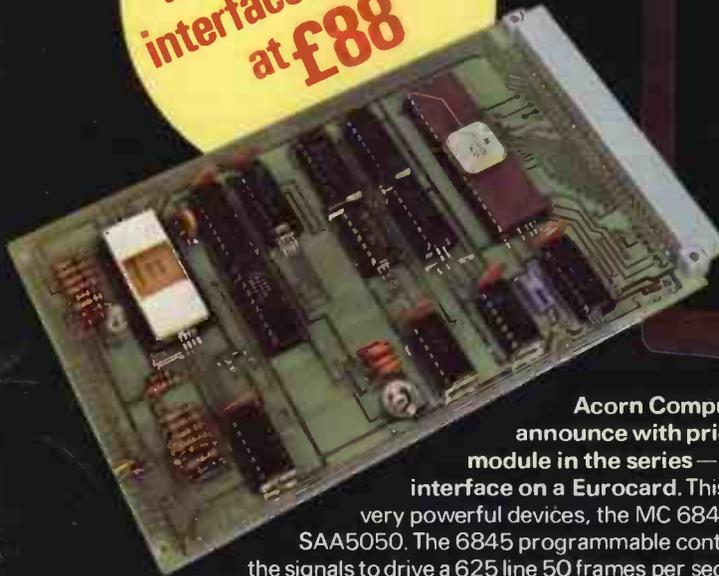
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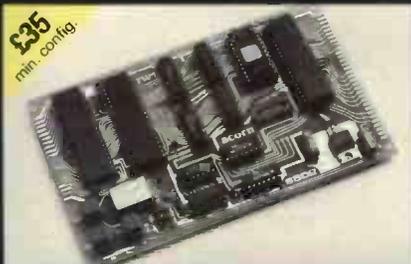
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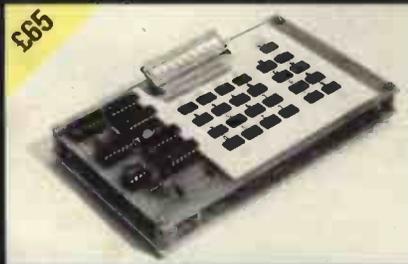
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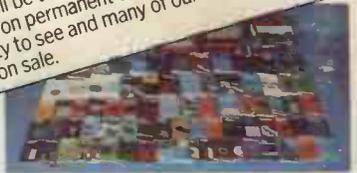
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