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JUNE 1980

55p

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DIGITAL TACHOMETER

GREENHOUSE TEMPERATURE CONTROLLER

Plus...

MICROBUS including MK14

AUTO-RANGING CAPACITANCE METER

PRACTICAL ELECTRONICS

VOLUME 16 No. 6 JUNE 1980

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES

AA119	15
AA129	25
AAZ15	15
BA100	10
BA102	15
BY100	24
BY127	12
CRO33	157
OA9	50
OA47	12
OA70	12
OA79	12
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN400/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

SCR's Thyristors

0.8A30V	28
0.8A100V	30
0.8A200V	35
1A/50V	37
1A/100V	42
1A/200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
BT106	150
BT116	150
C106D	38
MCR101	32
TIC44	22
TIC45	28
2N4444	140

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**

Range: 3V3 to 33V. 1.3W **15p each**

VARICAPS

MVAM2	165
MVAM115	140
BA102	25
BB105B	40
BB106	40

Noise Diode

Z5J	180

TRIACS

3A/100V	48
3A/400V	50
8A/100V	54
8A/400V	64
8A/500V	85
8A/800V	108
12A/100V	60
12A/400V	70
12A/800V	130
16A/100V	95
16A/400V	105
25A/400V	160
25A/800V	295
T2800D	120

DIAC

ST2	20

SPEAKERS

8Ω 0.3W	
2″; 2½″	75
2.5; 3″	75
40Ω 2.5″	88
64Ω 2.5″	80
80Ω 2.5″	80
8Ω 5W	
7″×4″	250
8Ω 3W	
6″×4″	160

ALUM.BOXES

3×2×1″	55
2¾×5×1½″	75
4×4×1½	75
4×2¾×1½″	75
4×5¼×1½	100
4×2½×2″	75
5×4×2″	98
6×4×2″	110
7×5×2½″	185
8×6×3″	185
10×7×3″	210
10×4½×3″	198
12×5×3″	215
12×8×3″	265

OPTO ELECTRONICS

LEDS Plus. Clip	
TIL209 Red 125″	13
TIL211 Grn 125″	18
TIL212 Yellow	22
TIL2200.2″ Red	15
0.2″ Yellow, green and Amber	18
Rectangular LEDS. Red, Green and Yellow	36
2N5777	45
OCP71	120
ORP12	63
LD271 Infra Red (emit)	40
TIL32 Infra Red (emit)	58
SFH205 (detector)	70
TIL78 (detector)	70
OPTO isolators	
IL74	48
TIL 111/2 or 117	100
7 Segment Displays (Red Displays)	
TIL312 & 313.3″	105
TIL321 5″ C.An	115
TIL322 5″ C.th	115
DL704 3″ C.Cth	99
DL707 3″ C.Anod	99
DL747 6″ An	180
8″ Orange C.A.	250
FND357	120
3″ Green C.A.	150
±1.3″ Red or Green	150
Bargraph 10 seg. Red	225

Liquid Crystal Display
3½ digit **875p**; 4 digit **975p**

VEROBOARD

	0.1 (copper clad)	0.15 (copper clad)	0.1 (plain)	0.15 (plain)
2½×3¾″	58p	51p	42p	30p
2½×5″	68p	62p	—	35p
3¾×3¾″	68p	—	—	—
3¾×5″	77p	86p	65p	54p
3¾×17″	264p	229p	210p	155p
4¾×17″	345p	—	—	245p

Pkt of 36 pins	20p	VQ board	129p
Spot face cutter	105p	DIP board	290p
Pin insertion tool	140p	Veroblock	324p

VERO WIRING PEN and Spool **325p**
Spare Wire (Spool) **80p**; Combs **7p** ea

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1 lb bag Anhydrous
125p + 35p p&p

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£5.20

DALO ETCH RESIST
Pen + Spare tip 75p

BIMBOARDS
£8.25

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9.5″×8.5″
6″×6″	90p	110p	95p
6″×12″	150p	195p	

SOLDERCON PINS
100 pins **60p** 500 pins **250p**

VOLTAGE REGULATORS

		+ve		−ve	
1A	TO3				
5V	7805	145p	7905	220p	
12V	7812	145p	7912	220p	
15V	7815	145p		—	
18V	7818	145p		—	
1A	TO220 Plastic Casing				
5V	7805	60p	7905	65p	
12V	7812	60p	7912	65p	
15V	7815	60p	7915	65p	
18V	7818	60p	7918	65p	
24V	7824	60p			
100mA	TO92 Plastic Casing				
5V	78L05	30p	79L05	65p	
6V	78L62	30p		—	
8V	78L82	30p		—	
12V	78L12	30p	79L12	65p	
15V	78L15	30p	79L15	65p	

CA3085	95	LM323K	625
LM300H	170	LM325N	240
LM305H	140	LM326N	240
LM309K	135	LM327N	270
LM317K	350	LM723	39
78H05 5V/5A	595p	TBA625B	85
UA78HG +5 to +24V 5A	650	TDA1412	120

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DPDT	13
4 pole 2-way	24

PUSH BUTTON
Spring loaded
Latching

SPST on off	60
SPDT C/over	65
DPDT 6 Tag	85

MINIATURE
Non Locking
Push to make **15p** Push Break **25**

TOGGLE 2A 250V

SPST	28
DPST	34
DPDT	38
4 pole on off	54

SUB-MIN TOGGLE

SP changeover	59
SPST on off	54
SPST biased	85
DPDT 6 tags	70
DPDT C/OFF	79
DPDT Biased	115
3 pole c/over	150

Push to change cover momentary **85p**
ROCKER: 5A, 250V, SPST **30p**
ROCKER: (white) 5A 250V SP change-over centre off **50p**
ROCKER: Lights red when on. Chrome Bezel. 3A 250V. DPST **85p**
ROCKER: (White) 10A/250V **85p**
ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop.
Accommodates up to 6 Wafers **78p**
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way **59p**
Mains DPST Switch to fit **40p**
Screen & Spacers **6p**
ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **41**
ROTARY: Mains 250V AC, 4 Amp **50p**

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Little Book of BASIC	540p
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CRYSTALS

		6.5536MHz	200p
100kHz	323p	7.680MHz	323p
455kHz	385p	8.867MHz	323p
1MHz	323p	9.375MHz	323p
1.008MHz	383p	10MHz	323p
1.80MHz	385p	10.7MHz	323p
1.832MHz	362p	12MHz	392p
1.6MHz	395p	14.318118M	300p
3.2768MHz	323p	18MHz	323p
4MHz	290p	18.432M	392p
4.032MHz	323p	20MHz	362p
4.433619M	135p	27.648MHz	350p
5.0MHz	355p	48MHz	323p
26.69MHz	390p	100MHz	300p

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14 pin **35p**; 24 pin **85p**
16 pin **39p**; 40 pin **375p**
(DIL Sockets on opp. page)

'D' CONNECTORS
(Cannon type)

	Plugs	Sockets	Covers plastic
9 way	70p	90p	—
15 way	95p	125p	114p
25 way	140p	198p	128p
37 way	210p	295p	135p

DIL switches (SPST)

4 way	110p
6 way	120p
8 way	145p

EDGE CONNECTORS
double type

	.1	.156
2×10 way	—	85p
2×15 way	—	99p
2×18 way	115p	120p
2×22 way	130p	135p
2×25 way	149p	160p
2×30 way	170p	120p
2×36 way	194p	—
2×40 way	210p	—
2×43 way	232p	—

TRANSFORMERS (mains Prim. 220-240V) 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA **215p**
8VA type: 6V-.5A 6V-.5A; 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A **195p.**
12VA: 4.5-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A 12V-.5A 12V-.5A **235p** (20p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A 20V-.6A **320p** (45p p&p)
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-.8A 30V-.8A **365p** (50p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A **695p** (60p p&p)
(N.8. P&P charge to be added above our normal postal charge.)

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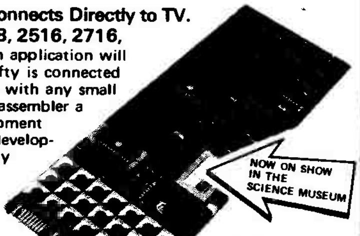

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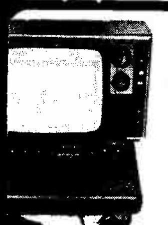
Atari VCS System



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Buying one of our PROJECT PACKS will save you the frustration of tracking down those evasive components that hold up the completion of your project. Our packs include Printed Circuit Board, all the components listed in the article together with sockets and solder. Cases, knobs etc can be supplied as extra items if required. Ask for more information . . . !

cars 80

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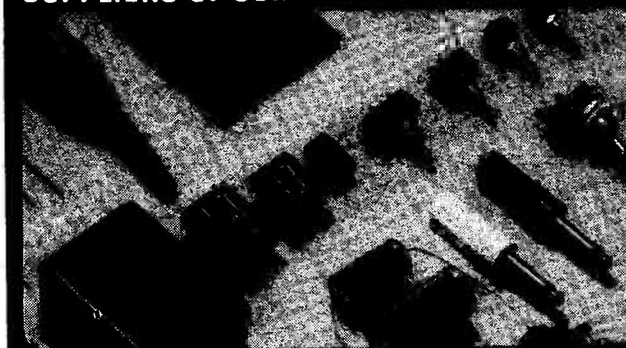
SUPPLIERS OF COMPONENTS THAT COUNT



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EXAMPLE TWO – PRINTED CIRCUIT MATERIALS

PCB's 300 x 150 mm		Etch Resist Pen	**£1.21**
SRBP S/S **£1.38**	D/S **£1.73**	**Breadboards**	
F/Glass S/S **£1.96**	D/S **£2.13**	Bimboard 12£9.23	
Positive resist 75cc	**£1.67**	Eurobreadboard	**£6.56 net**
Ferric Chloride 500 g	**£3.45**	T-DeC	**£5.18**

EXAMPLE THREE – SWITCHES

Chrome toggle		13A time switch adaptors	
Std. SPST **65p**	DPDT **89p**	Smiths TS100	**£14.43 net**
Min. SPDT **66p**	DPDT **92p**	Wavechange, Lorlin, 1P12W, 2P6W, 3P4W, 4P3W	**46p each**

EXAMPLE FOUR – CAPACITORS BY SIEMENS

Polyester 7.5mm PCM
0.1, 1.5, 2.2, 3.3, 4.7nf, 10, 15, 22, 33, 47nf **8p** each, 0.1μ **12p,** 0.15μ **15p,** 0.22μ **18p,** 0.33μ **21p,** 0.47μ **27p,** 0.68μ **34p,** 10mm PCM 1μ **37p.**
Electrolytic, axial, (μ F/V)
1/40 **24p,** 1/100 **15p,** 2.2/25 **24p,** 2.2/63 **15p,** 4.7/16 **24p,** 4.7/40 **15p,** 10/25 **15p,** 10/40 **18p,** 22/25 **15p,** 22/40 **18p,** 22/63 **19p,** 47/10 **18p,** 47/25 **18p,** 47/40 **16p,** 47/63 **20p,** up to 1000/16V **36p,** then 1000/25V **49p** etc.
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EXAMPLE FIVE – POTENTIOMETERS BY RADIOHM

Single gang lin or log	**34p**	*(Twin types stereo matched)*	
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Mono slider lin or log	**83p**	Presets lin, horiz, or vert	**10p**
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EXAMPLE SIX – RESISTORS

$\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$W **2.3p** 1W **6p**
Wirewound from **21p**

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1N914	**6p**	40673	**99p**	MJ481	**£1.70**	T1P41A	**69p**
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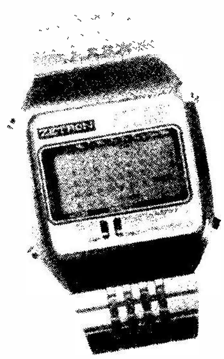

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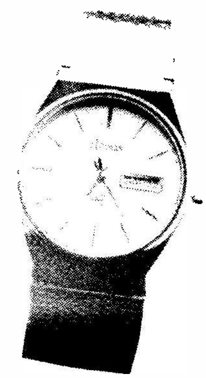
A 1/100th second chronograph with split and lap mode.
Facilities are built into the watch with a 12 hour capacity.

A 24 hour alarm with a 10 minute snooze function is also standard to this watch. A further feature is the backlight and fully adjustable stainless steel bracelet.

Only
£19.95

GENTS QUARTZ ANALOGUE

A truly superb timepiece with extreme accuracy. A choice of two colours on this outstanding watch are available. Blue or White.



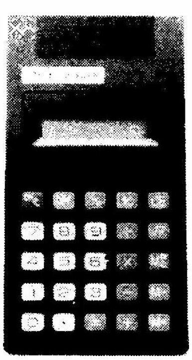
The calendar in the watch can be set to give a readout in either French or English with date indication being automatic.

An infinite adjustable stainless steel strap is built in as part of the watch.

The watch is fitted with a long life battery and comes with luminous markings to aid night time vision.

YES
ONLY £19.95

NEW – ZETRON L.C.D. CALCULATOR – NEW



Superb value in the economy range of L.C.D. calculators. What more could you ask for? This marvel of the silicon chip era boasts the following. Four basic functions, chain and mixed operations, constants for four functions, % calculations including discounts and mark ups, automatic accumulation in four functions.

★PLUS★ Square root facility.
★PLUS★ Memory facility.
★AUTO POWER OFF (7 minutes)

All this for a modest **£4.95**

GENTS ALARM CHRONO (12/24 CYCLE)

A really superb watch. It can be set as a 12 or 24 hour watch with hours, mins., secs. Am/pm and weekday indication always on display. A unique calendar is built into the watch. You can have month followed by date or date followed by month its entirely up to you.

A 24 hour alarm can be set to anytime within a 24 hour period.

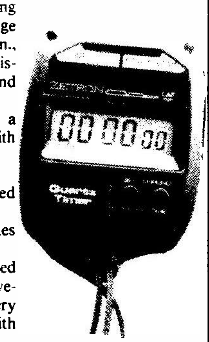
The chrono has a 12 hour capacity and runs at 1/10's split and lap mode facilities are available.

Battery hatch, mineral glass, long life battery, and a closely woven adjustable stainless steel strap finish the watch off with impeccable looks.

£16.50

NEW – QUARTZ L.C.D TIMER – NEW

A new style timer incorporating split second accuracy. The timer is finished in a strong black plastic case with large L.C.D. readout of hours, min., and secs. A further optional display mode of month, date, and weekday is available.



The timer incorporates a 1/100th sec. chronograph with numerous facilities.
(i) The timer can be frozen.
(ii) Two people can be timed simultaneously.
(iii) Split and lap mode facilities are available.
A strong black cord is attached to the timer which aids movement at sporting events. Battery replacement is made easy with screw back.

Offered at only
£19.95

ZETRON — WHERE RELIABILITY, STYLE AND ELEGANCE REALLY COUNT — ZETRON

WE ARE ABLE YET AGAIN to offer you the above watches, plus the complete ZETRON range. All at unrivalled prices. Just look at the following points.

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- (ii) Full instructions and 12 month manufacturers guarantee.
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- (v) Free felt presentation case with each watch.

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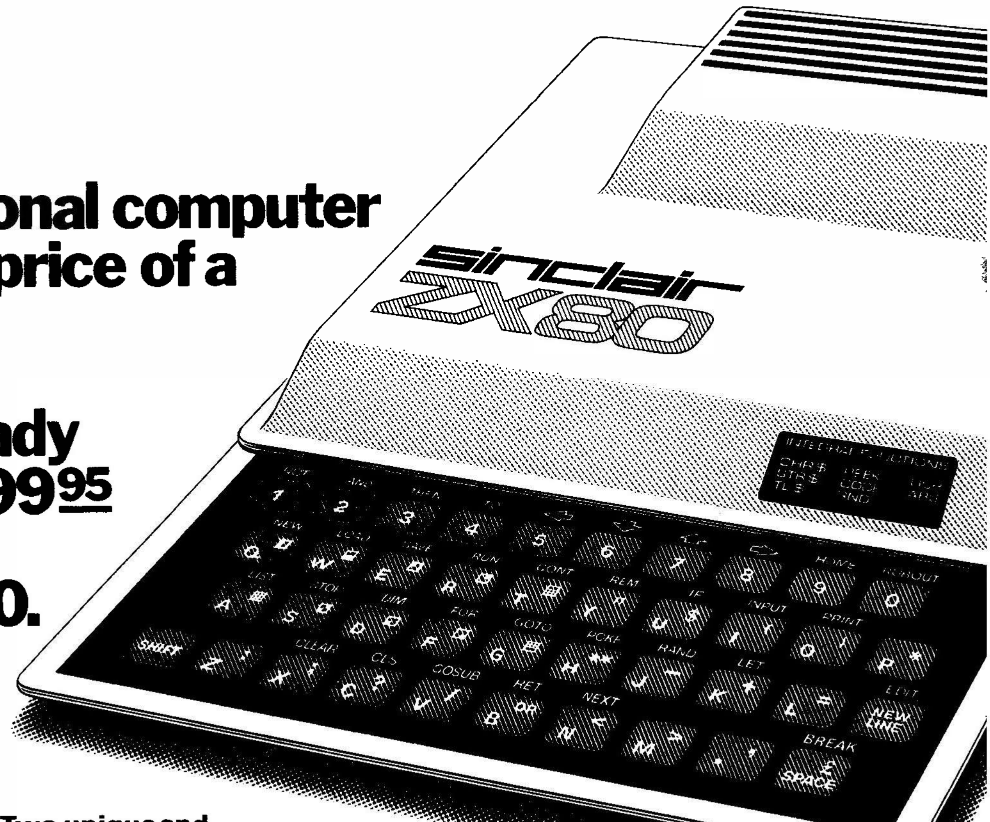
Britain's first comp



A complete personal computer for a third of the price of a bare board.

Also available ready assembled for £99.95

The Sinclair ZX80.

Until now, building your own computer could easily cost around £300 – and still leave you with only a bare board for your trouble.

The Sinclair ZX80 changes all that. For just £79.95 you get *everything* you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to your own cassette recorder and black and white or colour television; everything!

And yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers on the market at several times the price. The ZX80 is programmed in BASIC, and you could use it to do quite literally anything from playing chess to running a power station.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. Once assembled, it immediately proves what a good job you've done. Connect it to your TV set...link it to an appropriate power source*... and you're ready to go.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs – all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to any portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available – see coupon.)

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

Two unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

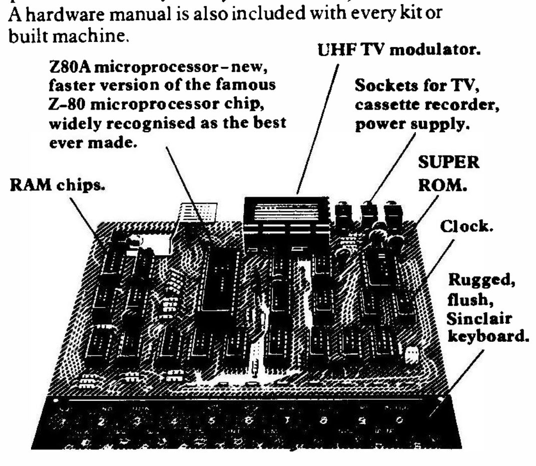
The unique Sinclair BASIC interpreter... offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.)

A hardware manual is also included with every kit or built machine.



lete computer kit.

Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer – typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled, for only £99.95.

Whether you choose the kit or the ready-made, you can be sure of world-famous Sinclair technology – and years of satisfying use. (Science of Cambridge Ltd is one of the Sinclair companies owned and run by Clive Sinclair.)

To order, complete the coupon, and post to Science of Cambridge for delivery within 28 days. Return as received within 14 days for full money refund if not completely satisfied.

sinclair ZX80

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To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Remember: all prices shown *include* VAT, postage and packing. No hidden extras.

Please send me:

Quantity	Item	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity.	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	
NB. Your Sinclair ZX80 may qualify as a business expense.		TOTAL	£

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £

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PE/6/80

NEW CONSTRUCTORS PACK 7

ALL THE PARTS TO BUILD THE PRACTICAL ELECTRONICS TRAVELLER CAR RADIO

* EASY TO BUILD * 5 PUSH BUTTON TUNING * MODERN STYLING DESIGN * ALL NEW UNUSED COMPONENTS * 6 WATT OUTPUT * READY ETCHED & PUNCHED P.C.B. * INCORPORATES SUPPRESSION CIRCUITS

The pack contains all the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue.
The P.E. Traveller features pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, negative ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit.
The P.E. Traveller fits easily in or under dashboards.
Complete with instructions.

£10.50 p&p £1.75

CONSTRUCTORS PACK 7A
Suitable stainless steel fully retractable locking aerial and speaker (approx 6" x 4") is available as a kit complete.
£1.95 Per Pack, p & p £1.00.
Pack 7A may only be purchased at the same time as Pack 7.
NOTE: Constructor's pack 7A sold complete with radio kit **£15.20** including p&p.

A FEATURED PROJECT IN PRACTICAL ELECTRONICS

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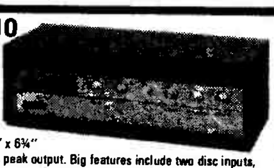
323 EDGWARE ROAD, LONDON W2. For Personal Shoppers Only.
21B HIGH STREET, ACTON W3 6NG. Mail Order Only. No Callers.
Mon-Sat 9.30am-5.30pm Closed Thursday

NEW 12+12 AMPLIFIER KIT

An opportunity to build your own 12 watts per channel stereo amplifier with up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.
Size 9¼" x 8¾" x 4" approx.
NOTE: for use with 4 to 8 ohms speakers. p&p £2.55 **£13.95**

TWO WAY SPEAKER KIT To suit above amp. Comprising 2, 8" approx Phillips base unit, and 2, 3½" approx tweeters with 2 crossover capacitors **£4.95** p&p £1.65.
Available only to first time purchasers of the 12 + 12 kit.

50 WATT MONO DISCO AMP £30.60



p&p £3.20
Size approx 13⅞" x 5¼" x 6¾"
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.

NOW AVAILABLE

30 + 30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stero jack socket. Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers.
Size 14¾" x 3" x 10" approx.
BUILT AND READY TO PLAY p&p £3.30 **£32.90**

Mullard AUDIO MODULES IN BARGAIN PACKS

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

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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.
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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 p&p £1.60

Two Way Speaker Kit Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors.
Per stereo pair plus p&p £1.70 **£4.05**

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21B HIGH STREET, ACTON W3 6NG
ACTON: Mail Order only, No callers
ALL PRICES INCLUDE VAT AT 15%
All items subject to availability. Price correct at and subject to change without notice.
All enquires Stamped Addressed Envelope.
NOTE: Persons under 16 years not served without parent's authorisation.

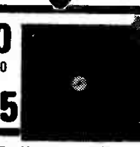
£76.00 p&p £4.00 100 WATT MONO DISCO AMP

Brushed aluminium fascia and rotary controls. Size approx. 14" x 4" x 10¼"
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.

EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround. 3½" Goodman 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 p&p £4.20

BSR P200 £25.50



Belt drive chassis turntable unit semi-automatic, cueing device. p&p £3.00
Shure M75 6 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 **£12.25** p&p £2.75

PHILLIPS RECORD PLAYER DECK GC037

HiFi record player deck, belt drive complete with GP401 magnetic cartridge—LIMITED STOCK.
UNBEATABLE OFFER AT **£27.50** complete.
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Ariston pick-up arm manufactured in Japan.
Complete with headshell.
Listed price over £30.00.
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PE VOLUME 16 No. 6 JUNE 1980

GOING UP

NINETEEN eighty looks like being the year in which i.c.s started on the never ending spiral of price increases which most other products tend to follow. Until recently, most of the i.c.s. employed in any great number have tended to continually fall in price. The only exceptions to this rule have been those devices in limited production, or those that for various reasons the manufacturer wished to phase out.

Over the last couple of years most major suppliers have "rationalised" their range in order to be cost effective on their own specialised products, but generally speaking, due to heavy competition, most prices have fallen steadily. There is no doubt that many of the more popular devices have for some time been available at incredibly low prices—some of them had become uneconomic to produce. Many manufacturers used the precious metal surcharge, slapped on virtually every device by all suppliers, to redress the price problem. It gave them the chance to increase prices without having to explain why.

At the same time as the surcharge some i.c.s were becoming scarce. Whether this has been deliberate or not it has most certainly enabled prices to rise and has led to something of a black market in various devices. It has also been possible to tell from the quoted price the availability of components from some distributors; high prices generally indicating an ex-stock situation and vice-versa.

HOBBYIST MARKET

To a great extent this situation has not had much effect on the hobbyist market, some protection being afforded by the stocks carried by retailers. It has, however, posed various problems for the retailer, particularly when faced with a protracted supply position and no devices on the shelf. Should he, for instance, buy from the black market and keep his customers supplied "at a price" or should he refrain from stoking the inflationary fire and advise the quoted delivery date or make a refund?

Perhaps his biggest problem is that of convincing you, the buyer, that he is doing his best in a difficult situation. Simply because "Bloggs Components" can still supply their remaining stock immediately, at the old price it does not follow that he ought to be able to do the same. Obviously retailers buy in bulk and it may be some time before one supplier has to up his price, especially if he has a slow turnover or a large stock. The increases therefore hit different retailers at different times, but in this competitive retailing area no one can afford to charge over the odds for any readily available device.

With the cost of plastic rising in line with oil and the continually increasing manufacturing costs we believe that the end has come to cheaper and cheaper devices. Most i.c.s are still very cheap in relation to their complexity and the vast capital investment necessary for their production. We can therefore expect to pay more for our devices in future, the only consolation being that as they become more complex we should be able to build better projects for the same cost!

Mike Kenward

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Dorset BH15 1JG
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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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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 £4·10 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, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

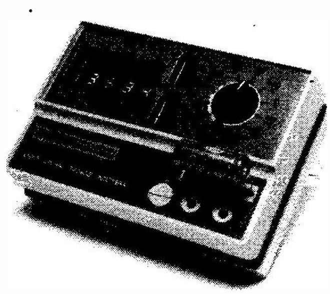
Market Place

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 David Shortland and Jasper Scott

CAPACITANCE METER

The new Model 820 portable capacitance meter from Havant Instruments Limited is an economical multi-range instrument combining digital accuracy with complete portablilty. Its ten ranges cover capacitances from 0·1pF to 1 Farad. Accuracy is 0·5 per cent or 1 per cent of full scale, and resolution down to 0·1pF, according to range.



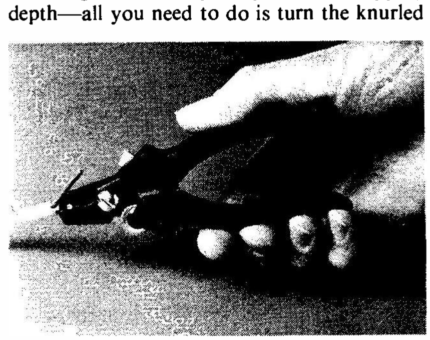
In use the capacitor leads are simply inserted into a pair of slots and the capacitance is indicated on the clear 4-digit l.e.d. display. A flashing display provides over-range indication. Provision is also made for using jack plugs when measuring in-circuit capacitances.

The Model 820 is ideal for production line, laboratory, or home use, and has a robust moulded case which weighs only 675g (1·51 lb). It will operate with rechargeable or disposable cells and there is provision for a charger. A tilt stand, spare fuse and 26-page operating manual are supplied.

The 820 costs £80 plus VAT and p&p, and is available from: **Havant Instruments Ltd, Unit 3, Westfields, Portsmouth Road, Horndean, Hants. (0705 596020).**

THE STRIPPER

If you need a new pair of strippers or cutters, read on. AB Engineering have introduced a low priced combined wire stripper and cutter known as the AB MK 001. As well as its attractive price, the AB MK 001 has the added advantage of easily adjustable stripping depth—all you need to do is turn the knurled



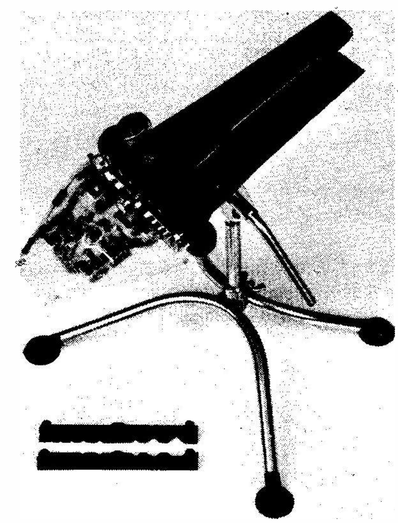
knob. Clean wire cutting is effected by means of a curved cutting edge, which results in a secateur-like action. A retaining clip is also provided to ensure that the cutter stays closed when not in use.

Priced at £2·15 + VAT, the AB MK 001 is available direct from the manufacturers: **AB Engineering Company, Timber Lane, Woburn, Beds. MK17 9PL.**

THIRD HAND

Here's an answer to the prayers of those constructors who find that they weren't provided with enough limbs—the Telpro Multi-Purpose Work Holder.

Unlike most miniature vices, this one has reversible jaws. One side has a series of holes which enable it to grip objects from 1mm diameter (such as component leads) up to 20mm diameter. The opposite side is serrated, so that flat objects such as p.c.b.s can be firmly held. Both metal and soft nylon jaws are supplied, and a spring loaded knob allows the clamp pressure to be varied. To give complete versatility, the clamp is mounted on a universal joint, giving 360° rotation and 180° tilt. It can of course be locked in any position.



Also, there's no danger of your project creeping across the bench while you're working, as the detachable stand is provided with suction feet.

The price of the Telpro Multi-Purpose Work Holder is £15 + VAT & p&p, and it can be purchased direct from the manufacturers: **Tele-Production Tools Ltd, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW.**

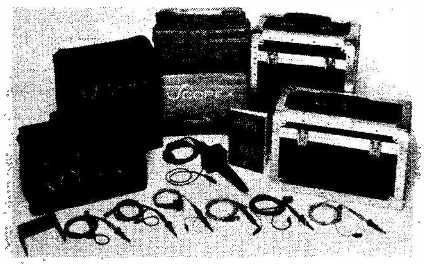
INSTANT IRON

From 'Down Under' comes a miniature soldering iron, the Scope Mini-Super-Speed. It reaches its operating temperature in only five seconds, and power and temperature can be controlled simply by moving the fingertip control lever. The iron uses a 3·3V transformer as a power supply, and a remarkably compact carbon heater gives up to 75W power. Even when the iron is at its hottest, the handle remains completely cool, as the element is situated right at the tip of the stainless-steel shaft.

The Scope Mini-Super-Speed Iron retails at £12·50 + VAT, and the 3·3V Safety Transformer retails at £7·50 + VAT. An element and tip spares pack is also available at £2·50 + VAT. All Scope products can be purchased direct from: **Toolrange Ltd., Upton Road, Reading RG3 2JA.**

SCOPEX

With so many engineers and technicians using oscilloscopes for field work today there is a definite need to ensure that the scope is well protected against any accidental damage which may be caused in transit. To protect their range of scopes Scopex have introduced a complete range of travel cases.



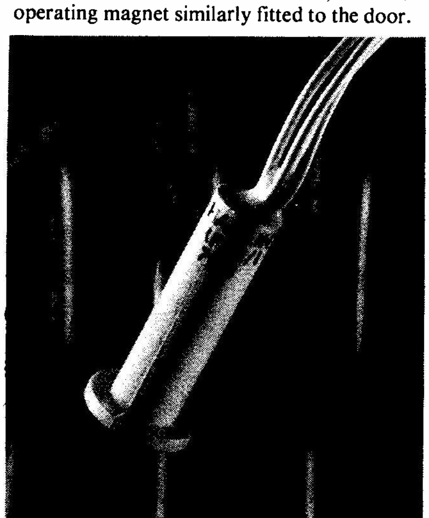
Two types are available; a heavy duty quilted p.v.c. case with a dense foam sandwich or an aluminium extruded edge model.

The prices for the p.v.c. cases range from £18·00 to £22·00 with the aluminium models priced between £49·00 and £58·00 (all prices exclude VAT and p&p).

Scopex Instruments Limited, Pixmore Industrial Estate, Letchworth, Herts, SG6 1JJ (04626 72771).

REED SWITCH

Hamlin Electronics has introduced a new flush-mounted axially operated proximity switch which is particularly suited for use with burglar alarms. Known as the Type RP113, the reed-switch device is easily fitted into a hole drilled in the door frame, with the operating magnet similarly fitted to the door.

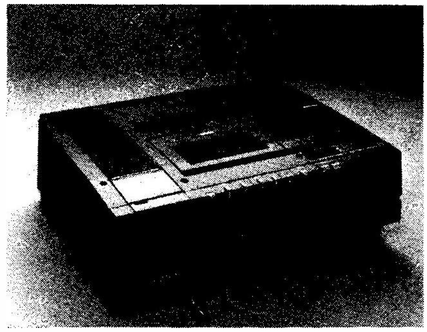


The switch measures 28mm in length × 7·62mm in diameter, and is supplied with two pairs of leads; one pair can be looped back into the circuit. Four reed-switch options are available: low-cost Form A (normally open); standard Form A; high-power Form A; and standard Form C (single-pole/double-throw).

The retail price should be approximately 67p for the standard Form A, and the switches should be available from Radio Resistor Ltd. In case of difficulty contact: **Hamlin Electronics Europe Ltd., Diss, Norfolk. IP22 3AY. (0379 4411).**

VIDEO WARS

The war between the Video manufacturers hotted up recently when Sony introduced their latest model, the C7. Using the well known Betamax system, the C7 is considerably more sophisticated than previous models, and will, according to Sony, set the standard for other manufacturers.

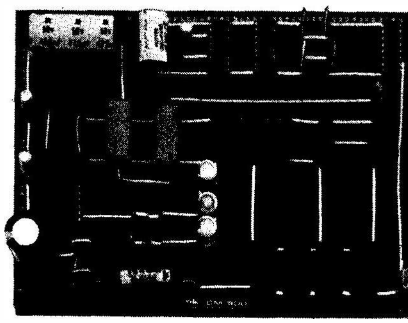


Among various features such as infra-red remote control, and a digital clock/timer which enables a very high degree of programming flexibility, is 'Picture Search', which Sony claim is unique to the C7. The facility enables the user to run the tape forwards or backwards at up to twenty times the normal speed with the picture still on the screen. Thus a particular place in the tape can be easily pinpointed. Sports enthusiasts will also be pleased to note that the slow-motion playback shows every frame—not just one or two frames out of every five as with many other machines.

Retailing at £721 including VAT, the Sony C7 is available from most Sony dealers.

PROTOTYPE BOARDS

OK Machine & Tool have introduced a new series of 'Circuit Mount' boards for electronic projects and prototypes. All boards feature solderless insertion type sockets on 0·1in centres and each row has five common points. Larger boards also feature 40-point bus lines, while a separate bus strip module is also available. Furthermore, all boards can accept standard component leads including d.i.p.s, while interconnections are easily made using standard 22SWG (0·64mm) solid wire.



Circuit Mount prototype boards are available in a range of sizes from small modules designed to hold a single i.c. up to 1020 point panel-mounted boards complete with binding posts. All separated modules are interlocking and also feature screw holes for permanent mounting.

Units are available directly from:

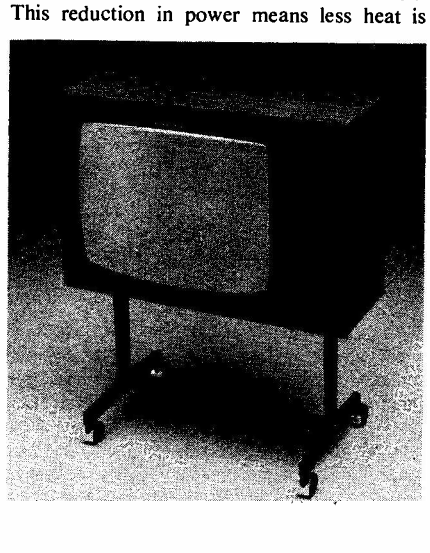
OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. (0703 610944.)

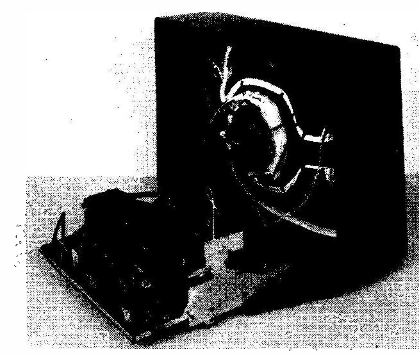
TX10 LAUNCHED

Following the success of their TX9 single board colour TV chassis for 14 to 20in sets, Ferguson has now developed a TX10 single board chassis for colour receivers with 110° tubes (20 to 26in screens).

The slimline cabinet styling has been achieved by splitting the single board chassis during manufacture and using a 30AX 110° inline tube with high brightness and fast warm up.

Power consumption has been reduced to less that 70 watts at black level—hitherto it has been around 150 watts for 110° chassis. This reduction in power means less heat is





generated resulting in longer component life and improved reliability.

The TX10 chassis is electrically isolated which means servicing can be carried out with a greater degree of safety whilst the mains power is on. The isolated chassis also enables the addition of external sockets for video, audio, home computers, etc., which can be plugged in easily and safely.

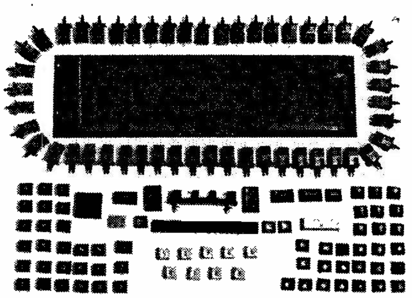
At present only basic 22in TX10 sets are being manufactured but the following options can be exercised in the future without affecting the basic chassis: simple or sophisticated remote control, sweep tuning, bass and treble control, teletext, Prestel, hi-fi outputs, extension loudspeakers, headphone socket and audio outputs.

Thorn Consumer Electronics Ltd., 284 Southbury Road, Enfield, Middlesex, EN1 1TJ.

BLACK DOOR SUPPLIER

Behind a rather uninviting black door in a South London suburban back street lies an "Aladdin's Cave" full of electronic goodies of every description. Everything in fact from new semiconductor devices of which a reasonably large range is stocked, right up to daisy wheel printers, Tektronix 'scopes, computer tape drives and virtually every description of test gear and computer peripheral.

Most of the equipment, which is used is in remarkably good condition and anyone with an interest in practical electronics (with a small "p" this time) could loose themselves for an hour or two just looking through what's



available. Warning—it is very difficult to come away without parting with a few readies!

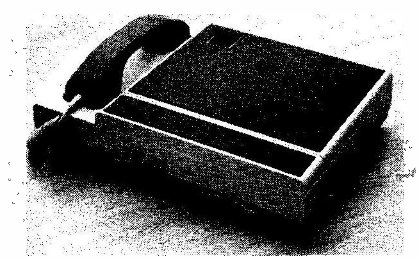
We discovered an excellent VDU and keyboard unit in a smart case for about £49 and the 77 key, keyboard kit shown above which sells for about £27. We could have picked out about ten items which represent incredible value for money, without looking too deeply so, if you have some time to spare, pay a visit, and say Market Place sent you; there's even room to park.

Where is it: **Display Electronics, 64-66 Melfort Road, Thornton Heath, Surrey, 01-689-7702** (they do mail order too). It's not far from Thornton Heath Station.

STORACALL

Storacall has just launched their new Ansamaster II telephone answering computer. This unit is the first to use a microcomputer to monitor each function of the machine and can inform the user through a alpha-numeric display; how much time has elapsed while recording the outgoing announcement, how many calls have been received, which call is being listened to during playback, whether a call is being taken, and whether the user has mis-operated the unit, or if there is a fault with either of the two cassettes.

Among its many features are included fast forward, fast rewind, an answer only facility,



variable length outgoing announcement, built-in microphone and call monitor facilities. The most important feature, however, is the remote recall that enables the user to listen to his messages without returning to his home or office. Unlike most other remote controlled answering machines, the Ansamaster II does not use bulky and expensive pocket activators. Instead a changeable voice code is used, which is programmed by five changeable code switches on the back of the unit. This means that it is easy for more than one person to use the unit and greater security is gained as the code can be changed at will.

The Ansamaster II can be purchased outright or rented from £3·36 per week.

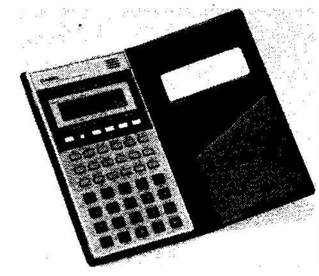
Storacall Ltd. 28 York Street, Twickenham, Middlesex (01-891 3321).

CASIO

For their fx-8100 calculator Casio have incorporated a clock, calendar, alarm, two countdown timers and a stopwatch into a scientific calculator which has 46 functions and can handle up to five levels of parenthesis.

The clock which has an accuracy of ±3 seconds a day is based on the 12 hr system and displays hrs, mins, secs, PM and day of week. The calendar has been programmed to the year 2000 and requires no adjustment but must be reset after replacing the batteries.

The three alarm functions include a main alarm which once set will sound the buzzer for 20 secs at a preset time everyday until it is



cleared. The other two alarms are of the countdown type; timer 1 can be set by entering hour and minute digits up to 9 hrs and 59 min or it can be set in minutes up to 99 mins. When preset time has elapsed the buzzer sounds for 20 secs and is automatically cleared whereas timer 2 will sound the buzzer each time the preset period has elapsed. The stopwatch function allows for timing periods up to 9 hrs, 59 min, 59 secs and 99/100ths of a second. Normal, net and lap times can all be measured.

Also included with this calculator is a comprehensive instruction book which covers all aspects of operating the fx-8100.

The price of the fx-8100 is £24·95 excluding VAT and p&p. **Tempus, (Dept. PE), Beaumont Centre, 164-167 East Road, Cambridge, CB1 1DB.**

TEXAS TI-99/4

The latest home computer from Texas Instruments is the TI-99/4. This system uses TI's own extended BASIC and has a total memory capacity of up to 72K: 16K RAM, 26K ROM and 30K of ROM in each of the solid state software modules. These plug-in pre-programmed modules which have been written by TI cover, Home Management/Personal Finance, Education and Entertainment. Each module is a complete program with its own extra memory capacity. The concept was developed by TI for their range of advanced programmable calculators.

A sub-program in the TI-BASIC enables you to use up to 16 colours on the screen at one time and to specify the colours of the characters and the background display. Another sub-program allows the playing of tones over a five octave range with up to three notes (for computer music) and one noise tone (for sound effects) available simultaneously. The duration and volume of the sound can also be controlled.

Among the accessories available for the TI-99/4 is a speech synthesizer, which gives the computer a vocabulary of over 200 words.

The price of the TI-99/4 is £655 with the speech synthesizer priced at £79·95 and memory modules available from £16·95 to £44·95 (all prices inclusive of VAT).

For further information contact **Scan Computers, Ltd., Chanctonbury House, Church Street, Storrington, Sussex (09066 4342).**

CSC CATALOGUE

The latest 36 page catalogue from Continental Specialties Corporation covers the company's range of counter timers, frequency counters, pulse generators, logic probes and analysers. Instrument cases as well as solderless breadboard systems are also covered and the catalogue includes the company's latest digital capacitance meter (model 3001) which provides direct $3\frac{1}{2}$ digit reading of capacitance from 1pF to 199·9μF.

The catalogue is available free of charge from **CSC, Shire Hill Industrial Estate, Saffron Walden, Essex. CB11 3AQ.**

VMOS power f.e.t.s

A selector guide covering a wide range of VMOS power f.e.t.s is now available from Hunter Electronics. Breakdown voltages range from 40 to 600 volts with low on resistances (down to 0·3 ohms). The devices are available in a variety of packages including 14 pin d.i.l. complementary devices.

Hunter Electronic Components Limited, 55 High Street, Burnham, Bucks. (06286 65421).

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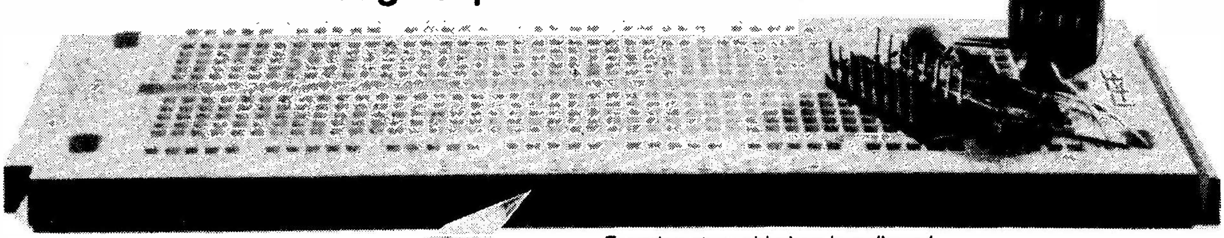
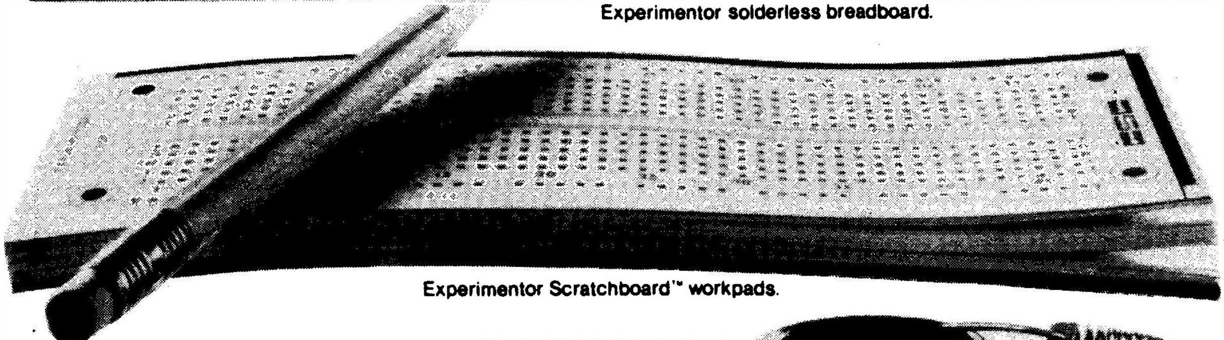
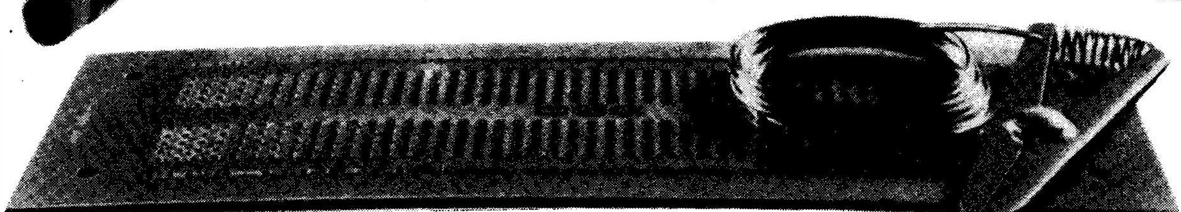


Experimentor solderless breadboard.



Experimentor Scratchboard™ workpads.



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With Experimentor Matchboard you can go from breadboard to the finished product nonstop! We've matched our breadboard pattern again, this time on a printed circuit board, finished and ready to build on. All for about £1.32.

There's even a letter-and-number index for each hole, so you can move from breadboard (where they're moulded) to Scratchboard™ (where they're printed) to Matchboard™ (where they're silkscreened onto the component side) and always know where you are.

When you want to save time and energy, you can't beat The Experimentor System.

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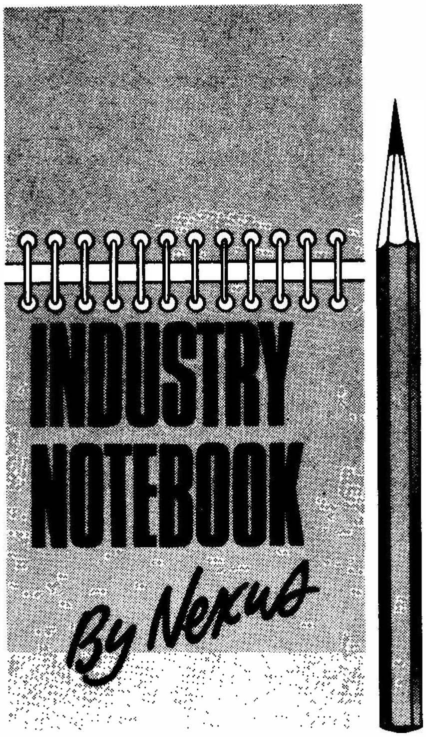


Status

When I commented at length on the Finniston Report in the April issue of *PE* the views expressed were my own first instant reaction to the new proposals. Since then there has been a substantial volume of published letters in the professional engineering journals and the broad consensus of opinion appears to be at best lukewarm to the ideas set out in the Report. Other engineers, it seems, are equally as sceptical as I was, and still am, on the merits of the proposals and the effect, if any, of their implementation.

Most engineers, while generally contented in working at their chosen profession, are unhappy with their status and relate this to earnings. A distinctive title such as the present Chartered Engineer or proposed Registered Engineer is not sufficient in itself to command respect.

Well, it's all a question of the 'going rate' for the job. There is no question that professional engineers are undervalued in society in both earnings and respect. Most, I fancy, while welcoming more respect would far sooner have a higher income. At one stage, not long ago, their salaries were actually falling behind the rate of inflation so, in real terms, salaries were sliding down. The results of this year's IEE salary survey show that the hypothetical average electrical/electronic engineer enjoyed an increase of 18·5 percent in salary, up from £7204 to £8580. Although the inflationary trend is now upwards towards 20 percent this is not true of the whole year in review and so there is a marginal gain. But not nearly enough. Far too many engineers have a gross income below that of many categories of manual or craft labour.

On the vexed question of pure status, disregarding salary level, it is a pity that the news media generally refer to organised workers in the engineering industries as 'engineers' without qualification and generally only in a context of dispute with employers.

Despite all the rumblings of dissatisfaction there is no mass exodus of young engineers to better paid but less congenial jobs in the mines, on building sites, or on oil rigs. Neither is there evidence that senior engineers are busy retraining for more lucrative posts in law or medicine. One is left with the conclusion that despite all their grievances, some real, some imaginary, most if not all engineers prefer to stay put. One consolation is that the present chronic shortage guarantees that any engineer worth his salt need never be without comparatively enjoyable employment for the forseeable future.

Suite 210

Suite 210 could well become a catchphrase for success in the electronics industry. For it was in Suite 210 in the London International Hotel that Racal's Ernie Harrison planned the coup that brought Decca into the Racal empire. It was here that on a Sunday evening Harrison got together with Decca Chairman Nigel Graham Maw and their respective merchant bank advisers and agreed the attempt to swing the institutional investors into backing Racal against the powerful GEC counter-bid. By the following Thursday Racal had a guarantee of over 50 percent of Decca's voting shares and the battle was won.

With the addition of Decca, Racal now has some 20,000 employees of which some 6,000 plus are overseas. Turnover is targeted at £500 million for 1980-81 and pre-tax profit £90 million. Much depends on re-organisation in Decca on which Ernie Harrison will concentrate in the coming months since officially moving in to Decca's head office at 1500 hours on April 1. Racal is now a true multinational with 15 companies in the USA alone. Paradoxically, having recently pulled out of South Africa, Racal now finds itself back there again through a Decca subsidiary.

Resurgence

Plessey now looks in much better shape. Their third quarter results showed sales for the nine months up 13 percent at £526 million but more important was the 31 percent increase in operating profit to £40 million over the same period last year. Loss-making Garrard has now gone and other loss-leaders like the remaining BPO Contracts for Strowger exchanges are on their way out.

On recent visits to Plessey establishments I noticed there was quite clearly an uplift in morale. And it wasn't just the disappearance of the threat of a Racal takeover, it now being considered that Racal will take some time digesting Decca before making any more predatory moves.

The uplift is more due to the realisation that Plessey has a strong product line and a newly aggressive attitude in the market place. This is particularly noticeable in the electronics group. Plessey Electronic Systems Ltd., employing some 9,000 people and now achieving sales of some £200 million a year with greatly improved operating profit and a sharp rise in exports. Plessey Marine's factory at Newport, Gwent, is being doubled in size and Plessey Defence Systems is busy building new production areas on the site at Christchurch formerly occupied by the MOD Signals Research and Development Establishment (SRDE) which has now moved to Malvern and is incorporated into the Royal Signals and Radar Establishment (RSRE).

The new wave of optimism is not confined to the big military systems in which Plessey has special expertise. Perseverance in the difficult semiconductor market is also paying dividends. Plessey Semiconductors achieved over £1 million of sales to the USA alone last February for high-speed dividers. On the broader export front some £20 million of orders were taken in the past year and the forward order book is worth £11 million for semiconductors.

Overall, throughout the whole group, Plessey's forward order book is of the order of £1,000 million. Quite a transformation.

Avionics

Avionics is one sector which is perennially buoyant. The new Boeing 757 and 767 airliners now being designed will have their pilots trained on British Redifon flight simulators to be delivered over the next three years. The new orders from Boeing bring Redifon's current order book for simulators up to some £80 million.

Ultra Electronics has won a £14 million contract for sonobuoys. MEL has won a £10 million production order for Sea Archer radars which will be built in a new factory at Dunfermline.

"Small is beautiful" is a saying appropriate to the precision rate gyroscope built by Marconi Avionics. Weighing only 4ozs and only slightly larger than your thumb the 10,000th recently came off the production line. This little marvel has been worth £50 million worth of business in its lifetime so far and is still in production at the rate of 100 a month.

Prestel Lift-off

1908 will be make or break year for the BPO Prestel viewdata service. The less than 3,000 present subscribers it is hoped will be boosted to tens of thousands by the end of the year as more and more Prestel-equipped TV sets roll out from the factories. A new 3-chip Teleview system for viewdata was unveiled at the Paris Components Show in April by General Instrument Microelectronics. GIM say the whole low-cost system will go on a 6in by 4in single-sided p.c.b. and enables access to Prestel, Ceefax and Oracle through a normal TV set.

The BPO for its part has done well to provide a constantly up-dated data base of 150,000 pages of information. And a new development is Picture Prestel to be introduced towards the end of the year. This will enable full colour photographs to be used on Prestel pages but viewers will need another modification to their sets to receive them.

Wersi and Clef SOUND PROCESSOR KITS Reviewed

OVER the last few years, the name of **Wersi** has established itself in the UK with its large range of high quality musical instrument kits. The company, formed in 1969, originates from Halsenbach in West Germany, and aimed from the start to provide kits that were "technically the most advanced on the international market". A few minutes study of their lavish catalogues soon verifies this and their present range consists of eight large-scale organs, that include a portable combo organ, spinet and theatre style home organs, an electronic "church organ" and their top Galaxy W4SKT organ. There are also other instruments such as string orchestra and electric touch-sensitive piano as well as audio mixers, amplifiers, speakers/cabinets and a host of special effects boxes.

WERSIVOICE

The Wersivoice sound processor adds the effect of rotating speakers to the electronic organ without having to use the mechanical "Leslie" type of amp/speaker system. The sound from a Leslie cabinet is comparable to the Doppler effect—where moving sound appears to a stationary listener to change pitch. In the cabinet is a mechanical motor-operated rotating speaker for covering mid/high range frequencies with a separate section that houses bass range speakers. These are fixed and usually have cones pointing downwards with either a rotating drum underneath or some form of electronic "tremolo" modulation built into the amplifier control system. The rotating speaker unit operates at two speeds selected by a control box fitted to the organ or by foot-switches. Ideal running speeds preferred by most organists are a slow rotation of 0·6Hz and a fast spin of 6Hz. The slow "chorale" effect makes a straight organ output sound rich and ecclesiastical, and is highly desirable for any kind of electronic organ. Changing to the fast "vibrato" speed gives the traditional Hammond theatre organ sound that is great for jazz and lively music with lots of punch from percussion tabs.

The Wersivoice has another effect provided at the touch of a button—String Choir. If a single sound is fed into the unit, in the "Choir" mode the output gives a "multiplied" version of the input. It can make an instrument sound like several instruments playing in unison or a solo voice sound like more than one singer. It is most effective on straight string tone from the organ (usually a sawtooth waveform) which will become transformed into a rich string orchestra.

MAKING IT

The kit can be purchased in two forms—one for mounting as a "chassis" unit plus transformer, power supply and switchbank straight into the console of an electronic organ, or as a free-standing item with wood cabinet cover. I chose the latter and this was delivered in a small package along with the wooden cover and two manuals, one with the instructions and the other with general assembly notes.

Having spent some time reading the manuals, the component bags were laid out on a workspace in their numbered order, 1–47, ready for assembly. To build the kit you need a 15–25 watt soldering iron with a ⅛in bit or less plus holder, small wire-cutters, wire stripper, small flat-ended screwdriver and a general purpose voltmeter for testing the completed unit. Before mounting components on the board, a small piece has to be cut out using a fretsaw to allow the circuit board to clear components on the front panel.

Assembling order was set out in a logical manner, with wire links first, followed by diodes, resistors, i.c. sockets, bridge rectifier, voltage regulator, solder pins and capacitors. By installing a particular capacitor, the speed of rotation, when switched from slow to fast, increases slowly. This simulates the mechanical inertia of the motor-driven Leslie system. It can be left out for immediate speed changes. The transistors used are rugged silicon types that require no heat sink during soldering. To finish the board came the switch assembly, presets and transformer.

All i.c.s were supplied on pieces of polystyrene in their component bags—a little disconcerting when CMOS devices were identified. Two of my chips did not function correctly and as they were marked WIC4000 I began to suspect the Wersi equivalents of CD4000 were undoubtedly affected by inadequate packing precautions. Actually, this was not so, as they were really LM3900N i.c.s—but two points became obvious here: first, handle i.c.s with due care and second, Wersi numbers do not correspond to standard i.c. markings!

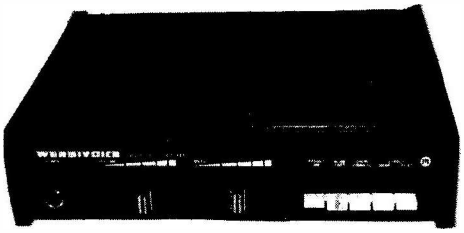
Once the 13 i.c.s are mounted correctly, the circuit board was finished, taking about 3½ hours to complete. Chassis preparation is now undertaken, with front and rear panel hardware mounted and linking wiring so straight-forward that no wiring harnesses are required. The clamp provided for the mains wire was a little small and could penetrate the outer casing if fastened too tight. The only other fault was that the switch buttons were scratched on insertion into the front panel opening due to rough edges on the chassis. It's worth putting a small file on these or you'll probably end up with some unsightly control buttons.

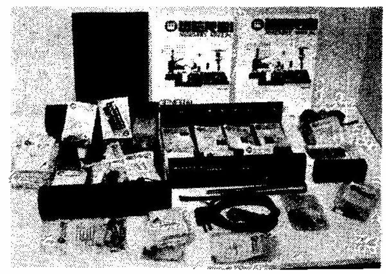
This is one of Wersi's smallest "complete" kits and has no awkward assembly steps at all for you to encounter, taking about two evenings to build. In order to get the best sound from the Wersivoice a series of 15 tests are made during initial operation of the unit, using a d.c. voltmeter in the 20–30V d.c. range. Checkpoints with important voltages are all screen-printed on the circuit board and the unit passed all the tests satisfactorily.

IN USE

A straight organ sound was fed to an input and the output sent to an amp/speaker system with very good results immediately evident. The different controls provided plenty of variety in operation. There is a "Volume" slider, a manual "Speed" control slider and pushbuttons for switching "Effect On," "Choir", or fast and slow "Vibrato", with the actual depth of both these effects selected by combinations of "Deep" and "Flat" buttons. Switches worked silently except for "Effect On" which gives a noticeable click unless a high input signal is used so that the main output volume slider level can be reduced. The "Deep" button provides a degree of feedback (presetable) which can give a high-pitched whine if too much feedback is used, the same as in flanging effects. There are two input jack sockets with levels that can be adjusted between 50V r.m.s. to 1V r.m.s. and one signal jack output. If the unit does not function then there is not much advice given in the manual, although a careful check of circuit board locations and wiring should solve any problems. Still, there is always help from the shop you purchased from if really stuck and for the more experienced the circuit diagrams will prove sufficient for diagnosis.

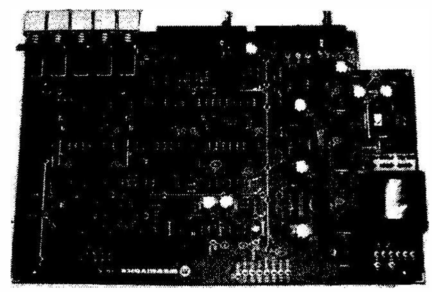
The two effects of "rotating sound" and "string choir" are put in one package because they both rely on the use of bucket brigade delay chips. In fact, the heart of the circuitry consists of three analogue (bucket brigade) shift registers, clocked by three independent VCOs with basic shift frequency of 50–250kHz. These are themselves frequency modulated by two further VCOs, the first giving a set 0·5–0·6Hz for "Choir" mode and the second giving slow to fast "Vibrato" from 0·5–7Hz. Combinations of these two control voltages are used so that the output signal receives complex phase frequency and amplitude modulation.





The circuitry used produces a depth of phase-modulation that is more than adequate to get the traditional Leslie effect and can produce interesting results with electric guitar, piano, trumpet, violin and synthesiser as well. In "Choir" mode, it gives the typical string machine sound from a sawtooth waveform (with suitable sound envelope) that is so popular today. The actual effect on the voice is not as dramatic—simply adding "thickness" which contains the fast vibrato modulations.

Showing the finished Wersivoice, kit packs and board assembly



An optional remote control switch box is provided as standard in this kit and is useful for placing on an instrument or fastening via its screw holes to the underside of the organ console nearest the player's left end of the keyboard. It can be purchased in three ways: As a basic chassis kit for £156, as a free-standing kit for £201, and as a ready built unit for £304 (prices quoted include VAT). In my opinion, these prices are rather high.

Mike Beecher

THE **Clef** electronic rotor CPK 1200 is a new edition to the range of electronic musical instrument kits from Clef Products, and comes from the same designer of the popular *PE* "Electronic Piano" and "String Ensemble" projects. Clef specialise in high quality touch sensitive electronic pianos up to full 7¼ Octave size, and the study of the use of analogue delay lines for both the *PE* "String Ensemble" and the current range of electronic pianos has led to the design of a system which provides both rotating speaker simulation and three phase chorus.

KIT CONTENT

The kit is designed for easy integration into electronic keyboard instruments or may be built as a stand-alone unit for guitar or microphone driven effects. The complete effects system is contained on one small p.c.b., (8in × 5in), Containing 20 i.c.s, and the total kit also includes a mains transformer, a four-way push button switch unit which can be mounted in a remote position for convenient operation, and a stereo headphone driver board which gives easy realisation of one of the most useful features of this type of rotor simulation. All the integrated circuits in the system are commonly available types, and sockets are provided throughout avoiding any risk involved in soldering. Printed circuit board markings adopt the component value principle which avoids the tedious process of looking up resistor and capacitor values before insertion into the board. Due to the compact size adopted for the unit, the soldering operation must be carried out carefully and some of the wire links are best inserted before any of the components. Careful inspection of the tracks is required after soldering to ensure that bridging has not occured.

The kit includes adequate instructions and circuit information to complete the project and integrate it into your system, and as with all Clef products telephone advice can be obtained direct from the designer.

OPERATING MODES

The four way push button switch unit allows selection of either the chorus or two speed rotor mode, with three positions for the latter. The chorus mode is of three-phase type with adjustable depth and slow/fast modulator balance. In the rotor mode run-up and run-down characteristics are all important. Three buttons are labelled "Off", "Slow", and "Fast".

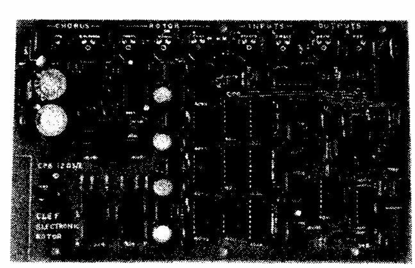
A change from "Off" or "Slow" to "Fast" always produces a run-up effect, whilst a change from "Fast" to "Slow" produces a run-down effect. Changing from "Fast" or "Slow" to "Off" instantly kills the rotating effect, and controls are provided to adjust "Rotor Depth", "Slow Speed", and "Fast Speed".

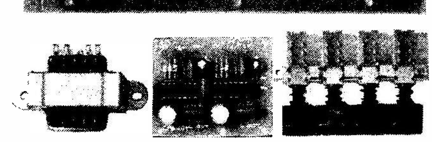
OPTIONAL TWO CHANNEL OPERATION

The rotor is unique in providing a second channel facility which gives an increased spatial effect due to its electronically created anti-phase output. This extra feature can be utilised by the addition of a second power amplifier and a small speaker. The stereo rotor effect produced is permanently available from the headphone driver board.

The price of the rotor kit is £89 and it can be obtained direct from Clef Products (Electronics) Limited, 16, Mayfield Road, Bramhall, Cheshire, SK7 1JU.

Adrian Boothroyd





The Clef Products rotor kit with the board assembled

PE Congress 30W I.C. STEREO AMPLIFIER

PART 3

GRAHAM JACKSON

LAST month we looked at the operation and construction of the pre-amp section of the PE Congress amplifier. In this concluding article final wiring and chassis details will be given. We start, however, with a description of the main amplifier circuitry.

MAIN AMP

The amplifier is based on a hybrid module made by Sanyo, which is a stereo, or dual, 30W amplifier needing a minimum of support circuitry. Transistor TR17 forms a 6mA constant current source which is used as an active load for the class A drive amplifier within the module. This significantly improves the performance of the module against using a boostrapped resistive load, especially with regard to crossover distortion. The performance of this module with a minimal increase in distortion with frequency, in conjuction with only a small amount of feedback, indicates that the internal power devices are designed to have a high transition frequency, which is probably the factor which gives the module its excellent transient characteristics.

The module also relies solely on the loudspeaker fuse for protection, which, in the absence of a.c. load line protection, allows difficult reactive loads to be driven (see published specification in the April edition). This does mean, however, that the specified fuses must be used. These are of the 20mm 3 amp quick blow type, which are also used in the positive and negative rails.

The feedback network also encloses the fuse which helps to compensate for any resistance between the fuse and its mounting clips. This in conjunction with the recommended 4mm speaker sockets and banana plugs gives good low impedance coupling to the loudspeaker leads, helping to maintain the best obtainable performance.

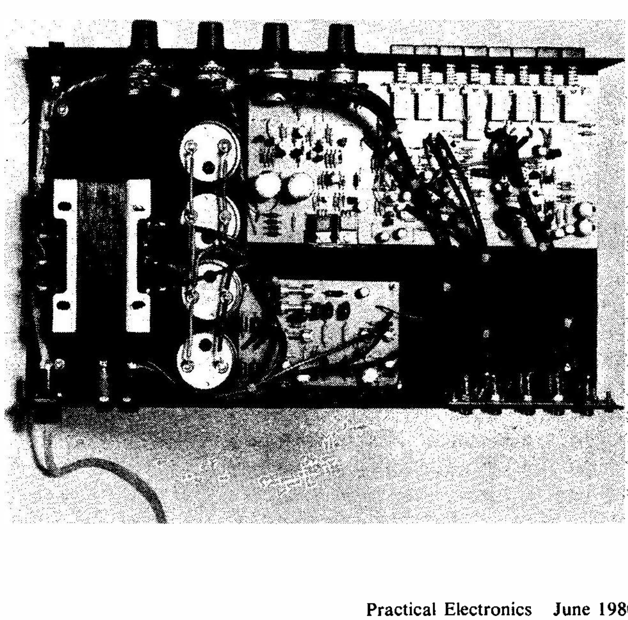
A further advantage of the module is the absence of any adjustment for quiescent current, this being set internally. The hybrid construction allows for excellent temperature stability. The module must not, however, be used without first mounting onto a suitable heatsink. The aluminium chassis detailed in this article provides adequate heatsinking under all types of use, but should be sprayed matt black for best results.

POWER SUPPLY

The power supply is very straightforward consisting of diodes D14-17, which mount directly onto the main amp board to help simplify interconnection, transformer T1, and capacitors C29-32. To get the best results and to meet the published specification, two capacitors of 4,700μ (or one of 10,000μ) on each rail must be used, and the transformer must have good regulation with a rating of 125VA.

To enable the transformer to be small enough to fit in the chassis, high quality grain-orientated laminations must be employed. A toroidal transformer could be used, but the greater expense is not warranted as no advantage in performance is given if the physical layout shown is used.

General layout and wiring of the PE Congress



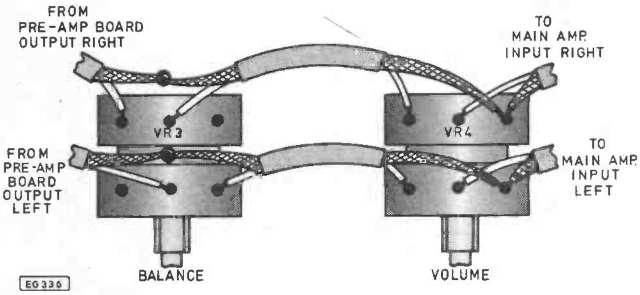
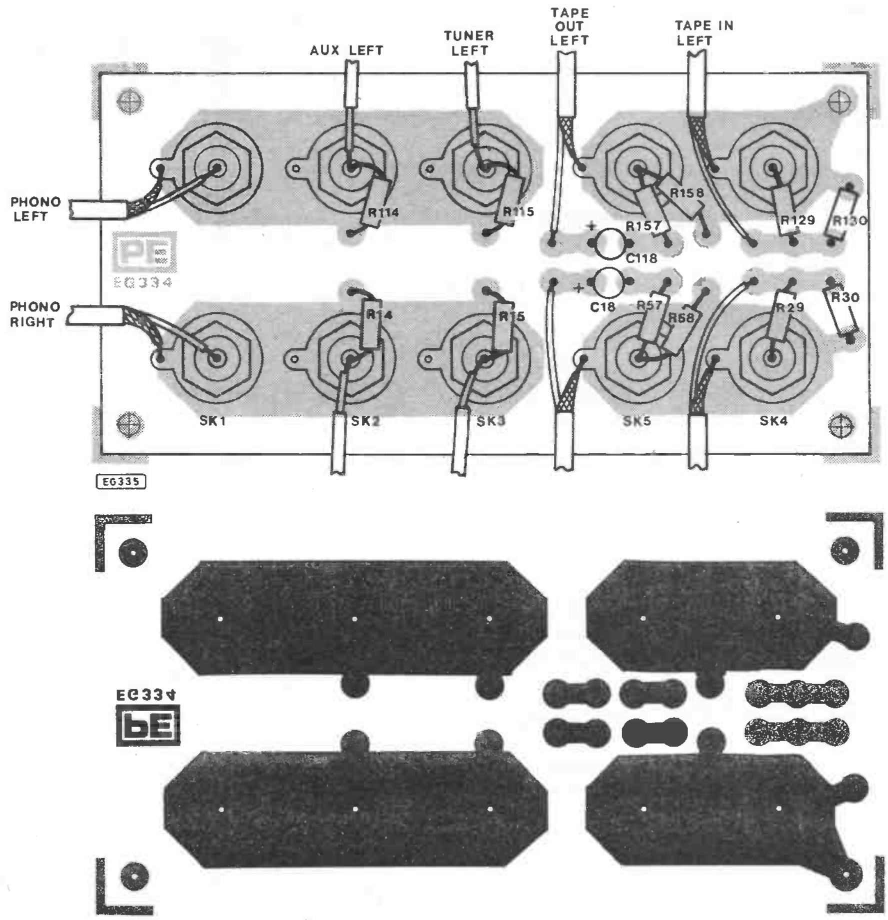
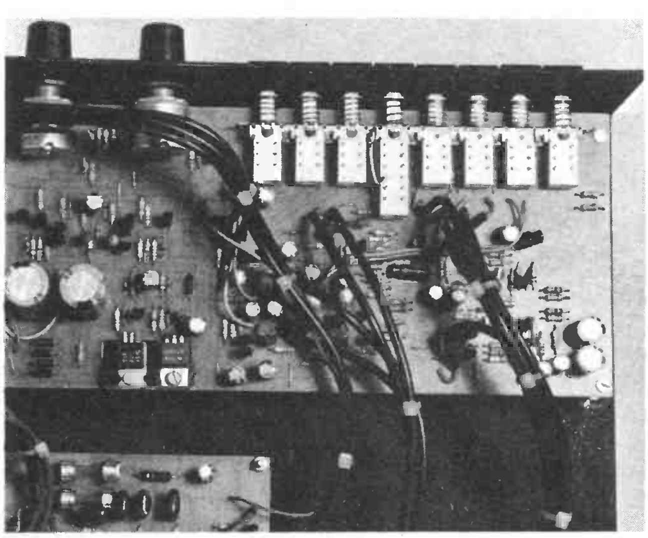
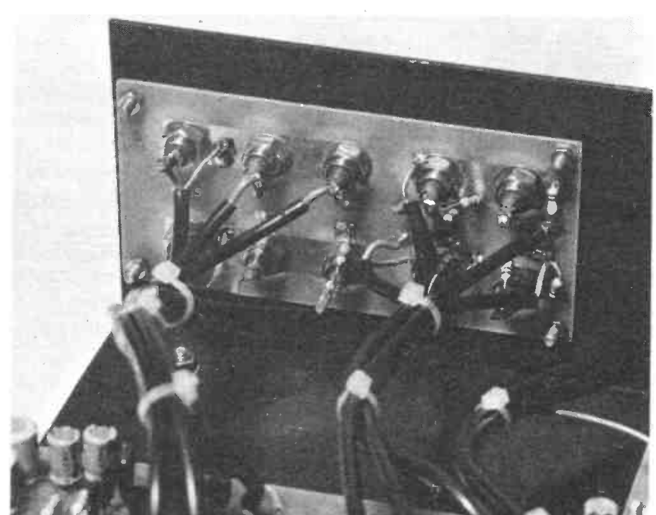


Fig. 13. Wiring of the volume and balance controls

Fig. 14. (Below). Layout and wiring of the phono socket board. Note that the only holes through this board are for the ten sockets and the four fixing holes. Both views below are of the copper side of the board.







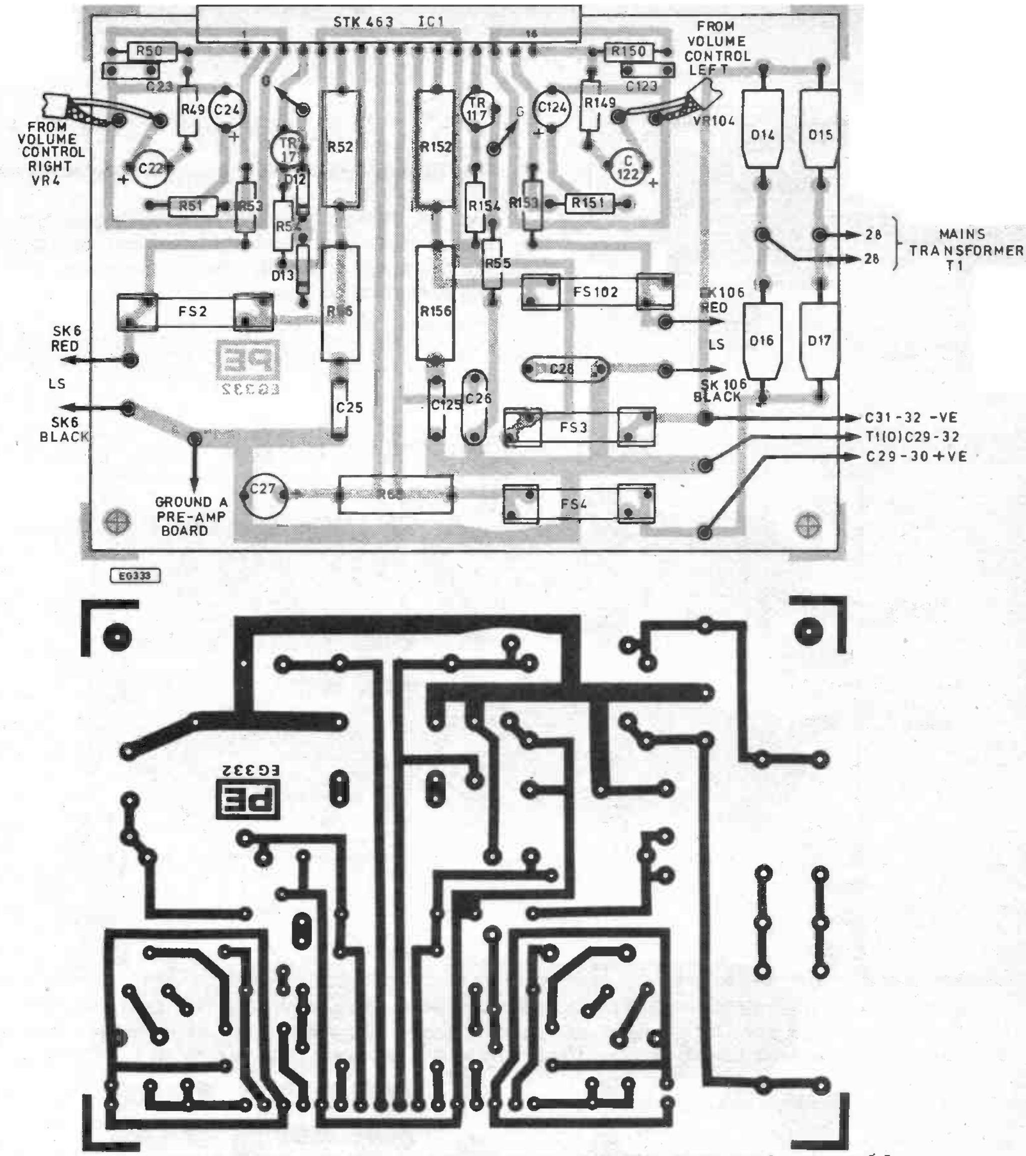


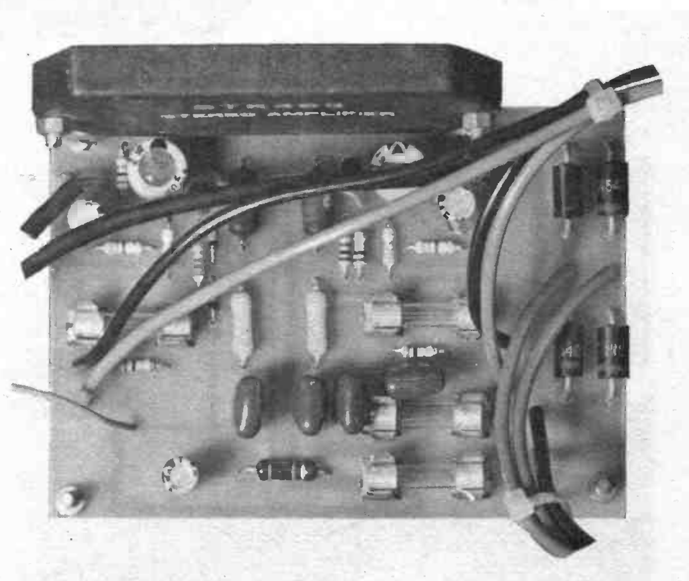
Fig. 15. Layout and wiring of the main amplifier p.c.b. Note the ground A link to the pre-amp board and the wire link from G to G

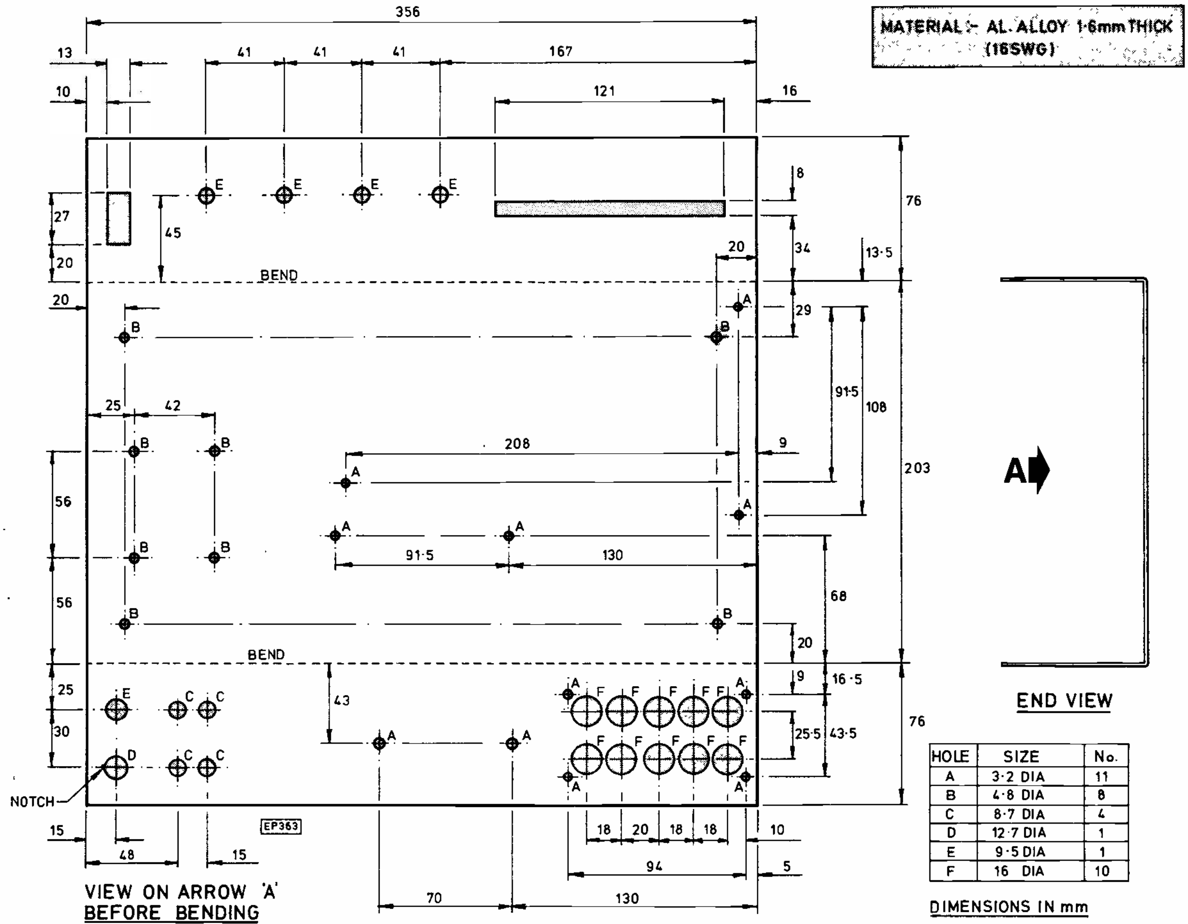
WIRING

The wiring between the pre-amp and main amp board must be followed as shown, as two grounds on the main amp board go back to the pre-amp board via the volume and balance controls (Fig. 13). This stops any noise pick up at the main amp. The grounds are connected by the outer screens of the screened cable, the return being by a single lead back to the main output ground of the main amp board (Fig. 15) and then to C29-32 and the OV tap on the transformer. If the main amp is used in isolation it should only be operated when the two separate grounds have been connected to the main ground going to the common connections of C29-32 with the board layout shown.

The ground connection to the chassis is made at the phono input board (Fig. 14); no other ground connection should be made apart from mains earth which goes to a solder tag on one of the transformer mounting bolts (Fig. 17).

The unit has been designed for straightforward wiring that should present no problem. Screened lead must be used for all signal leads. The only components that are not board mounted are the main amp power supply capacitors, the mains switch and mains fuse, and the balance and volume controls. All fuses in the amplifier are the 20mm size.

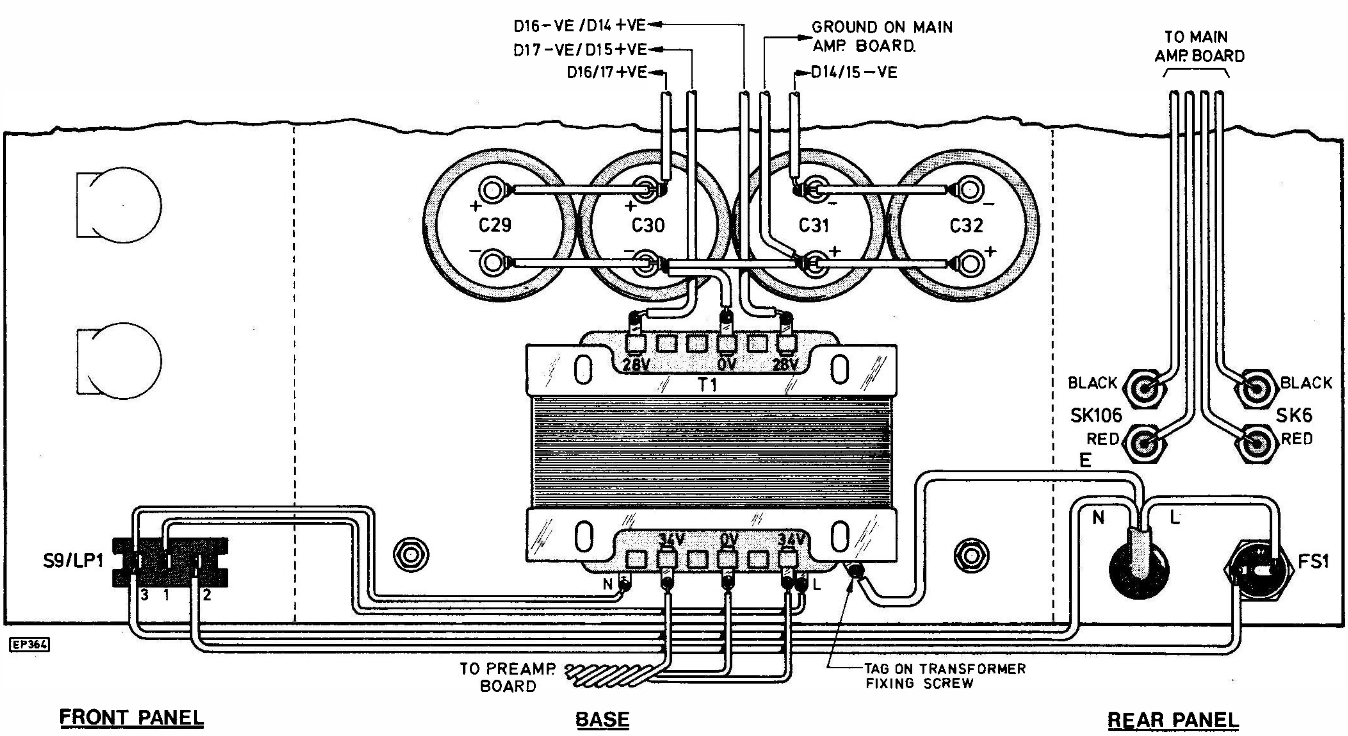




HOLE	SIZE	No.
A	3·2 DIA	11
B	4·8 DIA	8
C	8·7 DIA	4
D	12·7 DIA	1
E	9·5 DIA	1
F	16 DIA	10

Fig. 16. Drilling and bending diagram for the chassis. It is suggested that mounting holes for the p.c.b.s are marked through the board fixing holes with the boards in place to ensure accurate alignment. If the holes are marked out after bending 1·5mm should be added to all dimensions taken from the bends, all measurements to be made on the outside of the chassis

Fig. 17. Wiring of the supply components not mounted on the p.c.b.s



TESTING

When the amplifier has been completed, before connecting the loudspeakers and switching on, the following tests should be made. Firstly, disconnect the leads from the transformer to the pre-amp. The centre tap lead may be left connected. Ensure the correct fuses are fitted to the board and in the mains fuse holder and then with no load connected to the loudspeaker sockets, plug in with the mains switch in the off position, i.e. with the switch rocker set so that it projects at the bottom. If the neon lights then recheck the switch connections. If not then switch on at the switch. The neon should light.

Check the voltages across the power supply capacitors. These should be $\pm 38V$. Next, check the voltage across the loudspeaker terminals; these should be less than 70mV (0·07V). If a fuse should fail, switch off immediately. Recheck all connections and the polarity of the diodes and smoothing capacitors. If these are correct, double check the resistors R53, R51 which are the feedback resistors. If these are wrong they can lead to instability which can cause fuse failure. The STK463 modules are very robust, and show no significant difference between samples. Failure should never occur if the directions to its use and wiring are followed carefully.

If everything checks out then connect the transfomer leads to the pre-amp. Checking and testing was detailed last month. In the event of a short, then R59 or R64 will fail. These should protect the rest of the pre-amp except for a wrongly polarised electrolytic. If everything checks out, try out the amplifier.

Provided care is taken in construction no problem should be experienced.

AUTHOR'S NOTE

In the weeks leading to this series of articles, the amplifier was tried with various programme material on very expensive and very critical monitor loudspeakers. The PE Congress has given extremely good results, and was capable of allowing these speakers to give their full range. Comparisons have been made with much more expensive amplifiers and in many cases the Congress has been adjudged to be better.

I personally make no claims other than the extreme care and many hours I have devoted to this project, and I hope that my experience of the results is borne out by all that decide to build this design. ★

Please note TR105 is incorrectly shown, the flat should be towards the back edge of the board in Fig. 12 i.e. rotate 180 degrees. Transistor TR115 has been designated TR11; TR115 is near 114 and 116. A small link should be added to the p.c.b. to join R4 and R8 to C2 and C6 positive (back left of board in Fig. 12). Also the "back" end at R63 should be joined to the D23 positive line and not to TR19 and the link as shown in Fig. 12. Boards supplied by Wicca Electronic Systems Ltd., will be correct.

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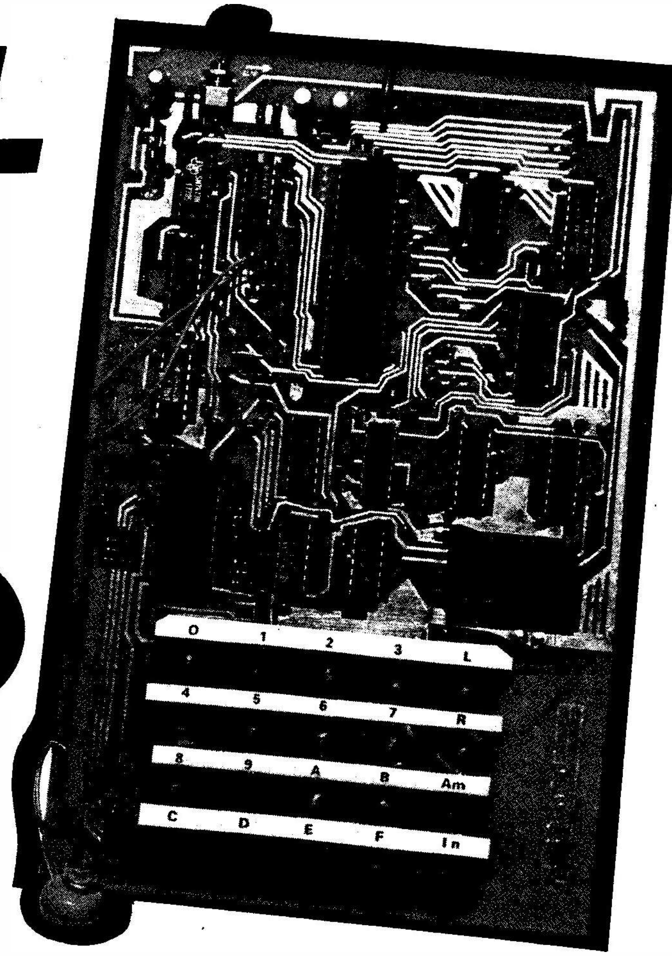

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Semiconductor UPDATE...

FEATURING mPD 7801 HEDS-1000 XRL556 BT155

R. W. Coles

LAND OF THE RISING CHIP

So far the American semiconductor industry has had the microprocessor market more or less to itself. By being first, and by implementing aggressive sales and research programmes they seemed to be so far ahead of the competition that they might never be overtaken.

You may have been wondering why the Japanese are not more prominent in this important field, they are after all, major exporters of cars and electronic consumer goods, and it is difficult to see how they could maintain their competitive edge in these fields without homegrown micros, especially now that these devices are becoming so cost effective for the replacement of electro-mechanical components, and essential for the addition of attractive new features such as digital tuning.

The fact is, those canny Japanese semiconductor manufacturers have not been idle, and there are already numerous examples of their micro know-how on the market. These devices have been mainly second-sources or pseudo-copies of existing American microprocessors up to now, but already Japanese suppliers are building up a good reputation for high quality and low prices, not only for microprocessors but also for support circuits such as memory and peripherals. The time is now ripe for the Japanese to launch a frontal assault on the American giants, and it looks as though the first shots have already been fired.

Take the mPD 7801 from the Nippon Electric Company for example. When I first saw the data on this chip I thought that someone had turned my dreams into silicon. I have always liked the powerful and compact instruction set of the Intel 8080, and judging by the sales figures so do a lot of other people. To keep the basic 8080 system competitive into the 1980s, Intel introduced the 8085 which is faster, has more on chip facilities, and runs from a single 5 volt supply. To make it work in small systems, Intel also introduced the 8155 RAM-Timer-I/O chip, and the 8355 ROM-I/O chip; only three forty pin packages to make up a complete system with 2K bytes of ROM and 256 bytes of RAM. Pretty neat, but just look at the mPD 7801!

All into one (quite compact) 64 pin package, NEC have stuffed 4K bytes of ROM (enough for a Monitor *and* Tiny BASIC!) 128 bytes of RAM, a 12 bit timer, *46* parallel I/O lines and 2 serial I/O lines, three external and two internal vectored interrupts, and last but not least, an 8085 compatible central processor which runs the standard 8080 instruction set with some useful additions. As if all that wasn't enough, they have even given *their* CPU *2* register banks, just like the Z80, and made access to external memory easy for the sacrifice of 24 I/O lines as data and address buses.

In large quantities all this is expected to cost less than £15, and so we can expect to see some very low cost home computers before long, not to mention TV games, car computers, robots and all the rest. If the Americans aren't careful, we could soon see an electronic equivalent of Pearl Harbour!

BIFOCALS

Now that bar-codes are an everyday fact of life on everything from baked beans to library books, the race is on to make the readers or "wands" as cheap, compact and reliable as possible. A new device from Hewlett Packard, the HEDS-1000, could go a long way towards meeting all three requirements.

The new device is a high resolution optical reflective sensor and emitter which comes in an elongated eight lead TO5 can. The end of the can is open and inside is a cunning double (or bifurcated) lens of high precision. Mounted on the base of the can are two semiconductor chips, one being the LED light source and the other an IC photo detector. The emitter output is focussed by one half of the lens into a spot less than 0·2 mm. in diameter a few millimetres in front of the package, the other half of the lens acts to focus the reflected light from this spot on to the detector chip.

Using the HEDS-1000, bar-code reading is easy, the device will run from a single supply in the 3·5 to 20 volt range and the whole package is sealed for durability and easy cleaning. The use of a visible light source helps when reading coloured (as opposed to black and white) bar codes, and the precision glass bifuricated lens eliminates the need for careful alignment.

O.K. for supermarkets, but what about hobby applications? Well there must be lots of uses for such a neat device. Microprocessor buffs will know that software has been published in bar-code form in paper-back books, so the HEDS 1000 could be used to build a reader which is more reliable than the usual "lash-ups". With a spot size of 0·19 mm. the new device could also be used to detect objects as small as a single human hair, and all sorts of size and pattern recognition systems could be built with it, its up to you!

TWO TIMER

You all know about the 555 timer chip I'm sure. A really useful building block which can form the basis of monostables, astables, modulators and a host of other circuits.

Some time ago I covered a new improved 555 which did everything that its predecessor did but without the current glitches on the supply lines during switching, and with a consumption many times less for the same timing stability. The "Improved" 555 has been a big success and following on this there has been a demand for duals and quads with the same advantages. I don't know of any *"quad"* super-555s, but Exar Integrated Systems have produced a "dual", coded XRL556 and every bit as desirable as their XRL555 single.

The XRL556 comes in a 14 pin DIL package and consumes only one fifteenth of the power of a "standard" 556 when in standby mode. It runs from 2·5V to 15V supplies and can source 100mA when triggered. Timing stability is excellent with typically 0·5 per cent initial accuracy and only 50ppm/°C temperature drift. Surprisingly, the XRL556 does not use CMOS technology but rather an improved bipolar process employing Ion implantation.

QUICK TURN OFF

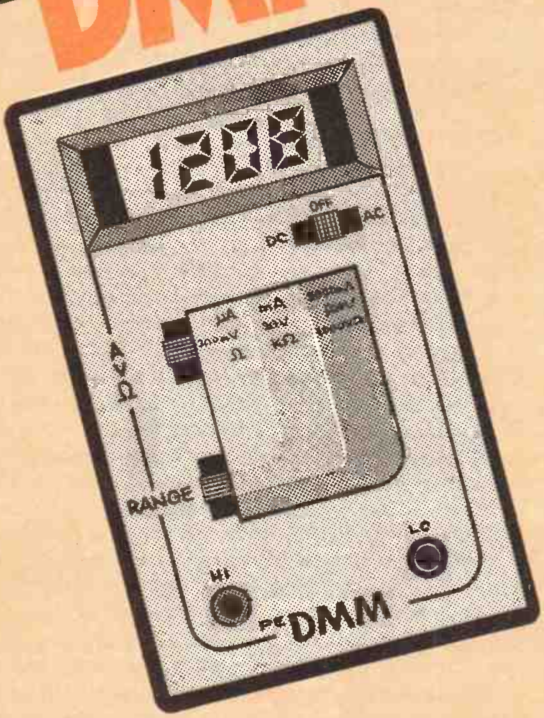
If you need to switch power efficiently, you need a thyristor. Just a few milliwatts of trigger power applied for a short period will turn on many amps of current, and switch-off occurs automatically in a.c. circuits as the current through the device drops to zero at the zero voltage crossover point. For these reasons, thyristors and their close cousins the triacs, are almost universally used to control a.c. *mains* power in everything from light dimmers to oven controllers. The snag is that the construction of a thyristor semiconductor chip involves the use of larger geometries than are used in the fabrication of conventional transistors, and this tends to make the thyristor a rather slow switch, suited only to low frequency applications such as those involving the 50Hz mains supply.

This limitation is inherent in thyristor construction, and has largely prevented their use in higher frequency circuits where their efficiency could be put to very effective use, in inverter and ultrasonic generator applications, for example.

To ease the situation, Mullard have recently introduced the BT155 series of Fast Turn-Off thyristors which are optimised for use in high frequency applications. To those weaned on the nanosecond performance of TTL gates, the BT155's 9–12 microsecond turn-off time may seem no big deal, but this is actually quite an improvement over conventional thyristors, and remember, the BT155 can hold-off over 650 volts and pass peak currents of over 100 amps when triggered!

NEXT MONTH

PE DMM



PE DFM

Also...

CASIO WATCH OFFER
SINCLAIR ZX80 REVIEW

PRACTICAL
ELECTRONICS

BENCH P.S.U.

J.P. MacCaulay

ONE of the most important pieces of equipment for the home electronics constructor and experimenter is a variable power supply. Although the supply requirements of circuits vary greatly, most require a supply between 1·5V and 30V and a current of less that 1A. The power supply described here will provide a stabilised supply voltage which is infinitely variable between 0V and 26V and also features an infinitely variable current limit up to an ampere.

Due to the rapidly falling price of integrated circuits and especially quad op. amp. devices, it has now become feasible to build such a power supply at a relatively low price. The quad op. amp. which is the basis for this particular project is the LM324 from *National Semiconductor.* This device contains four 741 type operational amplifiers which have the added advantage of having inputs and outputs which can go to ground even when operated from a single power supply. This feature enables one to design a power supply that can deliver extremely low output voltages, and thus replace 1·5V batteries when required.

CIRCUIT DESCRIPTION

Fig. 1 shows the full circuit of the supply, and this breaks down into three functional blocks. First the mains voltage is stepped down by T1, rectified by the bridge D3-D6 and smoothed by C1. So far the circuit follows that of a simple unstabilised supply. A stable reference voltage is obtained from the output of IC1a which functions in the following manner.

The op. amp. is used as a d.c. amplifier, the input voltage being provided by the stabilised potential across D8, which is applied to the non inverting input. On switch-on the voltage here is zero so that the Zener appears, for an instant, as an open circuit. However, the bias current which flows out of the op. amp.'s inputs, although only of the order of a few tens of nano-amps, is sufficient to hold the inverting input at a slightly lower voltage than the non inverting.

In consequence, the output of the op. amp. goes towards the positive rail, stabilising at twice the Zener voltage. Since the output is constant it follows that a constant current flows through both R1 and D8. The net result is a very stable and virtually ripple free voltage available at the output of the amp. This voltage is applied to the potentiometer VR1.

The slider of VR1 picks off a portion of the stabilised output and applies it to the non inverting input of IC1b. This op. amp. contains the output current stage TR1 and TR2 in its feedback loop. These transistors are operated in the emitter-follower mode to provide a high input impedance and a low output impedance; the ideal conditions for a voltage regulator. By connecting these transistors as a darlington pair the current gain is extremely high, so preventing loading on the output of the amplifier. The amplifier itself is more or less identical to the circuit around IC1a. The voltage gain of the stage is defined by the ratio of the feedback resistors R4 and R5.

Because the output stage is inside the feedback loop the output voltage at the emitter of TR2 is precisely twice the voltage fed into the non inverting input of IC1b.

CURRENT LIMIT

A variable current limit is an extremely useful feature, especially when working on experimental rigs where a stray wire can cause catastrophic currents to flow, leading to scrapped projects. This facility can also be used to measure the exact value of electrolytic capacitors by using the formula $C=It/V$. The procedure here is to select a value of current I and time the period, t, required for the capacitor to charge to a known voltage V. This facility comes in very useful for selecting known values of C for timing circuits etc.

The current limit circuitry is somewhat unusual and slightly more complex than is normal. This is due to the adjustable facility. The current that flows into the load also flows through R7 and develops a voltage across it.

The output voltage from the supply is fed into the non inverting input of IC1d which forms a simple d.c. amplifier with a gain of two. In consequence the output of the amp. tries to reach twice the input voltage, but is prevented by D2 in the feedback loop, VR2, across the diode, samples the output voltage of IC1d which remains at 0·6V above the output voltage of the supply. The sample, from the slider of VR2, is fed into IC1c whilst the voltage across R7 is also fed into this amp. Because no feedback is employed the op. amp. acts as a comparator between these two voltages. When the voltage fed from the slider of the potentiometer is exceeded by the voltage across R7 the output of IC1c goes low, reducing the voltage at the base of TR1. At the same time current is drawn through D7 and R6 indicating the current overload.

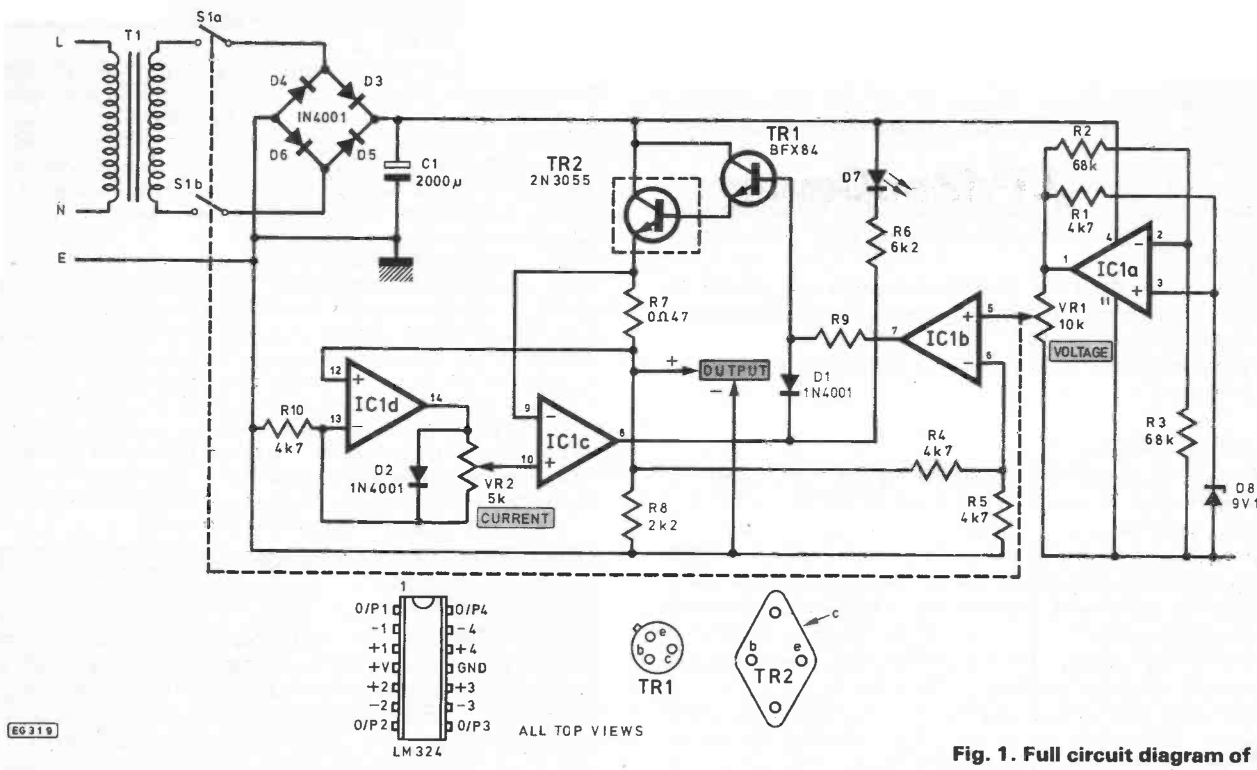


Fig. 1. Full circuit diagram of PSU

COMPONENTS . . .

Resistors

R1, R4, R5, R10	4K7 (4 off)
R2, R3	68K (2 off)
R6	6K2
R7	0·47 2½W w.w.
R8, R9	2K2 (2 off)

All resistors ¼W 5% unless otherwise stated

Potentiometers

VR1	10K lin. + d.p.s.t. switch
VR2	5K lin.

Capacitors

C1	2000μ/35V electrolytic

Transistors and Diodes

D1–6	1N4001 (6 off)
D7	0·125 inch l.e.d. + clip
D8	BZY88 9V1 Zener
TR1	BFX84
TR2	2N3055

Integrated Circuits

IC1	LM324

Miscellaneous

0·1 inch stripboard
T1 18V secondary at 1A mains transformer
Insulating kit and heatsink for TR2
3-core mains lead
2 × 4mm banana plugs and sockets
Case: Centurion Model 119

Since the voltage drop across R7 is directly proportional to the current being taken by the load, and since the pot track is linear, it follows that this can easily be calibrated.

CONSTRUCTION

Construction starts with the stripboard panel which is shown in Fig. 2.

This is fairly straightforward as long as care is taken to ensure that all the semiconductors are correctly inserted. Once completed, the board should be given a thorough visual inspection. Firstly, ensure that all the diodes are orientated correctly and that all the links are in place. Turn

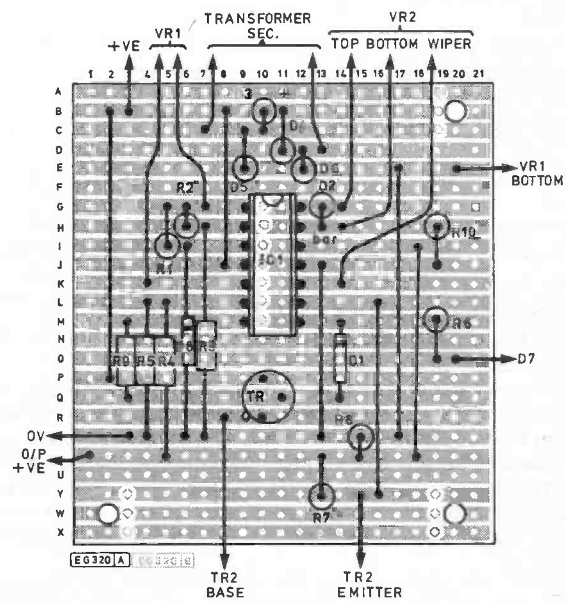


Fig. 2. Stripboard layout (actual size)

the board over and check that the breaks in the tracks are correctly made. Lastly, examine the soldered joints to make sure that none are "dry" and that none of the solder has bridged any of the tracks. Once satisfied that all is okay the flying leads should be attached. These need not be longer than 230mm.

Next, take the case and drill it to accept the stripboard, transformer and power transistor etc. The legends should now be applied with Letraset and fixed with a proprietary spray varnish.

When this is done the pots and sockets etc, should be mounted in their appropriate positions and the flying leads from the board terminated.

Having checked that all is well the circuit can be tried out and calibrated.

CALIBRATION

There is no reason why a milliammeter with a suitable damping resistor should not be used to give direct reading of the output voltage.

For this purpose a meter calibrated 0-3 is ideal. Meters though, are expensive and so in this design the equipment is calibrated by means of a multimeter, appropriate markings can be made around VR1 and VR2. Voltage calibration is accomplished simply by monitoring the output voltage with a multimeter and marking up accordingly.

The current limit control is calibrated by setting the output voltage to about 10V and connecting a multimeter across the output in the current measuring mode. This should be started with the multimeter switched to a range which will safely indicate in excess of 1A. From here the current limit can be calibrated downward, and with care, the calibration can be resolved to 1mA. Once this has been accomplished the power supply is ready to use. ★

News Briefs

MICROPROCESSOR COMPETITION WINNERS

ON MARCH 17th at a London hotel, awards were presented to the winners of the British Microprocessor Competition, sponsored jointly by the National Research Development Council and the National Computing Centre. Aimed at encouraging British innovation in the application of micro's in products and services, the event's 218 entrants were mainly private individuals, with the remainder from educational and research establishments.

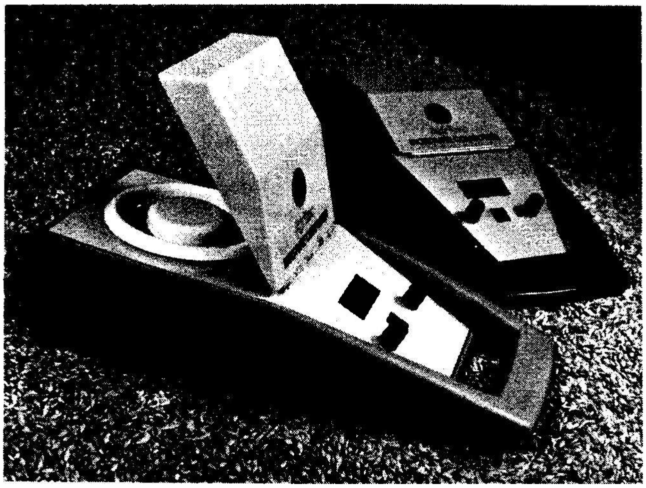
The first category required a working model and commanded a cheque for £10.000. The winner was Sinar Agritec Ltd., with a portable grain moisture meter. For second prize, £5,000 went to a research team from Manchester University Institute of Science and Technology. This was for an *easy-to-program* computer for numerical control lathes. To Grundy Terminals Ltd., went a cheque for £2,000 for their stock control system in which a light pen is used to select parts quickly from a set of diagrams.

Ideas on paper constituted the second category, and the first prize of £2,000 was won by MDB Electronics for a portable electrocardiograph. Mr. Christopher Goss claimed second prize for his voice synthesiser design for the severely speech handicapped. Using available synthesis chips, the microprocessor employs clever algorithms to produce complete sentences.

A special prize of £500 was also awarded to two pupils of the Royal Grammar School, Newcastle. Development to a deadline of their computer controlled theatre lighting system, and demonstration of it to the press after the award, undoubtedly gave Graeme Harker and Anthony McKay a valuable taste of the real world outside school. Using a PET, their system allows fingertip fade in/out of preprogrammed stage lighting combinations. Screen representation takes the form of a histogram to give instant visual status.

Sinar Agritec's grain moisture meter was a fine example of how a micro' can *simplify—not complicate*—the controls of a device. It uses a sensitive weighing mechanism, the technique of which was under wraps at the time of writing, and also measures temperature automatically. It then takes from the user via a simple control, the grain type being measured, to give an instant readout of moisture content. Capacitance is used to detect the moisture, and of course any presence of water affects the weight per given volume as well as the volume affecting the capacitance—it takes a micro' to sort all that out! Why moisture? Well, grain moisture needs to be known for storage preparation, harvest timing, malting processes, and pricing in commercial transactions.

British ingenuity continues to produce the goods!



Prototype Agritec Moisture Computer. The winner!

LONDON COMPUTER FAIR

THE North London Computer Club, having formed the *Association of London Computer Clubs,* has now arranged a London Computer Fair. This will be held at their home base, the Polytechnic of North London (opposite Holloway Road tube station), on July 11–12, 1980. The exhibition/bazaar will take place in the polytechnic's theatre between 10am and 5pm each day, with an admission fee of 50p.

Clive Sinclair will be opening the event on the Friday, when there will also be an *educational computing* Seminar. Saturday will include a commercial users "questions and answers" workshop, and an obsolete equipment bazaar, followed in the afternoon by a software and hardware jumble sale.

The event should suit the amateur, commercial user, and interested onlooker; because there will be retail exhibitors, club stands and "surgeries". Telephone Robin Bradbeer on 01-607 2789 for further details.

IEC CATALOGUE

THE INTERNATIONAL Electrotechnical Commission's 1980 edition of the Catalogue of Publications is now available in English and French. It contains a comprehensive list of international electrical and electronic standards adopted in over 100 countries. The IEC is based at 1 Rue De Varembé, 1211 Geneve 20, Switzerland.

MASTERTUNE

B. J. HAMILL B.Sc. Ph.D.

An aid for tuning up to six strings on a guitar

IT is a sad fact that many groups who think nothing of investing in kilowatts of amplification still rely on crude methods, or even on guesswork when it comes to tuning up.

The device described in this article is designed to simplify and improve the accuracy of guitar tuning. The circuit is crystal-controlled and generates six output frequencies corresponding to the six strings of a guitar, feeding these to a small loudspeaker, or, alternatively, to a pair of stereo headphones; in the latter modification, the spare channel of the headphones may be used to monitor the output of the guitar amplifier.

PRINCIPLES OF OPERATION

The circuit is basically a programmable frequency divider built round a 12-bit CMOS counter. The maximum possible output code from this counter therefore corresponds to decimal 4095, and division by any number up to 4096 is possible using suitable auxiliary logic. The frequencies required for the six strings of the guitar are listed in the table.

TABLE 1

Note	Frequency (Hz)
E2	659·25
B1	493·88
G1	392·00
D1	293·67
A0	220·00
E0	164·81

The six strings and their frequencies

DIVIDER LIMIT

The operating frequency limit for CMOS devices is of the order of a few megahertz, but power consumption rises sharply as the upper limit is approached. For this reason, the input frequency to the divider was limited to 1MHz.

The maximum permissible error in frequency which will remain undetected even by the most expert musician is of the order of 0·05 per cent of the true frequency. Table 2 lists the division ratios required to generate the frequencies in Table 1; the maximum relative error is well within the required limit.

TABLE 2

Divisor	Output Frequency (Hz)	Relative Error (%)
759	659·03	0·03
1013	493·78	0·02
1276	392·01	0·002
1703	293·71	0·01
2273	220·06	0·02
3035	164·81	0

Division ratios to produce the frequencies

THE CIRCUIT

The astable formed by IC8c and IC8d feeds pulses to the twelve-bit counter IC1. The output code from this counter passes to the six 8-input NAND gates IC2–IC7, the outputs of which go low when the following codes appear on the outputs Q1–Q12 of IC1.

NAND Gate	Code Q1–Q12	Decimal Equivalent
IC2	011011110100	758
IC3	001011111100	1012
IC4	110111110010	1275
IC5	011001010110	1702
IC6	000001110001	2272
IC7	010110111101	3034

Codes which drive the NAND gates low

One of the outputs of IC2–IC7, selected by S2, is inverted by IC8b which controls IC9a; this flip-flop is positive-edge triggered, while IC1 is negative-edge triggered. When IC1 reaches the required count—on the falling edge of the clock pulse—the output of IC8b goes high, taking the "D" input of IC9a high; this means that, on the next rising edge, $\overline{Q}$ of IC9a goes low for the first time in the count cycle. This output is NORed with the clock pulse by IC8a, so that the output of IC8a is high during the next low period of the clock, and this resets IC1 one pulse after the selected count is reached.

The output of IC8a passes to IC9b, in which "D" and "$\overline{Q}$" are interconnected, and which therefore functions as a

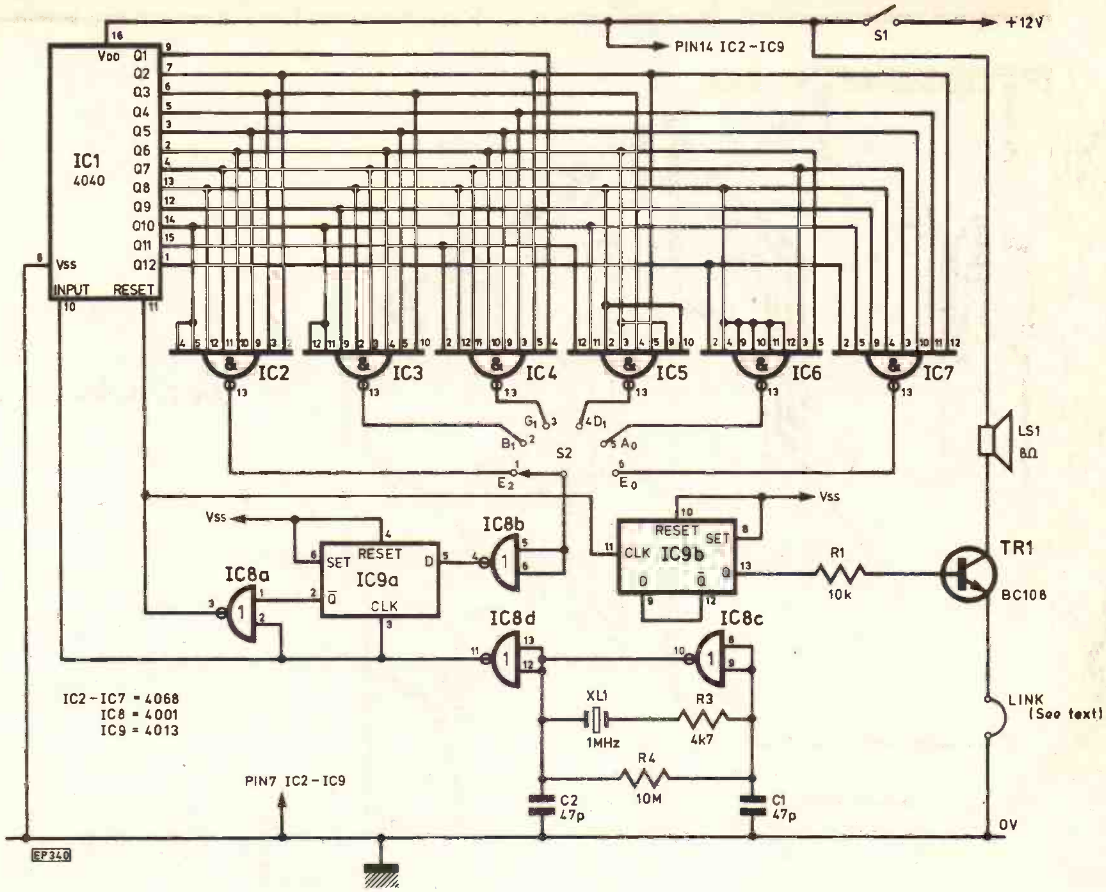


Fig. 1. Circuit of Mastertune.

divide-by-two stage, providing the required output frequency according to the setting of S2.

CONSTRUCTION

As will be apparent from the circuit diagram a large number of interconnections are required for this device, as the outputs of IC1 must feed six 8-input NAND gates. It would, of course, have been possible to get away, with just one NAND, a 6-pole 8-way switch, and 48 bits of wire. The CMOS way, is however, easier, cheaper and more reliable.

To simplify the interconnection problem, a double-sided p.c.b. is used. If you do make it yourself, a few hints may be useful. Start by really cleaning both sides of the board thoroughly with a non-abrasive cleaner. Then coat one side of the board with masking tape—it's a good idea to run round the edges with a resist pen before doing so. Now lay out the resist pattern for side one of the board—and don't etch it till you're absolutely sure it's right—remember, mistakes count double!

Once side one is o.k., drill through those holes which also have connections on side two, and any holes which involve components other than i.c.s—including the connecting wires to the switches, etc. When that's done, draw out the resist for side two, using the drill holes as points of reference, and taking care to avoid any other holes in the vicinity. Now side one gets the masking tape treatment, and side two is etched, after which we're almost there!

All that now remains to be done is to connect sides one and two, and drill the remaining holes. Any connections to i.c.s, supply lines etc., should be soldered on both sides of the board, where appropriate—if socket pins are used, this is

COMPONENTS

Resistors

R1	10k.	$\frac{1}{4}$W	10%	
R2	10Ω	$\frac{1}{2}$W	10%	or link (see text)
R3	4k7	$\frac{1}{4}$W	5%	
R4	10M	$\frac{1}{4}$W	10%	

Capacitors

C1, C2 47pF polystyrene

Switches

S1 Single pole single throw
S2 Single pole six way rotary

Semiconductors

TR1 BC 108 or BFY 50 (see text)
IC1 4040
IC2–7 4068
IC8 4001
IC9 4013

Miscellaneous

Loudspeaker (8 ohm). 1MHz crystal. Two 6 volt batteries or a 12 volt power supply. Verocase 202. Soldercon pins.

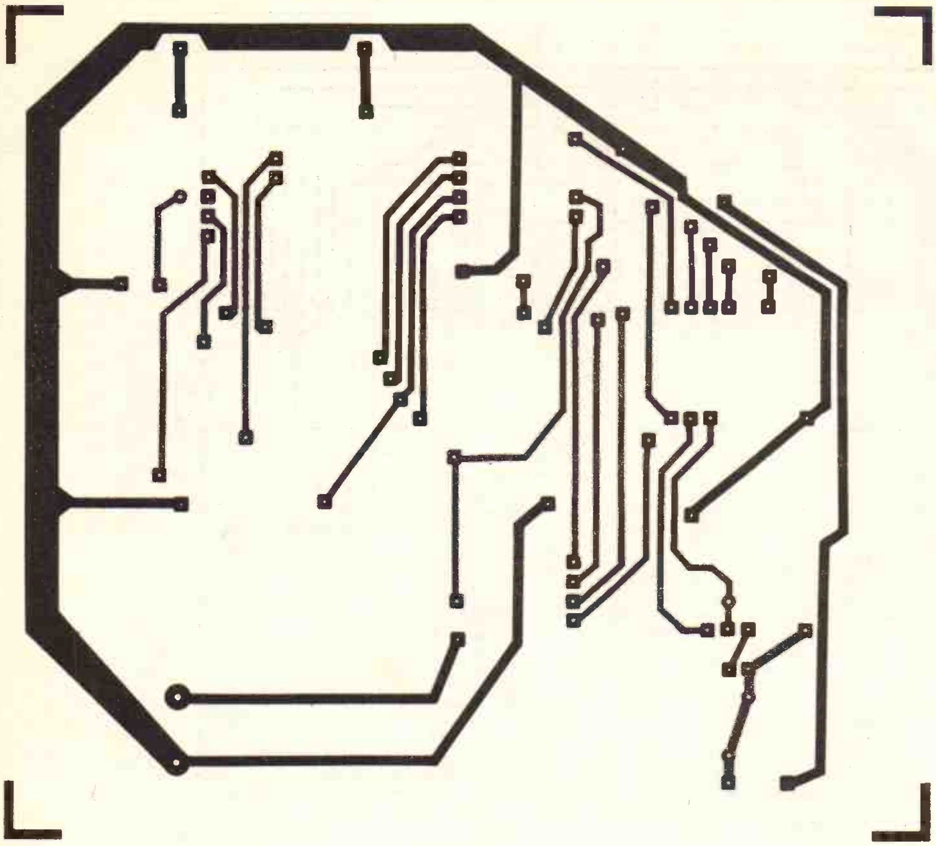


Fig. 2. Topside of p.c.b.

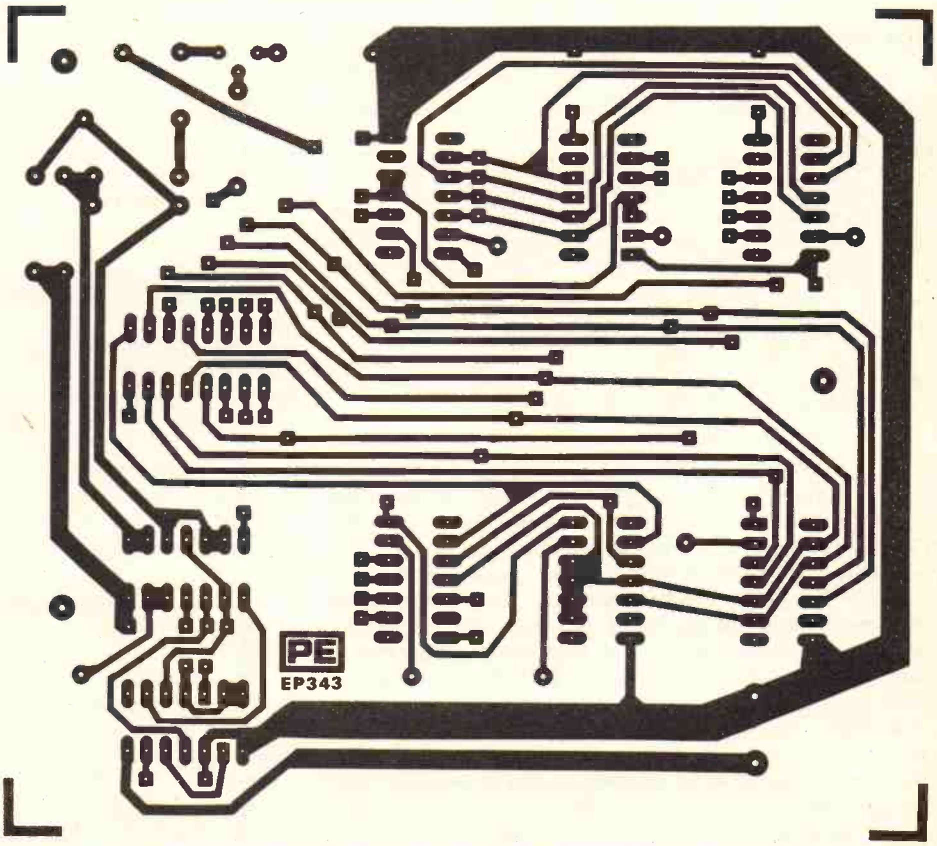


Fig. 3. Underside of p.c.b.

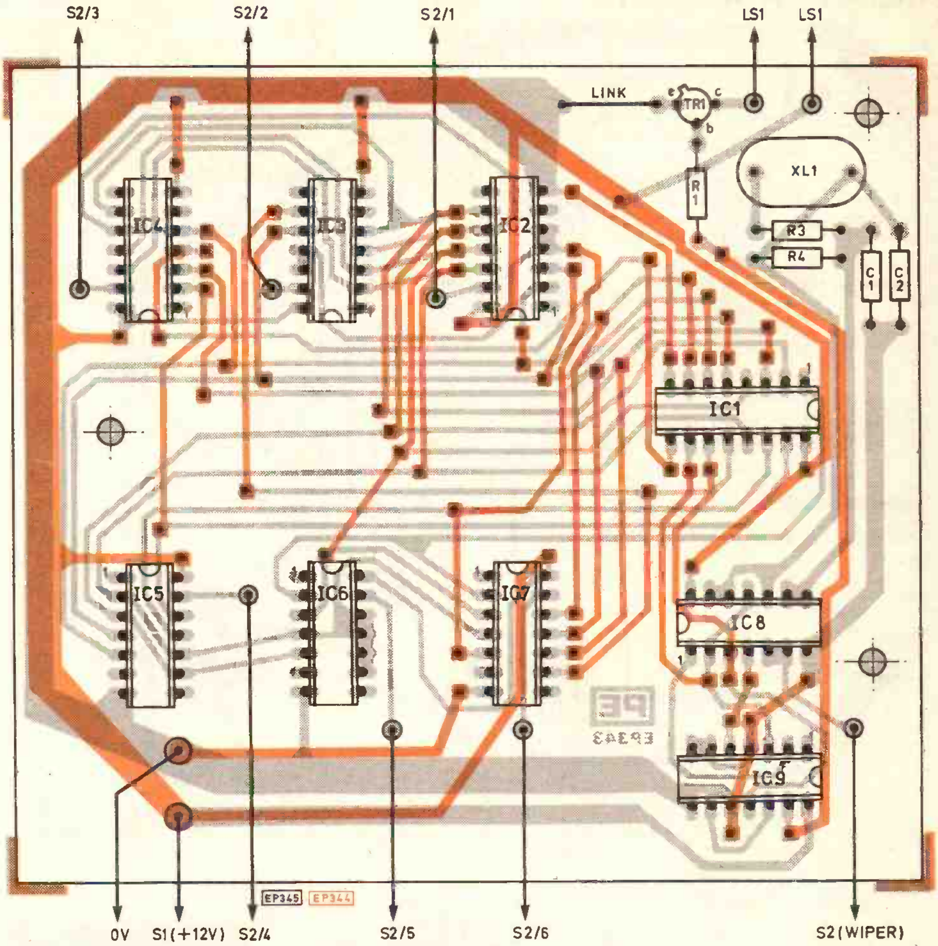


Fig. 4. Component overlay of p.c.b.

no problem. The remaining connections on side two, apart from the output common to the loudspeaker (this powers IC's 1 and 8 on the other side) are associated with the outputs (Q1–Q12) of IC1. All these connections must be wired through the board, and all the lines except Q12 have at least one such connection. It's worth noting that the output lines from IC1 are arranged in numerical order (Q1–Q12) on side one of the board, working downwards so that players of more exotic stringed instruments need not feel left out.

FREQUENCY

The formula for calculating the frequency is

$$\frac{5 \times 10^5}{N} = x \text{ Hz.}$$

where x is the required frequency and the logic gives a low input to IC8b when the count on IC1 reaches N-1.

The power supply required for satisfactory operation of the crystal oscillator is 12 volts. In the prototype, a small transformer and bridge rectifier was used, but a pair of small 6-volt batteries can be squeezed into the case. If a mains power supply is used, make sure that the positive line is earthed, as this is also the common terminal of a stereo jack socket if used for connection to an external guitar amplifier. The BC108 specified will drive a single eight ohm headphone at reasonable volume, but if connection to several sets of headphones simultaneously is required, TR1 should be a BFY 50, and R2 should be inserted in place of the wire link to avoid overrunning the transistor.

The completed Mastertune unit

CASE

The case used for the prototype was a Vero case 202, and this provides room for the p.c.b. and a small power pack or small batteries. If several output sockets are to be fitted, or if larger batteries are required, a larger box should be substituted.

In the prototype, the power consumption, driving a single eight ohm loudspeaker, was about 12mA. ★

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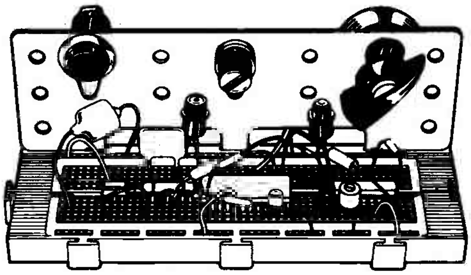

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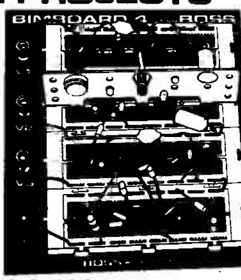

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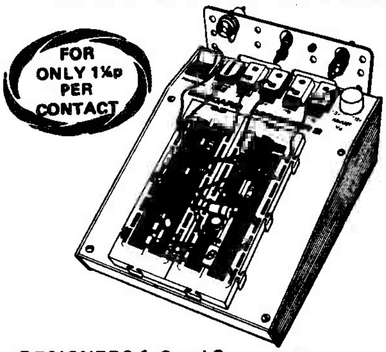

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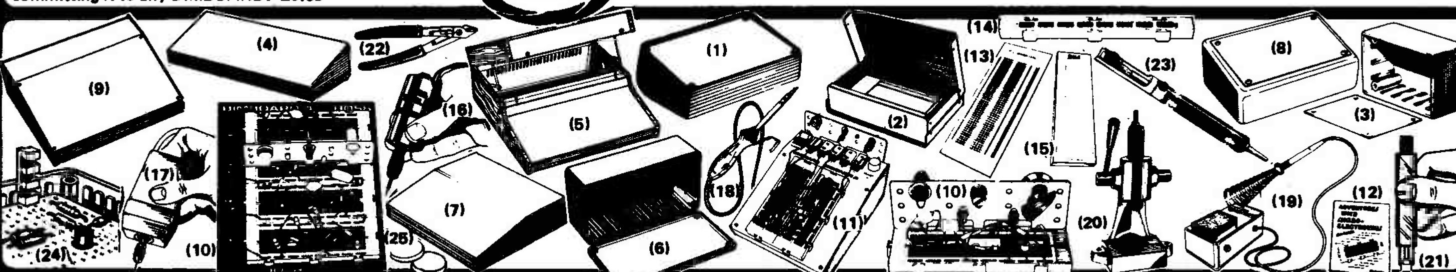

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FRANK W. HYDE

THE STUDENTS SATELLITE

The National Aeronautics Space Administration (NASA) will provide space for a piggy back load on board the Thor-Delta vehicle which will carry the Solar Mesosphere Explorer. The piggy load is the student satellite Uosat. This is the first satellite to be completely built by a college as a project. The University responsible is Surrey, in conjunction with the United Kingdom branch of the Amateur Satellite Corporation (Amsat). The project has backing from the British Aerospace industry.

The launch is scheduled for September 1981, in a planned orbit which will be polar at a height of 530km. The principal objective of Uosat is to afford radio enthusiasts with the means of studying the propagation of radio waves in the ionosphere. To this end Uosat will be equipped with radio beacons operating at 7, 14, 21 and 28 MHz popular amateur operational bands. The satellite will also have on board radiation counters and a three axis magnetometer supplied by a United States enthusiast. The initial design has already been completed by the University of Surrey. British Aerospace Dynamics have undertaken the structural analysis. Ferranti Ltd have provided a prototype low power mini-computer and the Science Research Council have donated solar cells which were left over from UK-6.

The satellite is being built in three stages. The first is the breadboard which is expected to be completed by August 1980. The engineering model stage should be completed by December this year. The flight model has then to be completed by August 1981. The arrangements for testing have already been made which will include the thermal and vibration stress conditions. The budget for the project is very small by ordinary satellite standards—some £85,000. This, however, is supplemented by the aid being given by industry. It is, however, a reminder that the amateur eventually invades every field of human endeavour with a major contribution to the furtherance of knowledge.

HIPPARCOS

Hipparcos, named after a Greek astronomer who lived about 200BC, has been chosen by the European Space Agency as a new astronomy vehicle. Its principle object will be Astrometry. This is the measurement of star positions and their velocities. Hipparcos is expected to provide data on the Big Bang. The proposal at the moment is to put it in a geostationary orbit in mid 1986. The cost of Hipparcos and its payload is expected to be around £80 million. The mass would be 375 kilogrammes, of which some 120 kilogrammes would be experimental payload. It would be launched by an Ariane launch vehicle and will have a design life of 2·5 years.

If, however, the United States decide after all to fund the Halley comet mission then Hipparcos may be delayed, for the European Space Agency will want to participate in the mission.

JAPAN'S LOSS

The experimental Comsat which the National Space Development Agency (Nasda) launched failed to reach its orbit and was lost. This is the second failure that Japan has suffered. The satellite ECS-b was launched from Tanegashima on February 22. The boost motor, to inject it into the geostationary orbit planned, fired three days after launch but after only 8 secs. into the burn the satellite was lost. This suggests that the boost motor exploded.

SOVIET ACTIVITY

A survey of the Soviet Space Programme compiled from a number of sources establishes a fairly good picture of the next several years of progress. It is expected that there will be extensive manned space activity. The development of their sychronous orbit communications systems and the expected flights to Venus seem to be major activities. Although it is not known for certain whether they have a plan for a shuttle like programme, this cannot be ruled out. In view of the special development of the remote controlled vehicles which they have and the expertise they have attained in the man-machine interface operations, they must be near to a reusable winged vehicle, which will probably emerge during the next five years. At the moment the re-usable vehicles used as transports have shown the viability of the design, and costs must already be cut considerably. Using expendable boosters it may well be that a boost launch and a winged return will be achieved during the next decade. An important point to be borne in mind is their techniques of hard landings. Given the ability to get off with large loads, they may already have conceived a design for a controlled motor return. The modular system they have makes simple add-on standard units a simple and easy build up to extensive space stations, any of the units of which could successfully return.

In December last a new Soyus T was launched. This is an up-dated manned transport compared with the earlier Soyus spacecraft. It would not be difficult to speculate what might be done towards a return unit. One of the new units they have is the Proton booster. For the third time the Russians repeated during 1979 a mission using the Proton booster to carry two vehicles into orbit. In each case they made only one or two revolutions before being returned. The recovery in each case was around dawn. The latest mission of this kind involved Cosmos 1,100 and Cosmos 1,101. This was during May 1979. The analysis of these missions made by the United States showed that they were part of a manned space flight programme, but the nature of the flights have not been determined.

VENUS MISSIONS

The USSR plan two missions to Venus—one in 1981 and another in 1984. They will have acquired a substantial amount of data before the next United States mission in the late 1980's. For the 1981 mission there will a dual lander surface imaging type similar to the previous ones with the Venera 9 and Venera 10. In the 1984 mission they will cooperate with France. The plan on that occasion will be to use balloons to carry gondolas into the Venusian atmosphere.

LUNAR MISSIONS.

It is now several years since there has been a lunar mission and it does not appear that any such missions are being planned at the moment. It would seem that a lunar landing is not part of the Russians' programme.

RESOURCES RESEARCH SPACECRAFT

Last year a series of missions began with what the Russians called Ocean Resources spacecraft. Cosmos 1,076 was launched into an orbit, near circular and inclined at 82 deg. It was relatively heavy and launched by a booster similar to military designs. This was in February 1979. In May and October (or between those times) a series of missions were flown in a rather unusual manner. They were earth resources missions and seemed to be related to the crop seasonal time. Ten spacecraft were launched and recovered after flying at the inclined orbit of 82 deg. All of them had a photographic task as a declared object. The United States do not rule out military objects as well. There have indeed been many military missions but this is not of course known in detail.

Undoubtedly there will be much space station activity. The deploying of large structures must be expected, first of all large antennas. It has always been a feature of Soviet plans to use space 'platforms'. In personal discussions with the space people before the Apollo missions it was revealed that Soviet plans for manned planetary landings revolved around space platform facilities. They now have the capability of carrying out such missions. During 1980 a new vehicle, a more highly sophisticated Salyut will be launched. This is intended to step up the activities.

In recent years the number of launches has been very high as shown by the following figures:— 1978-88, 1977-98, 1976-99, 1975-89. In 1979 the launches amounted to 87.

The proposals and trends of both the USSR and the USA will be given in some detail in the next issue of Spacewatch.

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.

Velikovsky versus Hyde

Sir,—As a regular reader of Frank Hyde's *Spacewatch* I was saddened to read his April column, wherein he chose to join the ranks of the many who try to pre-empt any objective evaluation of the theories of Velikovsky. His use of such words and phrases as "bizarre", "gullible", "no basic credibility" does no service to himself nor to the pursuit of science. His contribution to the debate on the assessment of veracity in science is minimal. The acceptance of a theory by the majority is not necessarily proof of its veracity. The heliocentric theory of the solar system has not always been accepted in the Western world. The speculations of Hyde may appear to be bizarre to some not versed in current theories of the origin of the Solar System but such a feeling is neither proof for nor against such a theory. If it should transpire that observations from probes and results from computer modelling and simulations come up with some conclusions that were predicted by the Velikovsky model(s) then why should he not be extended the courtesy of having his precedence acknowledged?

I look forward to a reasoned argument from Hyde for the rejection of the Velikovsky theory so that I may resolve my own uncertainties about whether to acept Velikovsky or reject him. So far, his opponents, in resorting to argument by value-judgement words and sometimes not very honourable behind the scenes lobbying, have failed to help me resolve my conflict.

Perhaps we should remind ourselves that computers, in general, only come up with the answers that are predetermined by the program they obey. Those that don't have not yet been made!

W. G. C. Austin,
Newcastle-upon-Tyne.

I am sorry that I have offended Mr Austin by my remarks in the April issue. However, there is no difficulty in dealing with the Velikovsky claims which have increased over the past decade. To do so in a short letter would be difficult, for when someone puts forward a point of view which stems from a conviction that the Earth came into being less than 4000 years ago, a good many words are required to show the many facts against such a view. Indeed my own small attempt has already run into many thousands of words.

Mr Austin takes me to task for the statement in April Spacewatch which dealt with another aspect of the past history of the solar system. His statement that Velikovsky's 'predictions' might be confirmed puts him in rather a difficulty because Velikovsky does not believe that there was a system before 1500 BC or thereabouts. The fact is that there have been statements and speculations by astronomers and physicists (who do not claim them as 'predictions') that have proved to be valid. In the case of the radiations from Jupiter, I too can point to certain statements made by myself which were later proven. These statements are in fact a direct rebuttal of the 'predictions' made by Velikovsky. Mr Austin has asked for reasoned argument for the rejection of Velikovsky claims but he does not say which of the claims he means. I will gladly answer any questions if Mr Austin will formulate them.

It is difficult to understand sometimes why people assume that when a theory is challenged it is the challenger who is the persecutor. It is true that when Velikovsky came into the academic eye he was very badly treated but this has long passed and great efforts were made to give him a fair hearing by many eminent academics. This reached a peak when he was offered the freedom of the American Association for the Advancement of Science in 1974, he did not accept the opportunity so far as astronomy was concerned but dealt only with his theories of the loss of several hundred years of Egyptian history.—Frank W. Hyde.

On the fence?

Sir,—Although I follow your editorial argument with "Disgustedly", in *PE* of March 1980, have you not rather missed the essential point?

The projects you describe are the major feature of your magazine, and of course "Practical etc" means you expect us to make them. It is not really part of the exercise to ferret out who supplies the essential bits. I find that I can spend upwards of a £1, i.e. more than the cost of the magazine, merely to identify suppliers, and on top of that there is post and packing, minimum order charges and so on. Whilst, therefore, I agree with your policy not to mention specific companies etc., whose side are you on, the suppliers or the readers? Surely, anything you can do to ease our identifying the supplier must increase the numbers of readers actually making your projects?

If, for example, you "encouraged" suppliers to advertise that they will supply all the parts for a project, as do some of your "Practical" colleagues, even though such suppliers might charge a bit more it would probably still be cheaper and certainly as competitive than the present system.

In short, you really must come down off that fence and decide whose side you are on. The dealers can have no grounds for complaint, especially if more projects are made, and since at the very least it would save them the labour of packing tiny parcels of parts. The only complaint possible would lie with the Post Office, and even there the reduction of parcels might even speed the posts, not to mention the many letters of enquiry and reply, so you might even be doing something of national importance as well as for us.

D. Hart,
Aylesbury.

Might we suggest that with a collection of three or four catalogues from mail order suppliers most of your component buying problems will be solved. We are sure that you will be able to get parts for nearly all our projects from one supplier. We do of course encourage suppliers to advertise kits, and we also send out p.c.b. artwork and issue copyright licences to any companies requesting them. As you say you agree with our policy, we cannot understand what it is you want us to do. We are already quoting suppliers where we anticipate difficulty—so, what fence? and where are the sides?—Ed.

The Ultimate CPU

Sir—On reading about such devices as the IU 101 microprocessor (April p. 24) one really begins to wonder what these semiconductor experts will think of next!

However, I have to tell you that even this amazing device is far from being the most powerful machine of its kind. Another CPU exists against which the IU101 seems puny by comparison, and what is more, was being mass-produced in vast quantities long before the IU101 had ever been thought of!

I enclose details of this amazing device as published in the journal of the Southampton University Computer Club.

SYSTEM SPECIFICATION

Available now! Hybrid parallel processor, combining the benefits of both digital and analog techniques. The whole system presents an incomparable processing capability, the great store capacity alone renders all present machines obsolete.

TECHNICAL SPECIFICATION

Total store:

10^{799} Bytes!. Although the actual core storage available to the user is lower than this figure, which includes peripheral handling and a number of pre-programmed system macros.

Speed:

Absolute figures are difficult due to the nature of a parallel processor. However, individual operations can take from 1·5 s to as long as 12 s. This slow speed is not a real disadvantage in real-time situations as complex network operations can take as little as 90 secs. to complete.

Data Busses:

Analog data is handled by the processor by frequency modulated sawtooth impulses. Two types being provided; slow carrier (150-300 Hz) with an amplitude of 200μV and fast carrier (1-2 kHz. typ.)

Environment:

Humidity tolerance 0-100% with little reduction in efficiency at extreme levels.

Ambient temperature:

310 ± 0·7K Peak efficiency

310 ± 5K Maximum tolerance

Pre-programmed temperature macros are available to ensure system stability. Power: Supplied by the processor's own 'fuel-cell-technology' modules. Running costs are negligible. Maintainence: minimal, should last a lifetime.

Peripherals:

The unit comes ready wired with a wide range of peripherals: Optical character readers, A/D Auditory convertors for verbal input, Vocoder and slow speed hard copy facilities.

General:

Weight is minimised by molecular microcircuit techniques (typical weight of the CPU without peripherals is only 1·4 kg.). The CPU itself comes ready cased (150 × 200 × 150 mm typ.)

Needs to sleep!

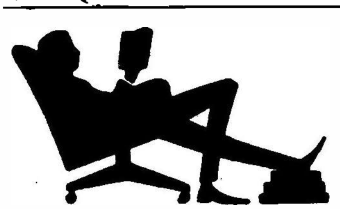
Unfortunately this incredible device does not constitute a 'first' for British technology. Although the Designer was at one time thought to be an Englishman, He is now considered to be of extra- terrestrial origin.

C. R. Harris,
Brighton.

Countdown

Hevac (heating and air conditioning) May 19–23. NEC.
International Word Processing (Exhibition and Conference) May 20–23. Wembley Conference Centre. **O**
East Suffolk Wireless Revival May 25. Grounds of Ipswich Area Civil Service Sports Association, Straight Rd., Bucklesham. **V1**
Electronic Hotel June 4–5. West Centre Hotel, London. **Z1**
Satellite Communications (Conference) June 18–19. London Press Centre. **O**
Great British Electronics Bazaar *cancelled*
Intel Fair June 24. Wembley Conference Centre, London. **U**
The Energy Show June 24–26. National Exhibition Centre, (NEC), Birmingham. **Z1**
Tempcon July 1–3. Wembley Conference Centre, Exhibition devoted to temperature control & measurement. **T**
Transducer July 1–3. Wembley Conference Centre. **T**
Microsoftware (symposium) July 7–10. University of Sussex. **S1**
The 1980 Microcomputer Show July 10–12. Royal Lancaster Hotel, London. **O**
BAEC Amateur Electronics Exhibition July 12–19. The Esplanade Shelter, Penarth, near Cardiff, S. Glam. **B**
Computer Graphics (exhibition & conference) Aug. 12–14. Metropole, Birmingham. **O**
Harrogate International Festival of Sound Aug. 16–19 (18 & 19 trade). The Exhibition Centre + hotels. **X**
Edtech Aug. 19–21. Holland Park School, London. **C1**
Laboratory Sept. 9–11. Grosvenor Ho., Park Lane, London. **E**
Intron 80 Sept. 9–11. RDS, Dublin. **V**
West of England Electronics Exhibition Sept 9-11. Bristol Exhibition Centre **Q**.
Avionics (symposium) Sept. University of Surrey. **S1**
BEX (Business Equipment Exhibiton) Oct. 1–2. The Guildhall, Plymouth. **K**
BEX Oct. 15–16. Assembly Rooms, Edinburgh. **K**
Engineering Ireland Oct. 15–18. Leopardstown Exhibition Centre. **V**
Testmex (exhibition and conference) Oct. 28–30. Wembley Conference Centre. **T**
Compec Nov. 4–6. Olympia. **Z1**
BEX Nov. 5–6. Sophia Gardens, Cardiff. **K**
Semiconductor International 80 November 25–27. Metropole Convention Centre. **T1**
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**

B British Amateur Electronics Club, 26 Forrest Road, Penarth S. Glamorgan.
E Evan Steadman. ✆ 0799 22612
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth
O Online Conferences. ✆ 0895 39262
Q Exhibitions For Industry Ltd. ✆ 08833-4371
T Trident International Exhibitions. ✆ 0822 4671
U Brian Crank Associates, 58 London Rd., Southborough, Kent. ✆ 0892-31812 38414
V SDL Exhibitions, 68 Fitzwilliam Square, Dublin.
X Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ✆ 0423 62677
C1 Stereoscopic Television Ltd., 41/43 Charlbert St., St. John's Wood, London NW8 6JN. ✆ 01-722 4139
S1 Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351
T1 Kiver Communications U.K., Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX.
V1 Jack Tootill, G41FF, 76 Fircroft Rd., Ipswich, Suffolk IP1 6PX. Send s.a.e. (9 × 5 ins.) for details.
Z1 IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636.



BOOK REVIEWS

THE COMPLETE BOOK OF ELECTRIC VEHICLES
By Sheldon R. Shacket
Published by Davison Publishing Ltd.
168 pages. 215 × 280 mm. Price £3·95.

THIS book is packed with photographs and facts recording man's endeavour to go electric on the roads, both past and present. The pages are full of surprises, such as, that a *non-rechargeable* electric car was designed and built as far back as 1834. Even more surprising is the description of an era of thriving production-line electric cars which came and went in the USA around the turn of the century. There is a picture of a delightfully elegant Detroit Electric car of 1915 which had range and speed capabilities as respectable as many of today's efforts. That a *past* generation had elevated the state of the art to such a height, gives the electric car advocate a sense of *loss* when reading through early pages.

The incongruity of the space-aged bullet-shaped cars with top speeds of only 50 m.p.h. seen towards the end of the book, make you think that perhaps even *modern* electric vehicles should have the "vintage" look as part of their selling attraction.

Just as the relative economics of the internal combustion engine eclipsed the electric chariot in the "first round", now, in 1980, it could be these economics which depose the i.c.e. driven vehicle. The book helps you judge for yourself the possibilities ahead, because just about every prototype or production vehicle to be built, in just about every country in the world (with an emphasis on the USA), seems to be described. The work of private individuals as well as the big conglomerates is represented, invariably with exciting pictures.

Electric bicycles are shown, monorails and rapid transit systems, commercial vehicles, and, there are two chapters devoted to the principles of electricity and motors in the context of electric transport. To put matters into a final perspective, the world's various energy sources and alternatives are discussed. This material is sure to rivet the enthusiast to many hours of reading, its prime revelation being just how much research and prototyping is going on in the field.

It is refreshing to see such a busy catalogue of innovation centred on the motor car, the industry of which seems to regard progress as primarily bashing out the body shell to a different shape and spraying it a different colour. The ancient petrol engine will eventually be *drummed* out, and more and more motorists will cease to be seduced merely by the chromework. If you read this book you will be among them! It is well researched, and excellent value for money.

M. A.

COLOUR BLINDNESS

Dr. Janet Vokes

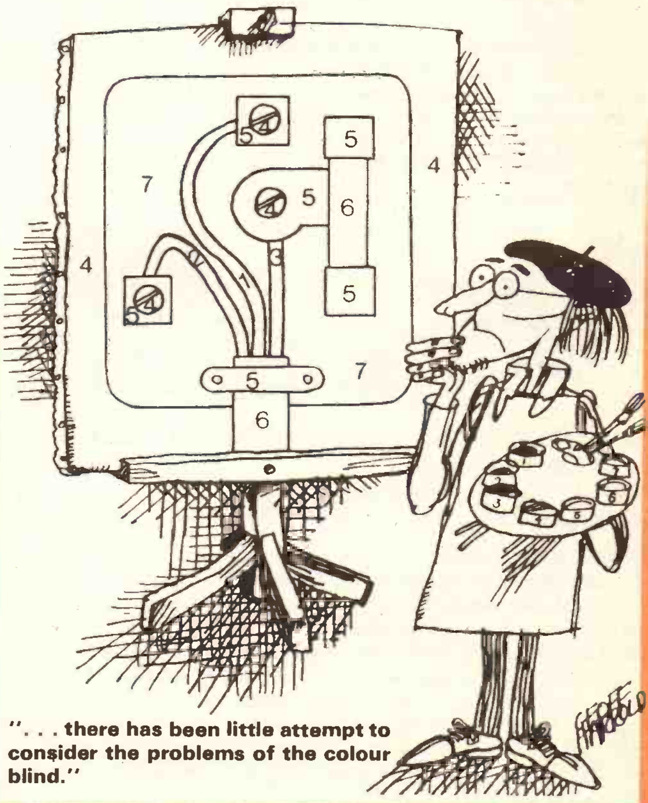
COLOURS and how we see them, have intrigued the layman and specialist alike for many centuries. Scientists and technologists from a wide variety of fields must consider colour in industry for standards and specifications. Designers and artists, photographers and sales staff are just some of the professionals who must have a critical eye for the many hundreds of hues that the eye can detect. Colour is used extensively to aid identification and code information in commerce, industry, education, navigation and military spheres. In many cases the correct identification of a colour code is essential for safe and efficient work; mistaken identity could result in serious accidents, not only to an individual and his immediate colleagues, but in the case, for instance of electrical wiring, to all who subsequently operate the hardware.

Although most of us enjoy a remarkable sense of colour appreciation it is often forgotten that one in twelve men, accounting for eight per cent of the male population, have varying degrees of difficulty with colour identification. Only in extreme cases are those individuals truly blind to colours, as they are often so unfortunately labelled, but instead a whole range of colours, particularly the reds, browns, oranges, yellows and greens, appear as a single sensation to their eyes and this may have significant and even dangerous consequences.

Over two million men in Britain alone may be at risk at home and at work from this common handicap; in the electronics field these errors in colour identification are most noticeable. Yet despite the reliance upon the visual sense for the identification of cables, wires and electronic components, there has been virtually no attempt by safety groups and manufacturing organisations to consider the problems of the colour defective individual. The new coding system for flexible domestic wiring is less confusing for the colour defective, but when the history is traced it becomes clear that standardising bodies and professional associations have rarely given this consideration major priority. It is disturbing that many manufacturers take no measures to screen prospective employees with colour vision tests. As a result, in at least one major company in the UK a large quantity of colour-coded capacitors had to be discarded recently because the wrong coloured stripes had been applied to the components by a colour defective operative. The financial and social consequences of such mistakes can be considerable. It is disturbing to consider the number of colour blind electricians who could make fatal errors simply as a result of mistaken colour identification.

HOW WE SEE COLOURS

Ever since Sir Isaac Newton's famous discovery at Cambridge of the nature of colour in the seventeenth century, the splitting up of white light by a prism into the seven spectral colours, there have been a great many theories about how we perceive such a wide gamut of hues. Scientists began considering the mechanisms of human colour perception seriously around the time when there was a concentrated effort to understand energy in all its forms, in Britain at the beginning of the nineteenth century. It is important to remember that we are dealing with a narrow bandwidth (the visible range) of electromagnetic radiation which shares a number of common features with the shorter wavelength ultra-violet, x-rays and gamma rays, and the longer wavelength infra-red radiation, microwaves and radio waves. As Newton first pointed out "the rays are not coloured themselves". Colour sensations result only as a consequence of the interaction of light energy with the eye's light sensitive chemicals which lie in the retinal cone-like recep-



". . . there has been little attempt to consider the problems of the colour blind."

(Reprinted with permission from Electrical Review) tors, and the brain's 'translation' of the coded message; colour is a truly perceptual phenomenon.

Around 1850 James Clark Maxwell, a Scotsman and one of the greatest theoretical physicists of all time, experimented with the additive mixing of colours. He showed that yellow could be produced by combining red and green lights in equal proportion, and white when all three "primaries" were added together.

Since Newton had shown that colour was not a property of the light itself, it was suggested by Sir Thomas Young, at the turn of the nineteenth century that the trichromatic nature of colour must be associated with the eye. Young had suggested that three photo-sensitive receptor mechanisms, responding maximally to red, green and blue light were involved, and later the German physiologist and physicist Herman von Helmholtz refined this basic idea suggesting that a definite overlapping of the sensitivities of the three mechanisms would allow the coding of all colour sensations.

It was almost a hundred years later that the existence of three kinds of chemicals in the monkey and human retina was substantiated by two independent groups working in the USA in the mid 60's and physiologists in Britain working at Cambridge and London Universities analysed the light reflected back from the living eye to confirm this theory. The coding of colour signals in this trichromatic form at the retina is similar to the principle of colour television, with a separate coding for luminance or brightness data. Beyond the retina the signals (which are converted from a chemical to an electrical form at an early stage in the receptors) are paired in an opponent (red-green, blue-yellow, black-white) manner, and remain in this form until they are interpreted in the visual centres of the brain; this format is also akin to the transmission of colour television with its economical use of band-width space.

FAULTS IN COLOUR PERCEPTION

The fault of defective colour vision is thought to lie at an early stage in the retina with some change in the photo pigments being responsible; more frequently the red and green channels are affected. Where one photo pigment mechanism is inoperative or absent the colour perception is considered to be *dichromatic* (two colours). *Monochromatism* (total colour blindness involving perception restricted to black and white) is rare in an inherited form. *Anomalous trichromats* are less severely handicapped, having the three pigment groups present but one is defective; these account for about 5 per cent of the total, dichromats make up the remainder. Depending on whether the red, green or blue channel is affected the Greek terms protan, deutan and tritan apply respectively. A mild green defective is medically known as a deuteranomalous trichromat; the more severe form being a deuteranope. A mild red defective is called a protanomalous trichromat and the red deficiency is known as protanopia.

Although colour vision defects are classified into convenient groups a whole spectrum is met in practice. Pale or desaturated colours present the trichromat with problems, whereas trouble with deep hues is typical for the more severe defective. Common confusions will be discussed later.

Colours Presented ↑ / Colours Named →	White	Black	Grey	Brown	Red	Orange	Yellow	Green	Blue	Violet	Silver	Gold
White	100											
Black		100										
Grey			63	2	6			8	5	14		
Brown		1		48	13	1		35	1			
Red		1		27	53			9	2			
Orange				1	3	82	11	2				
Yellow							100					
Green			4	22	7		2	62				
Blue									100			
Violet			8					1	51	40		
Silver											100	
Gold												100

EG322

Percentages given are to the nearest per cent.

Colours completely missed by Deuteranopes

Brown not seen on Brown	3%
Red not seen on Red	4%
Red not seen on Brown	3%
Green not seen on Brown	3%
Grey not seen on Brown	3%
Orange not seen on Light Brown	2%

Table 1. Errors in naming bands on resistors made by 16 green blind observers (deuteranopes). From a study by Voke (1976).

Colours Presented ↑ / Colours Named →	White	Black	Grey	Brown	Red	Orange	Yellow	Green	Blue	Violet	Silver	Gold
White	100											
Black		100										
Grey			83	2				2		11		
Brown			1	79	5			15				
Red				4	91	2		1				
Orange					3	96	1					
Yellow							99	1				
Green				4	2			94				
Blue									94	6		
Violet			4					2	15	79		
Silver											99	1
Gold												100

EG323

Percentages given are to the nearest per cent.

Colours completely missed by Deuteranomalous trichromats.

Brown not seen on Brown	1%
Grey not seen on Light Brown	1%
Grey not seen on Brown	1%
Red not seen on Red	1%
Red not seen on Brown	2%
Green not seen on Brown	1%

Table 2. Errors in naming coloured bands on resistors by twenty-two green weak observers (deuteranomalous). From a study by Voke (1976).

ACQUIRED DEFECTS

Faults in colour perception are usually inherited and of the red-green variety but cases of acquired colour deficiency can arise during life, accompanying a disease or resulting as a side-effect of medication or toxic poisoning and they can involve blue vision. The elderly are particularly susceptible, and there is, in any case, a gradual deterioration in colour vision after the fourth decade. Multiple sclerosis, diabetes mellitus, anaemia, malnutrition, chronic liver disease, and many eye diseases are just a few examples from the more common conditions involved. A head injury can lead to a temporary or permanent disturbance in colour perception. Excess of tobacco and/or alcohol can also affect colour perception. Toxic substances used in industry may also be a cause—carbon disulphide, monoxide and tetrachloride, sulphanilamide, thallium and lead, ethanolamine, manganese, mercury and hydrogen sulphide are examples. Acquired defects differ from the inherited class by being often progressive in nature, affecting even the whole colour sense, if the cause is not identified and treatment effected rapidly. They can be confined to just one eye or part of the eye space or field.

The severity of a colour vision defect is of far greater consequence industrially than the type of defect. To detect and classify a colour anomaly solely is far from adequate for industrial selection—what really matters is whether a deficiency significantly handicaps the individual in his work. Obviously the severe form of dichromatism presents the greatest problem in everyday life. Such people consider a confined region of the visible spectrum to be neutral. In practice grey is confused with red and blue-green by the red defective and with a purple-red and an almost true green by the green defective. The first record of dichromatism was made in 1684 in the Philosophical Transactions of the Royal Society. John Dalton, the famous atomic chemist gave the first clear description of his own protanopia a century later. The electromagnetic spectrum appeared to him in varying shades of blue and yellow with purple alone as a possible third hue. He described blood as "a bottle green colour".

Deuteranopes	
Resistors	Capacitors
Violet Brown } Red } Grey } Green }	Violet Brown } Grey } Red
Deuteranomalous Trichromats	
Resistors	Capacitors
Violet } Brown } Grey Red	Violet Brown Red } Orange }

Colours grouped show similar percentages of errors.

Table 3. Colours most frequently misnamed by deutans in resistor and capacitor trials.

A GENETIC CHARACTERISTIC

Abnormal colour perception affects around eight per cent of males in developed countries but a significantly lower proportion in rural isolated groups and nomadic populations. Only one in two hundred women show colour vision defects and this is accountable by the simple, predictable genetic mode of transmission. Mothers "carry" the condition to sons without themselves showing signs of the abnormality; when a "carrier" marries a colour defective man there is a fifty-fifty chance that the daughters will show a degree of colour defect themselves, the remainder being carriers so the proportion is low among women. It is fortunate that in the electronics industry a great many women assembly operatives are employed for this reduces the likelihood of mistakes due to colour identification.

COLOUR CONFUSIONS

In a study directed at establishing the likely consequence of defective colour vision in those concerned with identifying the colour codes of electronic components, the author found that anomalous trichromats made an average of 7·5 per cent of errors, suggesting one likely mistake in the identification of twelve resistors. Dichromats show a much greater risk misnaming 20 per cent of the sample of twenty-seven assorted resistors; they could be expected to place incorrect values on one out of every two resistors (total eight bands). Complete failure to identify the presence of a band was also more frequent for the severe defectives than the milder group. See Tables 1 and 2. The band pairs green and brown, red and brown, and green and red give greatest difficulty to all red-green anomalous. Deutans, the green defectives, additionally confuse blues and violets readily. See Table 3. It is highly desirable that dichromats should not be employed in operations requiring reliable recognition of colour codes involving three or more categories.

MULTI-PURPOSES

Colour is used industrially and commercially in a variety of situations to reinforce hazard warnings, to control the movement of vehicles in transport, to code the contents of pipes and containers, gas and medical cylinders, pressure ratings, in addition to the obvious areas of cables and wires. Where possible colour should be ancilliary to pattern codes and the hues should be as deep as possible, painted at numerous intervals particularly at the source and termination of supply pipes. International effort has been concentrated to agree strict specifications for signal colours used in transport where there is little clue in the form of shape or position. Careful thought was given to this aspect when the British Standard 1376 Colours for Light Signals was revived. A blue-green colour was agreed for the green signal as being more reliably recognised than a yellowish-green by both colour normals and colour defective observers. The choice of red for danger and green for safety is unfortunate and although studies reveal no higher incidence of traffic accidents among colour defective drivers, fatal accidents are on record as being caused by anomalous colour vision and in a number of European countries restrictions are placed on protanopes. However in other areas the potential problems of the eight per cent colour anomalous have been largely neglected. A green defective might well confuse the steam and water code for pipelines as set out in BS 1710—green for water and silver grey for steam. Of greater consequence perhaps might be confusion by the red-defective between the violet of acids and alkalis and the light blue for air. Since greens, oranges, yellows, browns and reds are confused readily by all red-green defectives, a pipeline of combustible liquids (light buff code) could well be mistaken for one of water (green) or a container of electrical wires (orange).

Cartridge fuse-links for telecom work as set out in BS 2950 involve a range of eleven hues with many likely confusions for the colour defective. Only extreme anomalous trichromats and all dichromats might be handicapped with normal cartridge fuses whose code incorporates white, blue, yellow, red and green.

COLOURED CABLES—A RECENT IMPROVEMENT

The colour coding of a cable is used for identification purposes only like the examples cited above, whereas colour signifies a definite numerical value for electronic components. It is therefore surprising that more attention has been given to the problems of confusion experienced by colour defective observers with wires than resistors. However objective methods are available for obtaining values of resistance and capacitance whereas it is difficult to replace the human observer for many wiring jobs.

It is pleasing that considerable efforts have been made to reduce the number of colours involved and the colour combinations for cables. Before 1939 the earth lead in the domestic wiring was coded brown; the three core code for flexible wiring using black, red and green were introduced because of the obvious associations but the colour defective was not considered. Before the European standard of brown, blue and yellow/green stripes was introduced efforts were made by the Chairman of the Society of Dyers and Colourists in1968/9 to request a change on the grounds of likely difficulty for the colour anomalous. Despite helpful persistence little attention was given by the authorities to the voice of visual experts in this matter. Nevertheless the new coding system is viewed as an improvement by the eighteen colour defective individuals interviewed by the author. In pairing coloured wires protanopes frequently confuse green and orange when they appear in a double-twisted

Single wires—most common confusions in pairing		
Deuteranomalous	Deuteranopes	Protanopes
Blue/Violet	Blue/Violet	Blue/Violet
Blue/Brown	Red/Green	Orange/Green
	Red/Brown	

Table 4. Common errors made in pairing single wire.

form such as is used in Post Office cables. Most varied confusions are made by deuteranopes (involving green with brown, green with red, orange with brown, red with brown, orange and red), similar confusions to the resistor bands. See Table 4.

TESTING REQUIREMENTS AND RECOMMENDATIONS

As so often happens, lessons are learned after the event, and the colour industries have had to pay a high price for some mistakes of colour identification. It is in the interests of both employer and employee that defects of colour vision should be identified before an employment arrangement is agreed, so that where there are slight or major differences from normal the possible consequences can be clearly established and assessed in the light of each individual situation.

The personal disappointment felt by a youngster who has set his or her heart on a specific vocation, only to be refused on the grounds of faulty colour perception is a saddening experience for all involved, one that could be avoided if better counselling facilities were available to such children. Employers and trade unions and associations, professional bodies and recruiting agencies all need to be aware of the extent of handicap imposed by a colour vision defect in their specific field and set their standards accordingly.

Sadly, but understandably, it is usually the financial aspects which most concern industry and business. Production rates are all important and it is simply not efficient to employ someone who may be slow or indecisive or inaccurate when judging colours in the colour orientated industries. Little attempt has been made in the past however, to evaluate just how capable the colour defective is at an occupational task which requires some degree of colour identification. As a result standards have often been set arbitrarily and testing methods have not been properly evaluated. The colour defective individual has often been misunderstood and occasionally the victim of unfair discrimination.

Although it is likely that the numbers of severely colour defective individuals employed in the electrical assembly industry are small on account of a degree of self-selection and the large numbers of women operatives, greater attention should be given to the matter of colour vision testing. Screening for defective colour vision is a simple matter, there are excellent simple tests to separate out the eight per cent of men who have some degree of deficiency; false colour tests, of which the Ishihara is most widely known, serve this purpose adequately when used with an appropriate daylight source though they do not test for most acquired defects. Unfortunately there is no way of checking for faulty colour vision unless proper tests are applied. In the occupational context, more are usually required. The severity of the defect is of far greater consequence industrially than the type. In the last two decades there has been a considerable improvement in the types of testing methods available. Diagnostic tests which indicate the severity and type of both inherited and acquired defects are now available at a modest price. Yet industry continues to use out-dated and inferior procedures.

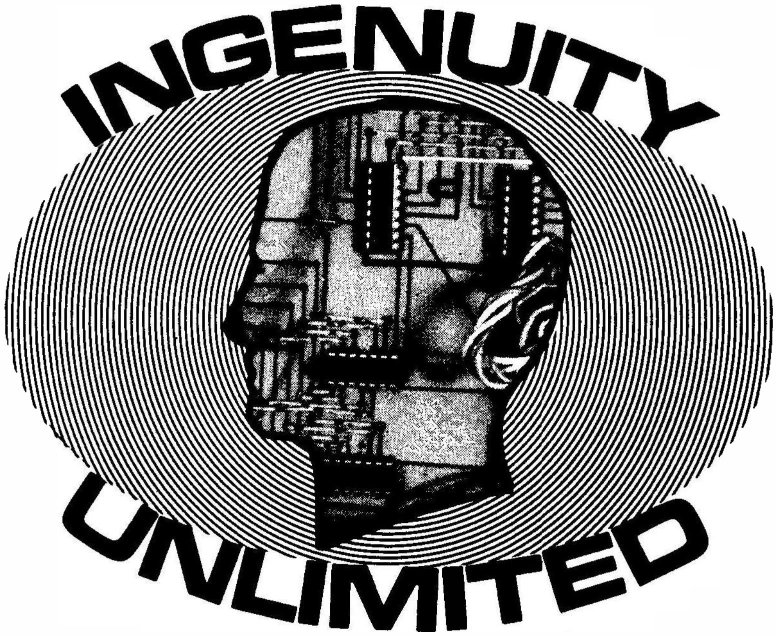
Separation of the 'safe' defective from the 'unsafe' is most important. During the last war it was recognised that many pilots with a slight green handicap (the deuteranomalous group) were able to carry out flying duties adequately. A test was designed by US military medical personnel to separate individuals into the safe/unsafe category. This has now been modified considerably in Britain, after further evaluation and appears in a simple book format, The City University Test, marketed by Keeler Instruments, 21/27 Marylebone Lane, London W1. It is easy and quick for the layman to use and interpret, and costs only a few pounds. More sophisticated tests for industry are available to indicate colour discrimination ability. One which uses a visual screener approach is the Lovibond Colour Vision Analyser produced by the Tintometer Company, Salisbury. Scores given by a large number of colour defectives on both these tests were found to give a much better correlation with practical ability than simple screening tests in the author's study.

Trade tests, which simulate the job in practice, such as a selection of coloured wires which must be identified, are valuable, but these can seldom be standardised and great care must be taken to ensure that the conditions are similar to those typically encountered in practice, e.g. dirty cables, or resistors and poor illumination. Trade tests should therefore be used with a clinical test, but employees should always have the option to show their performance in practice with such a simulation of the job in question.

It is true that great care and experience is needed to avoid rejecting the suitable and accepting the unsuitable and mistakes will undoubtedly arise but by a careful choice of a diagnostic test and a suitable pass/fail level a much more realistic screening procedure could be adopted, suited to the needs and requirements of individual industries. Costly errors could then be avoided and a fairer selection scheme would result.

In addition standardisation bodies should consider introducing tolerance limits for the colour codes of electronic components to reduce the variability between manufacturers and within batches from one manufacturer. These typical variations add to the difficulty of colour identification. Careful control of the brightness values and contrast and an effort to use only highly saturated (deep) hues would greatly assist the colour defective individual.

Although colour vision defects can be crudely identified by simple common mistakes in colour identification, only proper testing methods will indicate the existence of a defect for certain, and details of its type and severity. Such tests are usually available as part of the National Health eye examination by ophthalmic opticians.

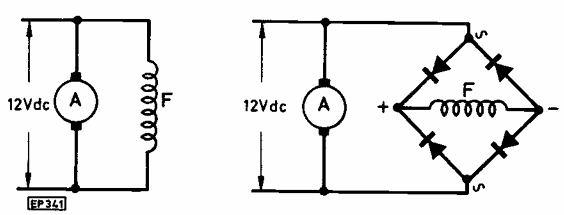


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

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

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



MOTOR REVERSAL

HERE is an unusual and interesting application for a bridge rectifier. A colleague of mine was building a device which is powered by a shunt wound d.c. motor (actually a discarded windscreen wiper motor) and he required the motor to be reversible. Because supply reversal causes reversal of the current in both the armature A and the field F, the motor remains stubbornly unidirectional. Fitting a switch on the motor to reverse only the field current was not possible as the motor was in an inaccessible place; likewise, adding two extra leads to bring the field winding out to a reversible supply was considered too clumsy.

The problem was eventually solved by supplying the (8Ω) field winding via a 2 amp bridge rectifier, thus enabling supply reversal to affect only the armature, and causing motor reversal. The bridge fitted neatly inside the motor, using the metal case as a heatsink.

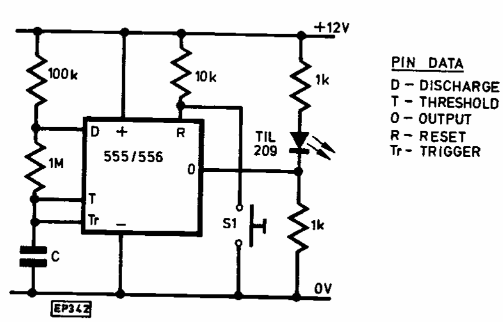
Note that with some motors, such as the windscreen wiper motor used here, it is preferable to retain the 'old' direction of rotation as the 'normal' new direction, since these motors contain thrust bearings designed with only one direction of rotation in mind.

C. P. Finn,
Beverley,
Yorks.

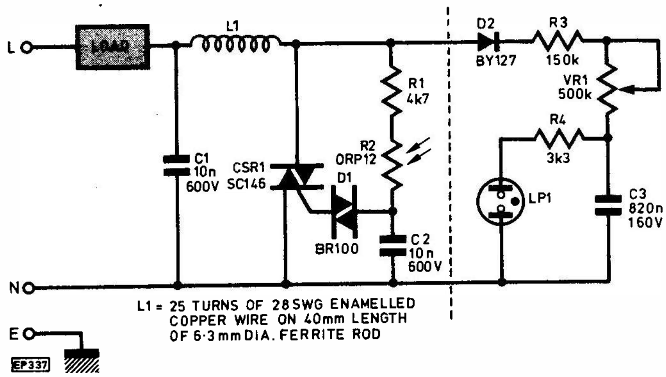
555/556 QUICK TESTER

THIS tester enables a quick 'Go/No go' test on the popular 555 and 556 i.c.s. (For the latter the circuit needs to be duplicated). It requires a supply of about 12V d.c. which in the absence of an i.c. on test, should light both l.e.d.s as a check. Next, switch off and plug in the suspect chip. Switch on—flashing l.e.d.(s) indicate a 'good' 555 (556). The flashing should give way to a steady light when the push button is pressed, causing the reset pins on the i.c. to be taken to 0V, thus holding the outputs low. The 'push button' can be merely two short pieces of wire, which are simply pinched together.

C. P. Finn,
Beverley,
Yorks.



LAMP FLASHER



THE circuit shown will flash mains lamps of up to 500W at a variable rate between 0·2 Hz and 5 Hz. It is simple to build, inexpensive and is easily connected in series with the lamp to be controlled.

The flasher has obvious applications in the disco and entertainments field but could also be used as an emergency signal. It could flash the hall or porch light of an aged or disabled person's house should they require assistance.

The part of the circuit to the left of the dotted line is a conventional dimmer circuit with one exception. An l.d.r. is used to vary the time constant instead of a potentiometer.

The remainder of the circuit is a basic neon oscillator where D2 rectifies the a.c. and VR1 controls the rate at which the neon flashes.

The neon is mounted close to the l.d.r., when the neon flashes it lowers the resistance and changes the phase. The pulse is fed to the triac via the diac. Thus the load flashes in sympathy with the neon.

R3 effectively lengthens the flash of the neon allowing the load to reach full brilliance. L1 and C1 are for suppressing RFI.

Finally the whole unit must be fitted in a light-proof box.

P. F. Farthing,
Melksham,
Wiltshire.

STEREO BALANCE METER

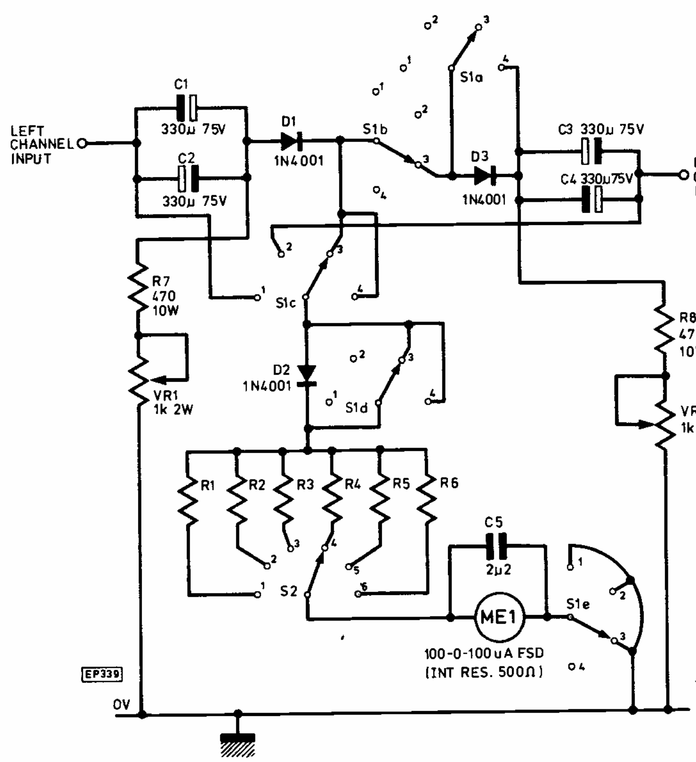


TABLE 1	R1 TO R6 AND S2 DETAILS				
POSITION S2	RESISTOR VALUE (Ω)	FSD (V)	FSD(W) 4Ω	8Ω	16Ω
1	1k5	0·3	·03	·01	·006
2	4k8	1	·25	·12	·06
3	15	3	2·3	1·1	·56
4	47	10	25	12·5	6·3
5	150	30	225	112·5	56·3
6	470	100	2500	1250	625

TABLE 2	S1 DETAILS
POSN 1	LEFT OUTPUT
POSN 2	RIGHT OUTPUT
POSN 3	LEFT–RIGHT OUTPUT
POSN 4	(LEFT–RIGHT OUTPUT)

NOTE:-
VR1 & VR2 = METER DAMPING & ARE GANGED

AS a disc jockey operating a mobile stereo set up with separate power amplifiers, a need has always been felt for some method of determining the optimum balance between the left and right channels of the set up, apart from the usual standing in the middle test, hence the circuit shown was developed.

It uses a centre-zero meter movement to measure the difference signal between the left and right speaker outputs of each channel, in a "surround sound", A-B type set up. It was soon apparent that the circuit could be modified, by means of a switch, to measure the output power on each channel and the magnitude, ignoring direction, of the difference signal. With the switch S1 in position 3 the magnitude and direction of the difference signal may be measured for example a negative going indicating left channel too high and positive indicating right channel too high.

By means of S2 the meter range can be selected so as input powers in excess of 100W may be handled. C1, C2, C3 and C4 prevent any d.c. path from one channel to the other, important when the amplifier outputs are d.c. coupled. VR1 and VR2 act as meter damping components and are made variable and ganged. The value of C5 will depend upon the meter resistance, as a guide the maximum frequency response of the meter is about 1 kHz, hence the time constant of C5 and the meter resistance should be 1ms = CR.

The meter movement may be calibrated to read power by the formula:

$$P = \frac{V^2_{ind}}{R}$$

Where R is the loudspeaker impedance.

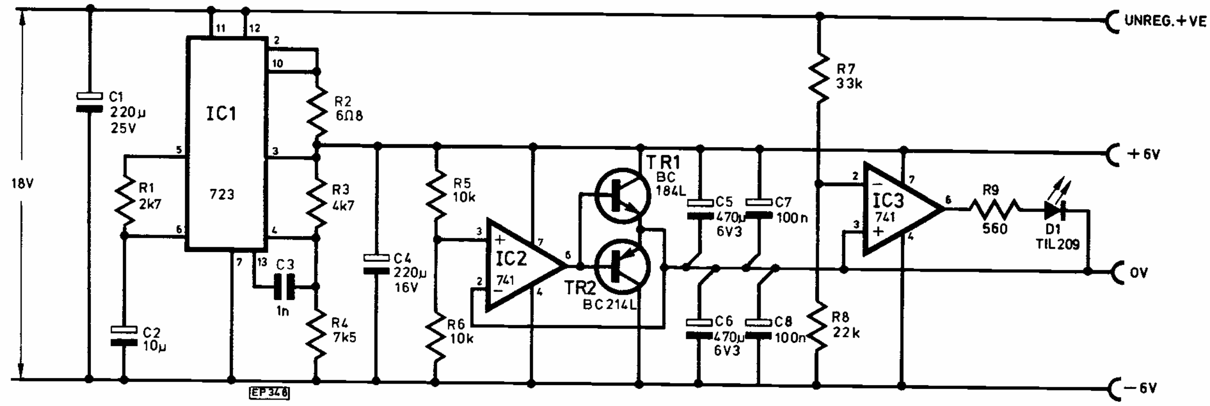
For 4, 8 and 16 ohms, 3 scales would be required although when in use a voltage scale was found quite sufficient as the rest is mental arithmatic. The value of R5 to R9 willl depend on the meter movement according to:

$$R_x = \frac{(V_r - 2I_{f.s.d.}R_{int})}{2I_{f.s.d.}}$$

$$V_r = V_{f.s.d.}$$

This circuit has been used extensively over the past three years and has proved invaluable and very reliable.

T. Austin,
Southampton,
Hants.



OP AMP BATTERY SUPPLY

HERE is a design to end all the problems associated with running sensitive op amp circuitry from battery supplies.

The circuit shown runs from two 9V batteries in series and provides a centre tapped plus or minus supply of nominal 6V, actually about 5·8V, and current of 50mA from either side. Quiescent current is about 4·5mA and an l.e.d. lights to warn of impending battery failure.

A. J. Flind,
Taunton,
Somerset.

MODEL RAILWAY SIGNAL CONTROLLER

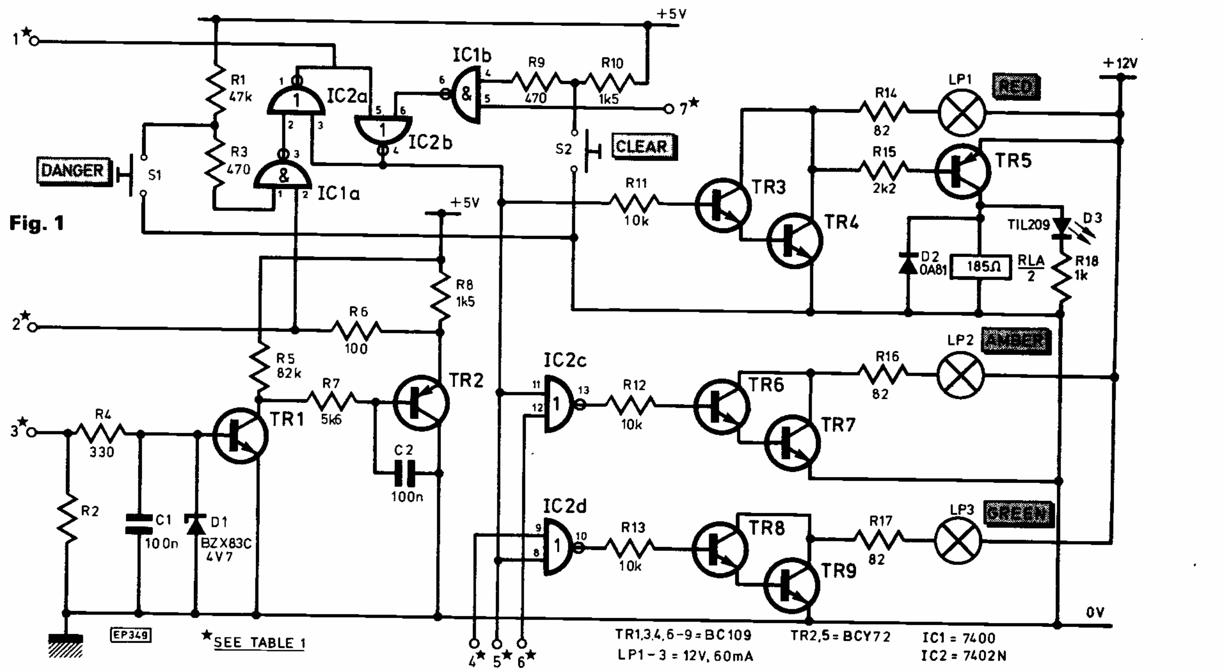


Fig. 1

THE circuit shown is designed to control a three aspect colour light signal when connected with other signals as shown in Fig. 2 and Table 1. The previous signal is not essential (if one is not installed board connections 1, 2 and 4 should be left unconnected but the next signal must be installed in order to control the "distant signal" part of the signal, (i.e. the green and amber lamps). If no next is installed, like when coming to the end of the line, a two aspect signal should be used—with a circuit designed for a two aspect signal.

When a train enters the section of track controlled by the signal its motor draws power from the train controller through R2 (see Table 2). This produces a p.d. of about 1V across R2 and hence across the base-emitter junction of TR1. (The BZX83C 4·7 Zener diode protects the base-emitter junction from excess voltages caused by short circuits of the track caused by derailments.)

This p.d. switches on TR1 which in turn switches on TR2. This changes the logic state at pin 2 of IC1a from 1 to 0. This makes IC1a pin 3 go to logic state 1, this in turn makes IC2a pin 1 (and IC2b pin 5) go to logic 0. This in turn makes IC2b pin 4 go to logic state 1, this, because it is connected to IC2a pin 3, now keeps IC2a pin 1 at logic state 0 and IC2b pin 4 at logic state 1. These now remain like that even if the train stops or is removed from the track.

Because IC2b pin 4 is in logic 1 state the Darlington pair consisting of TR3 and TR4 are switched on and cause the red lamp to light. Also, because IC2c pin 11 and IC2d pin

Table 1

Board connection No.	Connected to:
1	6 on control board of previous signal
2	7 on control board of previous signal
3	Connected to track (see Fig. 2)
4	5 on control board of previous signal
5	4 on control board of next signal
6	1 on control board of next signal
7	2 on control board of next signal

Table 2

Gauge of railway	Value of R2	Current drawn by train
"OO"	2·7 ohms 5W	500–800mA
"N"	10 ohms 5W	80–150mA

For others use the equation $R2 = \frac{1}{I}$

Where I = current drawn by train when moving at slowest normal speed.

9 are at logic 1 state when IC2b pin 4 is at logic 1 state, neither the amber or green lamps may light.

When the train enters the section controlled by the next signal the control circuit of this signal makes board connection 7 and hence IC1b pin 5 go to logic 0. This causes IC1b pin 6 to go to logic 1 causing IC2b pin 4 to go to logic 0. This extinguishes the red lamp, and allows IC2c pin 13 to go to logic 1 hence lighting the amber lamp. When the next signal in its turn is cleared IC2c pin 12 goes to logic 1 hence extinguishing the amber lamp and IC2d pin 8 goes to logic 0 hence causing pin 10 to go to logic 1, lighting the green lamp.

The signal can also be changed by pushing the push switches but when the clear switch is pushed the amber lamp will light if the next signal is in the danger position and the green lamp only if the next signal is clear.

TR5, RLA and associated components are an optional extra; the relay contacts may be used to stop trains when the signal is in the danger position, operate level crossing gates etc. The TIL209 l.e.d. may be mounted on the control panel (with the two push switches) and will light when the signal is in the danger position.

The power supply to the control board must be independent of the train controller (i.e. from an independent transformer winding or separate transformer) if not the circuit will short out each time the train controller output is reversed to allow trains to run backwards.

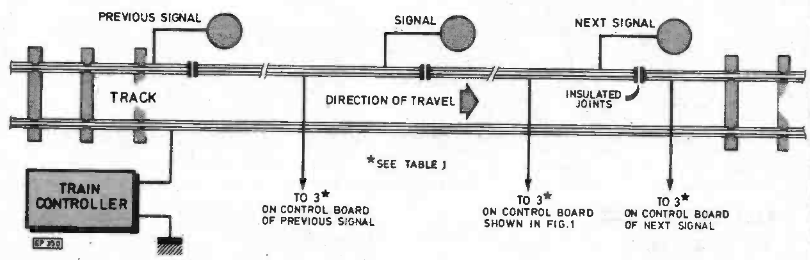


Fig. 2 ▲

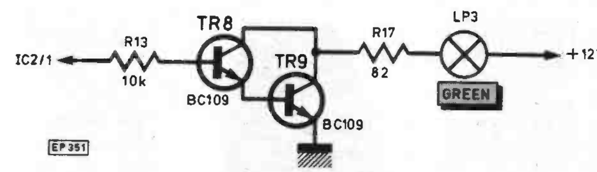


Fig. 3 ▶

Fig. 3 shows a modification enabling a 2 aspect signal to be used where there is no "next" signal. IC2c, IC2d, TR6, TR7, the amber lamp and associated components are omitted and TR8 is connected through a 10 kilohm resistor to IC2a pin 1.

C. R. Bray,
Cheddar,
Somerset.

FREQUENCY TESTER/ MISSING PULSE DETECTOR

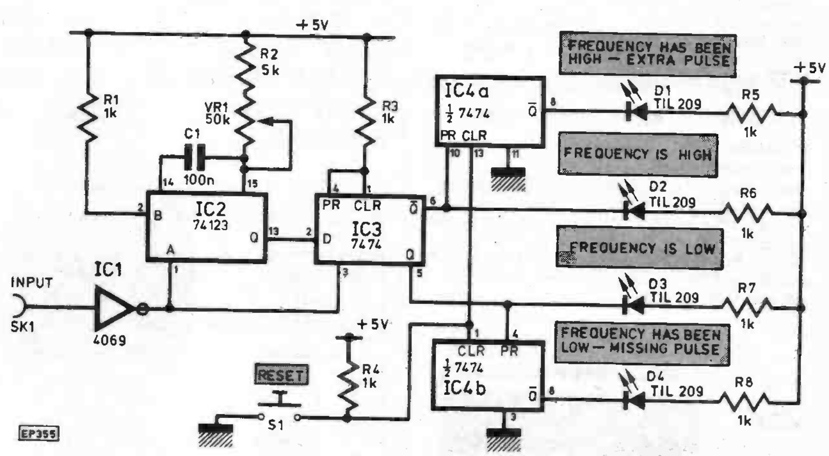
I built this circuit to examine a pulse generator for reliability. It was important that the pulse generator would neither miss a pulse nor generate a spurious one.

To detect missing pulses the time constant of the 74123 monostable is decreased until the upper pair of diodes is lit. The lower pair of diodes will light if a pulse is missed or if the frequency of the input falls and the lowest diode will stay lit until 'Reset' is pressed.

To detect spurious pulses the time constant of the monostable is increased until the lower pair of diodes is lit. The upper pair of diodes will light when an extra pulse is detected or when the input frequency rises. The uppermost diode will stay lit until 'Reset' is pressed.

If the time constant of the monostable cannot be altered sufficiently by the variable resistor the capacitor C1 can be changed.

P. R. Turner,
St. Helens,
Lancs.



WHEN heating a greenhouse during the winter months, it is desirable to keep the minimum temperature only just above that required for the least hardy plants so that energy and fuel bills can be saved.

Thermostatically controlled heaters are available on the market, but these are invariably of the electro-mechanical type and are thus inherently inaccurate and unreliable. They also exhibit a large amount of hysteresis between the switching points, partially due to the thermal inertia of the comparatively large mass of metal which forms the temperature sensing element. This large value of hysteresis means that the temperature must be set higher to allow for the lower temperature excursions, thus wasting energy and money.

It is also desirable to control the upper temperature limit during the summer months without the need for constantly adjusting the greenhouse ventilators. This can be implemented using an extractor fan controlled by an electro-mechanical thermostat, but with similar problems. Reliability is of the utmost importance when the temperature control system has to protect a large collection of valuable plants.

This temperature controller has been designed to perform both the above mentioned functions with reliability and accuracy as the foremost considerations. No mechanically operated contacts are used as triacs perform the switching of the heater and fan. The unit has a fast reaction time, and both the upper and lower temperature limits can be easily varied over a wide range.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Temperature Controller is shown in Fig. 1. The thermistor TH1 is used as a temperature sensor with the volt drop across TH1 and R15 used to determine the voltage at pin 3 of IC1 and pin 2 of IC2.

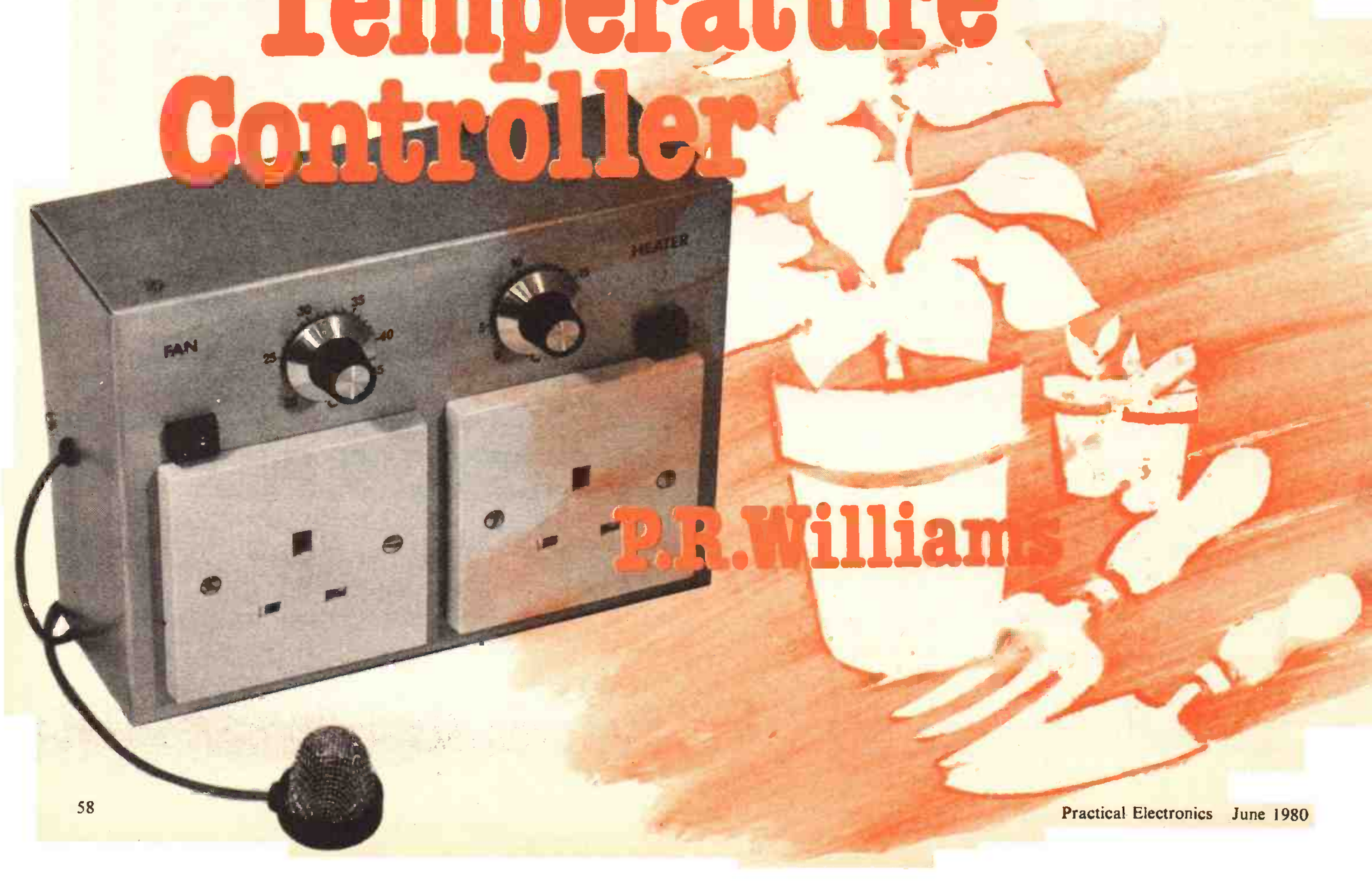
If the temperature at the sensor is higher than that set on VR1, the output of IC1 (pin 6) will swing positive switching on TR1, the triac CSR1, LP1 and the load which in this case is the extractor fan.

A negative gate current is used to trigger the triacs because they are more sensitive in this mode. The capacitors C1 and C2 suppress any mains voltage transients with R1 and R2 used to limit the discharge currents from the capacitors when the triacs switch on. A small amount of positive feedback is applied via R9 to IC1. This results in a hysteresis of $\pm 0{\cdot}5°C$ which is essential to prevent erratic operation.

The heater control circuit operates in a similar manner using VR2, IC2, TR2 and CSR2. The heater socket (SK2) is energised when the temperature at the sensor is lower than that set on VR2.

The power supply, which is formed by T1, D1, D2 and C3, requires no regulation since the resistances around the inputs of the op-amps form a bridge and only the resistance ratios affect the switching points rather than specific voltages. Great care should be taken to ensure the metal case is well earthed.

Greenhouse Temperature Controller



P.R.Williams

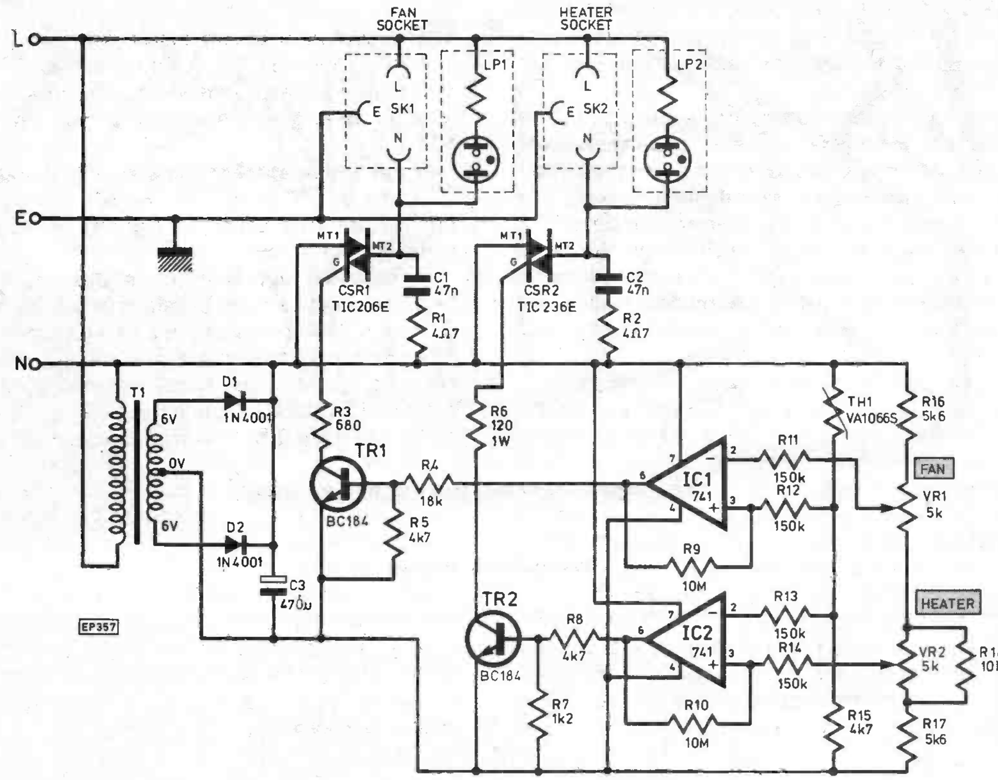


Fig. 1. Circuit diagram of the Temperature Controller

CONSTRUCTION

The p.c.b. design for the Controller is shown in Fig. 2 with the component layout in Fig. 3. The triac CSR2 should be soldered to the copper side of the p.c.b. and then bolted to the case. A mica washer smeared with thermally conductive grease should be used to insulate the triac from the case.

The p.c.b. should be connected to the sockets, lamps and potentiometers as shown in Fig. 4, using heavy gauge multi-strand wire for all the mains connections, and miniature solid wire for the potentiometer connections.

The two potentiometer scales shown in Fig. 5 will give a fair accuracy within the linear regions of the scale, but much improved accuracy over the whole scale range is however possible by selecting the thermistor, TH1 to within ±5 per cent of 4K7 at 25°C, rather than the normal ±20 per cent. This is a very worthwhile exercise, and a sample of half a dozen or so thermistors should contain a suitable component.

Fig. 6 shows the construction of the sensing unit which protects the thermistor while allowing free air circulation around it. The prototype unit was constructed using a plastic base, cut from the bottom of a 35mm film canister. The thermistor is soldered to a screened cable up to about 3 metres long, which is passed through a grommet hole in the base. The thermistor is then centralised in the base, which is then almost filled with epoxy resin. Before the resin is set, a piece

SPECIFICATION

Temperature ranges:	Heater 0 to 20°C
	Fan 20 to 50°C
Output power:	Heater 2kW max
	Fan 200W max
Thermal time constant:	30 secs.

COMPONENTS . . .

Resistors

R1, R2	4Ω7 (2 off)
R3	680
R4	18k
R5, R8, R15	4k7 (3 off)
R6	120 1W
R7	1k2
R9, R10	10M (2 off)
R11, R12, R13, R14	150k (4 off)
R16, R17	5k6 (2 off)
R18	10k

All ¼W 5% carbon except where otherwise stated

Potentiometers

VR1, VR2	5k lin (2 off)

Capacitors

C1, C2	47n 400V polycarbonate (2 off)
C3	470µ 16V elect.

Semiconductors

D1, D2	1N4001 (2 off)
TR1, TR2	BC184 (2 off)
CSR1	TIC206E
CSR2	TIC236E
IC1, IC2	741 (2 off)

Miscellaneous

SK1, SK2	13A mains socket (2 off)
LP1, LP2	Mains neon with resistors (2 off)
T1	6-0-6V 100mA transformer
Suitable case	200 × 150 × 70mm
TH1	VA1066 thermistor

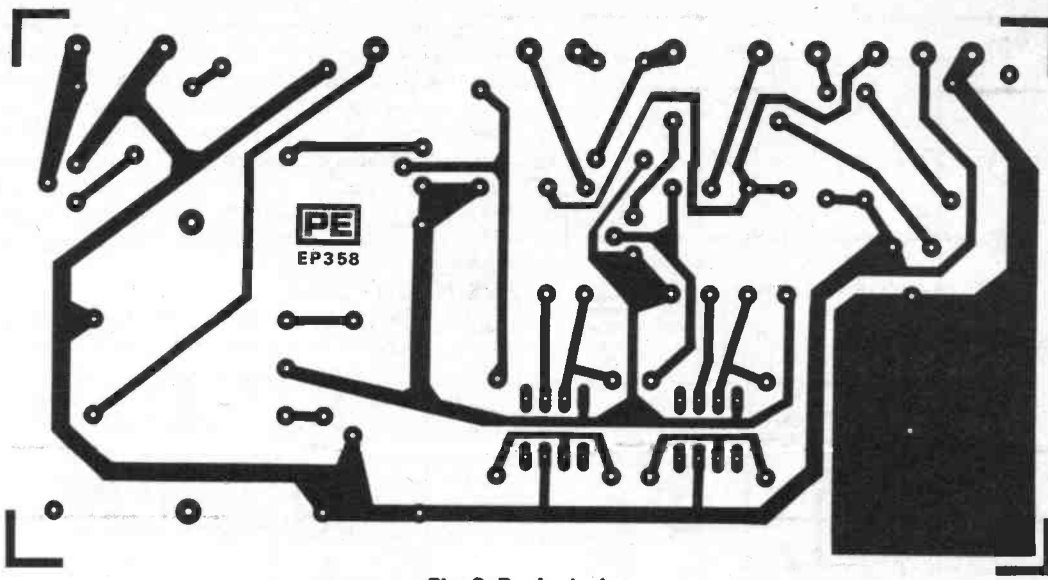


Fig. 2. P.c.b. design

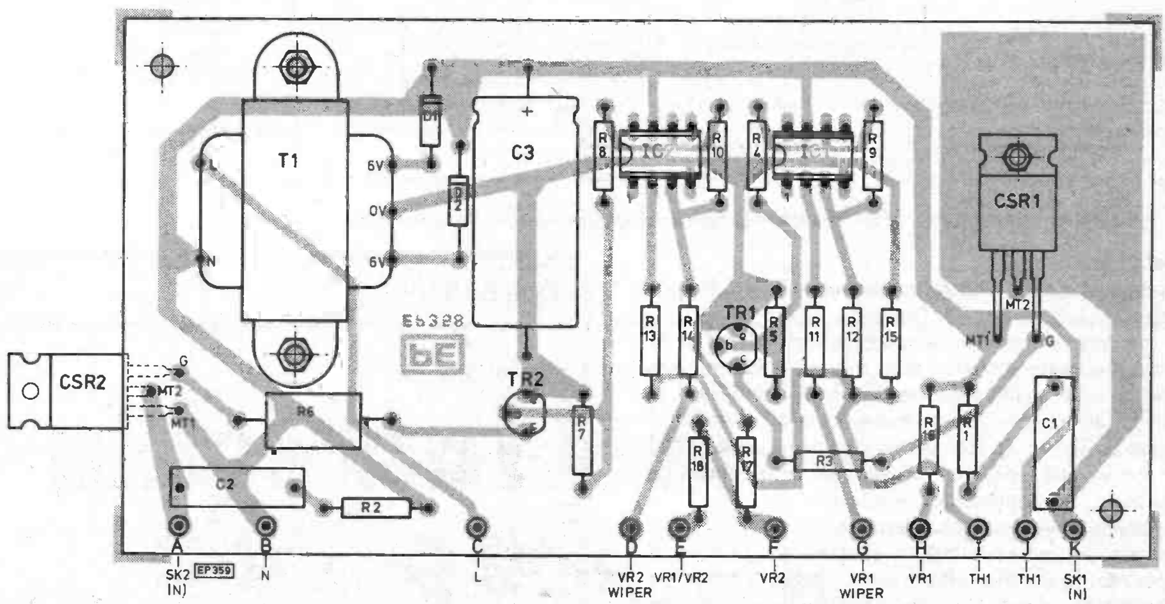


Fig.3. Component layout

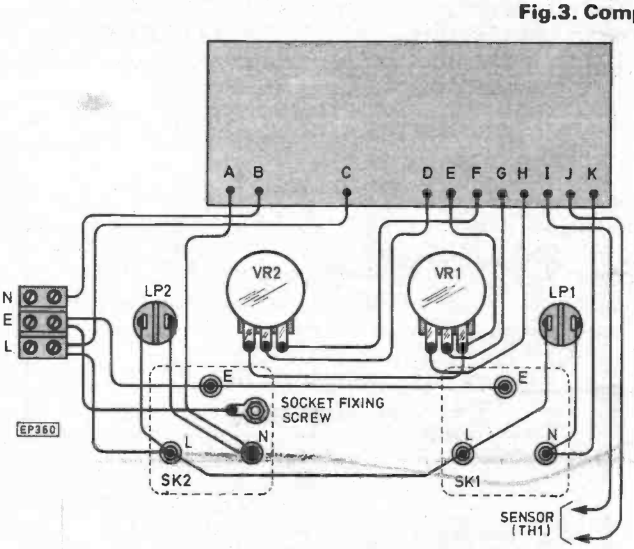
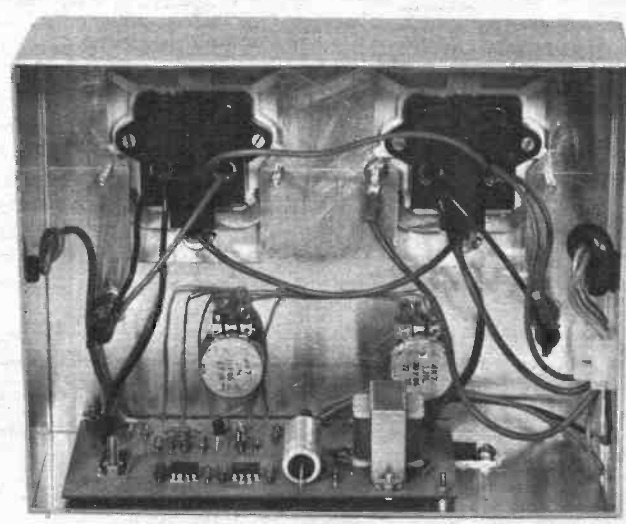


Fig. 4. Wiring diagram



Internal view of the Controller

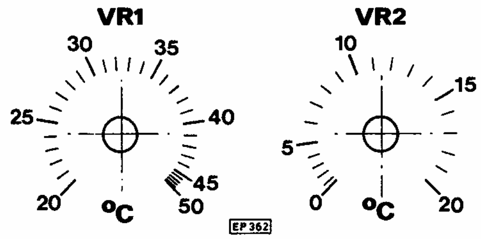


Fig. 5. Potentiometer scales

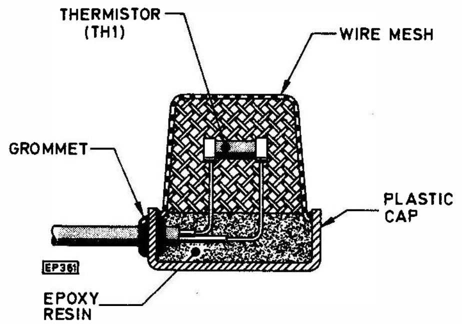


Fig. 6. Sensing unit construction

of wire mesh suitably cut and shaped, is placed over the thermistor, with the rim immersed in the resin.

SETTING UP

Because of the high voltages on the p.c.b. in this project, and the fact that the d.c. rails operate at mains neutral potential, no presets were included. The only setting up required is to position the control knobs relative to their scales.

Firstly, the sensing unit is taken to a known temperature, preferably close to the fan operating temperature that will be commonly used. VR1 is then adjusted to a position midway between the switching points. Note that the loads should be connected since without them, LP1 and LP2 will light even when the triacs are switched off, due to the small amount of current passed by C1 and C2. The control knob is then loosened and positioned to indicate the correct temperature. This procedure is then repeated for the heater using VR2.

USING THE UNIT

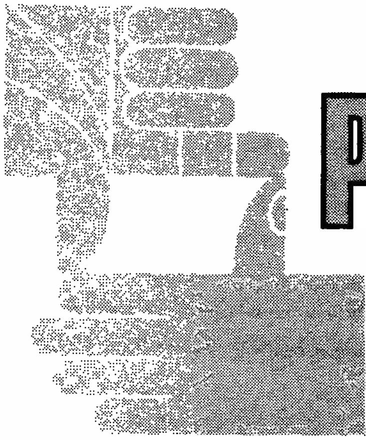
The unit should be installed in the greenhouse well away from any possible sources of dripping water, and connected to the mains supply via a fused plug.

The heater can take the form of electric tubes, a convector heater or a fan heater, the latter being preferable since it more effectively searches out any cold corners.

The extractor fan should preferably be large and slow rather than a small fast type since the latter can cause a draught which is often detrimental to the health of the plants. It can be positioned against a side ventilator or, as with the prototype unit, a roof ventilator. It should be borne in mind that there must be a path for cool air to freely enter the greenhouse, such as an alternative ventilator, or a slightly open door. However, many greenhouses have enough gaps and cracks to allow sufficient air flow without additional ventilation.

The sensing unit should be positioned at the same height as the majority of the plants. It should not be in the direct hot air flow from the heater, or too near the door or a ventilator.

Once installed, the unit will give many years of accurate, consistent and worry free protection to those valuable plants. ★



PATENTS REVIEW...

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

DOLBY RADIO

Dolby Labs have over recent years made several proposals for the transmission of Dolby-encoded radio signals. The aim is to reduce high frequency background noise by around 10dB in a manner comparable to the reduction of noise from cassette tape by Dolby encoding at the record stage. But the Dolby proposal for FM transmission also involves modification of the pre-emphasis characteristic. As it will be many years (if ever) before all broadcasts are in Dolby code there is obviously a need for automatic instruction of the listener and/or receiver circuitry when modified signals are being received.

Recently published British patent application 2 022 375 (filed under the new laws and dating back to March 1978) explains the Dolby proposal for providing an

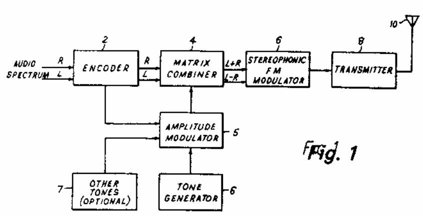


Fig. 1

automatic telltale of an encoded broadcast. The trick is to incorporate a tone in the audio spectrum which will not be audible and will not interfere with existing tones, eg. the stereo pilot tone.

Figure 1 shows the transmitter. Bass band (L + R) is summed in matrix 4 with an identification tone of low amplitude and high frequency which is generated by crystal controlled circuit 6. To facilitate detection at the receiver, amplitude modulator 5 can increase the tone level whenever high level, high frequency components are present in the audio signal. Normally, however, the amplitude of tone generator 6 is adjusted to produce a tone which is 70dB below the level of 100% modulation. The tone frequency is around 15 kHz.

Figure 2 shows the receiver. This is generally of conventional type but phase locked loop decoder 18 multiplies the 19kHz stereo pilot tone by a factor of four, and the resultant 76kHz signal is applied to divider 22. This divides by five to provide a stable 15·2kHz signal for one input of mixer 24. Band pass filter 20 receives the output of combiner 21 which extracts any tone from the decoded L and R signals, and feeds it to a second input of mixer 24. The 15·2kHz signal beats with any 15kHz identification tone in mixer 24, and a difference

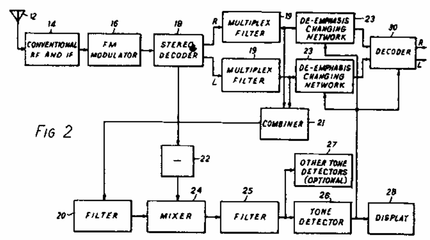


Fig 2

tone of 200Hz is produced. This is filtered at 25 to attenuate stray modulation products. Tone detector 26 senses the presence of any 200Hz tone and either automatically triggers Dolby-decoding and a change in de-emphasis time constant or switches a light to signify the reception of an encoded broadcast and advise the listener to switch the circuits manually.

REVERB DEVELOPMENTS

UK press visitors to the Acoustic Research Laboratories in Norwood Massachusetts last Summer heard a demonstration of the experimental surround sound system built by Bob Berkovitz of AR. This produced a remarkable feeling of space in a small room and, most interesting of all, offered a wide choice of spacial effect. Now British patent 1 559 832, from Teledyne Acoustic Research and Robert A. Berkovitz discloses working details of the system. The aim is to derive a reverberation pattern from conventional two channel stereo material which closely resembles that heard in large concert halls.

The concept of artificial reverberation is old, dating back at least to the 1940's and the work of Haas. Essentially a fraction of the main stereo signal is delayed and fed to additional loudspeakers behind and around the listener. But with systems so far proposed the delay is fixed and often sounds artificial. According to the AR system the delay pattern can be varied in its overall character (to give the listener a choice of apparent hall size) and the individual delay are varied inside the chosen character parameters to produce the effect of multiple reflections.

Figure 4 shows the basic system. Stereo input signals 169, 171 feed primary stereo speakers 163, 165 in conventional manner. In addition the stereo input is summed at 179 and fed to a delay system 183 which provides sixteen delayed signals for sixteen loudspeakers around and above the listener. These reproduce the mix of the primary stereo signals, delayed in time and displaced in azimuth. The delay 183 can be of either analogue or digital character. Digital delay is more flexible, albeit more expensive. The system demonstrated in Norwood used digital delays and the patent describes it in some detail.

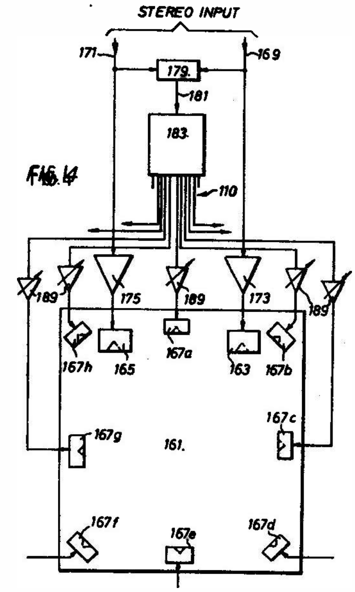
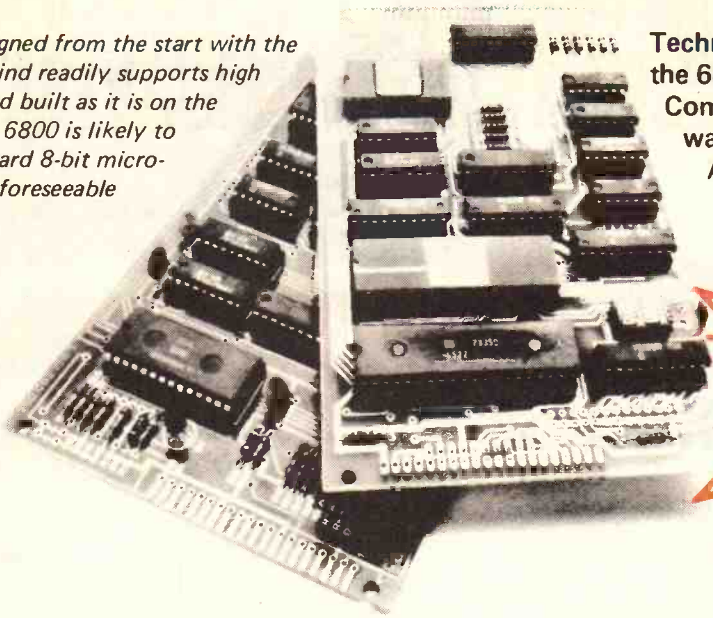


FIG. 4

Essentially the input signal is converted from analogue waveform into digital words and these words are fed into the data input of a RAM with several thousand storage locations. Each storage location has an address, and "read" and "write" commands from shift registers enter and recall words from the RAM with varying delays. The system is programmed to produce a chosen reverberation pattern of individual delays by selection of the address words entered into the shift registers. In practice the incoming analogue signals are sampled at 32KHz (to give a bandwidth of around 15KHz) and the delay constants range up to 256 milliseconds, in steps of one millisecond. The feeling of spaciousness results from the system ability to impart different delay constants for each of the channels passing through the delay block 183.

Maintain the lead with Acorn 6809

. . . the 6809 designed from the start with the programmer in mind readily supports high level languages and built as it is on the experience of the 6800 is likely to become the standard 8-bit microprocessor for the foreseeable future. . . .



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  VDU routine
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DIGITAL

Tachometer

G. I. WILLIAMS

THIS instrument was designed as a general purpose tachometer for measuring shaft speeds of rotating devices between 0 and 10,000 r.p.m. and has proved useful both in the laboratory and workshop.

It derives its timing reference from 50Hz mains frequency and counts either over a 6s or 60s period. The pick-up probe uses a reflective opto-switch, thus there is no physical contact between the pick-up probe and the rotating shaft. The tachometer is designed around the 7217 4-decade counter chip.

THIS INSTRUMENT WILL MEASURE THE R.P.M. OF A REVOLVING OBJECT, USING A REFLECTIVE OPTO SWITCH AS THE SENSOR. ALL THAT IS REQUIRED IS THE APPLICATION OF STICKY TAPE TO ACT AS AN OPTICAL MARKER.

CIRCUIT DESCRIPTION

A 50Hz signal, squared by D1, is fed into a divider chain IC1–IC4. These i.c.s are CD4018 counters and are configured to divide by 10, 10, 6 and 10 respectively. This arrangement gives one pulse every 6 seconds from IC3 and one pulse every 60 seconds from IC4. S1 selects either the 6s or 60s pulse to gate (via inverter IC7c) the count pulses from TR1. The 6s or 60s selected pulse also triggers IC5 which is connected as a monostable, this in turn triggers an identical monostable IC6. These monostables provide approximately 8 ms pulses for Store and Reset of the 7217 counting circuit. The 4-digit l.e.d. display is driven directly by the 7217 chip. A +5V regulated supply is produced by the power supply circuit and the voltage regulator IC9.

THE PROBE

The probe uses a "reflective opto-switch", which is an infra-red emitting l.e.d. source and photodarlington transistor sensor, arranged so that it senses a change from white to black. The optimum sensing distance is about 4·6 mm from the face. The prototype opto-switch was mounted at the end of a short probe made from 1 cm, square aluminium channel section, and connected to the electronics by one metre of 4-core miniature screened wire.

To use the tachometer, a piece of back insulating tape is placed around the shaft of the device being measured and a piece of white insulating tape is placed on top of the black tape to cover half the circumference. This forms one black and white segment per revolution. The reflective opto-switch is then placed 4 to 5 mm away from the shaft and speed measurements taken. For applications where speed adjustment is being undertaken the 6s gate time can be used to detect speed over a shorter time.

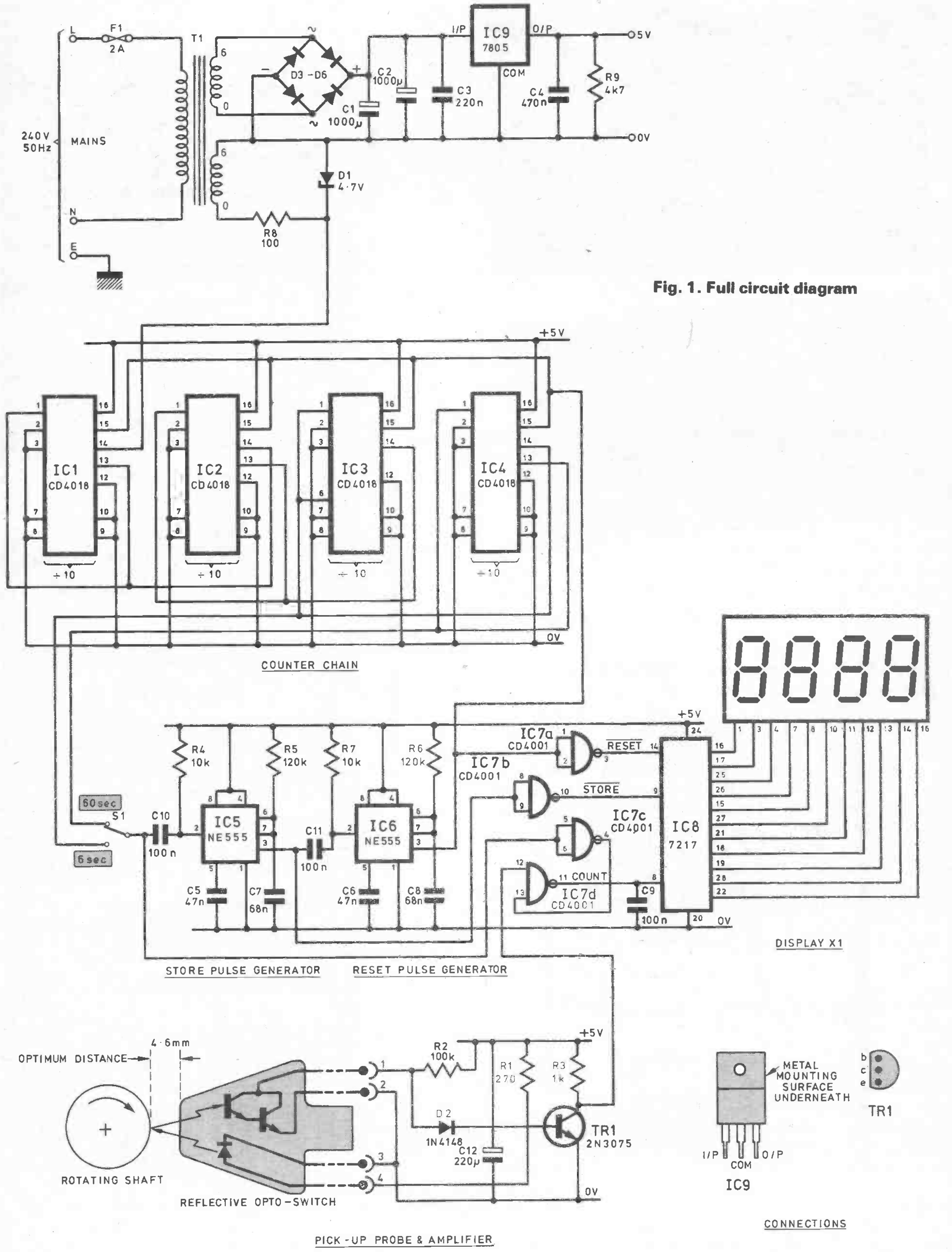


Fig. 1. Full circuit diagram

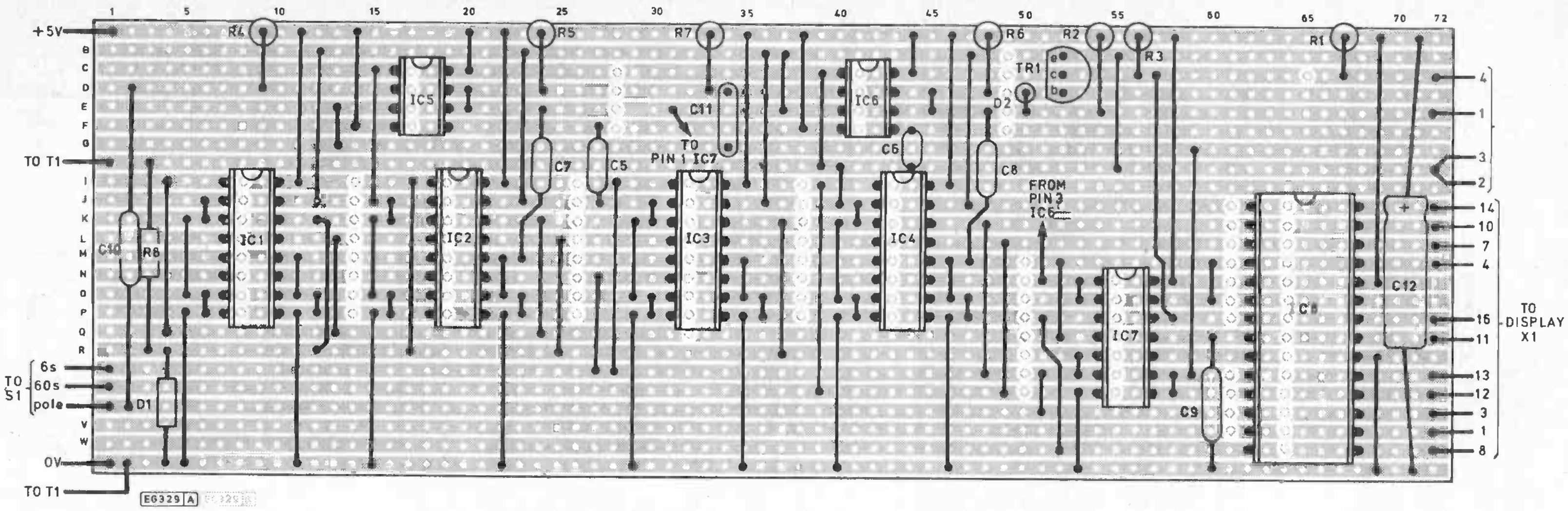
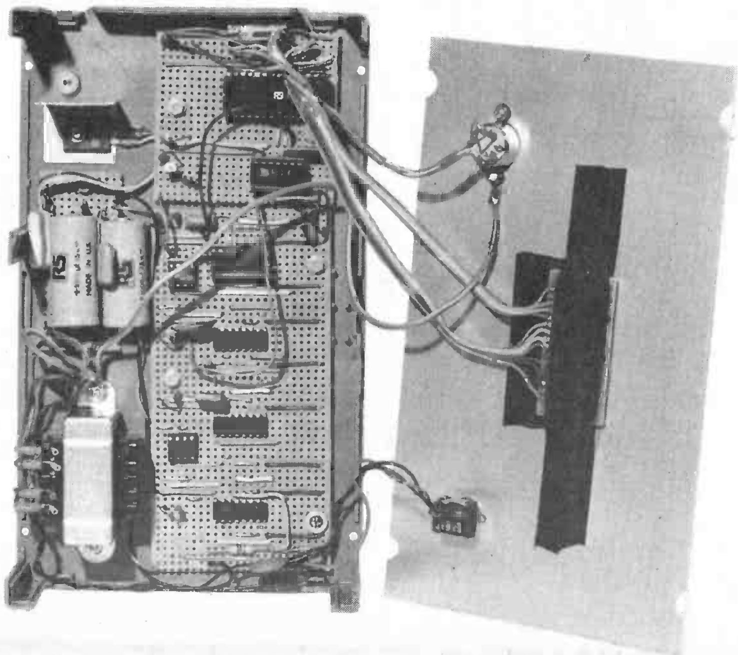


Fig. 2. Stripboard layout (actual size)



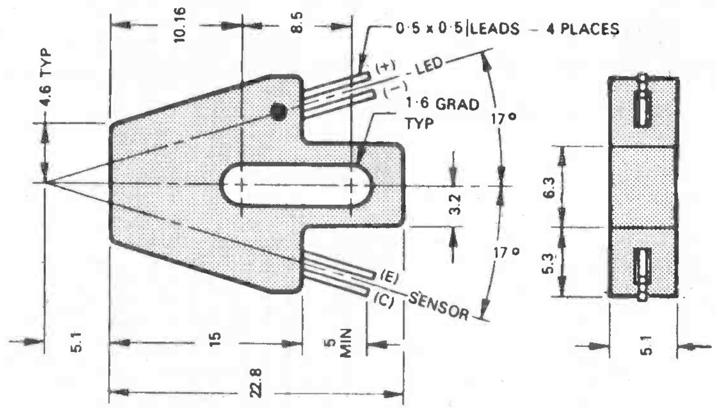


Fig. 3. Physical dimensions of the reflective opto switch

COMPONENTS . . .

Resistors

R1	270
R2	100k
R3	1k
R4, R7	10k (2 off)
R5, R6	120k (2 off)
R8	100
R9	4k7

All resistors 0·5W 10% carbon

Capacitors

C1, C2	1000μ/25V elect. (2 off)
C3	220n polyester
C4	470n polyester
C5, C6	47n cer. (2 off)
C7, C8	68n polyester (2 off)
C9–C11	100n/30V disc (3 off)
C12	220μ/25V elect.

Transistors and Diodes

TR1	2N3705
D1	BZX85 4V7
D2	1N4148
D3–D6	1A bridge rectifier

Integrated Circuits

IC1–IC4	CD4018 (4 off)
IC5, IC6	NE555 (2 off)
IC7	CD4001
IC8	7217 or ICM72171J1
IC9	7805

Miscellaneous

T1	Mains 240V transformer, 6-0-6 volts at 0·5A sec.
X1	4 digit 7-seg. display, 0·5 in. com. anode. (example: RS type 587-024)

Opto switch, reflective type RS 307-913

S1	Single pole c/o
Case	205 x 120 x 70 mm plastic

5 pin DIN plug & socket

Stripboard 0·1 in., nuts and bolts etc.

Constructor's Note

If the 4 digit display is to be the same as that used in the prototype, i.e. RS type 587-024, this may be obtained from ACE Mailtronix Ltd. The specified opto-switch may also be purchased from ACE, the VAT & carriage inclusive prices of these items being £6 each.

ACE Mailtronix, Tootal St., Wakefield, W. Yorkshire, WF1 5JR.

Alternatively, most high street electrical retailers and component suppliers have an RS account, and should be willing to order the specified parts.

VARIATIONS

The tachometer has been designed for ease of speed measurement and thus only one segment per revolution has been used. The disadvantage of this is that a long gate time is needed (60 seconds) in order to accumulate r.p.m. A count is produced on the transition from white to black. For increased accuracy (especially at low speeds) and a lower sampling time (1 second), a disc with 60 black segments can be constructed.

CONSTRUCTION

The unit was constructed in a plastic box measuring 205 × 120 × 70 mm using 0·1 in. stripboard. A 28-pin i.c. socket was used for the counter module and the probe was attached via a 5-pin DIN plug and socket. IC9 was mounted on a 76 × 50 mm aluminium plate which acted as a heat sink. ★

POINTS ARISING

6 CHANNEL MIXER *(Sept. 1979)*

To achieve the input impedance specification R2 should be deleted from Fig. 2. If different input impedances are required these can be achieved by switch required resistance values (the resistance is approximately equal to the input impedance) across the input with an extra switch.

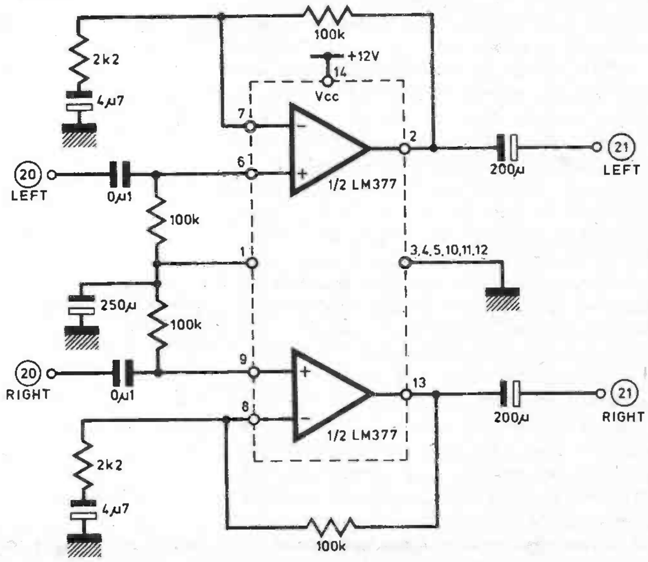
For a continuously variable gain control, R9 and R10 should be removed, and a 100kilohm log potentiometer connected between points (4) and (7) on the circuit diagram (see Fig. 2). The inclusion of this potentiometer however can reduce the overload capability of the pre-amp and an eye should be kept on the overload indicator.

More input channels can be connected in a similar manner to the existing channels. This means increasing the number of 22kilohm mixing resistors connected to the pan pots and to point (16) (see Fig. 3). Also more switch positions should be allocated to the p.f.l. switch to select the extra input channels.

If it is decided to eliminate the pan pots and use three input channels for the left output and three for the right, then the two 22kilohm mixing resistors should be replaced with a 47kilohm mixing resistor.

Biasing problems with the headphone amplifiers can be resolved with the inclusion of two pots in place of R23 and R27 (Fig. 5) These should be 47kilohms and 470 ohms respectively. The first is adjusted so that the voltage on the emitter of TR8 is half the supply voltage. The collector of TR8 should now be disconnected and a milliammeter connected between it and the positive supply rail. The 470 ohm pot is then adjusted so that the quiescent current is 10mA.

Constructors may wish to build an integrated circuit version of the headphone amplifiers based on a LM377 dual 2W audio amplifier i.c. The circuit diagram of these is given below.



MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas often come from readers working on their own systems, and payment will be made for any contribution featured.

IN this month's Micro-Bus we feature an auto-ranging digital capacitance meter which only requires three CMOS i.c.s, three resistors, and an Mk14 (or other SC/MP-based) microcomputer. The meter will give a digital display, automatically selecting a range of µF, nF or pF depending on the capacitor's value. The circuit and program, shown in Figs. 1 and 2, were designed by *A. C. Dickens of Leicester*, and he writes:

"I have constructed several capacitance meters during the past few years, but have not found any of them easy to use for a quick test of a lot of capacitors, especially large electrolytics. This design enables keen electronics enthusiasts to make greater use of their Mk14s in a very practical way. The user simply programs the computer, presses the GO button, and the value of the capacitor is displayed in µF, nF or pF (the pF range is very inaccurate for small values of capacitance). For values up to 9999µF the measurement time never exceeds about one second, so a large number of electrolytics from bargain packs can be tested and sorted in a very short time."

OPERATION

"The full circuit of the capacitance meter is shown in Fig. 1. Initially all flag outputs are at logic 0, so only SWD is energised to keep the unknown capacitor, Cx, discharged. When GO is pressed the program sets the range to 05; this value is copied into the status register of the micro, which sets flags 0 and 2 to logic 1. Thus SWD is switched off, and the capacitor charges via SWA and R1. When the voltage across Cx exceeds the switching voltage of the AND gate to which it is connected, SENSE-B is taken high. Incidentally, a switch is included in the connection to SENSE-B so that the unit will not interfere with the cassette interface unit. During charging of Cx the micro executes a count loop which repeatedly adds one into the memory locations OFOC and OFOE used by the monitor. If when SENSE-B goes to logic 1 the count is larger than 8, then this value is displayed together with the units, µF. If, however, the count is less than 8, the next range is selected by adding 1 to the range number. After a short discharge time SWB is switched on, and Cx now charges through SWB and R2. The computer then displays the number of count loops together with the units nF, unless the count is again less than 8, in which case the pF range is selected by adding another 1 to the range number. Approximate values are given for R1 and R2, but when the system has been set up these must be adjusted to obtain the greatest accuracy."

DATA FIND ROUTINE

The following program, designed for use with an Acorn micro, will find all the locations which contain a specified piece of data between two specified addresses. It was written by *Peter Mayne of London*, and makes use of three routines in the Acorn monitor. The program, shown in Fig. 3, gives prompts in the leftmost display digit of F for the 'from' address, T for the 'to' address, and D for the data. Each entry is terminated by a control key, such as M. So, for example, to find all the locations between 0200 and 0300 that contain A9 you would enter:

0, 2, 0, 0, M, 0, 3, 0, 0, M, A, 9, M.

After each address displayed any control key will get to the next address. If the data does not occur in the specified range, a return is made to the monitor's dots.

This is one of several interesting programs that Peter Mayne has written for use with an Acorn micro, and some of these will be presented in Micro-Bus over the next few months.

MINEFIELD GAME

The following game called 'Minefield' was invented by *V. W. Morley of Staffordshire*, and is designed for use with an Mk14 interfaced to the *Practical Electronics VDU* (as described in the *October 1978* issue). Alternatively with slight modification the program will work with a Mk14 VDU.

If the program is executed at OF21, with the screen cleared, a minefield will be displayed. Pressing GO a second time sets in motion the tank, which is represented by an 'X' moving across the screen towards the mines. A mine can be jumped and defused at

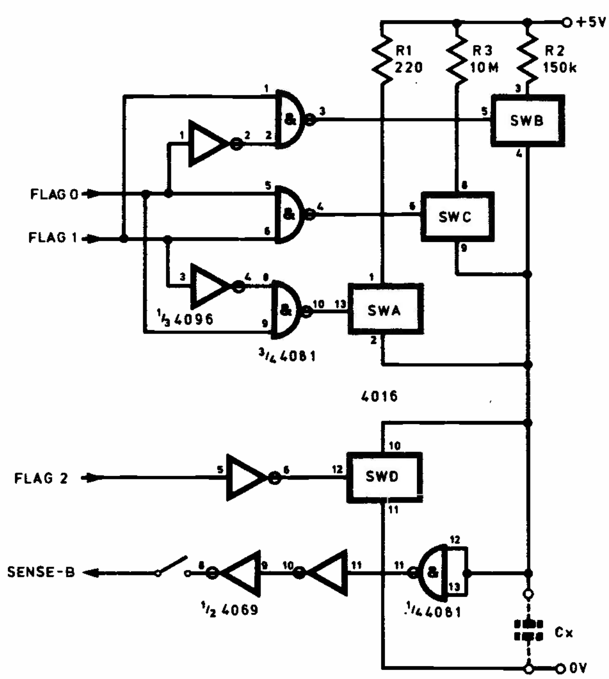


Fig. 1. Auto-ranging digital capacitance meter interface circuit

```
                ;         AUTO-RANGING CAPACITANCE METER
                ;
       0D00     DISP    =       0D00        ;DISPLAY ADDRESS
       0F00     RAM     =       0F00        ;RAM AREA
       015A     DISPA   =       015A        ;ADDRESS TO SEGMENTS ROUTINE
       000C     LCOUNT  =       12          ;RAM OFFSETS:
       000E     HCOUNT  =       14
                ;
0000                    .=0F20
0F20 C40D       START:  LDI     H(DISP)     ;POINT P1 TO DISPLAY
0F22 35                 XPAH    1
0F23 C400               LDI     L(DISP)
0F25 31                 XPAL    1
0F26 C40F               LDI     H(RAM)      ;POINT P2 TO RAM
0F28 36                 XPAH    2
0F29 C400               LDI     L(RAM)
0F2B 32                 XPAL    2
0F2C C401               LDI     H(DISPA)    ;POINT P3 TO DISPA ROUTINE
0F2E 37                 XPAH    3           ;  IN MONITOR.
0F2F C459               LDI     L(DISPA)-1
0F31 33                 XPAL    3
0F32 C405               LDI     5           ;SET RANGE TO 5
0F34 C80A               ST      RANGE+1
0F36 C400       CLEAR:  LDI     0           ;SET COUNT TO ZERO
0F38 CA0C               ST      LCOUNT
0F3A C400               LDI     0
0F3C CA0E               ST      HCOUNT
0F3E C405       RANGE:  LDI     5
0F40 07                 CAS                 ;SELECT RESISTOR
0F41 03         LOOP:   SCL
0F42 C20C               LD      LCOUNT      ;INCREMENT COUNT IN
0F44 68                 DAE                 ;  DECIMAL.
0F45 CA0C               ST      LCOUNT
0F47 C20E               LD      HCOUNT
0F49 68                 DAE
0F4A CA0E               ST      HCOUNT
0F4C 06                 CSA                 ;READ INPUT
0F4D D420               ANI     020         ;ISOLATE SENSE-B
0F4F 9C02               JNZ     TEST        ;HIGH?
0F51 90EE               JMP     LOOP
0F53 C400       TEST:   LDI     0
0F55 07                 CAS                 ;START CAPACITOR DISCHARGE
0F56 C20E               LD      HCOUNT
0F58 9C18               JNZ     DISPLY      ;OUT OF RANGE?
0F5A C20C               LD      LCOUNT
0F5C D4F8               ANI     0F8
0F5E 9C12               JNZ     DISPLY      ;LESS THAN 8
0F60 C00E               LD      RANGE+1     ;SET NEXT RANGE
0F62 02                 CCL
0F63 F401               ADI     1
0F65 C8D9               ST      RANGE+1     ;MODIFY BYTE
0F67 03                 SCL
0F68 FC08               CAI     8
0F6A 9806               JZ      DISPLY
0F6C 8FFF               DLY                 ;COMPLETELY DISCHARGE
0F6E 8FFF               DLY                 ;  CAPACITOR.
0F70 90C4               JMP     CLEAR       ;TRY NEXT RANGE
0F72 C0CC       DISPLY: LD      RANGE+1     ;GET CURRENT RANGE
0F74 03                 SCL
0F75 FC06               CAI     6
0F77 980A               JZ      R2
0F79 9402               JP      R3
0F7B 9C0C               JNZ     R1
0F7D C473       R3:     LDI     073         ;SEGMENT CODE FOR P
0F7F CA01               ST      +1(2)       ;RANGE DIGIT
0F81 900A               JMP     FARAD
0F83 C454       R2:     LDI     054         ;SEGMENT CODE FOR N
0F85 CA01               ST      +1(2)       ;RANGE DIGIT
0F87 9004               JMP     FARAD
0F89 C41C       R1:     LDI     01C         ;SEGMENT CODE FOR U
0F8B CA01               ST      +1(2)       ;RANGE DIGIT
0F8D C471       FARAD:  LDI     071         ;SEGMENT CODE FOR F
0F8F CA00               ST      (2)         ;UNITS DIGIT
0F91 3F         MONITR: XPPC    3           ;DISPLAY RESULT
0F92 90FD               JMP     MONITR      ;ILLEGAL RETURN
0F94 908A               JMP     START       ;NUMBER KEY RETURN

     0000               .END
```

Fig. 2. SC/MP program for the auto-ranging capacitance meter

```
                        ;       DATA FIND ROUTINE
                        ;
                        QHEXTD =$FE64           DISPLAY X,X+1 IN HEX
                        QDATFE =$FE88           GET ADDRESS INTO X,X+1
                        COM16  =$FEA0           INC X+6,X+7 AND
                        INIT   =$FEFB             COMPARE WITH X+8,X+9
                        D      =$0010           DISPLAY BUFFER
0000                           .=$0020
0020   A9 71      FIND    LDA   £$71            F SEGMENT CODE
0022   85 10              STA   D               LEFTMOST DIGIT
0024   A2 60              LDX   £FROM
0026   20 88 FE           JSR   QDATFE          GET FROM ADDRESS
0029   A9 78              LDA   £$78            T SEGMENT CODE
002B   85 10              STA   D
002D   A2 62              LDX   £TO
002F   20 88 FE           JSR   QDATFE          GET TO ADDRESS
0032   A9 5E              LDA   £$5E            D SEGMENT CODE
0034   85 10              STA   D
0036   A2 64              LDX   £DATA
0038   20 88 FE           JSR   QDATFE          GET DATA
003B   A0 00              LDY   £0
003D   B1 60      CONT    LDA   (FROM),Y
003F   C5 64              CMP   DATA
0041   F0 0A              BEQ   FOUND
0043   A2 5A      LOOK    LDX   £FROM-6         INCREMENT AND
0045   20 A0 FE           JSR   COM16             COMPARE FROM & TO
0048   D0 F3              BNE   CONT
004A   4C FB FE           JMP   INIT            RETURN TO MONITOR
004D   A2 60      FOUND   LDX   FROM
004F   20 64 FE           JSR   QHEXTD          DISPLAY ADDRESS
0052   20 88 FE           JSR   QDATFE          WAIT FOR KEY
0055   18                 CLC
0056   90 EB              BCC   LOOK            CONTINUE
0058                      .=$0060               VARIABLES:
0060              FROM    .=.+2 START ADDRESS FOR SEARCH
0062              TO      .=.+2 END ADDRESS FOR SEARCH
0064              DATA    .=.+1 DATA TO SEARCH FOR
                          .END
```

Fig. 3. 6502 program, for use with an Acorn microcomputer, will search for a specified byte

```
                        ;    SHORT BINARY-TO-DECIMAL
                        ;    ROUTINE FOR Z80
                             ORG    0C50H
0C50               DEC:      DEFS   5             ;FOR RESULT
0C55   F0D8        CONTAB:DEFW   -10000
0C57   18FC                  DEFW   -1000
0C59   9CFF                  DEFW   -100
0C5B   F6FF                  DEFW   -10
                        ;
                             ORG    0C70H
0C70   215FEA      BINDEC:LD     HL,59999      ;FOR TEST
0C73   ED73920C              LD     (STAKSV+1),SP
0C77   31550C                LD     SP,CONTAB     ;POINT TO TABLE
0C7A   01500C                LD     BC,DEC
0C7D   D1          LOOP1:    POP    DE
0C7E   3EFF                  LD     A,-1
0C80   19          LOOP:     ADD    HL,DE
0C81   3C                    INC    A
0C82   DA800C                JP     C,LOOP
0C85   ED52                  SBC    HL,DE         ;RESTORE
0C87   02                    LD     (BC),A        ;SAVE DIGIT
0C88   03                    INC    BC
0C89   7B                    LD     A,E
0C8A   FEF6                  CP     -10           ;ALL DONE?
0C8C   C27D0C                JP     NZ,LOOP1
0C8F   7D                    LD     A,L
0C90   02                    LD     (BC),A        ;SAVE REMAINDER
0C91   310000      STAKSV:LD     SP,0          ;TO BE MODIFIED
0C94   C9                    RET
```

Fig. 5. Improved Z80 routine to convert a binary number to decimal

the same time by pressing the 'F' key on the Mk14 just before the tank collides with the mine. If the mine is hit the tank and mine are destroyed displaying 'BANG' where the mine was. A new tank then starts from the beginning and the score, which is displayed in the top left-hand corner of the screen, is incremented by one. When ten tanks have been destroyed the program stops. Pressing GO twice then reloads the minefield and starts the game again, with the last 'BANG' still displayed as the target to beat.

As a slight departure from normal policy the program in Fig. 4 is presented as a hex dump rather than as a full assembler listing. However, the operation of the program is fairly straightforward, and there should be no problem discovering how it works.

```
        MINEFIELD
0F20 3F C4 30 C8 FC C4 04 36
0F28 C4 20 32 C4 00 CE 15 B8
0F30 F0 98 02 90 F6 3F C4 04
0F38 36 C4 01 32 C4 30 CA 00
0F40 C4 04 36 C4 06 32 C4 04
0F48 35 C4 09 31 C4 58 CE 02
0F50 CE 01 8F 66 C4 20 CE FD
0F58 CE 01 8F 66 C5 01 98 02
0F60 90 32 C4 20 CE 01 CE 01
0F68 CE 01 C4 42 CD 01 C4 41
0F70 CD 01 C4 4E CD 01 C4 47
0F78 CD 01 C4 04 37 C4 01 33
0F80 C3 00 EC 01 CB 00 E4 40
0F88 98 02 90 B4 C4 00 37 C4
0F90 22 33 90 8C C4 0D 37 C4
0F98 00 33 C3 07 E4 EF 98 02
0FA0 90 AA C4 20 CE FD CE 01
0FA8 CE 04 CD FD CD 01 CD 04
0FB0 90 9A
```

Fig. 4. SC/MP program for the Minefield game

BEST Z80 ROUTINE

Readers were challenged to improve on the execution times of the binary-to-decimal routines presented in the *October 1979 Micro-Bus*. The published routine for the Z80 took 1631 cycles to convert the worst-case number EA5FH to its decimal equivalent 59999, and several routines have been received which improve on this figure. Readers were unanimous in avoiding use of the index registers, IX and IY, since the indexed addressing instructions take many more cycles than the equivalent instructions using HL or BC as pointers. The best routine, shown in Fig. 5, was submitted by *D. J. Smith of the Midlands Amateur Computer Club*, and it reduces the number of cycles to 1245. The routine modifies itself at STAKSV and so could not be put into ROM, but a temporary location could equally well have been used to hold the stack pointer, at a cost of only 10 cycles. A similar, but slightly slower, routine was submitted by *B. G. W. Lloyd of Brighton*, and he summarises the improvements as follows:

1. The slow 2-byte SBC instruction is replaced by the single-byte ADD instruction.
2. Register pair BC is used instead of IX as a pointer to the result.
3. The biggest saving comes from using the stack pointer, instead of IY, to reference the table of powers of ten; thus the POP instruction can be used instead of LD and INC. The original stack pointer is saved and restored again at the end of the routine.

Incidentally, several readers were puzzled by the fact that in Table 1 the number of executions of the inner loop was given as 32, not 36. This was because the time for the last execution of the inner loop was included in the time for the outer loop, which was executed 4 times. This approach was chosen to make the calculation simpler in the case of the 6502, because its branch instruction at the end of the loop is one cycle shorter when the branch is not taken.

SOLUTIONS TO NINE PROBLEMS

Finally this month, here are the solutions to the nine programming problems posed in the last Micro-Bus.

One. The first problem asked for a program to find the highest prime factor of a number using the following hypothetical instruction set (where X and Y represent any of the four registers A–D, and L represents a label):

LD	X,Y	Load X with the value in Y
DEC	X	Subtract 1 from the value in X
JZ	L	Jump to L if result of previous DEC was zero
JNZ	L	Jump to L if result of previous DEC was non-zero
DIS	X	Display value of X

The solution, shown in Fig. 6, uses just 14 instructions and is believed to be the shortest possible. To the right of the solution is shown an equivalent BASIC program which can be used to verify that the algorithm works. It is, however, very difficult to explain exactly *how* it works, and a flowchart of the program is not very enlightening. One reason why the program is so difficult to understand may be that it breaks all the rules of structured programming; for example, it contains two mis-nested loops, at labels LOOP and NEXT. If any reader can come up with a concise explanation it will be included in a future Micro-Bus.

```
         MINIL:               BASIC:

                              10 INPUT A
NOT:  LD  D,A                 20 D=A
NEW:  LD  C,D                 30 C=D
NEXT: LD  B,A                 40 B=A
LOOP: DEC B                   50 B=B-1
      JZ  NEXT                60 IF B=0 GOTO 40
      DEC C                   70 C=C-1
      JNZ LOOP                80 IF C≠0 GOTO 50
      DEC A                   90 A=A-1
      DEC B                  100 B=B-1
      JNZ NEW                110 IF B≠0 GOTO 30
      LD  C,A                120 C=A
      DEC C                  130 C=C-1
      JNZ NOT                140 IF C≠0 GOTO 20
      DIS D                  150 PRINT D
```

Fig. 6. Two programs to find the largest prime factor of a number, using a minimal instruction set

The simple instruction set given above is described in the Mk14 booklet 'Further Applications Programs', available from Science of Cambridge, where it is referred to as the 'MINIL' language. The prime factor program of Fig. 6 is one of four MINIL programs given in the booklet, and for readers who enjoy the challenge of programming in such a primaeval instruction set the booklet includes the listing of an interpreter which will enable MINIL programs to be run on a SC/MP processor.

Two. The five ways of loading zero into the accumulator on a SC/MP micro, using just two bytes, are:

	C4 00	LDI 0
	C0 00	LD 0
	D4 00	ANI 0
	D0 00	AND 0
and	40,60	LDE, XRE.

The problem, devised by *Geoff Phillips*, appeared in the third issue of the Mk 14 Users Group Magazine 'Complement and Add'. Readers interested in joining the club should write to: Geoff Phillips, 8 Poolsford Road, London, NW9 6HP.

Three. The larger of two numbers, A and B, can be printed without using the IF statement by the following BASIC statement:

PRINT (A+B+ABS(A−B))/2

where ABS is a standard BASIC function giving the absolute value of its argument (regardless of sign). The solution relies on the fact that given any two numbers, one can be expressed as their average plus half their difference, and the other as their average minus half their difference.

This problem is adapted from page 6 of Donald E. Knuth's scholarly work 'The Art of Computer Programming', Volume 3.

Four. A little experimentation shows that there is no way, on the 6800, of reversing the bits in a byte in under 10 cycles using software alone. However, the problem did not prohibit the use of hardware in its solution; if an 8-bit output port is wired to an 8-bit input port as shown in Fig. 7, the instructions:

```
STAA  PORTA
LDAB  PORTB
```

will set B to the reversal of A, as required, in just 9 cycles on the 6800. The method can be used for any desired rearrangement of bits by appropriately wiring the connections between PORTA and PORTB. The problem is not without practical importance; the operation of reversing the bits in a number is used by some Fast Fourier Transform programs as an essential part of the efficient algorithm.

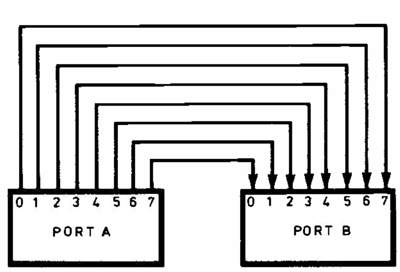


Fig. 7. Connection between two 8-bit ports to implement a 'reverse' instruction

Five. The shortest way to toggle the carry bit on the 6502, 6800 or 6809 is by means of the instructions:

```
RORA
EORA  £$80
ROLA.
```

These instructions require four bytes for each micro, and leave the accumulator unchanged, as required.

Six. The single BASIC statement:

```
PRINT A*(1−ABS(SGN(N−X)))
    + B*(1−ABS(SGN(N−Y)))
    + C*(1−ABS(SGN(N−Z)))
```

will print one of the three values, A, B or C, depending on whether N has the value X, Y or Z respectively. The solution makes use of the standard BASIC function SGN which returns −1, 0 or 1 depending on whether its argument is respectively less than zero, equal to zero, or greater than zero. Some BASICs will allow Boolean expressions in statements which evaluate to 1 if they are true and 0 if they are false. In this case the statement can be written more simply as:

PRINT A*(N=X) + B*(N=Y) + C*(N=Z).

Seven. The effect of the two SC/MP instructions 'LDI 0, CAI 0' does not depend on the value of the two arguments; for example, 'LDI 23, CAI 23' gives exactly the same result. Thus the instructions can be replaced by 'LDE, CAE' which, in half the number of bytes, achieve the same effect no matter what the contents of E are.

This trick is described on page 49 of the revised edition of the Mk14 'Microcomputer Training Manual'.

Eight. The following four single-byte instructions produce, for the 6502, the same effect as the 6800's ASRA instructions:

```
PHA
ROLA
PLA
RORA.
```

Nine. The following instructions for the 6800 will load the X register with the value of HERE, wherever the routine is positioned in memory:

```
HERE  BSR  *+2
      TSX
      LDX  0,X  X=HERE+2
      INS
      INS
      DEX
      DEX.
```

The routine uses the BSR instruction to push the program counter onto the stack, from where it is loaded into the X register. The routine formed part of a self-replicating program presented in the *June 1979 Micro-Bus*.

Note that an equivalent effect can be obtained on the 6809 by the instruction:

```
HERE  LDX  HERE,PCR
```

which uses program-counter relative addressing to give code which is position-independent.

COMPUKIT UPDATE

By Dr. A. A. BERK

LAST time I wrote an update, I promised a short course in Hexadecimal arithmetic and associated theory. This is presented here in order to help you understand the 6502 code in more detail, as well as the conversions between machine code and the decimal based PEEK and POKE statements. However, my first task is to present some comments on my last update, and introduce some suggestions from readers.

Last time, a memory map of the VDU screen was given, to allow you to place general patterns on display, and manage the screen contents directly. Unfortunately, some readers have confused the difference between those locations on the screen which the Compukit's software uses, and the ones which are available to the user. It is certainly true that the cursor is always written to the screen several spaces in from the left. All BASIC statements start from here and the BASIC interpreter never allows characters to be written over to the extreme left margin. This means that the only way to fill screen spaces over to the extreme left hand side of the display is to use POKE, or the machine code monitor. However, the majority of TV sets will not, in fact, display very many spaces to the left of the cursor, and that is the reason for the BASIC interpreter's apparent waste of display space. To retrieve some of the missing left hand positions, the screen contents must be moved over to the right by reducing the value of resistor R34. Of course, this also removes an equal quantity of the right hand side of the display, and it is up to you to decide which side is the more important.

Also last time, the set of characters which the Compukit is able to display was presented, and I made no mention of the source of this valuable piece of hard copy. This was originally produced on a "Video Writer" with the compliments of *Mr. Hardman* of *Jayman Electro Devices Ltd.* My thanks to him, and apologies for the omission.

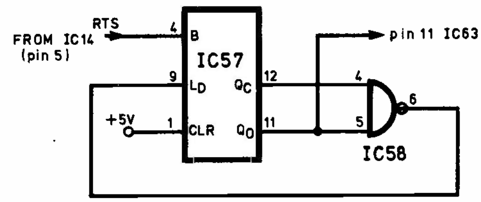
We should point out that the graphics chart as published, in no way reflects the output quality of the Video Writer—Ed.

I suggested a method of producing hard copy from a standard Teletype, working at 110 BAUD. In that section, it was stated that the Compukit gives out just one "stop" bit when communicating information serially. This is certainly an error, and comes from an early scoping of the serial data. In fact, two "stop" bits are given out, and hence the data will automatically be compatible with industry standard teletypes.

SOFT BAUD RATE

I am indebted to *Mr. C. S. K. Clapp* of Bracknell for the following ideas. He has suggested a way in which the BAUD rate of the serial data may be adjusted by software.

Fig. 1 shows his circuit modification to the p.c.b. This modification allows the BAUD rate and other parameters to be changed by storing the appropriate data in IC14's internal register. The address of this register is 61440 (decimal), and the statement: POKE 61440,82 selects 110 BAUD operation. IC14 is quite a complex chip, and is even capable of checking and generating parity bits in the serial data. Resetting, or using: POKE 61440,17 selects 300 BAUD back again. When set up, the ACIA (IC14) produces one start bit and two stop bits automatically. This may also be changed at will by storing the right data at address 61440. In order to appreciate the full potential of this chip, it is essential to read the ACIA data sheet in detail.



E6338 **Fig. 1. Modification for software BAUD rate**

Mr. Clapp also broaches the question of incompatibilities between different versions of the Compukit. There are two versions of the ROMs which are found in the machine, and this explains the differences in behaviour which occur. The very first version of these ROMs was produced by General Instruments and did not allow the "Rub Out" key to backspace the cursor and delete an error on the screen. The second ROM set was produced by Synertek, and these do allow on-screen editing. This is the simplest method of deciding which ROM set is resident in any given machine.

The other difference between the two ROMs is one of screen positioning. The first set place the cursor one space left of the position found by using the second set. The idea is to ensure that no matter how bad the TV set, the BASIC information is never lost to the left.

Of course, there are many different versions of the p.c.b. on which the machine is built, and the differences are too numerous to mention. The very latest version has green solder resist on it to facilitate soldering without bridging. Also, many different types of discrete component had to be supplied, depending upon availability, as is usual with such large volumes.

Let me once again say that your ideas and comments are read with great interest, and hopefully, these will continue to flow and appear on these pages.

WHAT THE HEXADECIMAL?

I should now like to turn to the business of Hexadecimal notation. In order to make the ideas clear, let us start with some of the properties of our *decimal* system— *the one we use every day.* When a number such as 3124 is written down, we all have an idea of the meaning of this notation. It means three thousands, plus one hundred, plus two tens (i.e. twenty) plus four (units). Each digit implies a certain quantity of some power of ten. A thousand is ten raised to the power 3.

$$1000 = (10)^3$$

Similarly, a *hundred* is ten to the power 2, *ten* is ten to the power 1 and, finally, *one* is ten to the power zero. (Any non zero number raised to the power zero gives one).

The number 63124 also includes ten to the power four six times and so on.

Our counting system uses just the ten digits 0 to 9 to describe any number by the method above. We say that the "base" of our system is ten. This presumably originates from our having ten figures. If we were endowed instead with eight fingers, we should certainly be using the "Octal" system, having just eight digits (0 to 7) and we should have to replace powers of ten with powers of eight in the above.

In a similar way, the Hexadecimal system is based upon the number sixteen. Hence, comparison with the above would suggest that sixteen digits are necessary. That is, we need sixteen single digit numbers to be able to count in Hexadecimal (Hex for short). Our decimal system is able to supply the first ten, but then it is necessary to invent six others. Any six symbols would do, but for convenience, the first six letters of the alphabet are used. Thus the sixteen Hex digits are 0 to 9 and A, B, C, D, E and F. A is the next digit after 9, and hence is the Hex equivalent of ten. B is the next number, i.e. eleven, and so on.

Table 1 shows the Hexadecimal counting system, and the decimal and binary equivalents of each digit. This diagram also highlights one of the most important aspects of the system i.e. to represent binary in a manageable form. Notice how a pattern of four 1's and 0's may be conveniently written as one Hex digit.

TABLE 1. NUMBER CONVERSION

HEXA-DECIMAL	DECIMAL	BINARY
0	0	0 0 0 0
1	1	0 0 0 1
2	2	0 0 1 0
3	3	0 0 1 1
4	4	0 1 0 0
5	5	0 1 0 1
6	6	0 1 1 0
7	7	0 1 1 1
8	8	1 0 0 0
9	9	1 0 0 1
A	10	1 0 1 0
B	11	1 0 1 1
C	12	1 1 0 0
D	13	1 1 0 1
E	14	1 1 1 0
F	·15	1 1 1 1

To count above the digit F in Hex, the same rules apply as for Decimal. That is, counting proceeds as follows: 0, 1, 2, 3 . . . . 9, A, B . . . E, F, 10, 11, 12, ... 1E, 1F, 20, 21, etc.

The address of any memory location in an MPU system, is given by the binary state of sixteen Address Bus lines. That is, each memory location has a unique pattern of 1's and 0's to identify it. These sixteen binary digits are best described using hex because just four digits are necessary instead of sixteen. BASIC uses Decimal to identify memory locations, and this is where most of the confusion arises. Thus, Address D308, for instance, is clearly a Hex Address, but in BASIC would be written as 54024. The reason for this is exactly as described earlier. Each hex digit implies a number of powers of sixteen, as follows:

4096's	256's	16's	1's
D	**3**	**0**	**8**

To arrive at the Decimal equivalent of this Hex number, add up the following:

D × 4096 3 × 256 0 × 16 1 × 8

The D is equivalent to thirteen in decimal, and hence D × 4096 equals 53248; add this to the other values and 54024 is the result. Note that 1 is sixteen to the power zero, 16 is sixteen to the one, 256 is sixteen to the two and 4096 is sixteen to the three.

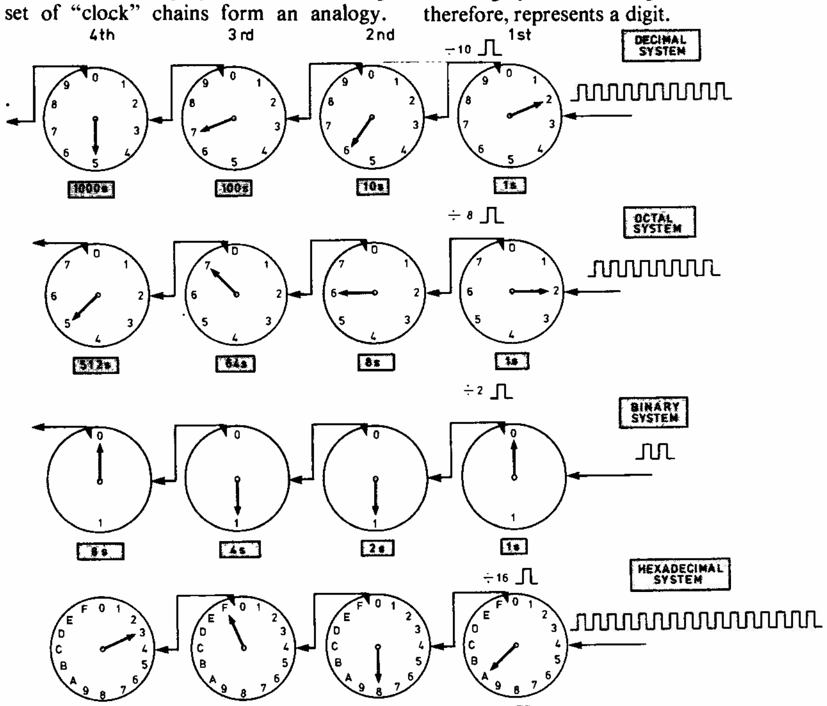
The next step is to be able to convert Decimal into Hex—see if you can generate a suitable alogorithm, and then write a program to do the conversion for you. The clue is that the number must first be divided by 4096 (if less than 65535), to determine the amount of "4096's" in the number.

That's all for this month, except to wish you all the best, and happy computing!

SUMMARY

To assist in the appreciation of each numerical counting system, the following set of "clock" chains form an analogy.

Each individual clock should be thought of as a counter/divider, dividing the absolute number of input pulses according to the counting system it belongs to. Each clock, therefore, represents a digit.



In the **Decimal** system each clock divides by *ten.* Overflow pulses are generated as the dial pointer returns to zero after a revolution. It took 5762 pulses to obtain the reading of 5762.

In the **Octal** system each clock divides by *eight.* The dial numbers on, for example, the 4th clock face, represent quantities of 512, and so here the number 5762 has an entirely different value to its decimal counterpart.

The **Binary** clock (or digits) divide by *two.* This system is suited to digital electronics for the obvious reason that ON/OFF or +5V/0V will readily represent any number.

The **Hexadecimal** system employs 16 states per digit, which, keeping to the analogy, means that these clocks divide by *sixteen.* Recourse to the alphabet for the extra states has resulted in 0–9, A–F. The readout illustrated is 3F8A; and what the F on the 3rd clock is telling you is that there are 15 lots of 256 (15 × 256). A *full* conversion to decimal would be:
(3 × 4096) + (15 × 256) + (8 × 16) + (10 × 1) = 16266
i.e. 3F8AH = 16266 decimal (H stands for Hex)

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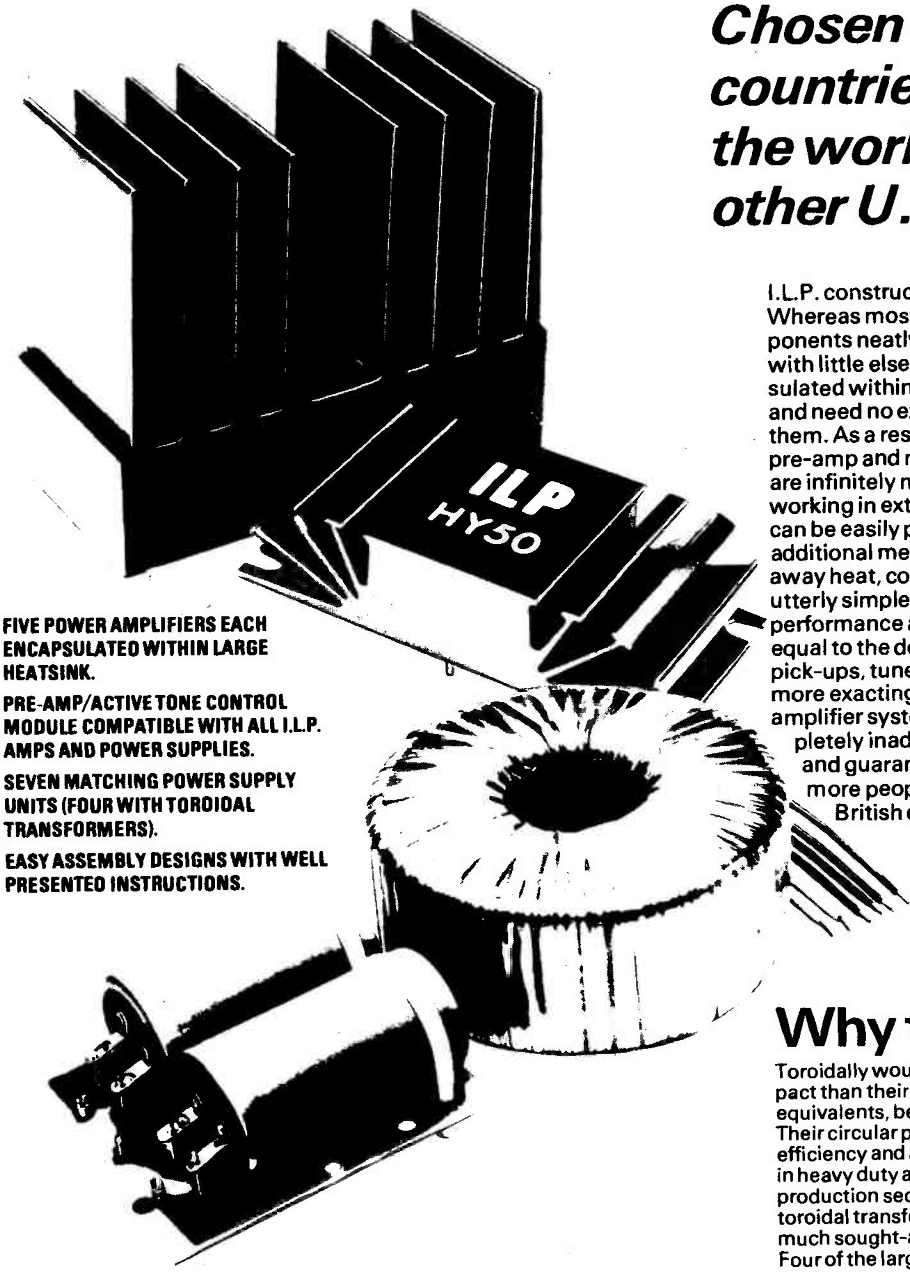

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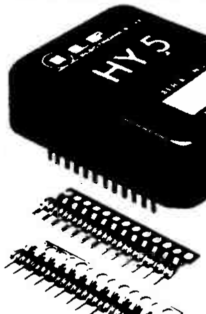

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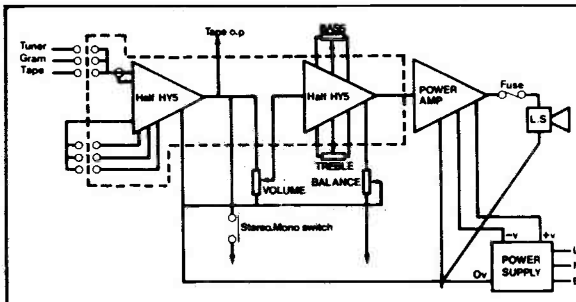

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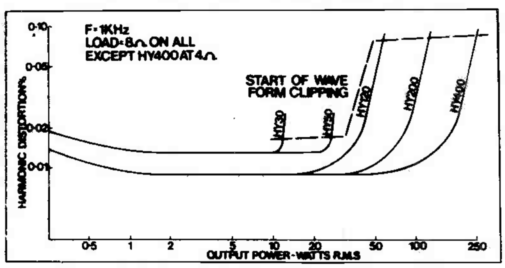

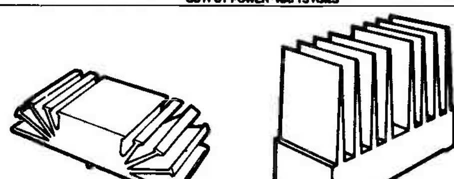

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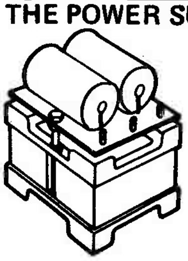

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BC147	6p
BC147B	6p
BC149	7p
BC149C	7p
BC159	9p
BC160	35p
BC167A	10p
BC178	12p
BC179	12p
BC182	8p
BC182L	9p
BC183	9p
BC183L	9p
BC184L	9p
BC186	20p
BC212	9p
BC212L	9p
BC213B	9p
BC327	13p
BC328	13p
BC337	16p
BC338	11p
BC440	32p
BC547	9p
BC548	9p
BC550	14p
BC558	12p
BCY33	99p
BCY34	99p
BCY39	299p
BCY58	16p
BCY70	12p
BCY71	12p
BCY72	12p
BF179	25p
BF183	25p
BF200	29p
BF336	33p
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BFX86	26p
BFX88	22p
BFY50	13p
BFY51	13p
BFY64	28p
BFY90	56p
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2N1304	40p
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2N1711	15p
2N2217	20p
2N2219A	20p
2N2221	18p
2N2368	15p
2N2369	14p
2N2894A	20p
2N2904	15p
2N2904A	15p
2N2905	15p
2N2906	15p
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2N2926O	10p
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2N4427	60p

DIODES

AA119	10p
BA154	9p
BA156	9p
IN4001	4p
IN4002	4p
IN4003	5p
IN4005	5p
IN4148	5p
IS44	3p

OPTO

Led's

.125 Red	10p
.125 Orange	10p
.125 Yellow	10p
.2 Red	10p
.2 Green	10p
.2 Clear	10p

Displays

704	110p
727	160p
741	160p
747	160p
750	160p

REGULATORS

7805	57p
7812	57p
7815	57p
7818	57p
7824	57p
7905	140p
7912	140p
7915	140p
7918	140p
7924	140p
LM320T5	149p
LM320T8	149p
LM320T15	149p
LM320T18	149p
LM340T5	74p
LM340T8	74p
LM340T15	74p
LM340T18	74p

TRIACS

		with internal trigger diac.
4A 400V	54p	66p
4A 600V	60p	75p
6A 400V	60p	75p
6A 600V	66p	90p
8A 400V	66p	90p
8A 600V	72p	95p.
10A 400V	72p	95p
10A 600V	84p	100p
15A 400V	108p	120p
15A 600V	126p	138p

TTL

7400	9p
7401	9p
7402	9p
7403	9p
7404	10p
7405	14p
7406	30p
7407	30p
7408	17p
7409	17p
7410	12p
7412	17p
7413	25p
7414	45p
7416	25p
7417	25p
7420	14p
7427	26p
7430	14p
7432	22p
7438	26p
7442	48p
7447	50p
7450	15p
7451	15p
7470	30p
7472	25p
7474	20p
7475	27p
7480	40p
7482	60p
7486	25p
7491	63p
7492	35p
7493	28p
7494	63p
7495	63p
74100	110p
74107	30p
74121	25p
74122	36p
74123	44p
74145	72p
74154	80p
74157	60p
74161	85p
74175	63p
74180	84p
74181	151p
74191	80p
74192	80p
74193	80p
74194	80p
74LS00	11p
74LS01	11p
74LS02	12p
74LS03	12p
74LS04	12p
74LS10	19p
74LS11	20p
74LS20	18p
74LS30	18p
74LS32	24P
74LS42	89p
74LS51	24p
74LS55	28p
74LS74	39p
74LS75	46p
74LS76	39p
74LS85	99p
74LS90	36p
74LS93	79p
74LS114	49p
74LS122	65p
74LS123	65p
74LS124	115p
74LS132	89p
74LS139	79p
74LS151	89p
74LS155	91p
74LS156	89p
74LS157	69p
74LS165	69p
74LS168	139p
74LS174	99p
74LS175	99p
74LS190	110p
74LS192	115p
74LS194	115p
74LS195	115p
74LS196	95p
74LS197	125p
74LS257	99p
74LS260	99p
74LS273	199p
74LS367	59p
74LS378	159p

MEMORIES | EPROMS | CPU'S | OPTO

BRIDGES

	50V	100V	200V	400V	600V
2A	45p	52p	60p	75p	100p
4A	52p	60p	68p	82p	105p
6A	60p	68p	75p	90p	112p

DIL SOCKETS

8 pin	10p
14 pin	12p
16 pin	13p
20 pin	25p
24 pin	30p
40 pin	40p

MEMORIES

21L02	109p
2114	400p
4027	275p
4116	750p

EPROM

2708	750p
2716	2600p

CPU'S

Mk 3880	1250p
Mk 3881	750p
Mk 3882	750p

CMOS

4000	14p
4001	14p
4002	14p
4006	69p
4007	16p
4008	79p
4009	36p
4010	36p
4011	19p
4012	16p
4014	59p
4015	73p
4016	42p
4017	79p
4018	79p
4019	45p
4020	89p
4021	83p
4022	79p
4023	16p
4024	49p
4025	17p
4026	129p
4027	39p
4028	59p
4029	89p
4030	49p
4034	189p
4035	99p
4042	69p
4043	86p
4044	63p
4046	109p
4049	45p
4050	43p
4051	69p
4052	69p
4053	69p
4066	49p
4069	17p
4070	17p
4071	17p
4072	17p
4073	17p
4075	19p
4076	75p
4077	35p
4081	19p
4082	17p
4160	105p
4161	105p
4162	105p
4163	105p
4402	36p
4404	110p
4412	86p
4445	174p
4446	148p
4502	99p
4511	89p
4512	89p
4514	229p
4515	229p
4516	99p
4520	79p
4522	129p
4526	125p
4531	125p
4555	92p
4556	69p
4581	269p
4582	115p
4584	59p
4585	99p

**35p P & P
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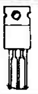
Write, telephone or call. Access or Barclaycard accepted**

TRIACS

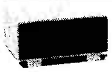


400V Plastic Case (Texas)

3A	49p	16A	90p
8A	58p	20A	165p
12A	85p	25A	190p

6A with trigger 80p
8A isolated tab 65p
Diac 15p

24 HOUR CLOCK APPLIANCE TIMER KIT



Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit **£14.90**
CT1000KB with white box (56/131×71mm) **£17.40**
Ready Built **£22.50**

MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

TEMPERATURE CONTROLLER/THERMOSTAT

Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. PCB (4 cm.sq.) potentiometer, plus all other components included with instructions.
500W **£3.20** 1KW **£3.50**

SOLID STATE RELAY

Ideal for switching motors, lights, heaters etc. from logic. Opto isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

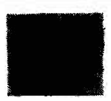
BAR/DOT DISPLAY

Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indictors etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER

Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0·5°C.
1·5KW **£5·25** 3KW **£5·55**

DIGITAL VOLTMETER THERMOMETER KIT



Based on the ICL 7106. This Kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply. (PP3 battery) **£20.75**

LEDs

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p

DISPLAYS

DL304 Red 0.3" c.c. pin compatible with DL704 **70p**
DL307 Red 0.3" c.a. pin compatible with DL707 **70p**
DL847 Red 0.8" (pin comp. DL747) c.a. **£1.80**
DL850 Red 0.8" c.c. (pin comp. DL750) **£1.80**
DL727 Dual 0.5" c.a. Red **£1.50**

LIGHTING CONTROL KITS

Directly replace conventional light switch and control up to 300W of lighting. No mains rewiring. Insulated touchplates. Easy to follow instructions.

TD300K TOUCHDIMMER. Single touchplate with alternate action. Brief touch switches lamp on and off, longer touch dims or brightens lamps. Neon lamp helps find the switch in the dark. **£6.50**

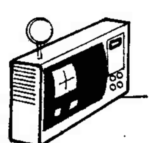
TDE/K Extension kit for TD300K for 2-way switching etc. **£1.50**

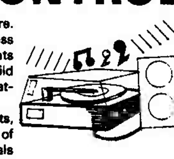
TSD300K – TOUCHSWITCH & DIMMER. Single touchplate, small knob controls brightness. **£5.50**

TSA300K – AUTOMATIC. Single touchplate. Time delay variable 2 secs. to 3½ mins. **£4.30**

LD300K – LIGHTDIMMER KIT. **£2.90**

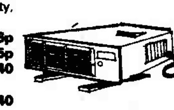
INFRA RED REMOTE CONTROL





If you've got the ideas, we've got the hardware. Hundreds of uses in the home, shop, business or industry. Our range of ICs and components for Infra-Red remote control enable you to build controllers for applications ranging from heating to Hi-Fi to toys to garage door openers.

Up to 16 channels with three analogue outputs, low component counts and large tolerance of clock frequency eliminate the need for crystals or coils. The systems offer high noise immunity, reliability and low cost.



LD271	IR Emitting Diode	36p
SFH205	Photodiode Detector	95p
SL480	I.C. Pulse Amplifier	£1.40
SL490	Keyboard Controlled Encoder/ Transmitter	£2.40
ML922	10-channel Receiver + 3 Analogue Outputs	£4.20
ML928	16-channel Receiver (4 latched binary outputs)	£1.40
Data sheets (per device)		5p

These ICs can also be used with ultra sonic or radio links, depending on range, cost and speed of operation. For more details why not give us a ring.

NEW CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance, enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, I.C., 4-digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 solid state relay kits.

£25.25

Size: 10×12×4.5 cms
Colour: Black

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION ADD VAT AT CURRENT RATE TO ABOVE PRICES PLUS 35p P&P
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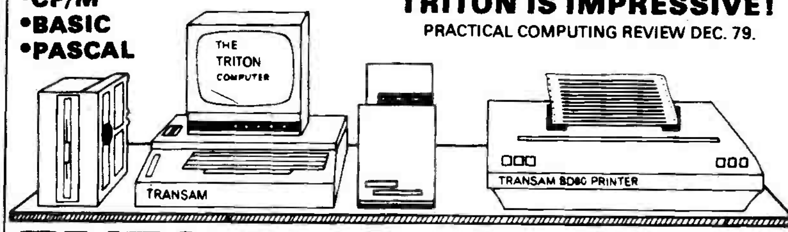
TRANSAM

COMPONENTS AND SYSTEMS FROM TRANSAM COMPUTERS

- •CP/M
- •BASIC
- •PASCAL

TRITON IS IMPRESSIVE!

PRACTICAL COMPUTING REVIEW DEC. 79.



TRITON
COMPUTER SYSTEM.

Designed for ease of construction and flexibility. Kits come complete and all components and software are available separately. UK designed and supported. Fully documented hardware and software and a totally flexible approach to system building. Powerful and easy to use system monitors – a range of languages available. Firmware is Eprom based and upgrading from one level to the next is easy.

● L5.2 with 1.5k monitor 2.5k basic	£294.00
● L7.2 with 2k mon 8k extended basic	£409.00
● L8.2 4k ed/mon 20k res pascal	£611.00
● L9.2 CP/M disc based system	P.O.A.
● 8k ram card kit (21141)	£97.00
● 8k eprom cards (EXCL 8–2708)	£31.00
● Motherboard expansion 8 slot	£50.00
● Trap-res assm/edit etc (8–2708)	£80.00
● Transam BD80 bi-dir printer	£595.00
● TVM 10 video monitor 9"	£79.00
● Eprom prog (2708) kit	£29.50

SEND FOR OUR CATALOGUE FOR FULL DETAILS OF TRITON FEATURES !

CP/M AVAILABLE NOW FOR TRITON

Disc operating system complete with text editor, assembler, debugger, system utilities and complete file management. Makes Triton fully CP/M compatible and able to run CP/M based software. Triton will support up to four 5¼ or 8" drives single or double density full CP/M software user group facilities available. SAE for details.

CP/M Disk + manuals (6) £75.00

DISK DRIVES & POWER SUPPLIES

SHUGART

SA400 5¼" drive	£205.00
SA800 8" drive	£380.00
Power one quality power supplies	
CP249 1×5¼ PSU	£33.00
CP323 2×5¼ PSU	£60.00
CP205 1×8" PSU	£56.00
CP206 2×8" PSU	£76.00

TCL PASCAL – CP/M COMPATIBLE

A standard Pascal compiler available on a resident (20k) Eprom based configuration* or available to run under CP/M on 8" disc plus documentation. CP/M version **£120.00.**
*P.O.A. TCL Pascal Manual and specification **£6.50.**

FULL RANGE OF MICRO SUPPORT CHIPS – IN STOCK

SN74LS00N	22	SN74LS54N	21	SN74LS138N	86	SN74LS195AN	.86	SN74LS325N	2.55
SN74LS01N	22	SN74LS55N	21	SN74LS139N	95	SN74LS196N	1.20	SN74LS326N	2.55
SN74LS02N	26	SN74LS63N	1.50	SN74LS145N	1.20	SN74LS197N	1.20	SN74LS327N	2.55
SN74LS03N	26	SN74LS73N	35	SN74LS148N	1.75	SN74LS221N	1.26	SN74LS352N	1.36
SN74LS04N	26	SN74LS74N	40	SN74LS151N	86	SN74LS240N	2.20	SN74LS353N	1.50
SN74LS05N	26	SN74LS75N	40	SN74LS153N	60	SN74LS241N	1.80	SN74LS365N	66
SN74LS08N	26	SN74LS76N	35	SN74LS154N	1.80	SN74LS242N	1.80	SN74LS366N	66
SN74LS09N	22	SN74LS78N	35	SN74LS155N	1.26	SN74LS243N	1.95	SN74LS367N	65
SN74LS10N	18	SN74LS83AN	1.15	SN74LS156N	1.26	SN74LS244N	2.10	SN74LS368N	65
SN74LS11N	26	SN74LS85N	1.10	SN74LS157N	60	SN74LS245N	3.00	SN74LS373N	1.76
SN74LS12N	25	SN74LS86N	40	SN74LS158N	90	SN74LS247N	1.25	SN74LS374N	1.70
SN74LS13N	55	SN74LS90N	86	SN74LS160N	1.15	SN74LS248N	1.96	SN74LS375N	72
SN74LS14N	90	SN74LS91N	90	SN74LS161N	1.16	SN74LS249N	1.30	SN74LS377N	1.75
SN74LS15N	25	SN74LS92N	90	SN74LS162N	1.16	SN74LS251N	1.46	SN74LS378N	1.32
SN74LS20N	20	SN74LS93BN	65	SN74LS163N	90	SN74LS253N	1.25	SN74LS379N	1.40
SN74LS21N	26	SN74LS95AN	1.20	SN74LS164N	1.50	SN74LS257N	1.40	SN74LS381N	3.66
SN74LS22N	26	SN74LS96N	1.75	SN74LS165N	1.70	SN74LS258N	95	SN74LS386N	57
SN74LS26N	29	SN74LS107N	39	SN74LS166N	1.76	SN74LS259N	1.46	SN74LS390N	1.80
SN74LS27N	35	SN74LS109N	30	SN74LS168N	1.95	SN74LS260N	30	SN74LS393N	1.50
SN74LS28N	35	SN74LS112N	30	SN74LS169N	1.96	SN74LS261N	3.50	SN74LS395N	1.80
SN74LS30N	25	SN74LS113N	44	SN74LS170N	2.50	SN74LS266N	30	SN74LS396N	1.70
SN74LS32N	27	SN74LS114N	44	SN74LS173N	2.20	SN74LS273N	1.85	SN74LS398N	2.76
SN74LS33N	30	SN74LS122N	70	SN74LS174N	1.16	SN74LS279N	70	SN74LS399N	1.80
SN74LS37N	29	SN74LS123N	90	SN74LS175N	1.95	SN74LS280N	1.75	SN74LS424N	4.50
SN74LS38N	29	SN74LS124N	1.50	SN74LS181N	2.75	SN74LS283N	1.80	SN74LS445N	1.25
SN74LS40N	25	SN74LS125N	65	SN74LS190N	1.75	SN74LS290N	1.80	SN74LS447N	1.25
SN74LS42N	70	SN74LS126N	66	SN74LS191N	1.75	SN74LS293N	1.80	SN74LS490N	1.95
SN74LS47N	95	SN74LS132N	75	SN74LS192N	1.46	SN74LS295AN	2.20	SN74LS668N	95
SN74LS48N	95	SN74LS133N	39	SN74LS193N	1.76	SN74LS298N	2.20	SN74LS669N	95
SN74LS49N	1.00	SN74LS136N	40	SN74LS194AN	1.80	SN74LS324N	1.80	SN74LS670N	2.70

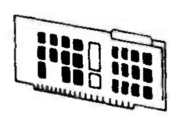
SUPPORT		RAMS	
8212	2.20	2101	2.32
8216	2.80	2102L4	1.20
8224	2.80	2111	2.32
3853 (F8)	10.00	2112	2.46
8228	4.20	6810	4.00
8T26A	1.75	8154	11.50
8T28	1.80	2114L-450	6.50
6522	6.76	2114L-250	7.00
8251	5.00	74C920	11.00
8253	11.00	74C921	11.00
8255	5.00	74C929	11.00
8257	£11.00	4027	5.00
8259	12.50	4044	7.00
8155	12.50	4045	7.00
6402	5.00	4060	7.00
6821P	4.50	2107	7.00
6850P	4.00	4116(58 for 8)	8.00
6852P	5.50	4118	20.00
AY.5.2376	11.50	Z80P10	8.00
MC14411	12.00	Z80CTC	9.00
M57109	12.43	Z80AP10	9.50
M57160	10.00	Z80ACTC	9.50
M57161	10.00	EPROMS	
TMS6011	5.00	1702	5.00
81LS95	1.00	5204	6.00
81LS96	1.00	2708	8.00
81LS97	1.00	2516	25.00
81LS98	1.00	2532	50.00

DIL PLUG SOCKETS & SWITCHES

W/WRAP SKTS		DIL SKTS		DIL PLUGS		DIL SWITCHES	
8DIL	0.20	8DIL	0.14	14DIL	0.60	4DIL	1.20
14DIL	0.35	14DIL	0.15	16DIL	0.65	7DIL	1.75
16DIL	0.42	16DIL	0.17	SCOTCHFLEX		8DIL	1.80
18DIL	0.60	18DIL	0.24	14DIL	1.30	16w ZIF*	4.95
24DIL	0.52	20DIL	0.27	16DIL	1.50	24w ZIF*	6.20
28DIL	0.74	24DIL	0.30	24DIL	2.00		
40DIL	0.86	28DIL	0.36				
		48DIL	0.50				

*ZERO INSERTION FORCE

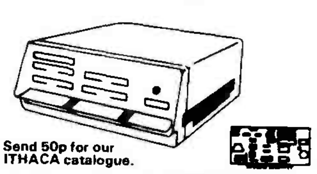
DOUBLE DENSITY S100 DISK CONTROLLER



Suitable for Triton, DPS-1 etc. Built and tested will drive Shugart compatible 8" or 5¼". Drives single or double-sided. Uses the 1791 chip and CPU independent crystal. Manual 50p + SAE. BOARD **£195.00** +VAT

DPS.1 MAINFRAME – PASCAL SYSTEM

S100 to IEEE spec



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PASCAL/Z build your own Pascal Micro Development system. IEE-S100 bus system using DPS1 main-frame. Supports K2, ASSEMBLE/Z and PASCAL/Z on 8" disc.

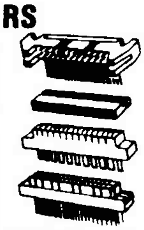
Complete system **£2910.00**

S100 BOARDS

8k Static RAM board (450ns)	£99.00
8k Static RAM board (250ns)	£117.00
Z80 cpu board (2MHz)	£105.00
Z80 cpu board (4MHz)	£123.00
2708/27 16 EPROM board	£57.00
Prototype board (bare board)	£15.00
Video display board (64–16, 128U/L Ascu)	£106.75
Disc controller board	£131.25
K2 disc operating system	£45.00
ASSEMBLE/Z Macro Assm	£37.50
PASCAL/Z compiler	£205.00
PASCAL/Z CP/M	£235.00
16k Static RAM	£275.00

DOUBLE DENSITY CP/M NOW AVAILABLE – CONTACT US FOR DETAILS

MULTIWAY CONNECTORS



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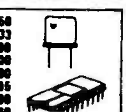

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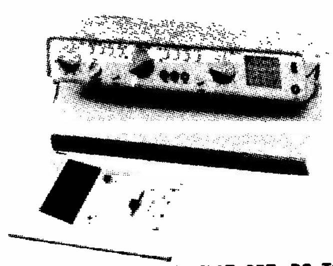

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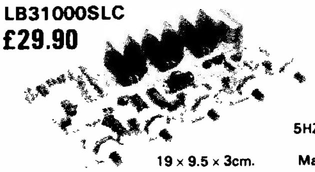

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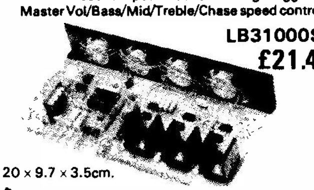

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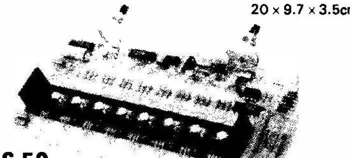

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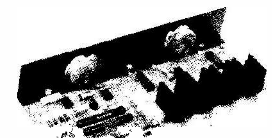

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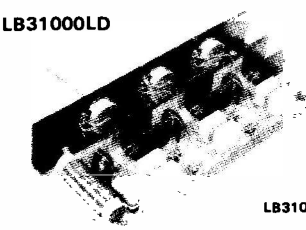

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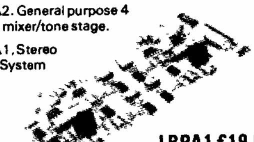

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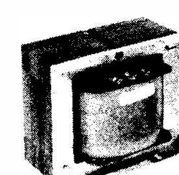

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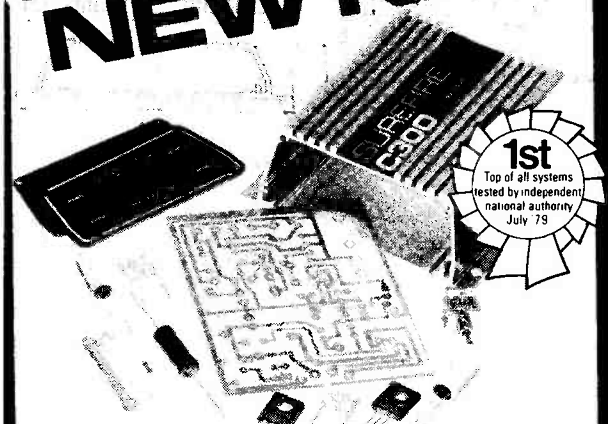

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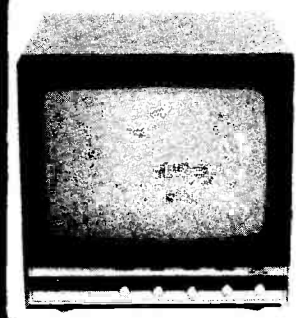

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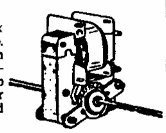

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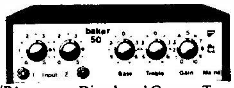

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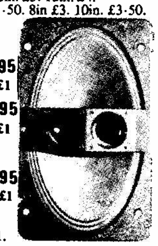

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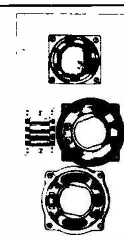

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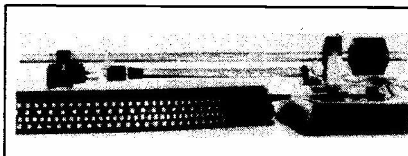

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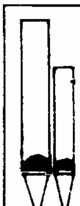

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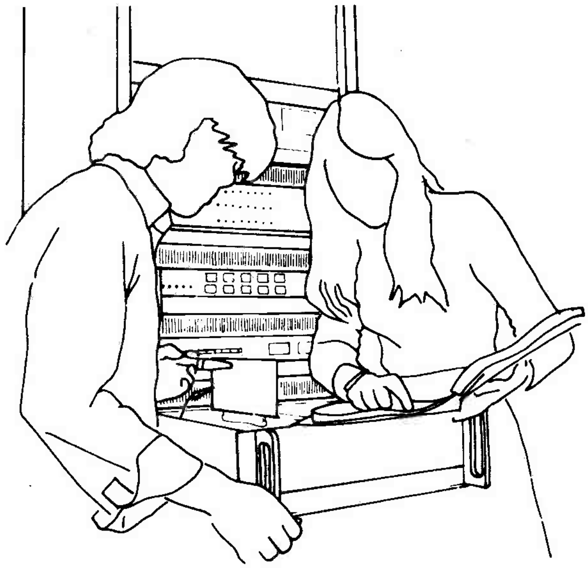

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8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

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

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2½"	8R	80p
2"	8R	85p
1½"	8R	85p

VOLTAGE REGULATORS Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	T8A625B	120p
LM317T	200p	TL430	65p
LM323K	550p	78H05KC	625p
LM723	37p	78MGT2C	140p

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

LEDS

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

DISPLAYS

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DL707 Red	140p	MAN3640	175p
707 Gr	140p	MAN4640A	200p
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Push to make	15p
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4P 3W	45p
2P 6W	45p

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