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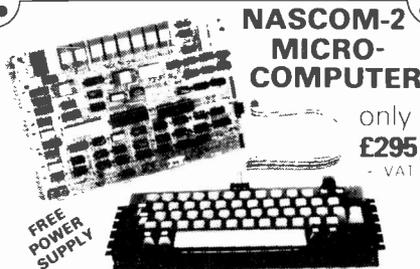
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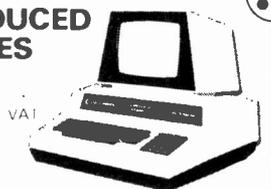
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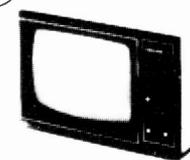
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VOLUME 16 No. 3 MARCH 1980

CONSTRUCTIONAL PROJECTS

AUDIO ISOLATOR by <i>G. Davies</i>	22
Banish shocks and hum loops	
ENLARGER TIMER by <i>R. Besson</i>	33
Photographic process timing control	
CAR RADIO	40
A 5 push button set with 6W output	
ACOUSTICALLY COUPLED TELEPHONE MODEM by <i>Kenneth Amor</i>	54
Part 2—Construction and applications	
A SIMPLE CONVERSATION AID by <i>J. M. Watt M.B., Ch.B.</i>	62
Amplifier for the hard of hearing	
DIGITAL FREQUENCY METER by <i>Michael Tooley B.A. and David Whitfield B.A., M.Sc.</i>	72
10Hz to 5MHz Portable unit	

GENERAL FEATURES

SEMICONDUCTOR UPDATE by <i>R. W. Coles</i>	25
8041/ISBC, Super E-line	
TRANSISTOR PARAMETERS by <i>R. A. Hatton</i>	29
Common emitter h-parameters discussed	
INGENUITY UNLIMITED	58
Wah-wah pedal—200W Temperature controller—Hexadecimal display—Guitar tremolo	
COMPUKIT UPDATE by <i>Dr. A. A. Berk</i>	68
Graphics and cassette speed revelations	

NEWS AND COMMENT

EDITORIAL	17
MARKET PLACE	18
INDUSTRY NOTEBOOK by <i>Nexus</i>	21
Almanac for the '80s	
BREADBOARD REVIEW	26
NEWS BRIEFS	30, 79
COUNTDOWN	63
PATENTS REVIEW	64
WATCH OFFER	65
SPACEWATCH by <i>Frank W. Hyde</i>	66
MICRO-PROMPT	67
POINTS ARISING	71
READOUT	80
COMPUTER CASE OFFER	81

SPECIAL SUPPLEMENT

P.A. LOUDSPEAKER SYSTEMS by <i>Ben Duncan</i>	44
For Discos and Rock Bands	

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 14 MARCH 1980
(for details of contents see page 61)

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(Continued from opposite side)

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AA215	15	1A/200V	25	8Ω 3W	74
BA100	10	1A/400V	29	8Ω 3W	74
BA102	15	1A/600V	34	8Ω 3W	74
BY100	24	2A/50V	35	8Ω 3W	74
BY126	12	2A/100V	44	8Ω 3W	74
BY127	12	2A/200V	46	8Ω 3W	74
CRO33	157	2A/400V	53	8Ω 3W	74
OA9	75	2A/600V	65	8Ω 3W	74
OA47	12	4A/100V	72	8Ω 3W	74
OA70	12	6A/100V	73	8Ω 3W	74
OA79	12	6A/200V	78	8Ω 3W	74
OA81	15	6A/400V	85	8Ω 3W	74
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OA90	6	VM18 DIL	50	8Ω 3W	74
OA91	6				
OA95	6				
OA200	9				
QA202	8				
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IN916	5				
IN400/2	5				
IN4003	6				
IN4004/5	6				
IN4006/7	7				
IN4148	4				
IS44	20				
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0 8A/200V	35	8A/400V	64		
1A600V	70	8A/500V	85		
5A300V	35	8A/800V	108		
5A600V	43	12A/100V	60		
8A300V	48	12A/400V	70		
8A600V	85	12A/800V	130		
12A300V	59	16A/100V	95		
12A500V	92	16A/400V	105		
12A800V	150	25A/400V	160		
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BT116	150				
C106D	38				
TIC44	22				
TIC45	28				
2N4444	140				

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TIL211 Grn 125"	22	12V 7812	145p 7912 220p
TIL212 Yellow	15	15V 7815	145p
TIL2200 2" Red	15	18V 7818	145p
0.2" Yellow, green and Amber	18	1A T0220 Plastic Casing	
Rectangular LEDS:		5V 7805	65p 7905 75p
Red, Green and Yellow	36	12V 7812	65p 7912 75p
TIL312 Yellow	120	15V 7815	65p 7915 75p
ORP12	63	18V 7818	65p 7918 75p
2N5777	45	24V 7824	65p
TIL32 Infra Red (emit)	58	100mA T092 Plastic Casing	
TIL78 (detector)	70	5V 78L05	30p 79L05 65p
OPTO ISOLATORS		6V 78L62	30p
IL74	48	8V 78L82	30p
TIL111/2	85	12V 78L12	30p 79L12 65p
TIL117	110	15V 78L15	30p 79L15 65p
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LS400	255	LM300H	170 LM325N 240
TIL307	450	LM305H	140 LM326N 240
TIL312 & 313 3"	105	LM309K	135 LM327N 270
TIL321 5" C.An	115	LM317K	350 LM723 30
TIL322 5" C.Ct	115	78H05	5V/5A 595p
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DL707 3" C.Anod	99		
DL747 6" An	180		
FND357	120		
MAN3640	165		
XAN351 3" Green	180		
Liquid Crystal Display		SWITCHES	
3 1/2 digit 875p; 4 digit 975p		TOGGLE 2A 250V	
		SPST	28
		DPST	34
		DPDT	38
		4 pole on off	54
		2 pole 2-way	24
		PUSH BUTTON	
		Spring loaded	59
		SPST on/off	55
		SPDT C/over	65
		DPDT 6 Tag	85
		SUB-MIN TOGGLE	
		SP changeover	59
		SPST on/off	55
		SPST biased	84
		DPDT 6 tags	70
		DPDT C/over	79
		DPDT Biased	115
		MINIATURE	
		Non Locking	15p
		Push to make	15p
		Push to c/over 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
		ROTARY: 'Make-A-Switch' Make your own multiway Switch Adjustable Stop Shafting Assembly Accommodates up to 6 Wafers Mains Switch DPST to fit Break Before Make Wafers, 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way Spacer and Screen	
		ROTARY: (Adjustable Stop) 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	45

VOLTAGE REGULATORS		SWITCHES	
1A T03	-ve -ve	TOGGLE 2A 250V	
5V 7805	145p 7905 220p	SPST	28
12V 7812	145p 7912 220p	DPST	34
15V 7815	145p	DPDT	38
18V 7818	145p	4 pole on off	54
1A T0220 Plastic Casing		2 pole 2-way	24
5V 7805	65p 7905 75p	PUSH BUTTON	
12V 7812	65p 7912 75p	Spring loaded	59
15V 7815	65p 7915 75p	SPST on/off	55
18V 7818	65p 7918 75p	SPDT C/over	65
24V 7824	65p	DPDT 6 Tag	85
100mA T092 Plastic Casing		SUB-MIN TOGGLE	
5V 78L05	30p 79L05 65p	SP changeover	59
6V 78L62	30p	SPST on/off	55
8V 78L82	30p	SPST biased	84
12V 78L12	30p 79L12 65p	DPDT 6 tags	70
15V 78L15	30p 79L15 65p	DPDT C/over	79
CA3085	95 LM323K 625	DPDT Biased	115
LM300H	170 LM325N 240	MINIATURE	
LM305H	140 LM326N 240	Non Locking	15p
LM309K	135 LM327N 270	Push to make	15p
LM317K	350 LM723 30	Push to c/over momentary	85p
78H05	5V/5A 595p	ROCKER: 5A, 250V, SPST	30p
78H6	5 to 24V 650p	ROCKER: (white) 5A 250V SP change-over centre off	50p
		ROCKER: Lights red when on Chrome Bezel 3A 250V, DPST	85p
		ROTARY: 'Make-A-Switch' Make your own multiway Switch Adjustable Stop Shafting Assembly Accommodates up to 6 Wafers Mains Switch DPST to fit Break Before Make Wafers, 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way Spacer and Screen	
		ROTARY: (Adjustable Stop) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way	41
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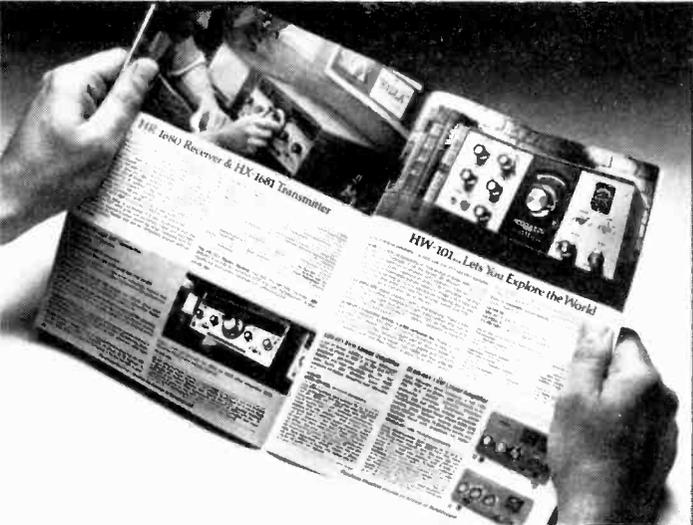
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MONO SYSTEM WITH LOUDSPEAKERS

£229.00 incl. of carr. & VAT Deposit £46.00
12 months @ £18.38 or 24 months @ £10.58

P.A. SYSTEMS

2 YEAR GUARANTEE

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12 months @ £16.57 or 24 months @ £9.69 £42.00

- ★ Four Mixing Inputs
- ★ Bass & Treble Controls
- ★ Twin Piezo Horn Columns

200 WATT
incl. of carr. & VAT Deposit £309.00
12 months @ £24.80 or 24 months @ £14.51 £62.00

AMPLIFIER UNITS ONLY

AP100 AMPLIFIER

£56.92 + Carr £1 50
incl. of VAT

- ★ 4 Mixed Inputs
- ★ Bass/Treble Controls
- ★ Vynide Case
- ★ 100 Watts Output

AP200 AMPLIFIER

£102.92 + Carr £1 50
incl. of VAT

- ★ Six Mixed Inputs
- ★ Three Sets Bass/Treble
- ★ 200 Watts Output
- ★ Slave Socket



NEW SAXON KLAXON

UK Police Hawaii 50
US Police Destroyer

Four Sirens in
one package £20.12
incl. of VAT
Individual Sirens £8.62



NEW SAXON SMASH

ALIEN VOICE
SIMULATOR

Add a new dimension
to your disco with
this press button effect unit
Insert between mic & amp £8.62

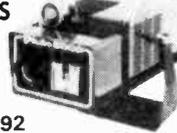


PLUTO PROJECTORS

P140 £44.27
150 WATT
INC WHEEL

P5000 £102.92

250 watt Q.I. inc Cassette/Wheel
(Full range of wheels - ask for list)



ELECTRECT MIC DI501 £21.27
TOP QUALITY UNIT + VAT £2.31

ECM105 LOW COST ELECTRECT
CONDENSER MIC + VAT 62p £5.75

MELOS CASSETTE ECHO-
REVERB UNIT - Twin input
VARIABLE SPEED & DEPTH £74.75

AMPLIFIER MODULES

- 30Hz-20kHz
- Short/open circuit proof
- Top grade components
- Suit most mixers



SA308 8 ohms 30W 45V £12.36
Supply for 2 modules £13.68
SA604 4 ohms 50V £16.67
Supply for 1 or 2 modules £17.19
SA608 8 ohms 60W 65V £17.82
Supply for 1 or 2 modules £17.19
SA1204 4 ohms 120W 75V £20.12
Supply for 1 module £17.19
SA1208 8 ohms 120W 95V £24.15
Supply for 2 modules £28.46

DISCO MIXERS - COMPLETE OR MODULAR



MONO OR STEREO WITH AUTOFADE

Available complete and ready to plug in or
as an easy to connect module with all
controls except monitor switch already fitted
- full instructions supplied.

FEATURES INCLUDE:
Twin Deck - Mic & Tape Inputs - Wide range
bass & treble controls - Full headphone
monitoring - Crossfade - Professional stand-
ard performance.

COMPLETE MIXERS

(with case)
Mono mains £45.75 + £3.66
Stereo main £73.31

MODULES

Mono module £31.62
Stereo module £43.12
Panel £4.54
Kit of knobs/
sockets etc £6.32

D.I.Y. MODULES FOR P.A. SYSTEMS MONO/STEREO

Input Modules
Mono PCB only £7.47
Stereo PCB only £12.07
Mono C/W
Front panel £10.92
Stereo C/W
Front panel £15.81
Mixer/Monitor Modules
Mono PCB only £7.47
Stereo PCB only £12.07
Mono C/W
Front panel £10.92
Stereo C/W
Front panel £15.81

Power supply to suit
£10.92

send for full details.



Make your own
mixer
Mono/
Stereo
up to 20
channels
accept all
inputs
available
as PCB
only or
complete
on front
panels

SOUND-TO-LIGHT UNITS



3 CHANNEL - 3kW £33.92

Operates from 1W upwards
 Bass/middle/treble/master
controls + £1 carr.
complete
Module only £22.71
Panel £3.39

4 CHANNEL -
4 kW SOUNDLIGHT SEQUENCER (illus)
£46.57

Dimmer on each channel
 Automatic sound light level
 Logic circuitry throughout
Module only £30.76 Panel £3.39

MOTOROLA PIEZO HORNS £7.99 YES!!

FUZZ LIGHTS Red, Blue, Yellow, Green £26.22

HEAVY DUTY SPOT BANKS - MATCHES LOUDSPEAKERS

3 way 600W £40.82 4 way 800W £47.72

100W SPOTS

Red - Blue - Amber - Green £1.72

CABINET FITTINGS

ICI Vynide 50" wide £4.02m
Kick-res grille 50" wide £4.02m
Nylon kick proof 24" wide £4.02m
Corners/feet-recess plates 17p
Recess handle 52p
Bar handles £2.87
Jack plugs/sockets 29p

LOUDSPEAKER CABINETS - COMPLETE WITH LEADS

- Fitted with 100W 17,000 Gauss drivers
- Rugged cabinets with aluminium trim - black vynide etc
- Lifetime guarantee on main drive unit

Standard 100W 1 x 12 (48 x 41 x 24) £50.60

Large 100W 1 x 12 (65 x 48 x 24) £62.67

P.A. 1 x 12 (+ 2 Piezos) (80 x 38 x 24) £82.22

P.A. 2 x 12 200W (100 x 38 x 24) £119.60

Disco 2 x 12 200W (80 x 63 x 24) £103.50

PDF reflex bin (80 x 40 x 41) £115.00

PDF100 Reflex Bin - Twin Horns - Integrated Slave
Amplifier - Accepts mono or stereo signals

Use with all types of mixer
 Pan and volume controls
 Send for details £155.25 Deposit £31.25

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P.O. or 60p COD charge to address below or
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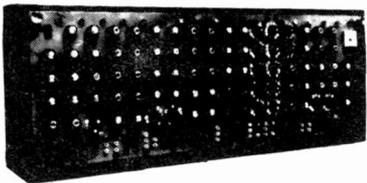
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MANCHESTER DISCO CENTRE,
237 DEANSGATE, MANCHESTER M3 4EN.
CALLERS ONLY - (061) 832 8772 - COMPLETE UNITS ONLY

D.I.Y. KITS FOR SYNTHESISERS, SOUND EFFECTS



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

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

PHONOSONICS

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

P.E. 128-NOTE SEQUENCER

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.

Set of basic component kits, PCBs and layout charts
KIT 77-7 **£34.58**
Set of text photocopies **£1.36**

P.E. 16-NOTE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synthesisers.

Set of basic component kits, PCBs and layout charts
KIT 86-5 **£27.99**
Set of text photocopies **£1.84**

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.

Set of basic component kits, PCBs & layout charts
KIT 77-8 **£92.89**

P.E. JOANNA PLUS ORGAN VOICING

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

Set of basic component kits, PCBs & layout charts
KIT 71-7 **£119.87**
"Sound Design" booklet **£1.00**

ELEKTOR ELECTRONIC PIANO

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

5-octave set of basic components and PCBs (as published)
KIT 80-9 **£136.41**
Additional 3-octave extension and basic parts and PCBs (as published)
KIT 80-10 **£54.62**
Set of text photocopies **£1.81**

P.E. MINISONIC MK2 SYNTHESISER

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

Set of basic component kits (excl. KBD R's & tuning pots - see list for options available) and PCBs (incl. layout charts)
KIT 38-25 **£76.82**
"Sound Design" booklet **£1.00**

P.E. SYNTHESISER

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

Main Unit basic component kits, PCBs & layout charts
KIT 23-31 **£101.43**
Keyboard Unit basic component kits, PCBs & layout charts
KIT 23-32 **£60.47**
Main Unit set of text photocopies **£5.91**
Keyboard Unit set of text photocopies **£2.30**

ELEKTOR FORMANT SYNTHESISER

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

Set of basic component kits, PCBs (as published)
KIT 66-14 **£247.60**
Set of text photocopies **£7.83**

P.E. GUITAR EFFECTS UNIT

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

Basic parts with foot switches, PCB & layout chart
KIT 42-3 **£10.02**
Text photocopy **28p**

ELEKTOR DIGITAL REVERB UNIT

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

Main unit basic component kit and PCB (as published)
KIT 78-3 **£53.68**
Extension unit basic component kit and PCB (as published)
KIT 78-4 **£48.85**
Text photocopy **86p**

ELEKTOR ANALOGUE REVERB

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

Main unit basic component set
KIT 83-1 **£29.49**
Additional Delay basic components
KIT 83-2 **£20.07**
PCB (as publ.) to hold both kits
PCB9973 **£4.31**
Text photocopy **67p**

P.E. GUITAR MULTIPROCESSOR

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

Set of basic component kits, PCBs & layout charts
KIT 85-5 **£54.37**
Set of text photocopies **£2.52**

P.E. PHASER

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

Basic components, PCB & chart
KIT 88-1 **£10.14**
2-Notch extension, PCB & chart
KIT 88-2 **£6.36**
Text photocopy **68p**

ELEKTOR PHASING & VIBRATO

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

Set of basic components, PCB & layout chart
KIT 70-2 **£21.67**
Text photocopy **67p**

P.E. PHASING UNIT

A simple but effective manually controlled phasing unit.

Basic components, PCB & chart
KIT 25-1 **£3.52**
Text photocopy **28p**

PHASING CONTROL UNIT

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

Basic components, PCB & chart
KIT 36-1 **£5.21**
Text photocopy **10p**

P.E. SWITCHED TONE TREBLE BOOST

Provides switched selection of 4 preset tonal responses.

Basic components, PCB & chart
KIT 89-1 **£3.82**
Text photocopy **78p**

P.E. TREBLE BOOST UNIT

A simple treble boost unit with manual control depth.

Basic components, PCB & chart
KIT 53-1 **£2.76**

ELEKTOR RESONANCE FILTER

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

Set of basic components & PCB (as published)
KIT 82-2 **£19.90**
Text photocopy **67p**

P.E. GUITAR OVERDRIVE

Sophisticated versatile fuzz unit incl. variable controls affecting the fuzz quality whilst retaining attack and decay, and also providing filtering. Usable with most electronic instruments.

Basic components, PCB & chart
KIT 56-3 **£9.35**
Text photocopy **68p**

P.E. SMOOTH FUZZ

Basic components, PCB & chart
KIT 91-1 **£5.01**
Text photocopy **55p**

TREMOLO UNIT

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

Basic components, PCB & chart
KIT 54-1 **£3.23**

GUITAR FREQUENCY DOUBLER

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

Basic components, PCB & chart
KIT 74-1 **£4.97**
Text photocopy **39p**

P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, PCB & chart
KIT 75-1 **£5.84**
Text photocopy **38p**

P.E. WAH-WAH UNIT

Can be controlled manually or by integral automatic control.

Basic components, PCB & chart
KIT 51-1 **£3.99**

P.E. AUTO-WAH UNIT

Automatically gives Wah or Swell sounds with each note played.

Basic components, PCB & chart
KIT 58-1 **£8.43**
Text photocopy **58p**

ELEKTOR WAVEFORM CONVERTER

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

Basic components, PCB & chart,
but excl. sw's
KIT 67-1 **£9.24**

P.E. V.C.F.

A voltage controlled filter extracted from P.E. Minisonic project.

Basic components, PCB & chart
KIT 65-1 **£7.88**

P.E. RING MODULATOR

Extracted from P.E. Minisonic project.

Basic components, PCB & chart
KIT 59-1 **£6.05**

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesisers.

Set of basic components & PCB (as published)
KIT 87-2 **£8.40**
Text photocopy **38p**

10% DISCOUNT VOUCHER (PE83)

TERMS: Goods in current adverts & lists over £50 goods value (excl P&P & VAT). Correctly posted, C.W.O., U.K. orders only. This voucher must accompany order. Valid until end of month on cover of P.E. Does not apply to credit card orders.

ADD: POST & HANDLING

U.K. orders: Keyboards add £2.30 each. Other goods: Under £5 add 25p, under £20 add 50p, over £20 add 75p. Recommended insurance against postal mishaps: add 50p for cover up to £50, £1 for £100 cover, etc., pro-rata. Insurance must be added for credit card orders. N.B. Eire, C.I., B.F.P.O. and other countries are subject to higher export postage rates.

ADD 15% VAT

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

EXPORT ORDERS ARE WELCOME but to avoid delay we advise you to see our list for postage rates. All payments must be cash-with-order, in Sterling by International Money Order or through an English Bank. To obtain list - Europe send 25p, other countries send 50p.

Note that we do not offer a C.O.D. service and that our terms are payment in advance.

PHONOSONICS · DEPT PE83 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH

TERMS: C.W.O., MAIL ORDER OR COLLECTION BY APPOINTMENT (TEL 01-302 6184)

AND OTHER PROJECTS

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

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

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



KIMBER-ALLEN KEYBOARDS AND CONTACTS

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

3 Octave (37 notes) **£25.50** 4 Octave (49 notes) **£32.25** 5 Octave (61 notes) **£39.75**

CONTACT ASSEMBLIES (gold-clad wire) — 1 required for each KBD note:

Type GJ — SPCO **25p** ea. Type GA — 1 pr of contacts, normally open **24p** ea. Type GB — 2 pr N/O **28p** ea. Type GC — 3 pr N/O **37p** ea. Type GE — 4 pr N/O **46p** ea. Type GH — 5 pr N/O **58p** ea. Type 4PS — 3 pr N/O plus SPCO **57p** ea.

P.E. NOISE GENERATOR

Extracted from the P.E. Minisonic.

Basic components, PCB & chart
KIT 60-1 **£4.00**

WIND & RAIN EFFECTS UNIT

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

Basic components, PCB & chart
KIT 28-1 **£4.68**
Text photocopy **28p**

P.E. ENVELOPE SHAPER WITHOUT VCA

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

Basic components, PCB & chart
KIT 44-1 **£5.24**
Text photocopy **49p**

P.E. ENVELOPE SHAPER WITH VCA

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

Basic components, PCB & chart
KIT 50-1 **£7.34**
Text photocopy **58p**

P.E. TRANSIENT GENERATOR

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

Basic components, PCB & chart
KIT 63-2 **£7.13**
Text photocopy **58p**

P.E. EXTERNAL-INPUT SYNTHESIZER-INTERFACE

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

Basic components, PCB & chart
KIT 81-1 **£3.23**

P.E. TUNING FORK

Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.

Set of basic components, incl. power supply, PCBs & charts
KIT 46-3 **£23.32**
Text photocopy **97p**

P.E. TUNING INDICATOR

A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of KIT 46 is not required.

Basic components, PCB & chart, but excl. sw.
KIT 69-1 **£8.19**
Text photocopy **58p**

P.E. DYNAMIC RANGE LIMITER

Preset to automatically control sound output levels.

Basic components, PCB & chart
KIT 62-1 **£5.03**

P.E. CONSTANT DISPLAY FREQUENCY COUNTER

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

Basic components, PCB & chart
KIT 79-2 **£32.28**
Text photocopy **78p**

P.E. 6-CHANNEL MIXER

A high specification stereo mixer with variable input impedances.

Basic components, (excl. sw.'s.) and set of PCBs and charts.
KIT 90-8 **£51.35**
Extra 2-channel set with PCB
KIT 90-9 **£9.69**
Set of Text photocopies **£1.50**

STEREO HEADPHONE AMPLIFIER

Extracted from P.E. 6-channel mixer.

Basic components, PCB & chart
KIT 92-1 **£5.04**

DIGITAL EXPOSURE UNIT

Controls up to 750 watts in $\frac{1}{2}$ second steps up to 10 minutes, with built-in audio alarm.

Basic components, PCBs & charts
KIT 93-3 **£22.40**
Text photocopy **£1.20**

P.E. DISCOSTROBE

A 4-channel light show controller giving a choice of sequential, random, or full strobe mode of operation, and with additional audio input.

Basic components, PCB & chart
KIT 57-2 **£23.79**
Text photocopy **78p**

RHYTHM GENERATORS

Several available, including programmable 16 beat 64000 pattern, 128 beat almost infinite pattern, and pre-programmed 15 pattern using either M252 or M253 rhythm chips. A selection of effects instrument circuits is also available.

P.E. VOICE OPERATED FADER

For automatically reducing music volume during talkover — particularly useful for disco work.

Basic components, PCB & chart
KIT 30-1 **£4.37**

TAPE NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings.

Basic components, PCB & chart
KIT 6-3 **£4.13**



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

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PHONOSONICS

The NEW Marshall's 79/80 catalogue is just full of components

and that's not all . . .

. . . our new catalogue is bigger and better than ever. Within its 60 pages are details and prices of the complete range of components and accessories available from Marshall's.

These include Audio Amps, Connectors, Boxes, Cases, Bridge Rectifiers, Cables, Capacitors, Crystals, Diacs, Diodes, Displays, Heatsinks, I.Cs, Knobs, LEDs, Multimeters, Plugs, Sockets, Pots, Publications, Relays, Resistors, Soldering Equipment, Thyristors, Transistors, Transformers, Voltage Regulators, etc., etc.

Plus details of the NEW Marshall's 'budget' Credit Card. We are the first UK component retailer to offer our customers our own credit card facility.

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Plus — Many new products and data.

Plus 100s of prices cut on our popular lines including I.Cs, Transistors, Resistors and many more.

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Available by post 65p post paid from **Marshall's, Kingsgate House, Kingsgate Place, London NW6 4TA**. Also available from any branch to callers 50p.



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THE NEW BSTL MONITOR

BSTL



8" MONITOR KIT SUITABLE FOR CCTV AND VDU APPLICATION.

INCORPORATING THE LATEST IN CIRCUITRY DESIGN.

THE KIT COMPRISES OF: 8" TUBE, SCAN COIL ASSEMBLY, PC BOARD WITH ALL COMPONENTS MOUNTED AND FULLY TESTED FOR 16VDC OPERATION.

SPECIAL INTRODUCTORY OFFER FOR THIS NEW PRODUCT.

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Telephone: 01-441 3734 Telex: 299 360 BSTL

JAYkit

Standard Parts



DM-2



DIGITAL MULTIMETER

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

FG-1a



FUNCTION GENERATOR

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

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

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

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

Name _____

Address _____

Please send:

- DM-2 @ £5.45
 FG-1a @ £4.95
(Incl. VAT and P&P)

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

JAYkits

NEW

CONSTRUCTORS PACK 7

ALL THE PARTS TO BUILD THE PE 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 £1.50

CONSTRUCTORS PACK 7A
 Suitable stainless steel fully retractable locking aerial and speaker (approx 6" x 4") is available as a kit complete.
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 Size approximately 9 1/4" x 8 1/2" x 4"
 p&p £2.25 **£12.25**

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£30.60
 p&p £2.70
 Size approx. 13 1/2" x 5 1/4" x 6 1/2"
 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in leak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder, DIN speaker and input sockets. 20 x 20 watts RMS. 40 x 40 watts peak for use with 8 to 15 ohm speakers.
 Size 14 1/2" x 3" x 10" approx. **NEW** feature—units now includes a built in four channel stereo sound facility.
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ST-45 SPECIFICATION

VERTICAL SYSTEM

Sensitivity 10mv/div 5v/div in 9 cal. steps

Bandwidth (3dB)

DC Coupled DC 5MHz

AC Coupled 5Hz-5MHz

Risetime 70µsec

Input Impedance 1MΩ + 22 PF approx. (for all ranges) 50Ω for 10mv/div 50mv/div

Input coupling AC CND DC

Accuracy ± 5%

HORIZONTAL SYSTEM

Time base speeds

50ms/div 1µsec/div in 15 cal. steps with X5 Multiplier to 250msec/div and X5 Expansion to 200nsec/div

External - X sensitivity 1v/div

External - X Bandwidth 500KHz

Accuracy ± 5%

ACCESSORIES

Passive Probe switched (X1, REF. x10)

100MHz bandwidth £11.50 + VAT

BNC to 4mm Socket Adaptor £2.95 + VAT

TRIGGER

Internal 0.5div (10Hz-2MHz), 1 div (2MHz-5MHz)

External 100mv (10Hz-2MHz), .200mv (2MHz-5MHz)

Bright Line Auto

Trace free runs in absence of signal

Trigger Level selects triggering point

Trigger (+)ve and (-)ve slope selection

FRONT PANEL

Black-Silver-White-ST-45-S The Silver Scope or

Black-Gold-White-ST-45-G The Gold Scope

GENERAL

Power consumption 10VA approx.

Mains selection 200V-220V-240V rms (40Hz-60Hz)

Weight 10lbs 4.5kg approx.

Case aluminium with black pvc finish and black handle, front panel white with black control knobs, black feet and tilt bar.

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56 Bishops Wood, St. Johns, Woking, Surrey GU1 3QB

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Electrolytic Axial Leads -10% to +50% Tol.				Cap 015 + μ F + V d.c.				Cap 034 + μ F + Volts				Cap 224, 352 Style Moulded Type: 10 2mm Pitch						
μ F	V.d.c.	16	25	40	63	100	150	220	330	470	680	1000	1500	2200	352	360	352	360
1.0					9	9	9	9	9	9	9	9	9	9	0.01	0.015	0.022	0.033
1.5					9	9	9	9	9	9	9	9	9	9	0.047	0.068	0.1	0.15
2.2					9	9	9	9	9	9	9	9	9	9	0.22	0.33	0.47	0.68
3.3					9	9	9	9	9	9	9	9	9	9	0.68	1.0	1.5	2.2
4.7					9	9	9	9	9	9	9	9	9	9	1.0	1.5	2.2	3.3
6.8					9	9	9	9	9	9	9	9	9	9	1.5	2.2	3.3	4.7
10					9	9	9	9	9	9	9	9	9	9	2.2	3.3	4.7	6.8
15					9	9	9	9	9	9	9	9	9	9	3.3	4.7	6.8	10
22					9	9	9	9	9	9	9	9	9	9	4.7	6.8	10	15
33					9	9	9	9	9	9	9	9	9	9	6.8	10	15	22
47					9	9	9	9	9	9	9	9	9	9	10	15	22	33
68					9	9	9	9	9	9	9	9	9	9	15	22	33	47
100					9	9	9	9	9	9	9	9	9	9	22	33	47	68
150					9	9	9	9	9	9	9	9	9	9	33	47	68	100
220					9	9	9	9	9	9	9	9	9	9	47	68	100	150
330					9	9	9	9	9	9	9	9	9	9	68	100	150	220
470					9	9	9	9	9	9	9	9	9	9	100	150	220	330
680					9	9	9	9	9	9	9	9	9	9	150	220	330	470
1000					9	9	9	9	9	9	9	9	9	9	220	330	470	680
1500					9	9	9	9	9	9	9	9	9	9	330	470	680	1000
2200					9	9	9	9	9	9	9	9	9	9	470	680	1000	1500

Trimmers				Order Code			
250V D.C. Wkg Film Dielectric, Miniature				Cap 808 A			
Value	Order Code	Value	Order Code	Value	Order Code	Value	Order Code
1.4 - 4.1pF	20	2 - 8pF	20	10000 μ F 16V	9.8A	8.1A	50°C
5 - 59.5pF	31	10000 μ F 25V	8.0A	4700 μ F 25V	8.0A	11.2A	282
		10000 μ F 40V	9.2A	10000 μ F 40V	9.2A	12.8A	393
		4700 μ F 70V	7.5A	4700 μ F 70V	7.5A	10.5A	403

Electrolytic Cap Type				Order Code			
High Ripple, IEC Grade 1, Low E.S.R. Supplied complete with Vertical Fixing Clip				Cap PR + μ F + Volts			
Value	Order Code	Value	Order Code	Value	Order Code	Value	Order Code
10000 μ F 16V	9.8A	8.1A	50°C	238			
22000 μ F 16V	9.8A	13.7A		370			
4700 μ F 25V	4.6A	6.4A		215			
10000 μ F 25V	8.0A	11.2A		282			
10000 μ F 40V	9.2A	12.8A		393			
4700 μ F 70V	7.5A	10.5A		403			

Integrated Circuits				Order Code			
4000 Buffered C-MOS - High Speed				7400 T.T.L.			
Part No.	Order Code	Part No.	Order Code	Part No.	Order Code	Part No.	Order Code
HEF4000	17	HEF4046	106	HEF4515	299	N7403N	14
HEF4001	17	HEF4047	87	HEF4516	101	N7404N	16
HEF4002	17	HEF4048	45	HEF4517	392	N7405N	16
HEF4006	95	HEF4050	45	HEF4518	94	N7406N	32
HEF4007	17	HEF4051	69	HEF4519	55	N7407N	16
HEF4008	80	HEF4052	72	HEF4520	94	N7408N	16
HEF4011	17	HEF4053	72	HEF4521	188	N7409N	32
HEF4012	17	HEF4056	49	HEF4528	99	N7410N	16
HEF4013	45	HEF4067	380	HEF4529	120	N7411N	16
HEF4014	84	HEF4068	17	HEF4534	510	N7412N	14
HEF4015	80	HEF4069	17	HEF4539	110	N7413N	23
HEF4016	45	HEF4070	17	HEF4543	155	N7414N	23
HEF4017	80	HEF4071	18	HEF4555	78	N7415N	21
HEF4018	80	HEF4072	18	HEF4556	78	N7416N	21
HEF4019	45	HEF4073	17	HEF4557	396	N7417N	14
HEF4020	89	HEF4075	18	HEF4585	97	N7418N	20
HEF4021	85	HEF4076	104	HEF4724	171	N7419N	23
HEF4022	82	HEF4077	17	HEF4009	67	N7420N	16
HEF4023	84	HEF4078	18	HEF4008	73	N7421N	20
HEF4024	62	HEF4081	18	HEF4007	72	N7422N	23
HEF4025	17	HEF4082	18	HEF4010	119	N7423N	23
HEF4026	195	HEF4085	64	HEF4016	119	N7424N	21
HEF4027	45	HEF4086	64	HEF4017	119	N7425N	28
HEF4028	71	HEF4093	50	HEF4018	119	N7426N	37
HEF4029	90	HEF4094	175	HEF4019	119	N7427N	38
HEF4030	46	HEF4104	166	HEF4025	119	N7428N	37
HEF4031	200	HEF4027	91	HEF4032	140	N7429N	77
HEF4035	110	HEF4505	571	HEF4033	140	N7430N	38
HEF4040	85	HEF4508	184	HEF4034	119	N7431N	38
HEF4041	75	HEF4510	108	HEF4035	119	N7432N	38
HEF4042	65	HEF4511	125	N7430N	13	N7433N	82
HEF4043	80	HEF4512	110	N7401N	14	N7434N	85
HEF4044	84	HEF4514	250	N7402N	14	N7435N	91
						N7436N	98
						N7437N	59
						N7438N	59
						N7439N	59
						N7440N	59
						N7441N	59
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						N7498N	59
						N7499N	59
						N7500N	59

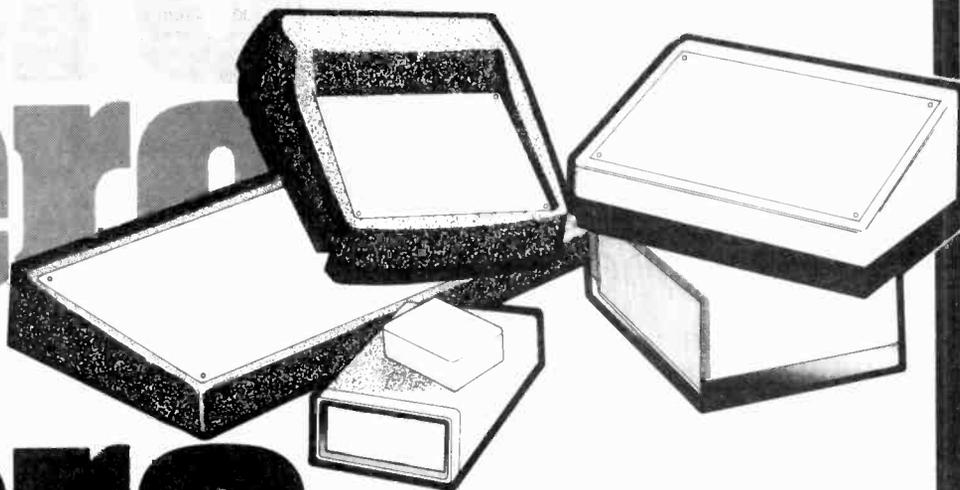
Tantalum Bead				Order Code			
20% Tol.				Cap PR + μ F + Volts			
μ F	V.d.c.	10	16	25	35	Value	Order Code
0.1						0.1	01
0.22						0.22	02
0.47						0.47	04
1.0						1.0	10
2.2						2.2	22
4.7						4.7	47

Cases				Order Code			
Slope Front Console, Recessed Top				Case B1M1005 OR			
Part No.	Order Code	Part No.	Order				

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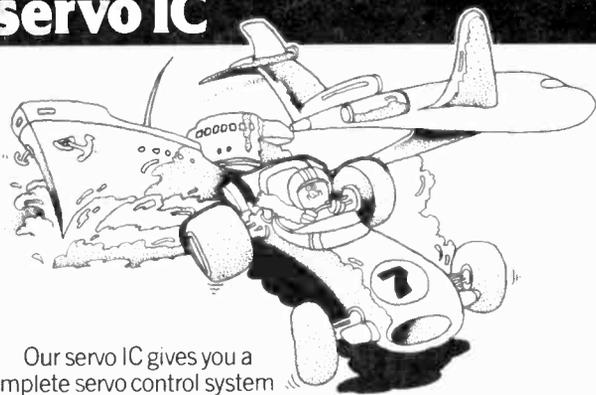


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M1

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M4

MULTI ALARM 6 Digits 10 Functions

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- Timer alarm with dual.
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- 8mm thick.

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M5



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

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M6



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M7



ALARM CHRONO with 9 world time zones

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- 6 basic functions.
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- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

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M8



SOLAR QUARTZ LCD Chronograph

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M9



QUARTZ LCD Ladies Day Watch

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M15



QUARTZ LCD Ladies Fashion Watch

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

£14.95

Guaranteed same day despatch

M17



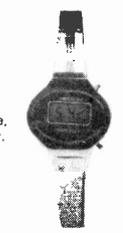
QUARTZ LCD Ladies Cocktail Watch

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

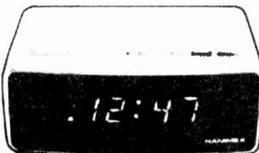
£15.55

Guaranteed same day despatch

M18



HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9 minute snooze. Display bright/dim modes control. Size: 5 1/2" x 3 3/4" x 2 3/8" (131mm x 111mm x 60mm). Weight: 1.43 lbs (0.65 kg). AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

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

£12.55

M60



MACY QUARTZ ANALOGUE

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

£24.95

M21



Metac price breakthrough for an Alarm Chronograph with Dual Time only

£13.55

OUTSTANDING FEATURES

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

Guaranteed same day despatch. **M16**

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

Metac Wholesale:

Trade enquiries - send for a complete list of prices for all the goods advertised plus many more not shown also minimum order details.

Telephone orders: Credit card customers can telephone orders direct to Daventry (03272) 76545 or Edgware Rd. 01-723 4753 24 hours a day.



Service Enquiries 03272-77659

CALLERS WELCOME Shops open 9-30am-6.00

Metac

ELECTRONICS
& TIME CENTRES

North & Midlands
67 High Street, DAVENTRY
Northamptonshire
Telephone: 03272 76545

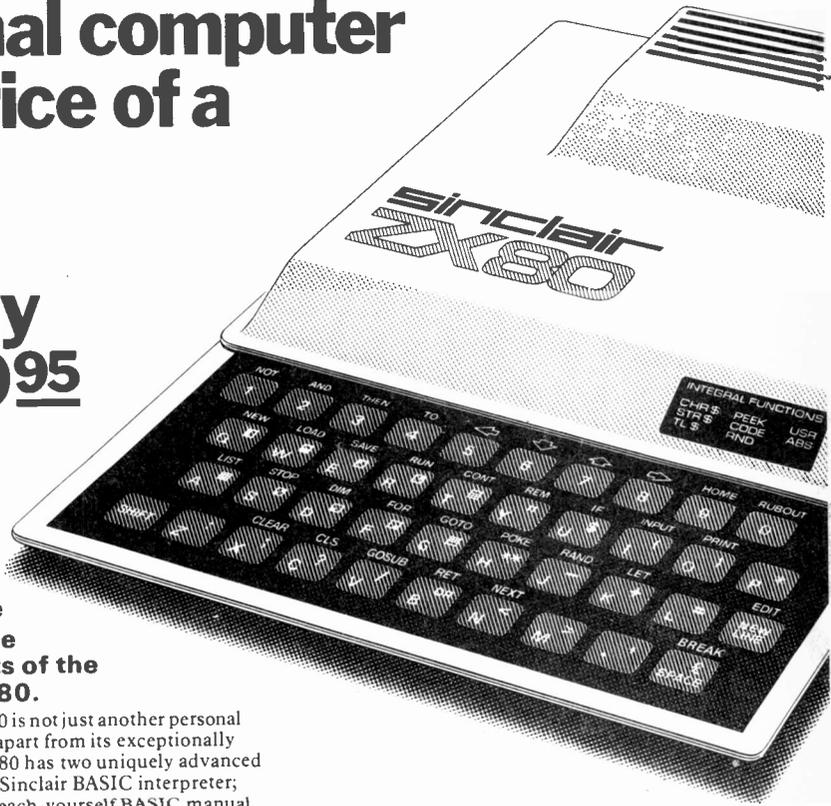
South of England
327 Edgware Road
LONDON W.2
Telephone: (01) 723 4753

Britain's first comp

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

Also available ready assembled for £99⁹⁵

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 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 any portable cassette recorder (to store programs) and domestic TV (to act as VDU).
- 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 board plugs in to take up to 3K bytes extra RAM chips. (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 these 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 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 to 26.
- Integer 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.

... 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 96-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.)

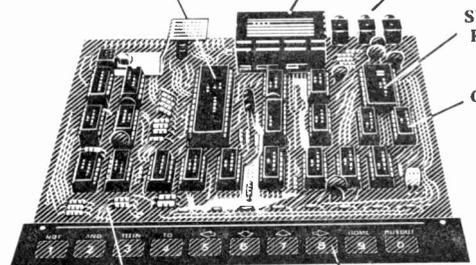
780-1 microprocessor – new, faster version of the famous Z-80 microprocessor chip, widely recognised as the best ever made.

UHF TV modulator.

Sockets for TV, cassette recorder, power supply.

SUPER ROM.

Clock.



RAM chips.

Rugged, flush, Sinclair keyboard.

Complete computer kit.

£79.95

**Including VAT.
Including post and
packing.
Including all leads
and components**

**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 onto 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, because the ZX80's brilliant design packs the RAM so much more tightly. (Key words, for instance, occupy just a single byte.)

To all that, add volume production – and you've that rare thing: a price breakthrough that really is a breakthrough.

**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**

Science of Cambridge Ltd
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 211488.

Order Form

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) (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	
		TOTAL	£

NB. Your Sinclair ZX80 may qualify as a business expense.

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

Please print

Name: Mr/Mrs/Miss _____

Address _____

PE

New 'L' series irons, designed to latest safety standards. Outstanding performance, lightweight and easy maintenance. New non-roll GRP safety handles. Ceramic and mica insulated elements enclosed in stainless steel shafts.

Fully earthed with screw connected 3-core leads. Interchangeable, non-seize iron-coated bits.

MODEL LC18 18 watts



Lightweight, high-performance iron for all soldering from calculators to T.V. sets. Fitted with 3.2 mm bit and complete with spare bits 1.6 mm, 2.4 mm and 4.7 mm. £7.89 including P & P and V.A.T. 240 volts standard but also available 12 and 24 volts.

MODEL LA12 12 watts



Similar to LC18 but with extra slim shaft and bits for fine work. Fitted with 2.4 mm bit and complete with spare bits 1.2 mm and 3.2 mm £6.69 including P & P and V.A.T. 240 volts standard, also available 6, 12 and 24 volts.

No. 3 SAFETY SPRING STAND for LC18 & LA12

Complete with sponge and location for spare bits £3.63 including P & P and V.A.T.



JOIN UP WITH LITESOLD.

C35S CORDLESS SOLDERING IRON

Built-in rechargeable batteries and twin spotlights. Heats in seconds. Solders safely anywhere. Complete with mains charger, sponge, 3 different tips and screwdriver. Best of its kind available. £23.93 including P & P and V.A.T.

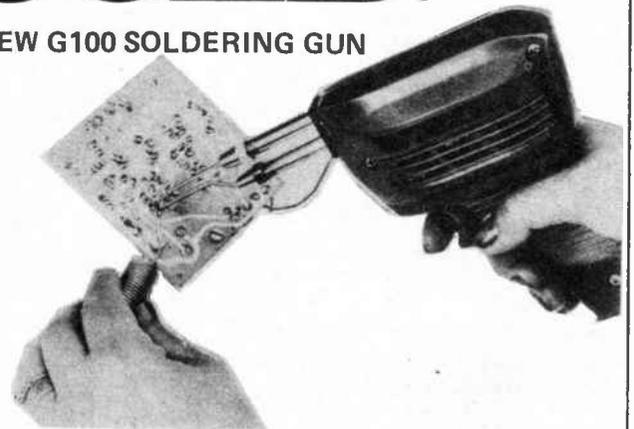


TRANSISTOR TESTER

Tests and identifies PNP or NPN devices both in or out of circuit. Two self-identifying leads, using coloured LED indicators, self-powered by PB3 battery £22.62 including Battery, P & P and V.A.T.



NEW G100 SOLDERING GUN



Safe 100 watt instant-heat, trigger operated tool. Heats and cools in seconds. With spotlight. For difficult or large joints, and shaping plastics. Ideal domestic and workshop tool. Complete with 2 spare tips, spanner, solder and flux £13.65 including P & P and V.A.T.

Order direct at these special mail order prices. Leaflets giving full information available on request from:
Light Soldering Developments Limited,
 97/99 Gloucester Road, Croydon CRO 2DN
 Telephone: 01-689 0574 Telex: 8811945

LITESOLD

LIGHT SOLDERING DEVELOPMENTS LIMITED

YOURS DISGUSTEDLY

"DEAR Sir, I am disgusted that in your recent car washing machine project you failed to give the winding details of the special toroidal transformer used in the automatic brush plunger. It would also have been very useful to have exact dimensions of the stainless steel slop tank to enable me to make one up.

I was annoyed to find this article was little more than a kit review, because some parts are only available from one supplier and no manufacturer's name has been given."

"Dear Sir, I am disgusted that in your recent automatic flasher project no kit of parts seems to be available. I have had to buy the p.c.b. from one supplier, the case from another and other components from a third source. Would it not be possible to arrange a kit of parts from one supplier for all your projects. This would greatly assist readers."

These are of course fictitious letters but are typical of many we receive.

Assuming we have identified a requirement amongst readers for a car wash and have achieved a useful, inexpensive, working design—maybe after years of trying—we find that some of the components required are not available to the hobbyist and others

have to be specially made. The toroidal transformer, for instance, employs a new core material, only available from one industrial supplier who operates a minimum order charge of £20 (not at all unusual). The core then requires a primary winding of 1,000 turns and a secondary of 400 turns.

The questions we must ask ourselves are:

- (1) Are many readers going to want to wind their own toroids and, if so, is it a practical proposition.
- (2) Can we arrange manufacture of the complete transformer at a realistic price.

In view of the complexity of this particular component and the fact that by manufacturing in quantity our supplier can obtain transformers at a very good price, there is only one practical answer.

Moving on to the slop tank; the supplier imports a special pressed stainless steel tank—essential for normal operation of the design—from the States. Is it really worth giving full details to enable constructors to buy the stainless and make up a tank. Have you tried working stainless steel? Once again we must decide if this is a practical proposition for most readers. Obviously it is not, so we are back with our one kit supplier.

The truth in many situations is that a number of parts are so specialised it is only practicable to source a complete kit (or the special bits individually).

Going to the other argument, the second letter is one that we see more often.

It would be most unfair if we went to one supplier and asked him to supply kits; that excludes all the others. If we make no recommendations all retailers have the chance to supply. However, it takes time to assess demand and decide if it is worth buying-in any parts they do not normally carry. They must also decide if their price would be competitive with other companies who may also sell the kit.

It is our policy only to mention specific companies if: they have an involvement in the design; or they can supply parts not readily available to the hobbyist; or they own copyright. We believe this is in everyone's interest, it allows competition on most projects and ensures parts are available to readers. It also allows us to bring you some exceptional designs which might otherwise be lost.

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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, Perry Mount 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

CLEANING KIT

The CK-90 multi-purpose cleaning kit from 3M has been designed to clean recording heads, guides, capstans and tape paths. The cleaning solution which is also suitable for computer systems and typewriters is quick drying, leaves no residue, is non-flammable



and will not harm metals, plastics or painted surfaces.

Each kit contains two 4oz bottles of solution, ten double-ended cleaning wands and fifty lint free wipes.

The kit is priced at £11.50 and is available from accessory shops.

MICROPROCESSORS FOR HOBBYISTS

A new book which has just been published called *Microprocessors for Hobbyists* is based on two popular series from PE (*Microprocessors Explained* and *Home Computers*) both of which were written by our regular contributor R. W. Coles.

The book is a general introduction to microprocessors, typical architecture, instruction sets, machine code programming and peripheral chips.

The home computer section covers a

typical system, the S100 bus structure, various peripherals available and a guide to choosing a suitable system. The final chapter deals with software and the high level language BASIC. A glossary of terms is also included to explain many of the "buzz words" used with microprocessors.

Copies of the book (ISBN 0-408-00414-2) which is priced at £2.95 including p&p are available from **Newnes-Butterworths Borough Green, Sevenoaks, Kent.**

ELECTROVALUE

The latest Electrovalue catalogue which is now available covers a wide range of items including chokes, coils, i.c.s. books and a very comprehensive range of ferrite components. There is also a complete range of Nascom microcomputers and peripheral devices.

The catalogue is available free of charge together with a separate price list which is valid until the end of July. Updated price lists can be obtained by sending a stamped addressed envelope to **Electrovalue, 28 St. Judes Road, Englefield Green, Surrey TW20 0HB.**

NEWTRONICS

Newtronics have moved to larger and more convenient premises close to Highgate tube station.

At their new showroom they will be demonstrating the popular ELF II and the new Explorer /85 computer kits and peripherals. The company are now supplying products direct to the consumer with the result that all their prices have been drastically reduced. The Elf II is reduced from £79.95 to £59.95 with all peripherals being reduced pro-rata.

Newtronics, 255 Archway Road, London N6 5BS.

NEW CASE

A new size of vacuum-formed case has been introduced by Vero to compliment their existing range. Although specially designed for housing a keyboard and display panels, this enclosure has wide ranging applications in the instrument field.

Vacuum-formed from black textured ABS, the case is supplied in two sections which screw together. A flat area is provided at the rear of the case for cable entry.



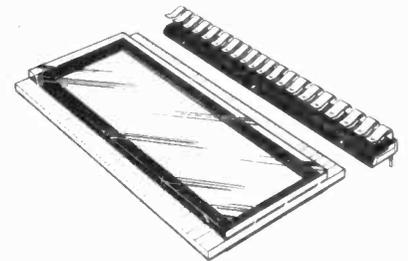
This intermediate size, with outside dimensions of 340 x 360 x 130mm is supplied with an anodised aluminium front panel 254 x 170 x 2mm thick, four self-adhesive rubber feet and case assembly screws.

The price of the case (75-2439K) is £16.71 excluding VAT and p&p.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants.

L.C.D. CONNECTORS

A range of snap-on connector strips which provide an alternative to dual in-line mounting for liquid-crystal displays is now available from Hamlin Electronics. The strips, which



are available with pin lengths of 0.1 or 0.2 in. are supplied in 2 in. lengths for a range of standard displays, and have pin compatibility with the standard dual-in-line pins.

Hamlin Electronics Ltd., Diss, Norfolk, IP22 3AY.

DEMA SYSTEMS

The Dema electronic ignition unit which is claimed to provide both petrol economy and improved performance is being marketed by Maywood Technical Developments Ltd.

The system takes a 5 to 15V supply directly from the coil and stores 400V in the units capacitor. The points which normally determine the build up time are used simply to trigger off a thyristor. A variable pulse width circuit determines when the voltage should be fed to the HT coil and the spark plug. The unit monitors the revs and varies the length of time the spark is at the plug in order to achieve complete combustion.

The system is priced at £49.50 including VAT and p&p. For further information contact **M.T.D. Ltd., Peake House, 232 High Street, Harlington, Hayes, Middlesex.**

FLUKE DMM

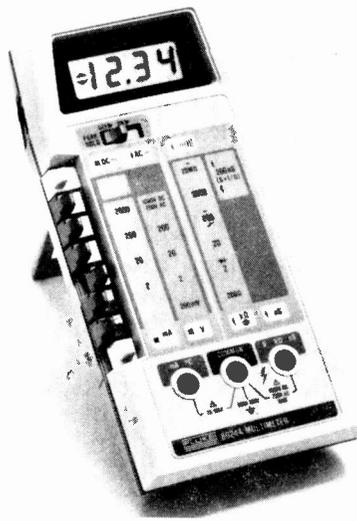
The latest DMM from Fluke is a $3\frac{1}{2}$ digit handheld DMM ideally suited for test and service applications. Fluke claim it is the first handheld DMM to offer logic level detection, direct temperature readout, a peak-hold facility and intermittent short circuit detection in addition to a full DMM capability.

Among the many features on the 8024A are direct temperature measuring capability from -100° to 1625° with any K type thermocouple, a peak-hold facility to store and display any a.c. or d.c. voltage or current peak, fast audible continuity checking and TTL logic state indication by visual or audible signal.

The peak-hold facility opens up many interesting applications such as transient detection for example in motor or lamp starting. Additionally, with hazardous circuits the operator can safely remove the leads before reading the display.

In logic circuits, the 8024A gives an instant visual or audible indication of TTL logic high or low. Fast response means it can also detect pulses or pulse trains up to 100kHz. On low frequencies, the tone warbles to give an indication of frequency level.

A fast 50 μ s settling time means that it is practically impossible to beat its high speed response even by running the leads very quickly down, say, an edge connector. Continuity is positively indicated by an arrow



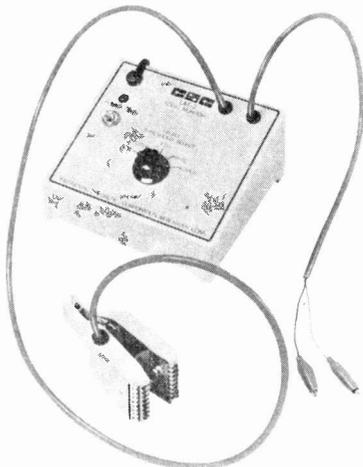
pointing up or down or by a 100ms 2kHz bleep.

The 8024A has $3\frac{1}{2}$ digit readout and a basic d.c. accuracy of 0.1 per cent. Temperature accuracy is 3 degrees ± 1 digit from -20 to $+300^{\circ}\text{C}$ and the instrument is specified for a full one year. The price of the 8024A is £135 ex VAT and p&p.

For details contact **Fluke International Corporation, Colonial Way, Watford, Herts. WD2 4TT.**

LOGIC MONITOR

The LM-2 logic monitor from CSC is for testing digital i.c.s. It simultaneously displays the static and dynamic logic states at each pin of a 14 or 16 pin dual in-line circuit. The device comes complete with an isolated power supply and has a selectable threshold control which allows it to be used with a variety of logic families.



There are two units which comprise the LM-2: the connector/display unit which clips over the circuit under test and contains the comparator circuitry and 16 l.e.d. indicators; and the power-supply module, which contains a precision reference power supply and a logic-family selection switch covering CMOS, HTL, TTL, DTL and RTL circuitry.

The threshold switch is used to select the appropriate logic family, a clip lead is connected to the negative or ground line of the circuit

under test (except for CMOS, when an additional positive lead is provided), and the clip module is slipped over the circuit under test.

Typical of states that can be seen from the monitor's 16 l.e.d. display are gate inputs rising and falling, pulses passing from circuit to circuit, flip-flops changing state, and decoders and encoders accepting and recording information.

Because of the self-contained power supply, there is no loading of the circuit under test—a problem that can cause logic-level shifts, false triggering and power-supply loading with some types of equipment. In addition, the power supply, in conjunction with the comparators, also provide a constant-current drive to the display indicators, ensuring uniform brightness.

CSC Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

BAR CODE READER

A handheld light pen which reads standard black and white bar codes and outputs the digitally coded information, is now available from Jermyn-Mogul Distribution.

Manufactured by Hewlett-Packard and called the HEDS-3000 Digital Bar Code Wand, this low cost device is completely self-contained, comprising optical sensor, amplifier and digitiser.

Features include a single, non-critical supply voltage, a replaceable low friction tip, push to read switch, full TTL and CMOS compatibility and solid state reliability throughout.

Apart from its already obvious use in supermarkets, a major demand for this device will be in the field of portable data entry as bar code scanning is not only faster than keyboard

entry but inherently more accurate.

One particularly interesting application is in service and repair where bar code labelled



printed circuit boards automatically set the parameters of the test equipment.

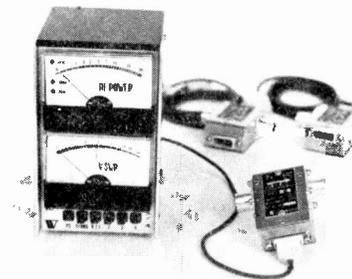
The price of the HEDS-3000 is £61.79 ex VAT. **Jermyn-Mogul Distribution, Vestry Estate, Sevenoaks, Kent. 0732 50155.**

VSWR/POWER METER

A combined VSWR and power meter offering direct reading of both functions without interpolation is now available from Zycomm Electronics.

In operation, the unit is autoranging for power output, covering 20W to 2kW in three ranges for 1.8–30MHz and 50–150MHz, and 2W to 200W for the 430–470MHz range. VSWR from 1:1 to infinity can be measured.

Separate sensing heads are supplied to



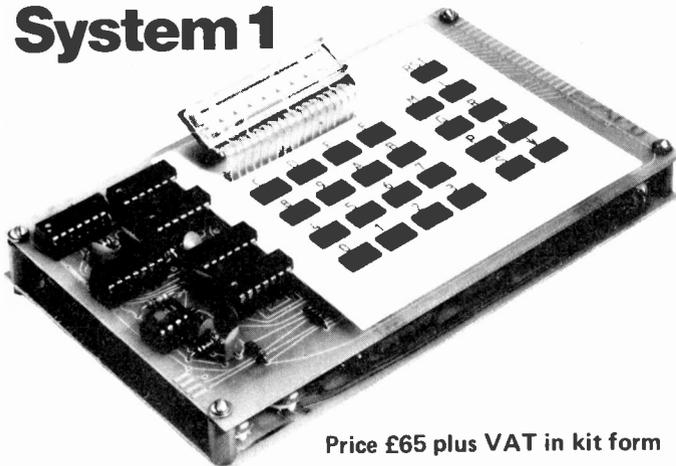
cover each frequency range, and these can be connected at any position in the feed line—including the mast head for precise radiated power indication. Press switches on the front panel allow the selection of the appropriate head, and the display of forward and reverse power as either peak or r.m.s. readings.

The electronic comparator included in the unit allows constant readout of VSWR irrespective of power variation, i.e. gives true indication during speech on SSB.

The price of the meter is £147.20 inc. VAT. **Zycomm Electronics Ltd., 47, 49 and 51 Pentrich Road, Ripley, Derbys.**

The Perfect Lead...

Acorn Microcomputer System 1



Price £65 plus VAT in kit form

This compact stand-alone microcomputer is based on standard Eurocard modules, and employs the highly popular 6502 MPU (as used in APPLE, PET, KIM, etc). Throughout, the design philosophy has been to provide full expandability, versatility and economy.

Specification

The Acorn consists of two single Eurocards.

1. MPU card
6502 microprocessor
512 x 8 ACORN monitor
1 K x 8 RAM
16-way I/O with 128 bytes of RAM

- 1 MHz crystal
5 V regulator, sockets for 2K EPROM and second RAM I/O chip.

2. Keyboard card
25 click-keys (16 hex, 9 control)
8 digit, 7 segment display
CUTS standard crystal
controlled tape interface circuitry.

Keyboard instructions:
Memory Inspect/Change (remembers last address used)
Stepping up through memory
Stepping down through memory

- Set or clear break point
- Restore from break
- Load from tape
- Store on tape
- Go (recalls last address used)
- Reset

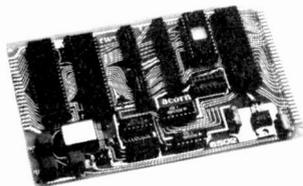
Monitor features

- System program
- Set of sub-routines for use in programming
- Powerful de-bugging facility displays all internal registers
- Tape load and store routines

Applications

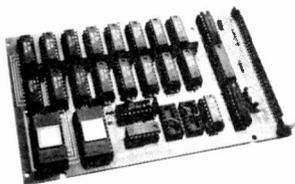
- As a self teaching tool for beginners to computing.
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- As a basis for a powerful microcomputer in its expanded form.
- As a control system for electronics engineers.
- As a data acquisition system for laboratories.

START WITH SYSTEM 1 AND CONTINUE AS AND WHEN YOU LIKE



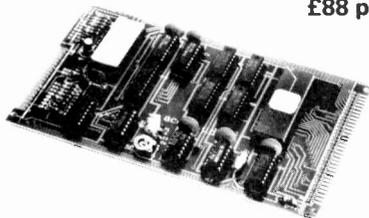
Acorn Controller
£35 plus VAT (min config.)

the CPU card of System 1, it allows for up to 4½ k EPROM, 1½ k RAM and 32 I/O lines. It has on board 5 V regulator and optional crystal control. Custom programs may be developed on System 1 and the card makes an ideal dedicated hardware module.



Acorn Memory 8 k
£95 plus VAT (kit form)

A fully buffered memory card allowing up to 8 k RAM plus 8 k EPROM on one eurocard, in an Acorn system both BASIC and DOS may be contained in this module. Static RAM (2114) is used and the card may be wired into other systems.



Acorn VDU
£88 plus VAT (kit form)

A memory mapped seven colour VDU interface with adjustable screen format. Full upper and lower ascii and teletext graphics are features of this module which along with programmable cursor, light pen, hardware scroll etc., make this the most advanced interface in its class.

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in ROM

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4A Market Hill, Cambridge, Cambs.
Cambridge (0223) 312772.

Order Form

Please send me the following:

- (qty) Acorn Microcomputer kit @ £65 plus £9.75 VAT.
- (qty) Acorn Memory kit @ £95 plus £14.25 VAT.
- (qty) Acorn VDU kit @ £88 plus £13.20 VAT.
- (qty) Acorn Power Supply (for System 1 only) @ £5.95 plus £0.89 VAT.
- (qty) Acorn Microcomputer assembled and tested @ £79 plus £11.85 VAT.
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Post and packing free on all orders.

I enclose a cheque for £

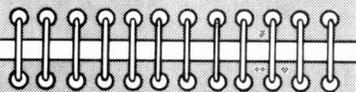
(indicate total amount) made out to Acorn Computers Ltd.
Please send me further details of this and other Acorn options

Name _____

Address _____

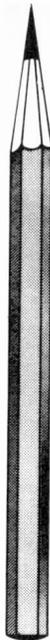


Acorn Computers Ltd. 4A Market Hill, Cambridge, Cambs. (0223) 312772. Regd. No. 1403810



INDUSTRY NOTEBOOK

By Nexus



Outlook

Never, in recent years, has the crystal ball been so clouded by external events, both political and economic. The domestic scene is unclear enough with the impact of contraction of heavy industries and industrial unrest, but when international factors are added the only certainty is uncertainty. Nobody knows the eventual outcome of the Iranian revolution, of the Rhodesia elections, of the U.S. elections, the nuclear power debate, arms limitations, the expected deaths or resignations of the elderly leaders in the USSR, the future cost and availability of oil, world interest rates and inflation, squabbles in formerly stable institutions like NATO and the European Common Market.

The list seems endless and probably is, the only good point emerging being a gradual realisation that no nation can plan and conduct its affairs in isolation from events elsewhere, maybe many thousands of miles distant and sometimes, by world standards, of only a minor character.

But through all the turbulence of the late 1970s and now for at least the early years of the 1980s if not beyond, the electronics industry has not only survived but has grown. Growth may have been erratic, profits wobbled, ownership of companies changed, as is characteristic of a dynamic industry in response to surges in demand and in rapid technological change, but the trend is still upwards. Apart from oil, electronics is probably the safest business to be in. But oil is said to be finite while electronics will go on for ever, which is a cheerful note for a winter's day.

Trend

The general trend was revealed in recent financial results of industry leaders. GEC showed a dip in profits, the result of heavy involvement in general engineering which was affected by the long engineering workers' strike. GEC's electronic companies continued to prosper. Racal only just

scraped home with an unblemished record of 25 years of continuous growth and profits. In their case the engineers' strike was probably more marginal in effect, the major obstruction being the greatly increased value of the pound sterling in the international market.

But both the Racal and GEC are still active on the takeover trail. Avery is now in the bag for GEC and was followed by the acquisition of the industrial robot company Hall Automation Ltd. Racal, at the time of writing, had not revealed an expected bid for all or part of Decca but, in the interim, extended overseas activities through buying 65 percent of the New York based Vikonics for \$1 million. This company will become Racal-Vikonics and as it is in the systems security business will be complementary to and a first-class U.S. outlet for Racal-MESL which came into the Group in January 1979. Racal has the option of buying the remaining shares in due course although some are likely to remain with Vikonics' founders as an incentive.

It is tedious to list orders but two are worth mentioning as significant in trend. First, for GEC whose Marconi Space and Defence Systems has booked its first defence order from China. It is for five FACE (Field Artillery Computing Equipment) systems worth £1 million with long-term business expected to follow. Second, for Racal-Milgo who in a single month recently won export orders worth £3¼ million. Only six years ago total exports for a whole year were less than this figure. The record month coincided with Racal-Milgo's move to a new headquarters building with 24,000 sq.ft. of floor area at Fleet, Hants.

Plessey, too, looks in much finer shape than for a long time and is firming everything up with yet another re-organisation.

Distribution

Although there are a handful of large electronics component distributors in the UK and lately a sprinkling of specialist MPU and instrument distributors, most are comparatively small businesses. We all used to believe that all the little firms would eventually be swallowed up by the big fish so that perhaps only six or seven "supermarkets" would blanket the country. We were wrong. True there are some big 'uns and doing very nicely thank you, but the great bulk are over 100 small independent companies carrying on the tradition of the corner shop.

The name of the game is customer service and this is an area where the small company can, and obviously does, score. It also attracts new entrants willing to have a go on their own rather than continue working in a big organisation.

The most recent example is House of Instruments (HI) which opened for business on January 1, 1980, from premises in Safiron Walden, Essex. The key figures are Gordon Pope and Fred Hutchinson both executives from Gould Advance, Pope giving up his job as chairman and Hutchinson as instrument manager. It needs courage these days to start a new business but the

two principles are extremely well-known, have a fine track record in the business and have some good products lined up as well as four salespeople on the road.

Crime

We have all heard of computer crime but nobody knows its extent. Interpol suggests that industrialised nations are losing as much as 2.5 percent of gross national product through fiddles by white-collar workers with the bulk being due to computer fraud. But this must be guesswork as it is admitted that computer fraud can be conducted successfully for years without detection.

At a recent Interpol conference some 50 basic types of fraud were listed but each has so many variations and subtleties that a full catalogue is a practical impossibility. The solution is that police fraud squads should now receive specialist training in computer technology and programming.

Fall of France

Chauvinistic France after years of struggle has at last surrendered to Sony advances. The news is that the Japanese company will open its first factory in France in 1981. It will be sited at Bayonne, close to the Spanish border, turning out tape recorder cassettes with a French workforce of 300 people. Sony has had a sales subsidiary in France since 1964 and has been hoping to expand ever since. The French government have now reversed their policy of exclusion in the interests of hoped-for exports and almost certain import savings to satisfy France's domestic market currently estimated at 25 million cassettes per year. Sony video cassettes will also be produced at Bayonne.

Spin-off

I recently spent an interesting day at the Royal Signals and Radar Establishment, Malvern. This was the home of the former TRE which generated so many war-winning inventions 40 years ago. I am pleased to report that a later generation of boffins are still at it as hard as ever although the urgency is less great than in the hectic years of World War 2.

Among the projects unveiled were a new battlefield radar for ground troops, highly portable, and a novel helicopter-borne radar which uses one of the rotor blades as the scanning antenna.

Those who are worried about the level of defence spending may be re-assured that all the money spent and the technology won does not go down the military drain. Much of it goes virtually as a free gift to industry and some is charged for. RSRE has two Queen's Awards for Technology under its belt, both won in 1979, a unique event for a single organisation.

Some of the fundamental research looks as far ahead as 1995 which even the most forward-looking commercial companies would have difficulty in financing. At the same time RSRE is still supporting older projects such as the Rapier missile system which has seen continuous improvement and is a world best-seller for Britain.

Audio Isolator...

G. Davies



THE audio opto-isolator is powered from a nine volt PP3 battery and *completely* isolates input from the output via an infrared light beam. Applications include safer connections from guitar to amplifier, microphone to PA, and is ideal for out of doors where added safety is required. It is also ideal when connection from one amplifier to another without the problem of earth loops is required. The unit switches on when the input jack is inserted. See Fig. 1.

SPECIFICATION

Maximum input 100mV R.M.S. (impedance up to 500k)
Output up to 100mV R.M.S. (impedance greater than 50k)

COMPONENTS . . .

Resistors

R1, R2 1M (2 off)
R3 10k
R4 100k
R5 1k
All resistors $\frac{1}{4}$ W 5%

Potentiometers

VR1 100k hor. min. preset

Capacitors

C1 10n/50V cer.
C2, C4 4 μ 7/16V tant. (2 off)
C3 100n/35V tant

Integrated circuits

IC1 741
IC2 CNY171

Miscellaneous

ABS box 100 x 75 x 40mm
Printed circuit board
Stereo jack sockets (2 off)
PP3 battery and clip

CIRCUIT DESCRIPTION

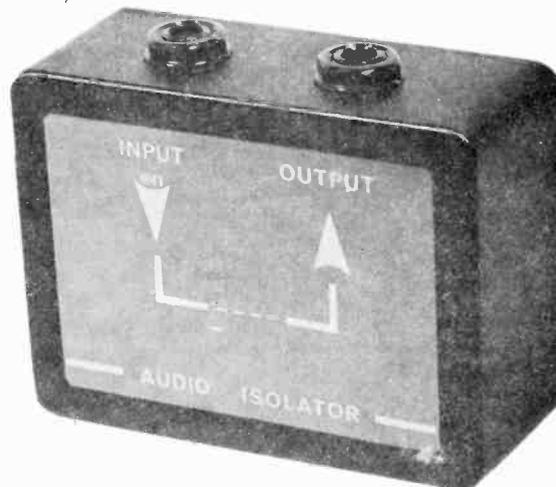
Resistors R1 and R2 form the bias for the 741 op. amp, and C1 decouples the input. The input signal modulates the input bias for IC1 applied to the non-inverting input. The output of IC1 is fed through the l.e.d. of the opto-coupler, IC2, the current being limited by R5. Negative feedback is applied from the potential developed across R5 to ensure low distortion driving the l.e.d. in a true current mode. (The voltage developed across R5 is proportional to the current passing through it, and the l.e.d.).

R4, R3 and C2 give an a.c. voltage gain of ten to provide adequate drive to the l.e.d.

The phototransistor in the opto-coupler in the configuration shown, acts as a current source which is converted into a voltage across VR1. The output voltage is limited to 0.6 volts peak to peak because of the forward voltage drop of the transistor junction. To ensure maximum output swing, the output transistor is biased at approximately 300mV by adjusting VR1 and measuring the d.c. voltage between pins 5 and 6 of IC2 with a high impedance meter. The pot VR1 can be adjusted by applying an input signal and adjusting for minimum distortion.

CONSTRUCTION

All components are p.c.b. mounted (see Figs. 2 & 3) and the whole p.c.b. assembly fits into two holes 12.5mm diameter, 38mm between centres in the side of an ABS box. To mount the jack sockets onto the p.c.b., junior hacksaw saw cuts in between the pads form an ideal solution for easy assembly. ★



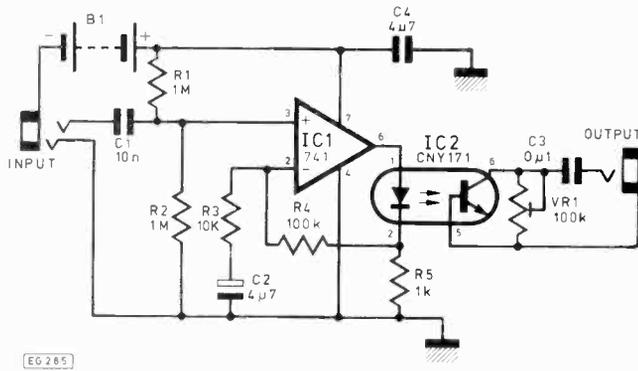


Fig. 1. Full circuit diagram. The input stereo jack socket is wired so that insertion of a mono jack plug will connect the battery to the circuit, thus eliminating the need for an ON/OFF switch

Fig. 2. Printed circuit layout (full size)

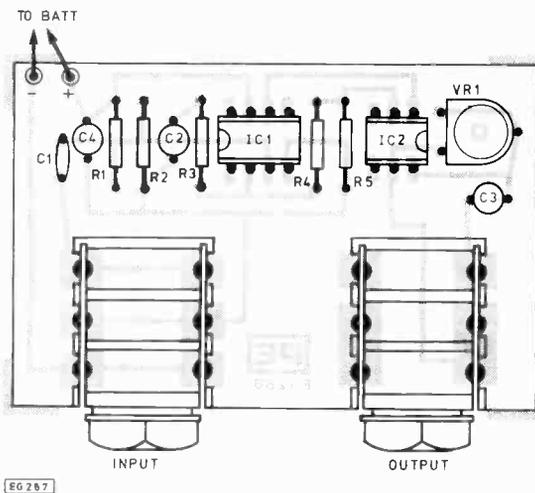
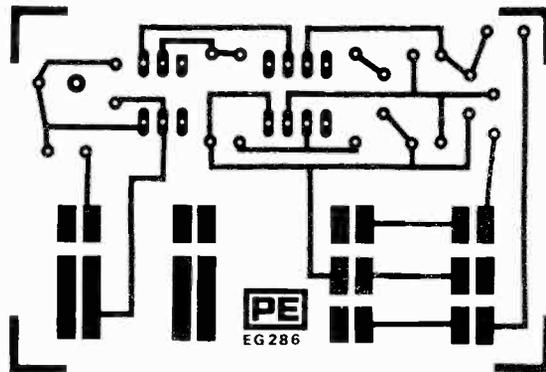


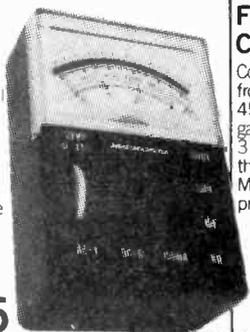
Fig. 3. Component layout of Audio Isolator. Four slots should be cut into the side of the board to accommodate the jack socket tags

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REG. PRICE

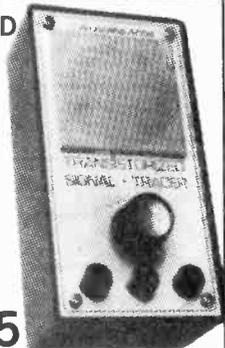
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SIGNAL INJECTOR

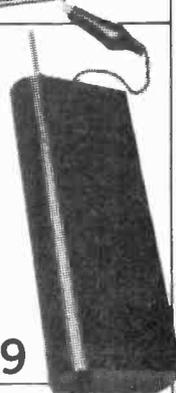
For RF, IF, AF circuits. Maximum accuracy. Easy pushbutton operation. Needs two "AA" batteries. 22-4033.

REG. PRICE **£2.79**

AC/DC CIRCUIT TESTER

Accuracy in 1-300 volts ranges. Safe in live/dead circuits. Needs two "AA" batteries. 22-4034.

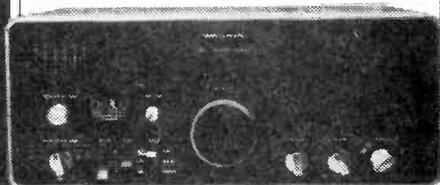
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REALISTIC DX 300

General coverage receiver. Quartz-synthesised tuning, digital frequency readout. 3-step RF Attenuator. 6 range preselector with LED indicators. SSB and CW demodulation. Speaker. Code oscillator. Batteries (not included) or 12V DC. 20-204.

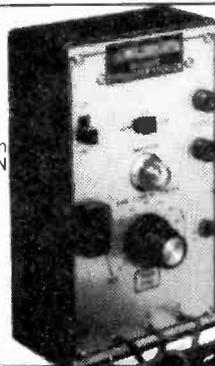
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Semiconductor UPDATE...

FEATURING

8041/ISBC 941 SUPER E-LINE

R. W. Coles

SLAVE CHIP

When any digital processor (such as a microprocessor chip) needs to converse with the outside world it usually has to rely heavily on external peripheral control logic circuits. This logic external to the processor itself can be minimised by trading off hardware for software; so that the processor becomes intimately involved in the transfer of data to or from the peripheral, perhaps a tape cassette or a printer.

The software solution certainly looks good from the circuit complexity point of view. A complete asynchronous serial I/O scheme can be implemented in software with the use of only two microprocessor pins and a couple of external buffers to replace the few dozen TTL packages which could be needed otherwise. The trouble is that software (or rather firmware in ROM) is quite expensive to write, and this method does not involve the CPU in a great deal of time wasting activity when in many situations its talents are urgently needed elsewhere. The software solution is therefore suitable only for very simple applications where the CPU doesn't have a lot of other things to do anyway.

For those more important CPUs, who find dealing with troublesome peripherals a tiresome job, the semiconductor manufacturers have produced dedicated I/O controllers which do some of the often needed jobs in hardware but with all the necessary logic squeezed on to a single LSI chip. The best known of these devices is probably the UART/USART/ACIA chip which can be used to relieve a processor of the need to control, slow, asynchronous serial I/O transfers. Data transfer of this sort, to and from teletypes, VDUs and other serial devices, can be a painfully slow process with the wide variety of transmission rates and data formats making the task quite complex. The necessary serial to parallel and parallel to serial registers, parity checking logic and start and stop bit insertion can all be done by the UART controller which the processor can treat just like a section of its own memory.

SOFT OR HARD?

Taking stock then, you can do it in software, or you can do it in hardware, but unfortunately, you can only do it with LSI hardware if it is an I/O function which is so common that the semiconductor manufacturers find it economic to make a special device to do the job. If you happen to be an industrial microprocessor user, however,

there will be many occasions where your particular I/O control function is so special that you either have to go back to software or put up with a board full of TTL. Or, rather, you did have to until Intel introduced their 8041A Universal Peripheral Interface chip.

The 8041A is actually a complete microprocessor system in a 40 pin package, like the 8748 we considered last month, but unlike the 8748 the 8041 is optimised for use as the "slave" of a main processor such as the 8080, 8085 or 8086. The main processor converses with the 8041 over its normal eight bit data bus while the 8041 itself takes over all the time consuming data and formatting and timing operations under the control of its own built in ROM based software. This solution provides the system designer with the best of both worlds: The flexibility of software driven I/O with all the convenience of a single LSI chip to do the work.

This is great for the industrial user who needs a thousand of these chips all with the same program, but what about those one-off jobs where ROM mask costs cannot be absorbed? Is it back to TTL? Well no, because good old Auntie Intel has considered the plight of small users like us and has programmed up an 8041 with a set of nine general purpose I/O routines which can be individually selected via the system bus.

The routines are aimed mainly at industrial applications such as switch sensing, motor speed control, stepper motor drive and simple serial I/O communications, but many other uses suggest themselves. This "custom" chip is coded ISBC 941 and it has all the usual facilities of the 8041 including 16 programmable I/O lines which can be used individually to implement functions such as pulse counting, pulse generation, period and frequency measurement and sensor monitoring.

The ISBC 941 comes in a 40 pin package, runs from a 5V supply, and can use either its own internal clock oscillator or one derived from the main processor clock.

E-LINE MUSCLE (SUPER E-LINE)

I like to buy British, but it is very difficult sometimes, especially in the electronics field. I know that Texas Instruments, National Semiconductor, General Instrument, Motorola, and several other American semiconductor firms do manufacture devices here, but when you buy from these firms, as of course you must

in many instances, there is usually no guarantee that the devices you get will really be British or that your purchase will benefit the British economy in any way.

I for one have my fingers crossed that the ambitious plans of the new British Inmos memory and microprocessor organisation will bear fruit in due course, but until that great day arrives you can still do your bit for Britain by using the home-grown discrete transistors like those from Ferranti. Now we all have to use discrete transistors from time to time, don't we, and (own up now) I bet you use devices from Texas or Motorola without even thinking about it. Well don't, because if you need a good range of plastic silicon transistors you can't do much better than to buy them from our very own Ferranti Semiconductors.

Their main range of devices, which I would like to commend to you, is the family known as "E-line". This range comes in a plastic package of a very compact and neat design, and family members can be recognised by the fact that their code number begins "ZTX". These devices are by no means new, but you may not be too familiar with it because Ferranti don't have the same kind of advertising budget as some of their competitors. If my own experience with E-line devices is anything to go by however, they certainly make up for their lack of advertising in the quality of their transistors and you can pick just about any combination of polarity (*n.p.n./p.n.p.*), current gain, and voltage rating you are ever likely to need from this versatile family.

Well so much for the unashamed plug of a British manufacturer—now for the hot news. To augment their existing range of E-line devices Ferranti have now introduced a brand new range of plastic transistors called "Super E-line". "Super" is the right word too, because I don't know of any other manufacturer anywhere who can pack so much power into such a tiny plastic T092 type package. Super E-line devices will dissipate 1.5W at a case temperature of 25 degrees C, and they'll handle voltages of up to 100V. Under surge conditions these very muscular transistors can sink 6 amps, and they have a minimum gain of 25 at 2A or 55 at 1A.

These sort of specs make Super E-line ideal for use in audio amplifiers, relay and lamp drivers, and anywhere else you need a very small device with a very hairy chest. In many circuits you will be able to use Super E-line in place of much bulkier power devices.

So do yourself a favour and buy British—it really is best sometimes!

BREADBOARD REVIEW

LAST year over the period December 4-8, the second *Breadboard* was held at the Royal Horticultural Halls, Westminster. At this annual event for the amateur of the technology, electronics was unchained from its usual business-like decorum, and the sixty or so exhibitors combined to produce a pre-Christmas electronic menagerie of synthesisers, effects units and microprocessor music; and a fulgurous psychodelia of lighting novelties, including a laser at the Watford Electronics stand.

The exhibition provided a panoptic view of the state of the art, with no unfair bias towards computers, musical instruments, hi-fi or anything else, although a radio enthusiast need not have spent long at the show. Robots demonstrated their agility, and cybernetic bits and pieces were seen "lopping" around under battery power. How long before some of the visitors fit this description? Demonstrations of various keyboard instruments by the maestros took place in listening areas. We even found Alan Boothman playing the *PE String Ensemble*.

SHARP MZ80K

The Newbear display included the Sharp MZ80K personal computer. This system is based on the Z80 microprocessor with a 14K extended BASIC, 10in VDU (40 characters x 25 lines), 78 key ASCII keyboard, 50 pin connector for system expansion and a music synthesizer with 3 octaves. The machine is available in a range of memory sizes (6K, 10K, 18K, 22K, 34K plus 14K for the BASIC) and a PASCAL compiler will be available in the near future.



The cassette speed at 1200 b.p.s. is quite fast and the machine includes a tape counter.

The music synthesizer can be programmed either in BASIC or machine code and the volume is adjustable from inside the case. The two instructions for the synthesizer are MUSIC and TEMPO with the TEMPO instruction either increasing or decreasing the length of the note.

The Basic has to be loaded from cassette which takes about 2 mins but this system does enable other languages to be used.

The price of the machines range from £520. **Newbear Computing Store Ltd., 40 Bartholomew Street, Newbury, Berks. (0635 30505)**

WEST HYDE DEVELOPMENTS

The West Hyde stand had a wide range of cases and components on display including their latest keyboard enclosure, the Bocon Commander. This moulded ABS case has anodised aluminium front and rear panels with the rear aperture accepting a 19in rack frame 100mm high. The housing which has been designed to accept most proprietary keyboards is priced at £77.50 ex VAT and p&p.



A catalogue covering the complete range of cases, components, test equipment and tools is available free of charge from **West Hyde Developments, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.**

THE DIGITAL WAY

A device of considerable potential seen at the show is called a "Graph Transducer". A versatile interface between the analogue and digital worlds, this invention can form part of a range of instruments which synthesise virtually any waveform, graphically equalise, and allow serial analogue control.

Produced by Turner Electronics under licence from Aragorn Dynamics, the S201S is a completely digital graphic equaliser of electrically similar characteristics to conventional units, but which allows narrow band frequency control superior to tone controls, and presents no interface problems. Cascading permits resolution to the desired degree. Specification: 2 x 10 bands at 1 octave spacing, S/N ratio > 80 dB below 1V. Distortion < 0.1% (20Hz-20KHz). The AD2000 series console comprises four stereo equalisers.

Operated in the Voltage versus Time Mode, the Graph Transducer forms the basis of a range of units called "Arbitrary Waveform and Control Sequence Generators" which are capable of envelope shaping, wave form generation (timbre or tone), and, for example, sequential lighting control. The cycle pattern is set up using precision conductive plastic slider potentiometers and the time-base can be varied from microseconds to hours. An exceptionally stable logarithmic VCO is incorporated.

With the S103 unit, a counter indicates incremental status, measures frequency and

CLEF PRODUCTS

The very busy Clef Products stand featured the *PE String Ensemble* (March-July 78) which is still a very popular design with constructors. Also on display were Clef's latest piano kits which have been based on the successful PE Joanna design with considerable refinements. The two designs are a 7½ octave (88 note) and a 6 octave (72 note). A stage version of the 6 octave piano is also available which requires an external amplifier and speaker whilst the domestic versions contain

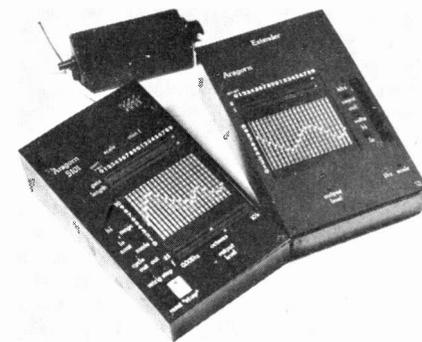


their own power amplifier and will operate with either a speaker or an external amplifier/speaker system.

Clef can supply ready built and tested instruments with full service instructions.

The price of the String Ensemble is £164.00, the 6 octave piano is £184.00 and the 7½ octave £209.00 part kits are also available.

For a complete price list covering all Clef's kits, contact **Clef Products, (Electronics) Ltd., 16 Mayfield Road, Bramhall, Cheshire.**



voltage, and an auto-ranging integrator smoothes the elastic signal. By superimposing the synthesiser's output on an existing waveform using a dual beam scope, the output can be adjusted to follow the original waveshape. In fact, using the memory mapped Computer Interface Board also available, a computer is conceivable which could learn to imitate any sound just by listening to it.

Two units from the range (S101 and S102) can be used to form a very superior conventional music synthesiser. Program card templates can remember waveforms.

Some sample prices are: S201S Stereo Equaliser—£142, S101 Control/Waveform Source—£184, AD2000 Equaliser Bank—£694. Details are available from **Precision Instrument Laboratories, Instrument House, 727 Old Kent Road, London SE15.**

TRANSPORTABLE ORGAN

If your last project was encased in a tobacco tin then it may not be a good idea to attempt to build one of the organs seen on the Aura Sounds stand, although Wersi do say that the Saturn (pictured below) is based on their "novel" d.i.y. method which makes construction easier. The console comes assembled, and prefabricated laced wiring harnesses eliminate one of the main causes of error.



The Saturn is described as a transportable organ, and has a list of attributes too long to quote here. Basically it has five-octave polyphonic keyboards, with an overall eight octaves available from a master generator providing a range of simultaneously available waveforms. The fixed stops give: Principal, Cello, Horn, Accordion, Trombone and Sax-

ophone all at 6', English Horn, Principal, Viola, Clarinet, Oboe, Schalmei and Trumpet all at 8', plus others.

The piano section gives: Celeste, Kinura, Honky Tonk, Harpsichord and Banjo, with tremolo, echo and damper functions.

Wersivoice rotating battle effect is included, along with auto accompaniment, and somewhere inside the cabinet is a string orchestra! Just to utilise any remaining space, a sound computer is also incorporated to give 32 user adjustable preset buttons. So if you have £5197 in your pocket, plus some petty cash for loudspeakers to go with it, the Saturn could be yours.

Anra Sounds, 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey.

COMPSHOP

The main feature on the Compshop stand was our Computik UK 101 which has rapidly established itself as the country's fastest selling single board computer.



Also on display was the ITT 2020 which is the English version of the Apple II microcomputer. **Compshop, 14 Station Road, New Barnet, Hertfordshire.**

CHROMATRONICS

The Chromascope from Chromatronics is a video synthesiser which can create a whole range of abstract colour patterns on a TV set. The display which responds to a musical input is available in kit form for £169.95 inc. VAT.

The kit includes a cabinet, components, ready built encoder, modulator power supply and manual. **Chromatronics Coachworks House, River Way, Harlow, Essex CM20 2DP.**

COMPETITION WINNER

The winner of our Lektrokit competition (Sept '79) Mr. D. J. Speakman was at the exhibition to receive his prize of a Powerace 102 with a jumper wire kit and 16 pin test clip.



Our Advertisement Manager Mr. D. Tilleard (left) presented the prizes together with Mr. G. Wilson of Lektrokit.



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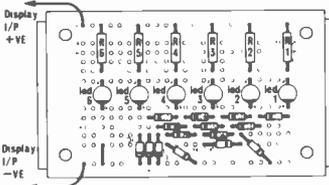
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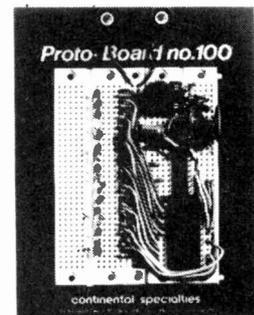
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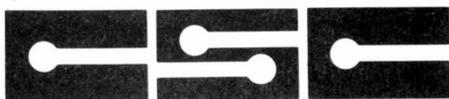


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Transistor Parameters...

If the amplitude of applied signals is small it is more convenient to replace the transistors by an equivalent circuit for determining externally, circuit parameters. Here common emitter h-parameters are discussed.

R. A. HATTON

LOOKING through transistor data sheets can be very frustrating if you don't know what the mass of data means or how it can be applied in designing a circuit. This article explains what the most commonly quoted parameters mean, and their relevance to a transistor circuit.

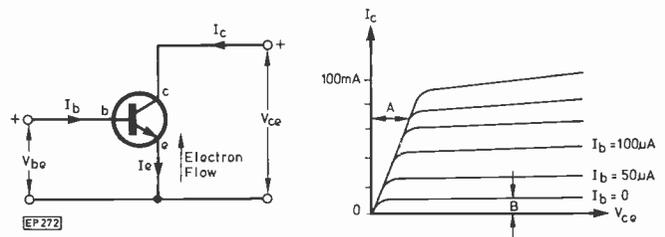
COMMON EMITTER MODE

Fig. 1 shows an *n.p.n.* transistor connected in the common-emitter mode, with normal voltage supplies and current flows labelled. Fig. 2 illustrates the typical output characteristics for such a transistor, and similar graphs can be found on most data sheets. The transistor is a current controlled device, and in the common-emitter mode a large current gain is possible, as shown by Fig. 2 where I_c is the collector current in mA, and I_b is the base current in μA .

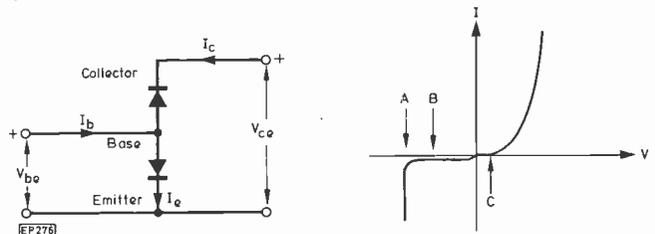
Note that the collector current depends only on the value of the base current, and not on the collector voltage (which means that V_{ce} can be a constant voltage power supply). For a given value of I_b , I_c is nearly constant for all values of V_{ce} , except near 0 volts and at very high levels (not illustrated, but typically about 50 volts). To appreciate what happens at these two extremes, look at the diode equivalent in Fig. 3 of a transistor. The collector-base diode is reverse biased, and the emitter-base diode is forward biased for normal operation. Fig. 4 shows the current flow in a semiconductor junction diode, and it will be noticed that in the reverse biased condition there is a sudden increase in current flow when the voltage at point A is reached. This is a result of avalanche breakdown, which will cause the destruction of the junction, and must not be allowed to occur. Hence for "safe" operation of the device the voltage at point B must not be exceeded. As the other diode is forward biased there is little voltage drop across it, and consequently approximately all V_{ce} is dropped across the reverse biased collector-base diode, and so a maximum value of V_{ce} must be stated to prevent destruction of the transistor from too high a power supply voltage. This parameter is quoted as V_{ce0} (max), the 0 suffix indicating that this voltage is measured with the base open circuit.

It will be noted from Fig. 4 that between zero volts and point C no current flows in the forward biased diode. This means that before current can flow into the emitter there must be at least this small voltage present across the base-emitter. It is called the "knee" voltage, and for silicon devices it is 0.7 volts. This explains why V_{ce} , as illustrated in Fig. 2, must have a minimum value (point A) before collector current will flow.

When the base current is zero, it is also evident from Fig. 2 that a small collector current, shown by B, flows. This is the leakage current which arises from the reverse biased diode across the collector-base.



Figs. 1 and 2. Transistor in common emitter mode with output characteristics



Figs. 3 and 4. Diode equivalent of transistor with diode voltage/current characteristic

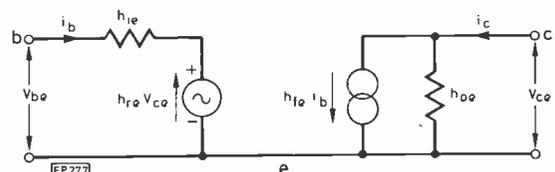


Fig. 5. Hybrid parameter circuit

Where *i* indicates input, *o* output, *f* forward, *r* reverse, *e* common emitter. Solving the equations for various circuit conditions:

$h_{ie} = \frac{V_{be}}{I_b} \Bigg|_{V_{ce} = 0}$	input resistance with output short-circuit (ohms)
$h_{re} = \frac{V_{be}}{V_{ce}} \Bigg|_{I_b = 0}$	reverse voltage ratio with input open-circuit (ratio)
$h_{fe} = \frac{I_c}{I_b} \Bigg|_{V_{ce} = 0}$	forward current gain with output short-circuit (ratio)
$h_{oe} = \frac{I_c}{V_{ce}} \Bigg|_{I_b = 0}$	output admittance with input open-circuit (mhos)

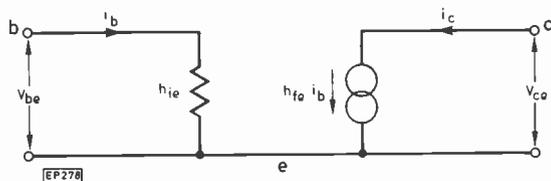


Fig. 6. Simplified hybrid parameter circuit

This current, which should be as small as possible in a good transistor, is termed I_{ce0} , the 0 suffix indicating that it is measured with the base open circuit. This leakage current flows in addition to the required collector current, and so the actual collector current $I_c = \beta I_b + I_{ce0}$, where β is the current ratio I_c/I_b , which is the ratio of output current to input current or current gain. This is an important parameter in circuit design, and β , which is called the common-emitter current gain, is usually found on data sheets as h_{fe} .

HYBRID PARAMETERS

The h parameters are derived from a model of the transistor. Fig. 4 shows this for small signal changes about an operating point, and is known as the hybrid-parameter equivalent circuit for a common emitter bipolar transistor.

The input side consists of the base circuit resistance h_{ie} and a voltage generator to take account of the junction potential, and it produces a voltage given as $h_{re} \cdot V_{ce}$, where h_{re} is the reverse voltage transfer ratio. The output side consists of a current generator which produces a current given by $h_{fe} \cdot i_b$ (small letters indicate small signals) or i_c , and a parallel resistance which covers the output admittance (inverse of resistance) h_{oe} . The parameters are defined by the following two equations:

$$\text{input voltage } v_{be} = h_{ie} \cdot i_b + h_{re} \cdot v_{ce}$$

$$\text{output current } i_c = h_{fe} \cdot i_b + h_{oe} \cdot v_{ce}$$

Of these parameters h_{re} and h_{oe} are usually very small, and consequently they are often neglected in circuit calculations in order to simplify things. Fig. 6 shows the simplified model, using just h_{fe} and h_{ie} , and Fig. 7 shows a common-emitter amplifier with its (simplified) model equivalent circuit.

As may be expected, the larger the current flowing through a semiconductor device, the larger the quantity of heat which is dissipated through the bulk of the material. There comes a point when the material has too high a current flowing through it to allow the necessary rate of dis-

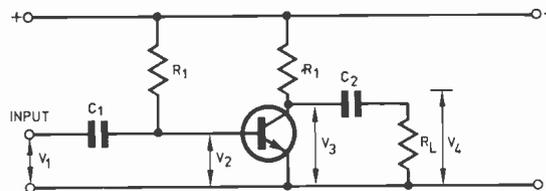


Fig. 7. Simple common emitter amplifier and its hybrid equivalent circuit

sipation for safe operation. This results in the destruction of the device, and you will find stated in data sheets the maximum collector current above the device will break down— i_c max.

POWER DISSIPATION

The manufacturer also quotes the maximum power dissipated by the transistor, and when this power has been reached it must equal the electrical power input, given approximately by $V_{ce} \cdot I_c$, and, of course, must not be exceeded. It may be necessary to calculate the power dissipation of a transistor when mounted on a heatsink, in which case the following equation would be used:

$$P_{max} = \frac{(T_j - T_a)}{(\theta_1 + \theta_2 + \dots)}$$

Here T_j is the maximum junction temperature for safe operation, and T_a is the ambient air temperature around the device (which will probably be above room temperature, because of the surroundings). θ_1 is the thermal resistance between the junction and the transistor mounting base, and can be found on the data sheet as $R_{th(j-case)}$ and it is expressed in $^{\circ}\text{C}/\text{mW}$. θ_2, θ_3 etc., are the thermal resistances of all other components in the heat flow path to, and including, the heat sink.

One final point, while considering temperature, I_{ce0} is very much temperature dependant so any quoted value must be at a stated temperature (usually room temperature) and steps must be taken in a design to exclude the effect of temperature. ★

News Briefs

LITERATURE AVAILABLE

INTEL (UK) have just published a 20-page brochure, called *Intelligence*, which provides a brief description of all their microcomputer families as well as the most popular memory products. The main characteristics of each family is discussed in turn and brief details of the support available are given. The brochure is intended for engineers who are unfamiliar with Intel's product range and is available free of charge. Details from—Intel Corporation (UK) Ltd., Dorcan House, Eldene Drive, Swindon, Wiltshire SN3 3TU.

Greenweld have produced a new 1980 catalogue. Lots of new lines have been added and to cater for the bulk buyer quantity prices on many lines are included. There are also many reductions in prices.

Included with every catalogue is a bargain list and 60p of discount vouchers.

The new Vero catalogue will be included in the despatch as soon as these are available.

Price of all this? 40p plus 20p postage from—Greenweld, 443 Millbrook Road, Southampton SO1 0HX.

IEETE LAUNCHES TRAINING SCHEME

THE Institution of Electrical and Electronics Technician Engineers (IEETE) has just published comprehensive training requirements for Technicians in electrical and electronic engineering. The scheme follows the pattern adopted for Technician Engineers, published by the Institution in 1977, and is designed to be supplemented by programmes applicable to the different sectors of industry. Organisations conducting training schemes to meet their own specific needs are being encouraged to submit them to the Institution for approval.

The publication of the two IEETE schemes highlights the importance of sound practical training in the qualifying process which, combined with an appropriate academic award, ensures that Technician Engineers and Technicians are equipped to meet the demands of rapidly advancing technology.

Further information and copies of both schemes are available from The Secretary, IEETE, 2 Savoy Hill, London WC2R 0BS. Telephone 01-836 3357.

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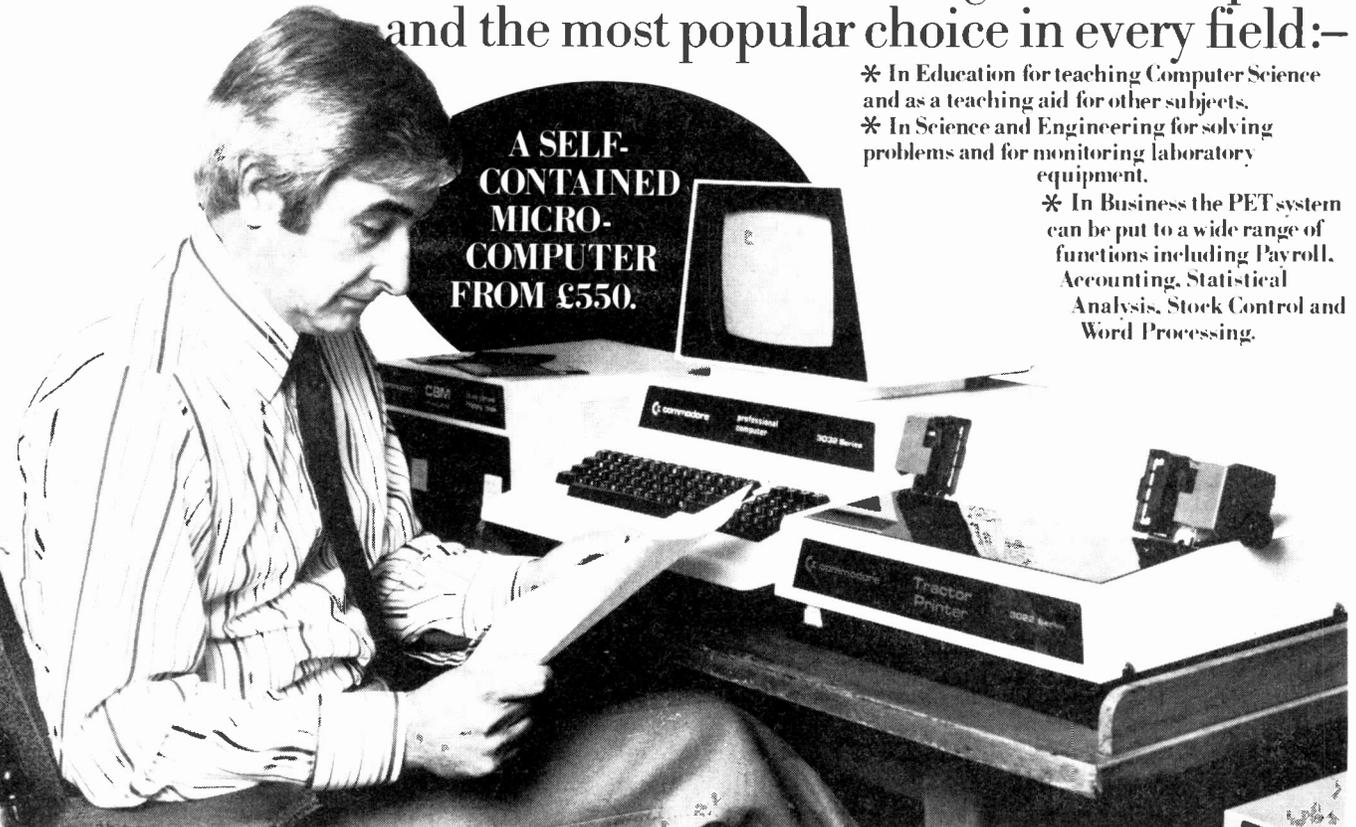
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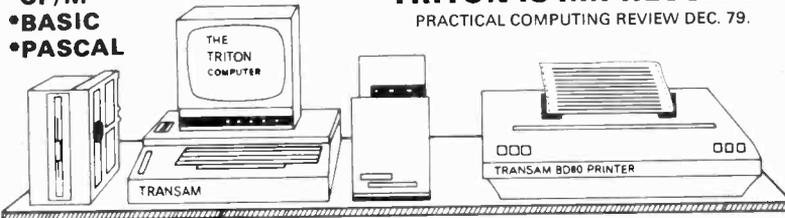
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16DIL 0.42	16DIL 0.17	SCDTCHEX	80IL 1.80
18DIL 0.60	18DIL 0.24	14DIL 1.30	16w ZIF* 4.95
24DIL 0.52	20DIL 0.27	16DIL 1.50	24w ZIF* 6.20
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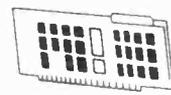


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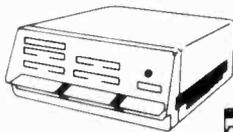


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SN74LS02N	26	SN74LS56N	150	SN74LS145N	120	SN74LS327N	255	8216	2.80
SN74LS03N	26	SN74LS57N	35	SN74LS148N	175	SN74LS322N	125	8224	2.80
SN74LS04N	26	SN74LS574N	40	SN74LS151N	85	SN74LS240N	220	SN74LS353N	150
SN74LS05N	28	SN74LS575N	45	SN74LS153N	80	SN74LS241N	190	SN74LS355N	65
SN74LS08N	20	SN74LS576N	35	SN74LS154N	180	SN74LS242N	190	SN74LS366N	65
SN74LS09N	22	SN74LS578N	35	SN74LS155N	125	SN74LS243N	195	SN74LS367N	85
SN74LS10N	18	SN74LS580N	115	SN74LS156N	125	SN74LS244N	210	SN74LS368N	65
SN74LS11N	26	SN74LS585N	110	SN74LS157N	60	SN74LS245N	380	SN74LS373N	175
SN74LS12N	26	SN74LS586N	40	SN74LS158N	99	SN74LS247N	125	SN74LS374N	170
SN74LS13N	55	SN74LS590N	85	SN74LS160N	115	SN74LS248N	195	SN74LS375N	72
SN74LS14N	89	SN74LS591N	99	SN74LS161N	115	SN74LS249N	130	SN74LS377N	175
SN74LS15N	26	SN74LS592N	90	SN74LS162N	115	SN74LS251N	145	SN74LS378N	132
SN74LS16N	26	SN74LS593N	115	SN74LS163N	90	SN74LS253N	125	SN74LS379N	140
SN74LS20N	22	SN74LS595AN	120	SN74LS164N	150	SN74LS257N	140	SN74LS381N	365
SN74LS21N	26	SN74LS596N	175	SN74LS165N	175	SN74LS258N	95	SN74LS386N	67
SN74LS22N	29	SN74LS597N	39	SN74LS166N	175	SN74LS259N	145	SN74LS390N	198
SN74LS27N	35	SN74LS109N	39	SN74LS168N	195	SN74LS260N	39	SN74LS392N	150
SN74LS28N	35	SN74LS112N	39	SN74LS169N	195	SN74LS261N	350	SN74LS395N	180
SN74LS30N	25	SN74LS113N	44	SN74LS169N	195	SN74LS262N	39	AY52376	1150
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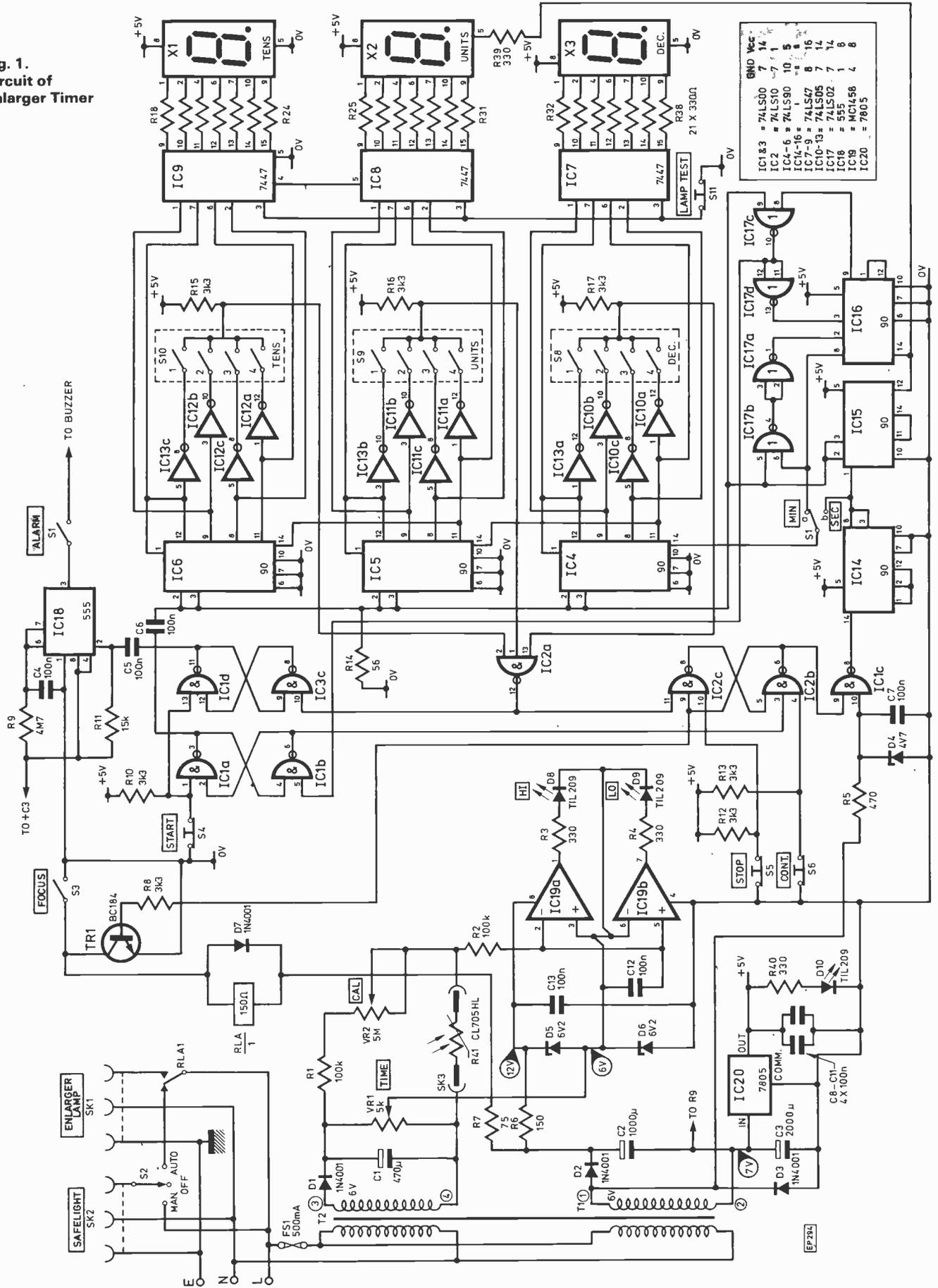
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ENLARGER TIMER

R.J. BESSEN

THE unit to be described has a digital timer that can read up to 99.9 in either 0.1 second or 0.1 minute steps. Its accuracy is mains controlled so it is far in excess of what is needed for darkroom use. The control of enlarger and safelight can be automatic or manual. Also incorporated into the unit is an analyser that will tell how much exposure is necessary for a particular enlarging paper. A lot of time and paper will be saved by using this unit making some of the frustrating hours wasted in the darkroom a thing of the past. The complete circuit of the enlarger is shown in Fig. 1. Here the power supply has a voltage doubling circuit consisting of D2, D3, C2 and C3 which will have approximately 7 volts across it as long as 74LS type i.c.s are used. This voltage will drop to about 6 volts when standard 74 TTL is used due to the heavier current drain causing a problem to occur as the 7805 needs at least 7 volts on its input to have the 5 volts on the output to supply the i.c.s. In this case an 8 volt lamp secondary should be used. At the positive terminal of C2 there is approximately 18 volts which is used to supply the relay and the op amp via R7 and R6. The second independent winding T2 is rectified and filtered by D1 and C1 providing a voltage of around 5-12 volts that is used to supply the bridge network in the analyser. The mains input is squared by D4 and C7 and is of sufficient quality for the clock pulse used in the timer.

Fig. 1.
Circuit of
Enlarger Timer



ANALYSER

The analyser section has a bridge network consisting of VR1 (known as the time dial) forming two arms, the third is R1, which is the reference from which the time dial is calibrated, against the resistance of the cadmium sulphide cell that makes up the fourth arm. VR2 is used to calibrate the unit for various speeds and makes of paper. Across the bridge is the 9 volt supply, which provides the potential and polarity at the output depending upon the resistance of the cell and where the wiper arm of VR1 is set (disregarding VR2 for the moment).

When the wiper of VR1 is at the zero side of the 9 volts the voltage appearing at the wipers (being the output of the bridge) will be out of balance. The negative output goes to the input of the op amps which will have a positive output if the inverting input is more negative than the non inverting input.

It should be noted that the inputs of the two op amps are reverse connected so that when there is a voltage at their inputs their outputs are out of phase i.e. one will have a positive output and the other will have a negative output. Since VR1 wiper of the bridge goes to (-) of IC19b and (+) of IC19a only the former will have a positive on its output causing D9 to be forward biased and illuminating it. This i.e.d. is termed low ('lo'), meaning that VR1 needs to be rotated to a higher dial reading. Moving VR1 wiper towards positive will eventually balance the bridge so that there is no voltage across the inputs of the op amps.

As the wiper arm of VR1 passes through balance the output of the bridge will now be positive with respect to VR2 wiper causing IC19a to have a positive output bringing on D8 ('hi').

TIMER

The timer section can be divided into three areas, clock, control and counter with display. Decade counters make up the clock circuit deriving its timing from the mains frequency. The input is squared by D4 and C7 then passed to IC14 which divides by 5 to give a 0.1 second pulse that goes to S7 and to IC15 which further divides by 10. A 1 second pulse will result that is used to indicate the decimal point on the three digit display, as well as going into IC16 to divide it by 6 to give a 0.1 minute clock pulse. This pulse also goes to S7 which will select whether the display, that can read up to 99.9, will be in minutes or seconds.

Pins 2 and 3 of the 7490 chips are the reset pins and if both of these go high the b.c.d. output will be zero, and will stay that way until one or both inputs go to a low. When these chips are used as straight decade dividers resetting them is easy, however, as pins 2 and 3 of IC16 are used to reset automatically when the count reaches 6 it becomes slightly more complex to reset it to zero on demand. IC17 wired as two OR gates solves the problem.

Under operating conditions pins 5 and 9 of IC17 have a low on them that has no effect, allowing the outputs 8 and 9 of IC16 to pass through the NOR gates to 2 and 3 of IC16. When the reset pulse comes along the high that is now on pins 5 and 9 of IC17 will pass onto 2 and 3 of IC16 regardless of what is on 6 and 8 of IC17. If this resetting wasn't done, clock errors could occur in the minute timing because at the first clock pulse there could be a number stored in IC16 which may only need another pulse on its input to give an output pulse. In other words 0.1 minute will be on the display yet only 1 second has passed.

The control circuitry consists of IC1 and IC2 and three thumbwheel switches, S8, 9 and 10. When S4 is pushed the debounce circuit IC1a and IC1b does two things, the low going pulse at pin 6 sets a second bistable IC2c and IC2b to

put a high on pin 9 of IC1c to enable the 50Hz on pin 10 to get through, as well as turning TR1 on that energises the relay to bring on the enlarger. A second function of the high going pulse at IC1a, pin 3 is to reset all the 7490s, and since R14 ties the reset line to a low, and C6 stops the high on pin 3 of IC1a from having any further effect on them, they will commence to count at the same time the enlarger comes on. After 2 seconds a low appears on pin 5 of IC1b that comes from pin 10 of IC17 and is used to reset the debounce circuit for further timing.

A problem occurs with this arrangement in that timing cannot be achieved below 2 seconds, because until this circuit is reset a low appears on pin 3 of IC2b. This stops IC2b/2c from being reset by the low going pulse that will come from pin 12 of IC2a when the time set by the thumbwheel switches is achieved, however it is extremely unlikely that the enlarger will be on for less than 2 seconds. One advantage of using this pulse to reset the debounce circuit is that a SPDT push button is not necessary.

Two other push buttons are used in the control circuitry and they are S5 and S6. S5 will stop the count by resetting IC2b/2c putting a low on IC1c inhibiting the 50 Hz and turning the enlarger off with the display not affected by this action. To continue the timing, S6 is pushed setting IC2b/2c, allowing the 50Hz to pass once more. These switches allow the exposure to be stopped and then commenced again without losing track of the time.

COUNTER AND DISPLAY

The counter and display section is made up of a very common circuit in three decade counters ICs 4, 5 and 6 with seven segment displays driven by ICs 7, 8 and 9. Connected to the b.c.d. outputs of IC4, 5 and 6 are hex inverters, connected to form buffers between the decade counters and thumbwheel switches S8, 9 and 10. The buffers are necessary because whatever number is selected it is connected to the common, e.g. if 5 is selected 1 and 4 are commoned, consequently without the buffers pins 8 and 12 of the 7490 would also be connected giving a false display.

When the time that is selected by the thumbwheel switches is reached the b.c.d. output from the 7490s will match the b.c.d. of the switches which now will have a high on all commons. These highs go to IC2a putting a low on its output pin 12 which resets IC2b/2c stopping the count and turning the enlarger off. The elapsed time will be on the display and will stay there until the start button is pushed.

ALARM

The remaining circuitry consisting of a 555 chip IC18 and a bistable IC1d and IC3c is used to turn on an alarm via S1. As mentioned when the timer reached its count a low appeared on pin 12 of IC2a. Besides being responsible for stopping the count it is also used to reset IC1d and IC3c. When this happens the low going pulse at pin 11 of IC1d is differentiated by C5/R11 which triggers IC18, that is wired up as a monostable, to give a high out of pin 3 to energise a small solid state buzzer.

The time the buzzer will be on depends upon the RC network R9/C4 which will be about 1 second with the components in circuit.

The purpose of the bistable is to stop the 555 from triggering every time the thumbwheel switches are moved. By its action no more trigger pulses can appear until it is set again by pushing the start button S4.

Leading zero blanking can be wired into the circuit if desired as well as lamp test.

The switch S2 associated with the safelight is wired so that in the auto position RLA1 will control when the safelight

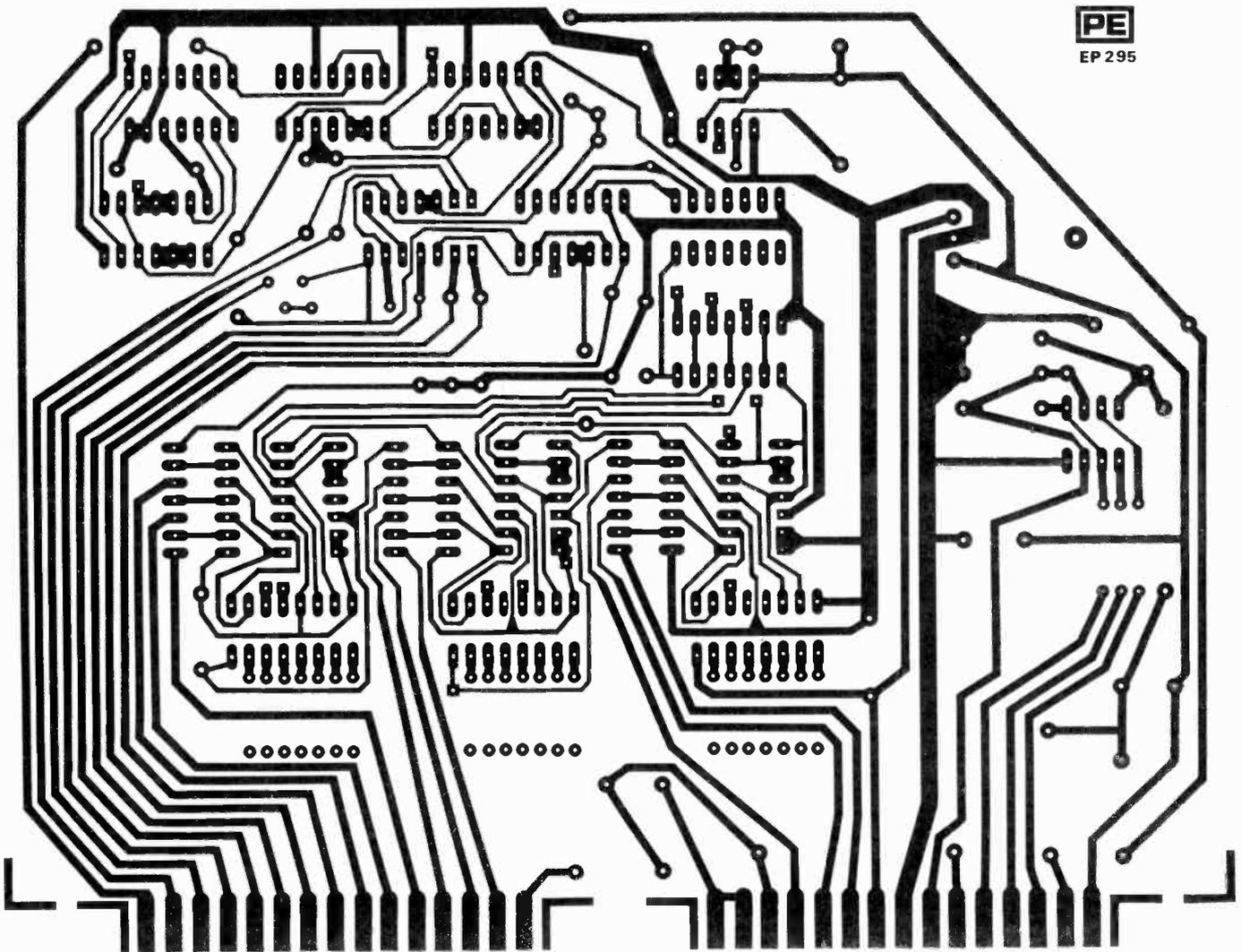


Fig. 2. Underside of printed circuit board

is on, i.e. with the enlarger on the safelight is off and vice versa. In the manual position the safelight is on all the time. This allows working with black and white papers (cutting, developing) while the timer is being used for the developing of films. It saves unplugging the safelight and putting it in a wall plug.

The timer is very useful in controlling motorised agitators when developing films or colour paper and this is what was in mind when the buzzer circuit was put in as it allows other work to be carried out, without having to constantly worry about the time.

S1 keeps the alarm from sounding which can be annoying when exposing paper. For colour work the safelight switch is put in the off position.

CONSTRUCTION

It is recommended that the double sided p.c. board shown be used due to the number of i.c.s in the circuit. The cost of the board is a small price to pay for the ease in constructing the circuit. If using the board begin at the bottom section of the board by inserting and soldering pieces of wire at the pads that have a dot next to them as these are used to connect both sides of the board together. Under two of the

7447 chips there are pads that have two dots and these will also have to have the wire "pins" if leading zero blanking is required. There should be 14 joins plus the two for blanking.

The i.c. sockets can now be inserted if they are to be used otherwise solder the chips direct to the board making sure they are correctly orientated by taking note that on the top of the board pin 1 is marked for all chips as is the last two digits for all the TTL i.c.s. After making sure all the pins on the chips are soldered insert the diodes and resistors and solder them on the bottom side of the board. Turn the board over and you will notice that some of the components go through pads which have to be soldered to the component leads as they are also used to complete the circuit from top to bottom, as do some of the capacitors that can now be inserted.

Finally the regulator chip can be mounted by carefully bending the leads so that the hole through the metal tag will line up with the one in the board having the copper area that is the heat sink. This now completes the main board.

The display board is fairly straightforward as it only has the three displays and R40 which is used to limit the current to D10 which is the indicator for the calibration dial. A 40 pin 0.6in socket can be used if desired.

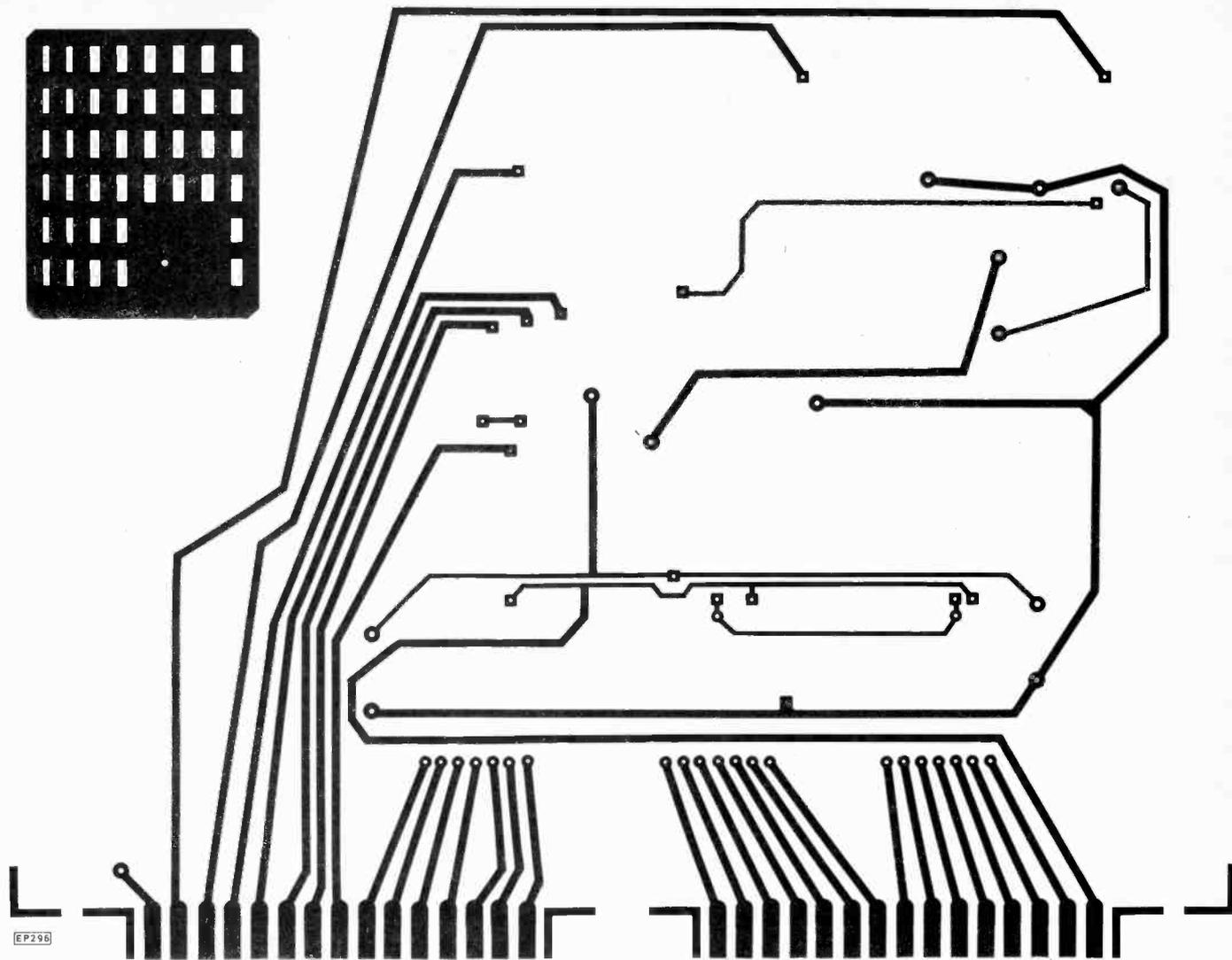


Fig. 3. Topside of printed circuit board

Mounting and wiring the mains voltage components should now commence paying attention to the safelight switch and making sure the lamp sockets bypass the fuse. A power switch can be mounted on the back of the panel if desired. Once all the chassis mounting components are in place (all but the main board) the wiring of the board to the chassis can go ahead. The board should ideally be mounted in edge connectors that are mounted on the front panel.

Ribbon cable is a definite advantage especially for the displays and b.c.d. switches, heavier gauge wire will be necessary for the 6 volts from the transformers. After checking the wiring you are in a position to turn the unit on.

TESTING

Place the alarm switch on, sec/min switch to sec., focus to off, safelight to auto and the three thumbwheel switches on 111. When power is applied the buzzer will sound and a random number will appear on the display that will read 0 when the start button is pushed. The display should now be counting at a 0.1 second rate and will continue so until either the stop button is pushed or the count reaches 111. If the stop button was pushed, the continuous button once pushed will allow the count to continue until 111 is reached. Failure for this to happen or if the count stops at some other

number then the odds are the thumbwheel switches are wired up incorrectly.

While the unit is counting the decimal point in the units display will be flashing at a second rate and anything plugged into the enlarger socket will be on. This will go off at the end of the count and whatever is plugged into the safelight socket will come on. Flicking the focus switch to on will switch the enlarger on and turn off the safelight that can be turned back on by placing the safelight switch to manual. The only time the buzzer should sound (other than when the unit is first turned on) is when the display reaches whatever is set by the thumbwheel switches.

DIALS

The two dials are made of 3in diameter perspex and are shown full size in Fig. 5. Calibration batons and numerals can be used from Letraset. Accuracy of the time dial depends upon the quality (tolerance) of the 5k lin potentiometer and if in doubt it will be necessary to calibrate your own dial using 1 or 2 per cent resistors.

Four 100k and four 10k in parallel and series combinations will give all the times necessary.

For the CL705HL cell the following values with times, will

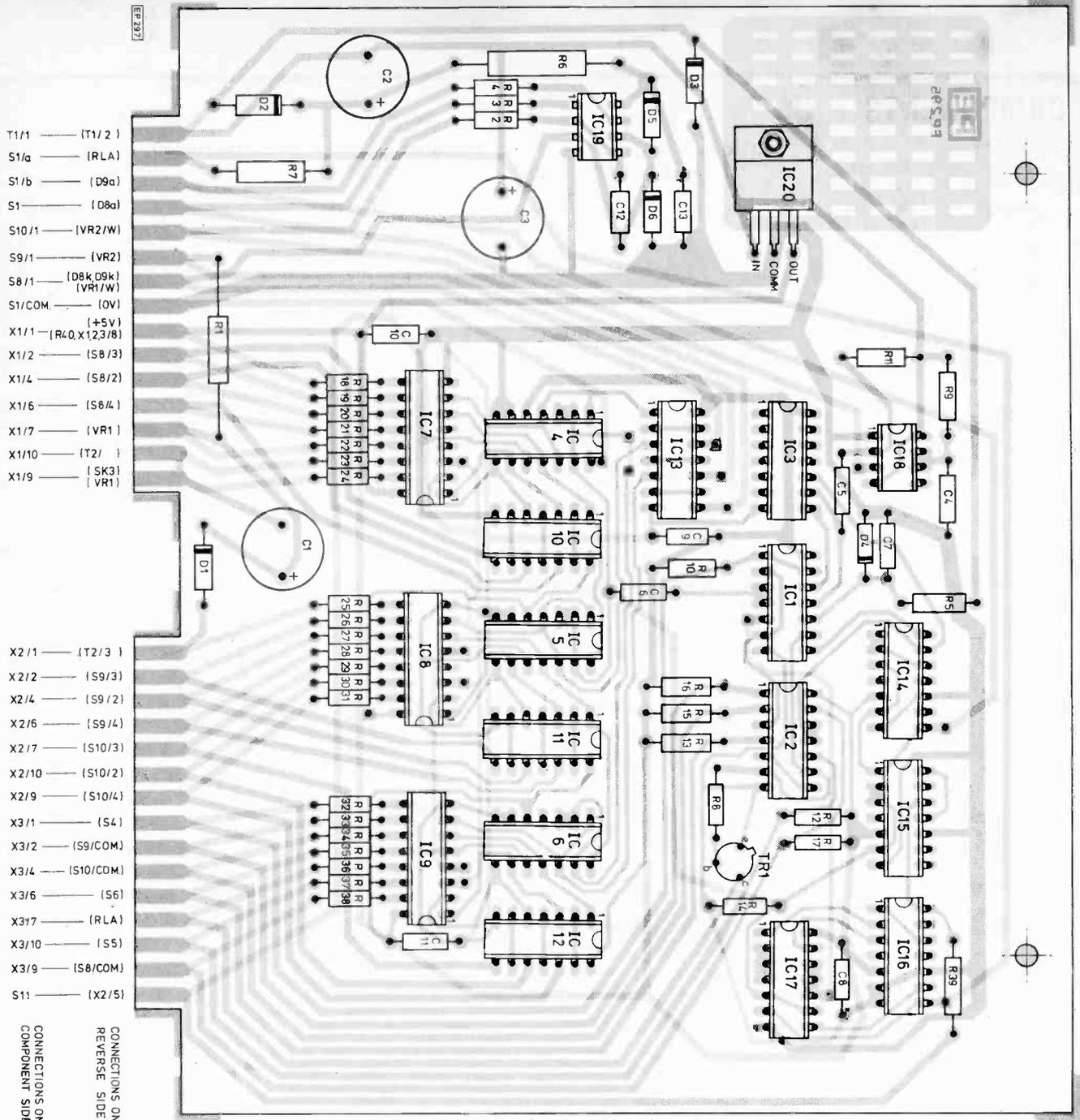


Fig. 4. Component overlay for the printed circuit board

be needed, 10k for 1 sec, 20k for 2 secs, 100k for 10 secs, 150k for 15 secs etc. These resistors take the place of the cell during calibration with the calibration dial at 0.

To zero calibrate short out VR2 with a piece of wire. The hole in the centre of the dials need to be enlarged to just over $\frac{3}{16}$ in so that it clears the potentiometer mounting screw. Ideally, D8 and D9 should be a dual colour type i.e.d. that is situated under the time dial both to partially illuminate the dial and act as a marker. D10 is a single red type used to illuminate the cap dial.

The advantage of the dual type is that it will always be on so at, or near, balance the dial reading can easily be seen.

COMPLETION

In the prototype the fascia panel was made up of thin gauge aluminium as it is not loaded. Two bends are introduced to produce a sloping front and the whole drilled to suit components purchased.

USING THE ANALYSER

There are two basic methods of taking readings, one is the integrated (average) that uses a diffusion screen under the lens to give an average light to the cell and is the method that I use on most occasions. If the negatives are not average then the spot method may have to be used. Separate calibrations are necessary for both methods.

INTEGRATED METHOD

Make a test print using an "average" negative. Select what you consider to be the best exposure as the analyser accuracy for all future exposures depends upon this step. Say 10 seconds gave the best print. Leaving the enlarger exactly as it was for the test print put the cell on the masking frame.

The diffusion screen is placed under the lens making a note where you put it as it needs to be in the same position for future prints. A good idea is to make a holder similar to the one used to hold the red filter that is on most enlargers.

COMPONENTS . . .

Resistors

R1	100k 1%
R2	100k
R3, R4	330 (2 off)
R5	470
R6	150 2W
R7	75 1W
R8	3k3
R9	4M7
R10	3k3
R11	15k
R12, R13	3k3
R14	56
R15-R17	3k3 (3 off)
R18-R40	330 (23 off)
All 5% 1/4W carbon film	

Capacitors

C1	470µ 16V elect
C2	1000µ 16V elect
C3	2000µ 16V elect
C4-C12	100n (9 off)

Diodes

D1-D3	1N4001 (3 off)
D4	BZY88C-4.7
D5-D6	BZY88-6.2 (2 off)
D7	1N4001
D8-D10	TIL209 (3 off)
(D8-D9) preferably MV5491,	
XC5491 two colour l.e.d.)	

Integrated Circuits

IC1	74LS00
IC2	74LS10
IC3	74LS00
IC4-IC6	74LS90
IC7-IC9	74LS47
IC10-IC13	74LS05
IC14-IC16	74LS90
IC17	74LS02
IC18	555
IC19	MC 1458
IC20	7805

Transistor

TR1	BC184
-----	-------

Switches

S1	Single pole on/off
S2	Single pole three way
S3	Single pole on/off
S4	Press to break
S5	Press to break
S6	Press to break
S7	Single pole change over
S8-S10	BCD thumbwheel (3 off)

Displays

X1-X3	FND507 (3 off)
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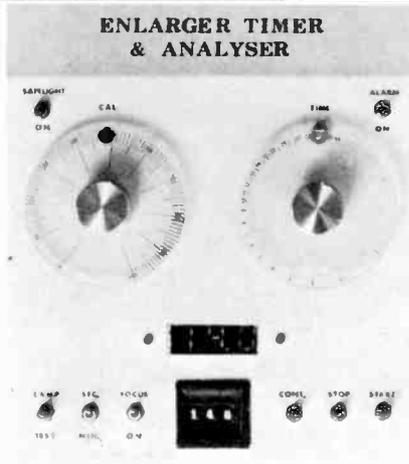
Miscellaneous

Miniature buzzer 6-9V, 15mA, T1-Mains transformer with independent 6V, 0.5A independent secondaries (R.S. 207-194)

Photocell

R41-CL705HL (Clairex)
Ace Mailtronix, Tootal St.,
Wakefield, West Yorkshire

Control fascia of timer. The enlarger, safelight and probe sockets are arranged at the back. 'Hi' and 'Lo' l.e.d.s appear at either side of the display

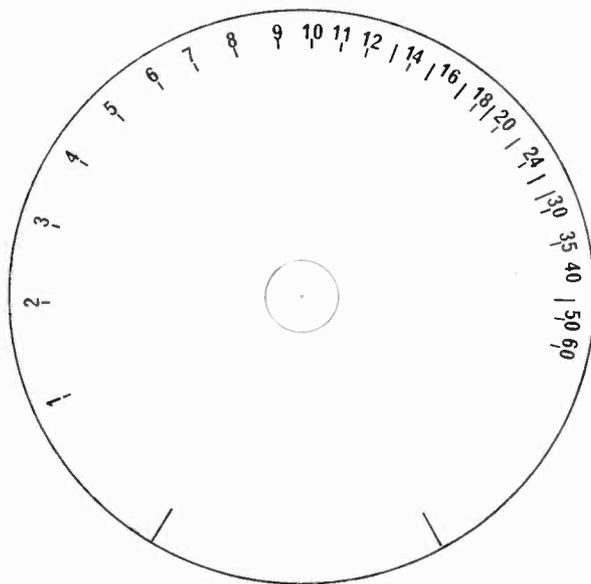


Now with the time dial on 10 seconds and with the safelight switch in auto (as the cell is sensitive to all colours) adjust the calibration dial until the l.e.d.s are both on and make a note of the reading on the calibration dial. Whenever that brand and grade of paper is used, just set the calibration dial to it. If you use several types of paper make a calibration for all of them.

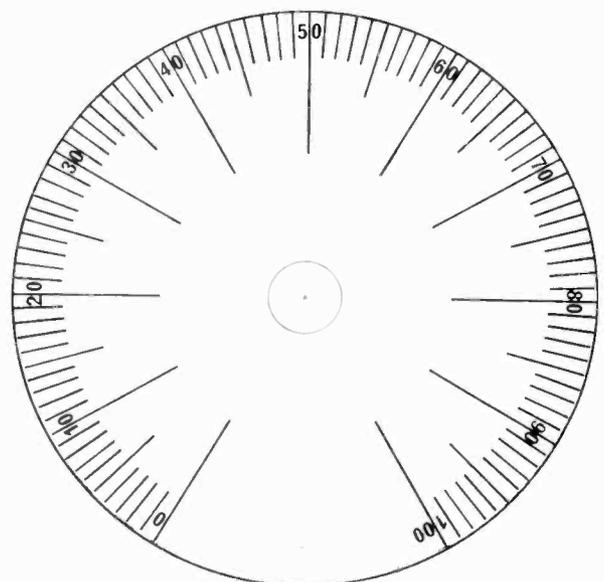
SPOT METHOD

The only difference between this method and the integrated one is the diffusion screen isn't used and the cell looks at a shadow (brightest portion).

A diffusion screen can be made from a piece of perspex that has been rubbed with a piece of fine emery paper. Another suitable material is draughtmen's tracing film or they are available from photographic shops. ★



TIME



CAL

Fig. 5. Full size details of dials

CAR RADIO



A 5 PUSH BUTTON SET WITH A 6W OUTPUT

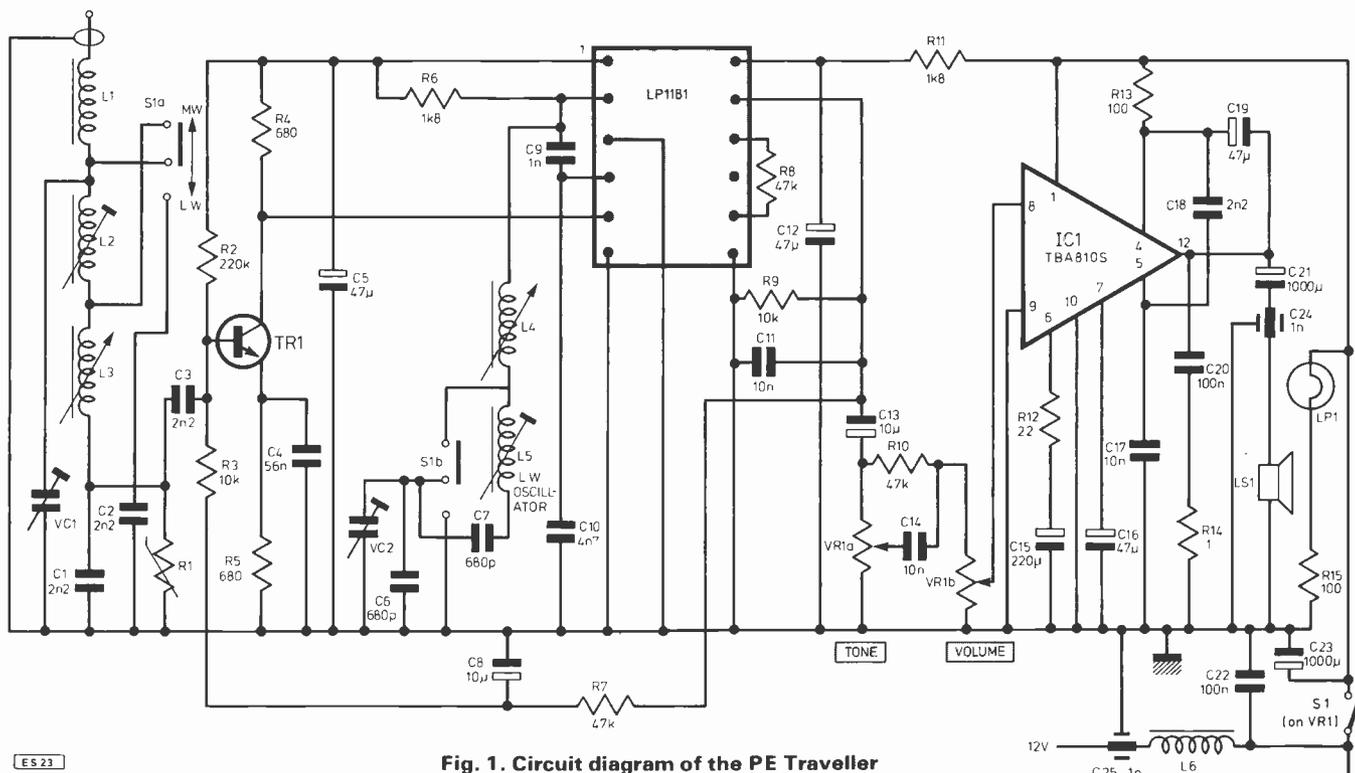
THE PE Traveller car radio has been designed around a pre-aligned tuner unit, ceramic filter and 6 watt audio amplifier i.c. The result of this design is a receiver which is straightforward in both construction and alignment. The Traveller, which costs approximately half the price of an equivalent commercial car radio and is available in complete kit form from RTVC, achieves an excellent performance, with one long wave and four medium wave push buttons and includes tone control.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Traveller is shown in Fig. 1. The aerial signal which is fed to the aerial tuning circuit via the r.f. choke L1 is impedance matched to the wide band amplifier designed around TR1. The input to this amplifier is protected against static discharge by the voltage dependent resistor (R1).

The output of the wide band amplifier (TR1 collector) is fed to the input of mixer/oscillator circuit. The resistor R8 sets the internal a.g.c. range of the pre-aligned i.f. module and a second a.g.c. line is fed to the input of the wide band amplifier via resistor R7. The value of this resistor can be altered to adjust the sensitivity of the receiver or a 100k preset resistor can be used. Any adjustment of the sensitivity will of course be a compromise between sensitivity, signal handling, interference etc. The maximum signal capacity of the set can be achieved by ensuring TR1 is ultimately reverse biased by the a.g.c. circuit. However, one problem encountered when using an amplifier in front of a self oscillating mixer is r.f. blocking.





ES 23

Fig. 1. Circuit diagram of the PE Traveller

When a receiver is rapidly tuned to a strong carrier (by push buttons) a very large signal can appear at the mixer input before the a.g.c. has time to operate. The oscillator may be prevented from operating and the receiver will be blocked. This can be avoided by keeping the r.f. amplification much lower than could otherwise be achieved.

The i.f. signal output of the LP1181 module is decoupled by C8 and fed to the input of the audio amplifier (IC1) via the tone and volume controls. The TBA 810S is a 12 lead quad in-line i.c. which will provide a 6W output at 14.4V with a maximum current of 2.5A. The audio i.c. which has a thermal limiting circuit can withstand a short circuit on the load with supply voltages up to 15V.

CONSTRUCTION

The printed circuit board design of the Traveller is shown in Fig. 2 with the component layout in Fig. 3. The smallest components should be fitted first and care should be taken when soldering IC1 and TR1 that excess heat is not applied to them. When fitting the r.f.-i.f. amplifier module ensure the orientation is correct by using the position of the three holes shown in Fig. 3. After the p.c.b. has been assembled, cut all

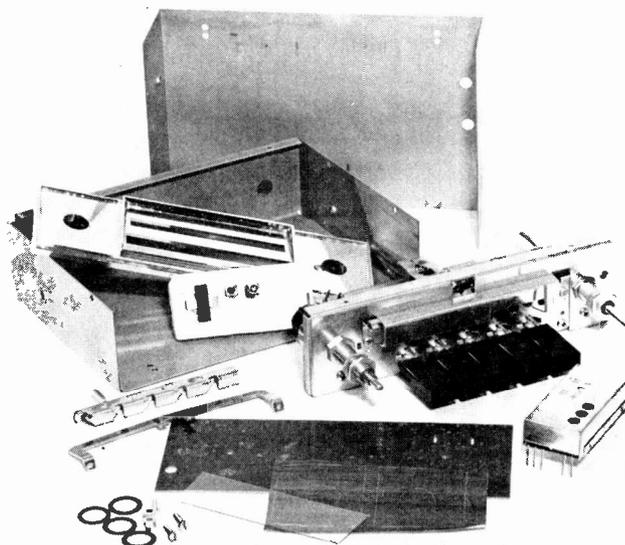
the excess leads from the components including the pins above the wave change switch S1. Carefully check the orientation of the electrolytic capacitors and the transistor TR1. Also check that there are no solder splashes shorting out the p.c.b. tracks.

A small modification should be carried out to the tuner unit before the p.c.b. is fitted. The switch bar at the back of the tuner should be removed and the modified switch bar and p.c.b. mounting bracket fitted in its place. Take care not to disturb the slide biasing spring fitted underneath the switch bar. A self tapping screw should be used to "tap" the two holes on the mounting bracket.

The tone, volume and on/off switch S2 should be fitted to the tuner unit and the capacitor C14, resistor R10 and wire links soldered as shown in Fig. 4. The p.c.b. can now be mounted onto the tuner unit using two self tapping screws

SPECIFICATION

Frequency range	m.w. 540kHz - 1620kHz l.w. 150kHz - 260kHz
Intermediate frequency	470kHz
Sensitivity	Typically 2µV @ 1MHz
Power output	6 watts r.m.s.
Speaker impedance	4 to 15 ohms (max power into 4 ohms)
Polarity	Negative earth only



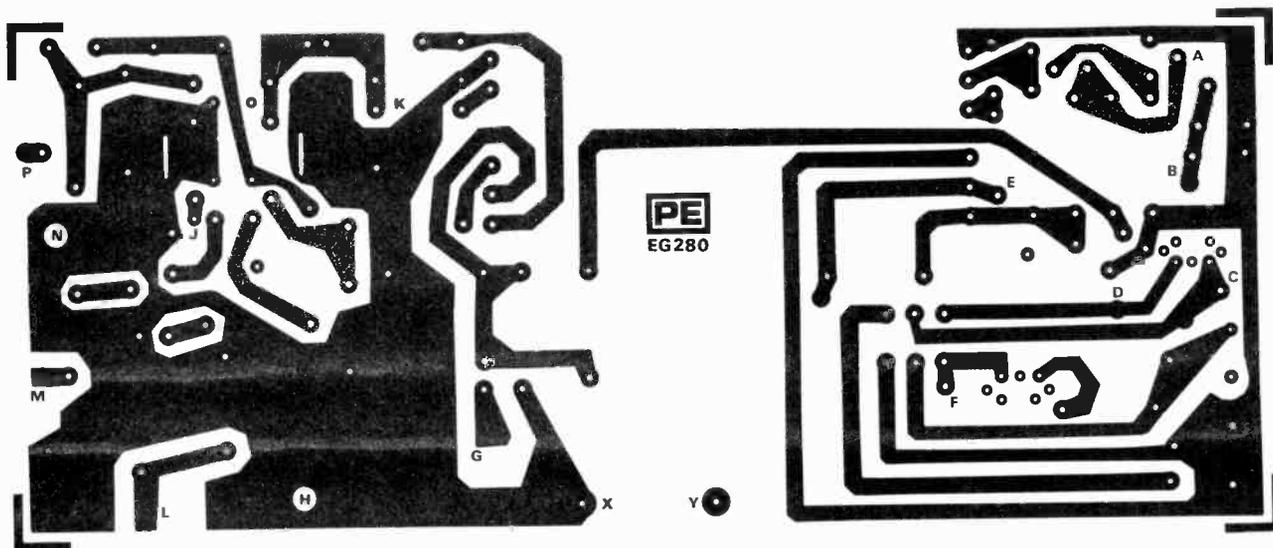


Fig. 2. Printed circuit board design

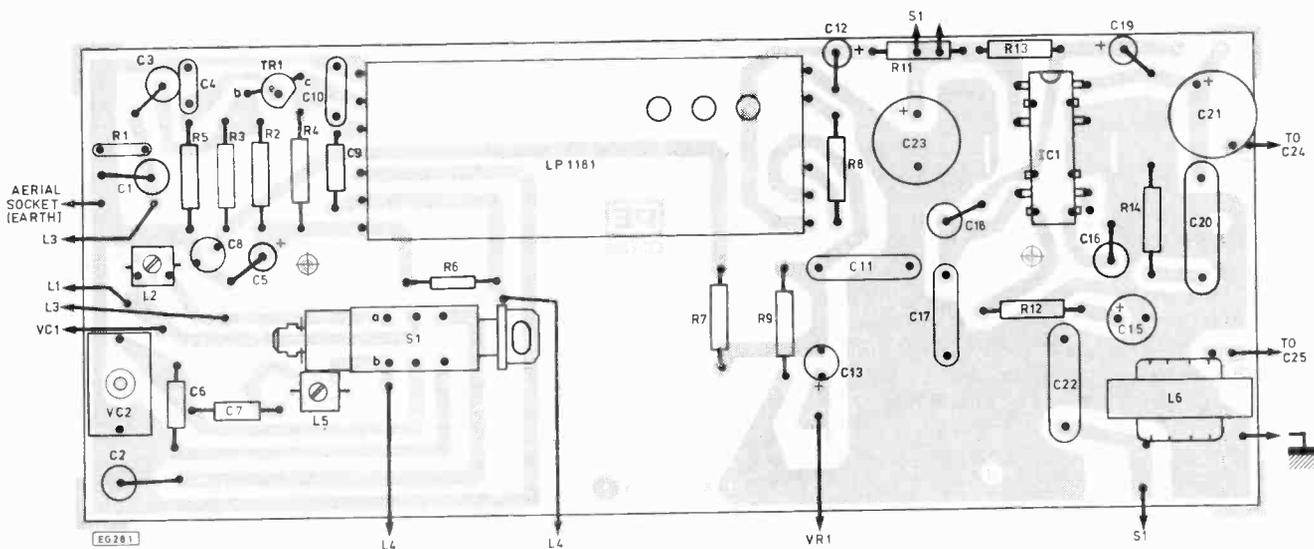
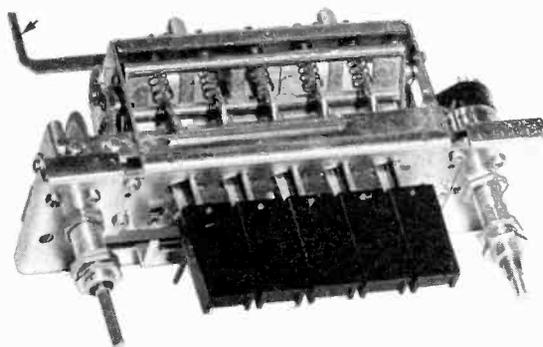
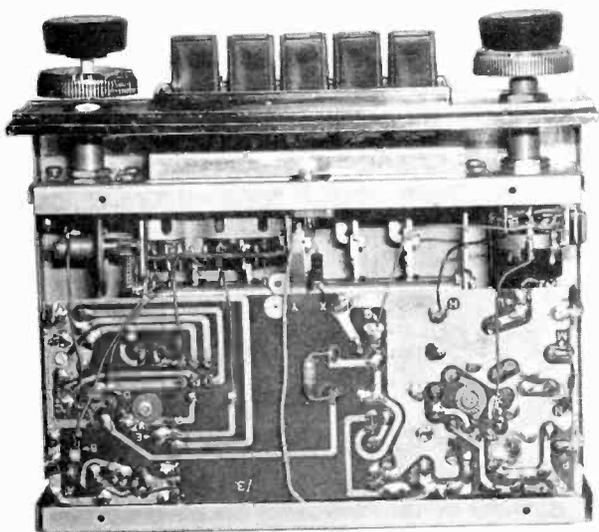


Fig. 3. Component layout



The switch bar (shown arrowed) should be removed and the modified unit screwed on to the tuner in its place. Check the operation of the push-buttons before the printed circuit board is fitted into position.

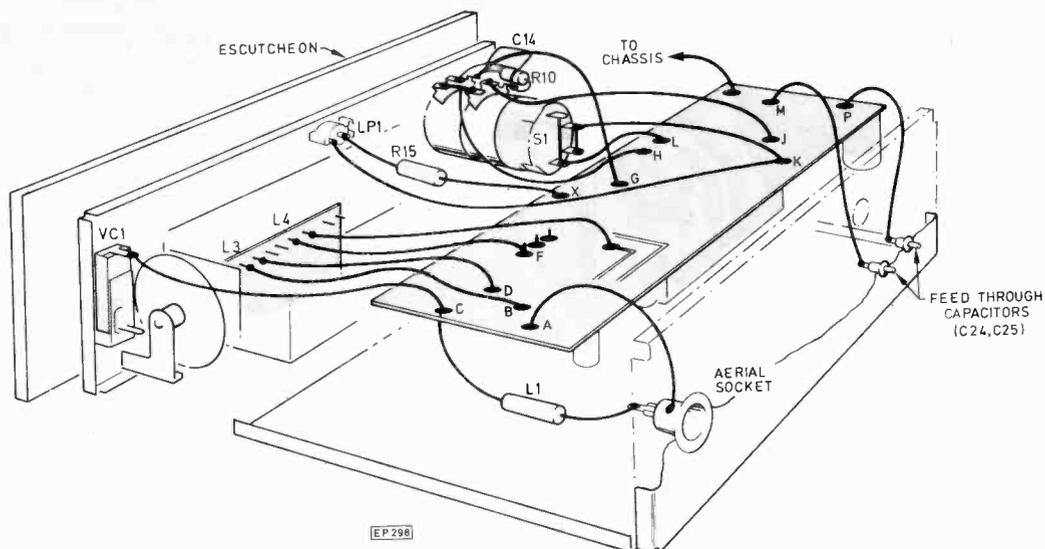


Fig. 4. Complete wiring diagram for the Traveller

COMPONENTS ...

Resistors

R1	VDR 6V
R2	220k
R3, R9	10k (2 off)
R4, R5	680 (2 off)
R6, R11	1k8 (2 off)
R7, R8, R10	47k (3 off)
R12	22
R13, R15	100 (2 off)
R14	1

All resistors $\frac{1}{2}$ W 10% carbon

Potentiometers

VR1	Dual concentric log with on/off switch (approx. 20k)
-----	------------------------------------------------------

Capacitors

C1, C2, C3, C18	2n2 (4 off)
C4	56n
C5, C12, C16, C19	47 μ (4 off)
C6, C7	680p (2 off)
C8, C13	10 μ (2 off)
C9	1n
C10	4n7
C11, C14, C17	10n (3 off)
C15	220 μ
C20, C22	100n (2 off)
C21, C23	1000 μ (2 off)
C24, C25 (feed through capacitors)	1n (2 off)
VC1	Attached to tuner approx. 80p max
VC2	140p max

Semiconductors

TR1	BF394 or BF195
IC1	TBA 810S

Miscellaneous

LP1181 r.f. - i.f. module. Tuner unit. P.c.b. Control knobs. Aerial socket
L1 r.f. choke, L2, L5 l.w. coils L3, L4 attached to tuner, L6 supply choke.

Constructor's Note

A complete kit of parts for the Traveller is available from **Radio & TV Components (Acton) Ltd., 21 High Street, Acton, London W3 6NG**. The price is £10.50 plus £1.75 p.&p. (pack 7).

with insulated washers. Before tightening the screws ensure the switch bar lug is located into the arm of S1. The operation of the wave change switch (S1) should then be checked by pressing the two push buttons nearest the tuning control. The movement should be the same in both directions. If necessary release the screws and adjust the position of the p.c.b. until the switch movement is correct.

The indicator lamp LP1 should be fitted next and the p.c.b. should be wired to the tuner unit (Fig. 4). The back panel of the radio should be drilled to accept the battery and speaker feed-through capacitors (C24, C25) (Fig. 4). Before soldering the battery and speaker capacitors clean the panel and terminals with emery cloth. The connections to the back panel should be made before the panel is fitted into position. The earth braid should be fitted to the case using a 6BA screw and nut.

TESTING AND ALIGNMENT

Oscillation may be prevented on longwave if the oscillator coil's inductance (L5) is too far out from its correctly aligned position. To overcome this problem unscrew the core of the coil (anticlockwise) so that the plastic top of the core is approximately 2 mm above the can. If the problem still occurs the value of R3 should be reduced.

For simplicity, "bench alignment" is recommended. The speaker, 12V supply and aerial (if an r.f. signal generator is not available) should be connected, then the set switched on and tuned to the medium wave. The scale (attached to the escutcheon) should be held in front of the radio and the set manually tuned to 250 metres. Adjust the trimmer (VC2) on the p.c.b. to receive radio 3 (247 metres). Switch to the longwave, tune to 1500 metres and adjust the l.w. oscillator coil (L5), with a non-metallic tuning tool, to receive Radio 4. Adjust the l.w. aerial coil (L2) for maximum output.

If an r.f. generator is available tune the set to the extreme h.f. end on m.w. and adjust the trimmer (VC2) on the p.c.b. to receive 1620kHz modulated signal. On l.w. tune to the extreme l.f. end and adjust the l.w. oscillator coil (L5) to receive a 150kHz modulated signal. Then set the generator to 200kHz and tune the set to receive this signal (1500 metres) and adjust the l.w. aerial coil (L2) for maximum output.

After the set has been correctly aligned fit the back and top panels into position using self tapping screws.

NEXT MONTH: Installation and suppression.

SPECIAL SUPPLEMENT



P.A. Loudspeaker Systems

Ben J. DUNCAN

Over the past years PE has published a number of designs for various guitar effects units and other pieces of equipment for the pop group. People working in this area are often familiar with the vast range of equipment available but not always knowledgeable on the correct methods of setting up and operating such equipment. Nowhere is this lack of knowledge more evident and potentially more audibly noticeable than in the use of PA loudspeaker systems. This supplement sets out to describe methods of achieving good sound at high listening levels, the type of equipment available and how to use it.

Since many of the enclosures available are still made to imperial rather than metric measurements and specifications are based on imperial units, for the sake of this supplement we have also employed them,

ROCK BANDS require high power sound systems, colloquially known as "PA" systems to attain the levels they require in auditoriums. The greatest difficulties and inadequacies in any audio system remain in the area of loudspeakers and acoustics and no-where are these inadequacies more manifest than in high power live sound amplification systems. Such systems require special techniques

far removed from domestic sound systems if high sound quality is to be achieved.

Whilst the atmosphere and excitement of a live performance often compensate for poor sound quality, audiences are becoming more critical, largely because their familiarity with high fidelity sound reproduction in the home leads them to expect the same standards elsewhere. That audiences

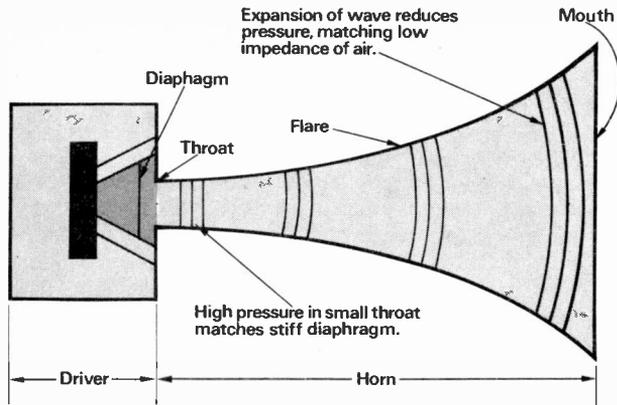


Fig. 1. Showing the various parts and operation of the horn

accept poor sound quality" is a common view, but this statement needs careful qualification. Running a sound system into severe overload on peaks is often acceptable, but indistinct vocals are not. The concept of live sound quality embraces far more than the main criterion of domestic sound quality—harmonic distortion. The vagaries of hall acoustics, phase interactions in multiple speaker arrays and the frequent need to push sound systems to their limits are other criteria which are unique and crucial to the sound quality of a live performance.

SOUND LEVELS

Discotheque levels lie between 105dB and 115dB, yet a lone soprano can exceed 104dBA, a symphony orchestra can notch up 115dBA, jazz bands have been measured at 125dBA and a lone rock drum kit at one metre can hit 130dB. Audience noise in excess of 120dBA has also been measured. These figures put typical rock concert levels of between 110 and 125dB into sharp perspective, especially when it is borne in mind that many musical instruments are capable of exceeding the threshold of pain (125dB) on their own.

HORN LOADED LOUDSPEAKERS

Most PA systems spend their life on the road, and apart from the need for exceptional physical robustness, size and weight must be sensibly limited if life on the road is to be tolerable. The heaviest and bulkiest items in a PA rig are the loudspeakers; clearly, the fewer needed the better. Thus very efficient loudspeakers are sought. It is pertinent to bear in mind that direct radiator (infinite baffle) loudspeakers are, at best, 2 per cent efficient.

If high sound quality is required, then this can only be achieved in exchange for even lower efficiency, as exemplified by domestic high fidelity loudspeakers, which are frequently less than 0.5 per cent efficient. Vented (bass reflex) enclosures offer somewhat higher efficiency, typically around 2–8 per cent, but only at low frequencies.

Prior to the birth of heavy metal rock and giant outdoor festivals, it was rarely considered necessary to amplify a whole band, and column loudspeakers were adequate for vocal amplification. Then, about a decade ago, the quintessential rock band Iron Butterfly used a 30 year old RCA loudspeaker design on stage at the Albert Hall, and a power revolution had begun.

Iron Butterfly had discovered the RCA "W-Bin", a horn-loaded loudspeaker designed for cinemas. Horn loading provides the most efficient loudspeaker action; horn loudspeakers are typically 25–50 per cent efficient. Moreover, the best horns provide arguably the most realistic

sound reproduction available. There is no doubt that for high power sound reproduction, horn loudspeakers are superior to all others on the basis of sound pressure level (SPL) per £, size, weight, sound quality and control of dispersion.

Inevitably, horn loudspeakers are the mainstay of live sound systems. Thus a knowledge of horn characteristics is essential if high power sound systems are to be competently engineered.

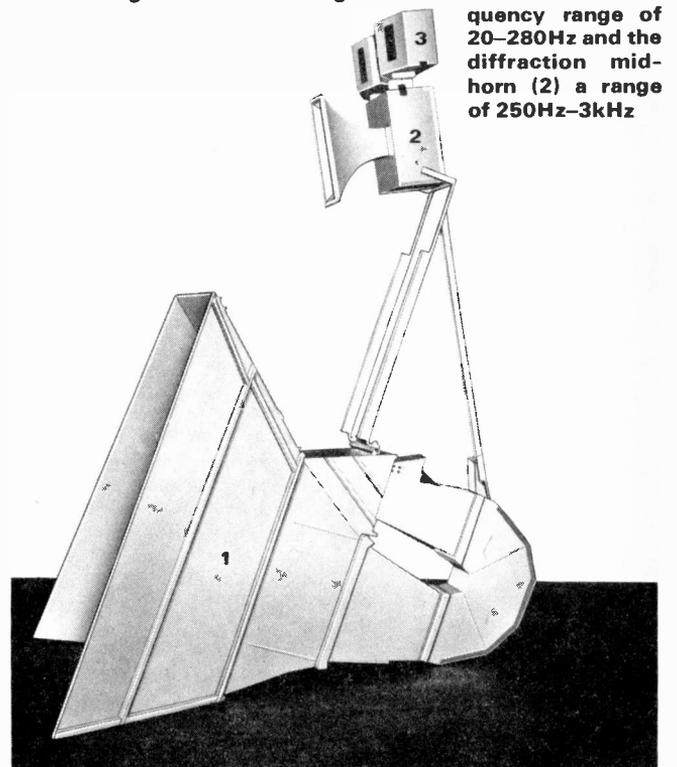
THE HORN

The horn is an acoustic transformer, matching the elasticity of air (a low impedance) with the stiffness (high impedance) of a loudspeaker diaphragm, by a graduated change in air pressure (Fig. 1). This transformer action is the secret of the horn's high efficiency. If a horn is asked to reproduce sufficiently long wavelengths, then adequate air pressure cannot be achieved at the throat. The horn then reverts to direct radiation, and its output falls sharply. The horn is thus a high pass filter, and cannot be used below this critical point, known as the *cutoff frequency*.

The area of the throat and the mouth, the flare curve, the cutoff frequency, and the length of a horn are closely related by physical equations. This relationship of five variables leads horns to have very definite and critical dimensions, unlike other loudspeakers.

Whenever a diaphragm moves, it causes distortion, particularly intermodulation distortion. This is perceived as "muddiness" and is very objectionable at high levels. A direct radiator diaphragm must move large distances to produce high SPL's, especially at low frequencies. Large diaphragm movements produce correspondingly large amounts of intermodulation distortion. The movement of a horn loaded diaphragm is typically 10 to 500 times less for the same sound output, thus horns can be driven harder without incurring excessive levels of intermodulation products.

The author's horn stack. The mouth of the horn is 6ft high and the wide dispersion piezo-electric treble horns (3) are 10ft from ground level. The giant bass horn (1) has a frequency range of 20–280Hz and the diffraction mid-horn (2) a range of 250Hz–3kHz



In exchange for greatly reduced levels of intermodulation distortion, horns produce low order harmonic distortion. This is a consequence of the high air pressure at the throat, which causes *air overload distortion*. The magnitude of this distortion is governed by the flare curve, the power input and the horn's operating bandwidth. The flare curve is usually exponential or tractrix (involute catenary) for high power sound systems, these curves being a compromise between efficiency and air overload distortion.

Limiting the operating bandwidth of any loudspeaker reduces intermodulation distortion, but bandwidth limitation in horn loudspeaker systems is especially useful, since it also minimises air overload distortion. Crossover networks, to achieve these limitations, are considered later.

Air overload distortion is predominantly 2nd harmonic, and is thus palatable to the ear. Thus horn loading exchanges low efficiency and high levels of *dissonant* intermodulation distortion (IMD) for high efficiency, critical dimensions and low order, and hence innocuous, harmonic distortion.

HORNS IN PRACTICE

Horn dimensions are closely related to the wavelengths of the sound they handle, thus bass horns (affectionately known as *bass bins*) are inherently large. Ideally, for smooth frequency response, the perimeter of a horn's mouth should be four times greater than the lowest wavelength to be reproduced. Thus for a cutoff frequency of 20Hz, a mouth of 40,000ft² is indicated! Clearly some compromises must be accepted in practice. This figure assumes loading into free space.

Each time the solid angle of radiation is halved, the mouth area can be halved. Likewise, if a higher cutoff frequency and a less than perfectly regular response is accepted, the mouth area can be greatly reduced. For example, a typical PA horn which is *wall loaded* (against a wall and on the floor, and thus radiating into a solid angle of π radians) and exhibits a 60Hz cutoff frequency, will only require mouth dimensions of 3ft by 2½ft.

Because horn length and mouth size are closely related, a horn with a nominal cutoff frequency of 60Hz with smaller mouth dimensions is possible, or instead, a lower cutoff frequency for any given mouth size. This is achieved by *foreshortening* the horn, that is, cutting it short before its mouth area expands to excessive dimensions.

Foreshortened bass bins exhibit a highly irregular response over the first two octaves, which result in coloured and distorted low bass. Thus it is far better to sacrifice the low frequencies and attain a smooth response than to drive a horn below its legitimate cutoff frequency. Table 1 shows the minimum mouth dimensions for wall loaded bass bins.

Table 1. The minimum mouth dimensions of bass bins for audibly smooth frequency response.

Mouth Area (ft ²)	Min. driving frequency in Hertz	
	Wall loaded	Corner loaded
28.0	30	20
15.7	40	29
10.1	50	35
7.0	60	42
5.1	70	50
3.9	80	62
3.1	90	65
2.5	100	71
ft ²	Hz	Hz

This table can be used to ascertain the minimum frequency at which a bass bin may be driven for an audibly smooth frequency response, regardless of manufacturers' specifications, which are rarely euphemistic.

In practice, few bass bins are sufficiently big to have a regular frequency response below 60Hz for reasons of mobility. Corner loading extends the response, as shown in the table, but mounting bins in a corner is not often possible.

It is common to use vented enclosures to cover the first two octaves; many bass bins have reflex ports which are driven by the rear radiation from the diaphragm. This seems an elegant solution, but it is far better to use a separate vented enclosure and to enclose the rear of the horn driver. The compression chamber so formed linearises the response of the horn.

For all their advantages, bass horns are a perpetual problem in live sound systems. The three best solutions if smooth frequency response is desired are:

- (1) Use a giant bass horn to provide smooth response down to 20Hz or lower.
- (2) Use a readily portable bass horn, typically responding down to 60 or 50Hz, together with several (less efficient) vented cabinets to cover 20–60Hz.
- (3) Corner load the above horn to provide a smooth response down to 35–42Hz, and accept the absence of the lowest audio frequencies. (In practice, a frequency response which rolls off sharply around 40Hz is quite adequate in live sound systems.)

Midrange and treble horns are small and rarely need to be compromised in the manner that bass horns are. However, they may also suffer from an uneven response over the first octave above their cutoff frequency, which is heard as a "honk". This characteristic has given horns a bad name, but it is simply a case of inexpert application. The simple solution is to drive a honking horn at a higher frequency, that is, crossover at a higher frequency.

CROSSEOVERS AND BANDWIDTH LIMITATIONS

A small direct radiator will handle the entire audio bandwidth, but limiting the bandwidth over which a loudspeaker operates greatly lowers IMD, particularly at high powers. Moreover, air overload distortion in horns is proportional to the operating bandwidth. For this reason, horns are rarely driven over more than three octaves.

When a horn is driven below its cutoff frequency, the diaphragm is no longer pressure loaded and it reverts to direct radiation. This implies large amplitude diaphragm excursions, which quite apart from producing highly distorted sound, may endanger the diaphragm. This effect is particularly fatal to high frequency horns, since they commonly use compression drivers which are designed solely for horn loading and cannot withstand the large diaphragm movements that are inherent to direct radiation. Clearly a good, steep crossover network is essential in horn loudspeaker systems if driver damage is not to occur.

The simplest crossover networks are passive (Fig. 2). In order to handle high powers—even over 50 watts—without great losses, these are expensive.

The performance of the simple LC filter illustrated is dependent upon the loudspeaker to which it is connected, and the combination presents a capricious load to the power amplifier, which may be upset. For these reasons, more complex LC or RLC networks are used in domestic sound systems. These provide very good performance, but unfortunately at the expense of efficiency. For this reason alone, crossover networks which appear in series with loudspeakers are to be strongly depreciated in high power

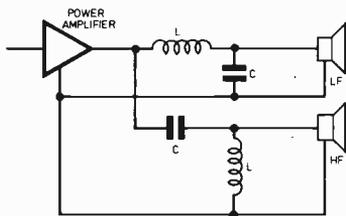


Fig. 2. Simple LC filter arrangements

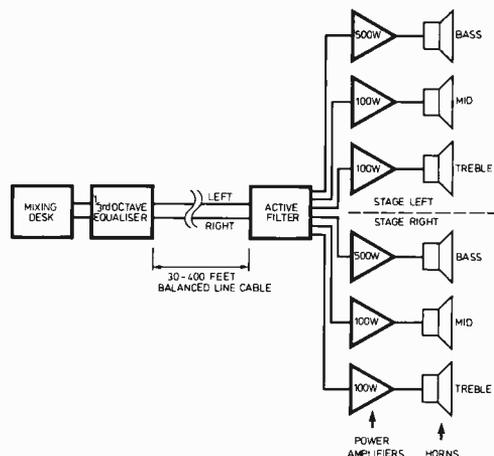


Fig. 3. A tri-amplified system using bandpass filters

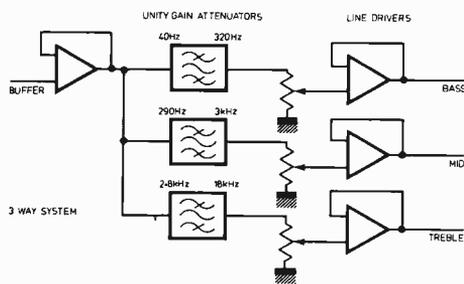


Fig. 4. Typical 3, 4 and 5 way systems

sound systems. Furthermore, any form of network in series with a loudspeaker can give rise to an audible "dullness", especially when the characteristically transparent sound of horn loudspeakers is considered.

The vast majority of professional high power sound systems now employ active crossovers. The term "active" indicates that the crossover filters use active devices; transistors or op-amps. Such filters are usually located immediately prior to the power amplifiers. By imposing bandwidth limitations in the small signal stages, a separate amplifier is required for each frequency band (Fig. 3). Thus a three-way active crossover uses three amplifiers and is said to be "tri-amplified".

The advantages of this method far outweigh the cost of additional amplifiers:

- (1) Active filters can be readily produced with steep slopes without the great losses inherent in steep passive filters. Steep slopes allow horns to be driven harder and closer to their cutoff points with less risk of damage. Active filter slopes are commonly two to four times steeper than passive filter slopes.
- (2) Switchable slopes and crossover frequencies are a practical proposition. It is possible to compensate for the difference in cutoff frequency of a bass bin when it is wall or corner loaded.
- (3) The load resistance of an active filter is well defined. This ensures predictable filter performance.
- (4) The power amplifiers are connected directly to their respective loudspeakers. This ensures good damping at low frequencies.
- (5) Around 50 per cent of the energy of rock music lies below 350Hz, thus amplifier clipping occurs initially in

the bass power amplifier(s). The resultant high order harmonics are directed solely to the bass bins, whose drivers are incapable of reproducing these high frequencies efficiently. Thus they are masked by legitimate (undistorted) high frequency signals.

(6) Intermodulation distortion is minimised in the power amplifiers as well as in the loudspeakers.

(7) Amplifier-loudspeaker combinations can be optimised, particularly in terms of power and impedance.

As a result of factors 1, 5, 6 and 7, a system using active filters can be driven much harder before the sound becomes "dirty". Thus a 1,000 watt tri-amplified system sounds much louder than a 1,000 watt system using passive filters. The improvement in sound quality is also far from subtle.

For an acceptable level of air overload distortion, the operating bandwidth of a horn is usually limited to three octaves. Thus a minimum of three horns is needed to cover the audio band. Starting at 40Hz, the typical crossover frequencies will be around 320Hz and 2.5kHz. Restricting the bandwidth even more, and using many horns to cover the audio spectrum may appear to be a means to very high quality. Whilst this is broadly true, anomalies around the crossover points, particularly if they infringe upon the critical midrange frequencies, are troublesome. Moreover, the proliferation of amplifiers and horns would be costly and leads to great bulk and weight.

The law of diminishing returns sets in after five way systems, and tri- and quad-amplification are the most common configurations. Fig. 4 illustrates typical 3, 4 and 5 way systems. Note that it is difficult to avoid the critical midrange frequencies (750-3,000Hz) with the 5 way system if the number of octaves handled by each filter is to be kept

reasonably constant. Note also that the bass filters have a bandpass characteristic, in order to protect the bass bins from high level signals below their cutoff frequency.

POWER AMPLIFIERS

All loudspeakers are readily damaged by excessive power inputs over long periods. When sound systems are operated by people who are not technically minded, it is always a good rule to use a loudspeaker rated at 10 to 100 per cent over the amplifier power. In high power systems, it is preferable for the loudspeakers to be overloaded before the power amplifiers, because the sound of an overloaded loudspeaker is much more pleasant than that of an amplifier driven into clipping. This assumes that the sound engineer is familiar with the sound of a distressed horn, and does not prolong its agony for any longer than absolutely necessary.

One of the essences of live music, especially rock, is the crescendo. It is necessary to try to achieve real dynamic range, because of this it is often not possible for sound systems to handle rock crescendos at realistic levels. One solution is to reduce the dynamic range requirements by using a limiter, but this greatly detracts from the performance. A compromise solution is to accept that something has to be overloaded on occasions, and this is usually the bass loudspeakers. A good 100 watt, 15 inch driver will, for instance, accept 500 watts of programme for a few seconds without undue distress. This reserve power handling capability should only be needed or used at climatic points, otherwise the loudspeakers will not live long.

In a tri-amplified system, each horn will usually have its own amplifier. High frequency horns generally use compression drivers which are capable of providing SPL's in the region of 140dB at full power, thus it is unlikely that they will need to be overloaded. Compression drivers are quite easily damaged by excessive inputs, thus it is unwise to use an amplifier rated in excess of 100W to power a horn rated at "100 watts programme". If the horn is rated at "100 watts r.m.s.", then it is in order to drive it with a slightly higher power amplifier provided (a) the system is *never* driven with pure sine waves and (b) the excess power capacity is only used sparingly. Bearing in mind that clipping will usually occur in the bass channels first, the bass amplifiers should be rated well above the r.m.s. rating of the loudspeaker amplifier powers, typically being two to five times greater.

The majority of professional power amplifiers on the market are very good, but the distortion figures at the maximum power output, particularly at the extremes of the audio band, are always revealing. Also, a good power amplifier should drive impedances well below its nominal load impedance at full power. In PA applications, the need for absolute reliability cannot be overstressed. Amplifiers with massive heatsinks, "redundant" output stages, thermal cutouts, failure and status indicators, welded steel cases, robust panel components and readily accessible fuses or circuit-breakers are a great help.

HORN DISPERSION CHARACTERISTICS

PA loudspeaker dispersion characteristics should be neither laser-like nor omnidirectional. When sound emanates from an aperture much smaller than the wavelength of that sound, the aperture is said to be a point source, and the radiation is omnidirectional. The wavelength of a 200Hz note is about five feet. At this frequency then, a 15 inch direct radiator acts as a point source. A bass bin, however, has dimensions which approach five feet, and thus bass bins are relatively directional at this, and higher frequencies. The larger a horn's mouth, the lower the frequency

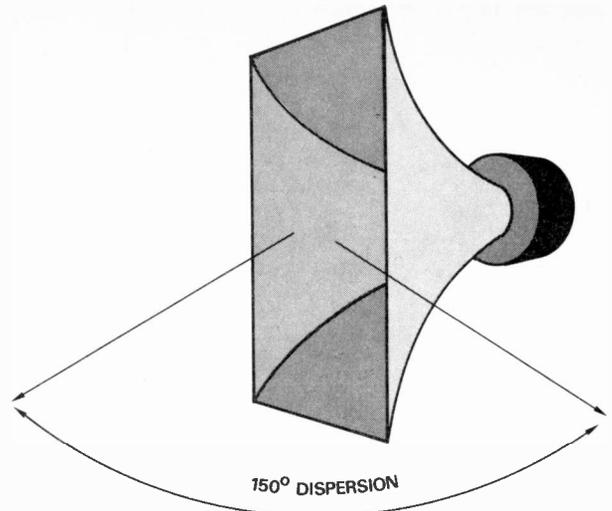


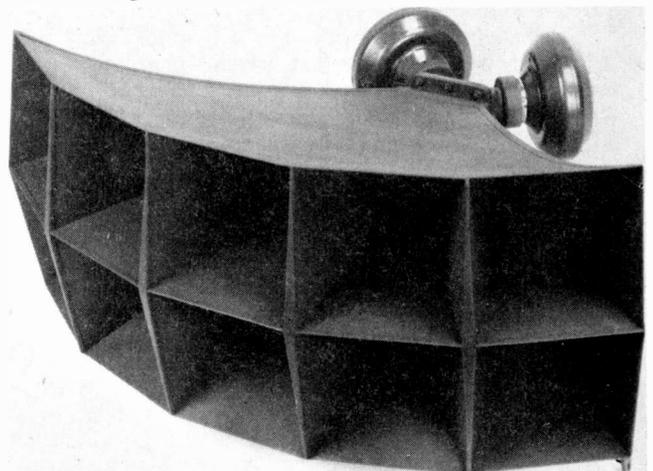
Fig. 5. The midrange diffraction horn

at which sound dispersion can be channelled forwards. Therefore, giant horns are to be preferred at outdoor concerts, where sound that does not reach the audience directly is lost sound.

Unlike direct radiators, the dispersion characteristics of high frequency horns are readily tailored. Direct radiators are invariably very directional at high frequencies, but the flare of a horn can be modified to diffract sound waves and provide very wide vertical and horizontal dispersion. The midrange diffraction horn (Fig. 5) has flares which suggest wide vertical dispersion. Indeed, diffraction horns are regularly seen mounted sideways, in the mistaken belief that this gives the best dispersion! In fact, the dispersion is typically 150 degrees in the horizontal plane when the horn is used as illustrated. This dispersion is a result of diffraction about the sharp vertical (unflared) edges of the horn.

If we couple lots of small horns, which approach point sources, to a common driver, we can achieve wide dispersion, and because the total mouth area of the horn (equal to the sum of the individual horns or segments) is large, the cutoff frequency can be low. Also, each segment points in a slightly different direction, which further promotes wide angle dispersion. The dispersion characteristics are thus partially controlled by the segments, which gives such a horn very flexible dispersion properties. This is the multicellular horn (Fig. 6), with a dispersion angle of 150 degrees by 60 degrees vertical. Many horns which look like multicells are merely bifurcated.

Fig. 6. A 5 x 2 multicellular horn (Vitamox)



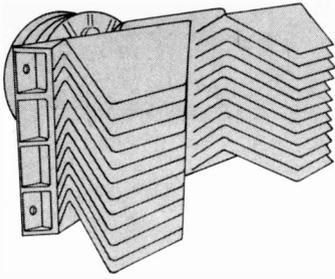


Fig. 7 (left). The acoustic lens

Fig. 8 (right). A radial horn

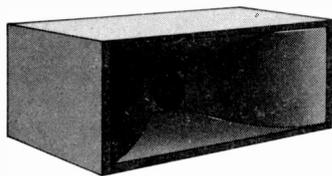
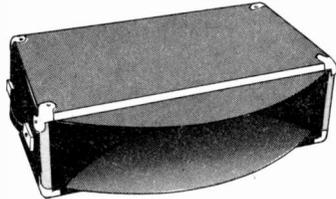


Fig. 9 (left). A "JBL" style long throw "mid-bin"

The acoustic lens (Fig. 7) defies visual analysis. It diffracts sound, but not only in the direction implied by the slanted plates. In fact, the dispersion is predominantly horizontal, being typically 140 degrees by 40 degrees. The lens is currently popular in live sound systems, but its cutoff frequency is usually quite high, and it usually has to be used with direct radiators. It is inferior to the multicellular horn in terms of efficiency, cost and dispersion flexibility. Moreover, the multicell has a much lower cutoff frequency, although the levity of a lens makes it amenable to roadies!

The wide dispersion horns described so far are used to cover the front rows at a large venue, or for comprehensive coverage in clubs and small halls. These are *short throw* horns. In larger halls, narrow dispersion horns are required to supply concentrated sound to the rear seats; these are *long throw* horns, and are usually of the radial variety (Fig. 8). However, in four way systems, high bass frequencies (200 to 600Hz) are often handled by the "JBL" style long throw "mid-bin", as depicted in Fig. 9. Both types of long throw horn have typical dispersions of 60 degrees by 30 degrees vertical.

THE MINIMUM SOURCE IDEAL

When several loudspeakers operating over the same bandwidth are close together, interaction occurs and spurious phase cancellations result. This "phase distortion" causes colouration (which is displeasing to the ear) and upsets the dispersion properties of loudspeakers. It can also exacerbate acoustic feedback problems. To minimise phase distortion, the minimum number of sound sources (over each band) should be used. This is an especially good reason for never using direct radiators in high power sound systems. A horn will replace 10 to 50 direct radiators, thus it is possible to get much nearer to the minimum source ideal using horns; indeed, in small PA systems it is often possible to achieve the ideal of only one sound source over each band of frequencies.

THE STACK

PA horns should be stacked up—hence "the stack". For small halls, where wide dispersion is all that is required, assuming a tri-amplified system is used, a three horn stack is ideal. This consists of bass, midrange and treble horns in ascending order. In larger halls, long throw mid and treble horns may be necessary, hence a minimum of five horns.

Interactions between long and short throw horns can be minimised by thoughtful angling and stacking. If higher SPL's are required, additional three or five horn stacks can be used. The stack is thus a *module*. However, the concept of a stack as a *certain physical configuration* must be dispensed with when several stacks are used in tandem. If they are merely used like building bricks, serious phase irregularities will occur; a rearrangement of the components of the composite stack is usually necessary. As SPL requirements increase, given that efficiency cannot be augmented, a proliferation of horns is inevitable, and skill is required in order to produce good results.

STACKS FOR SMALL HALLS

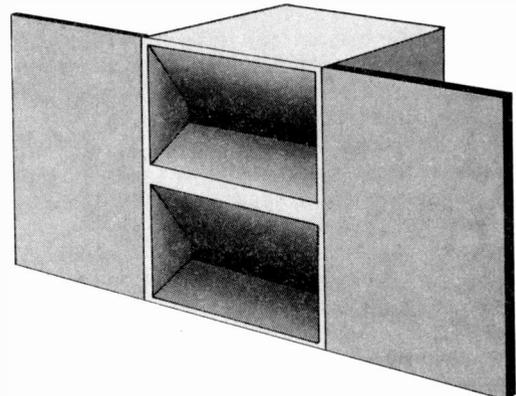
The author's horn stack shown on the second page of this supplement uses a giant bass horn with a cutoff frequency of 20Hz when corner loaded. A midrange diffraction horn provides wide angle coverage, and for low cost, piezoelectric diffraction horns are used above 3kHz. Several are required to counter the "deadness" common to small halls which have been acoustically treated. Note the strategic angling for minimal interaction. The stack is often at audience level, thus the midrange and treble horns are mounted well above head level to prevent excessive sound absorption. This stack weighs 80kg and is equivalent to 2 tonnes of direct radiator loudspeaker cabinets!

Table 1 shows that corner-loading a bass bin provides the lowest cutoff frequency, but wall loading is often the best that can be achieved. When using a single bass bin, however, wall loading is negligible. In this case, providing a solitary bin with baffles (Fig. 10) will greatly enhance the low frequency response. If a separate vented enclosure is used, this should be stacked immediately above the bass bin(s). Using the high frequency horns described earlier, Figs. 11a and 11b show alternative and broadly equivalent approaches to horn stacks for small venues, where wide dispersion is all that is required.

STACKS FOR LARGE HALLS

In large halls, long throw horns are required to reach the furthest seats, though these should not be used unless

Fig. 10. A bass bin fitted with baffles



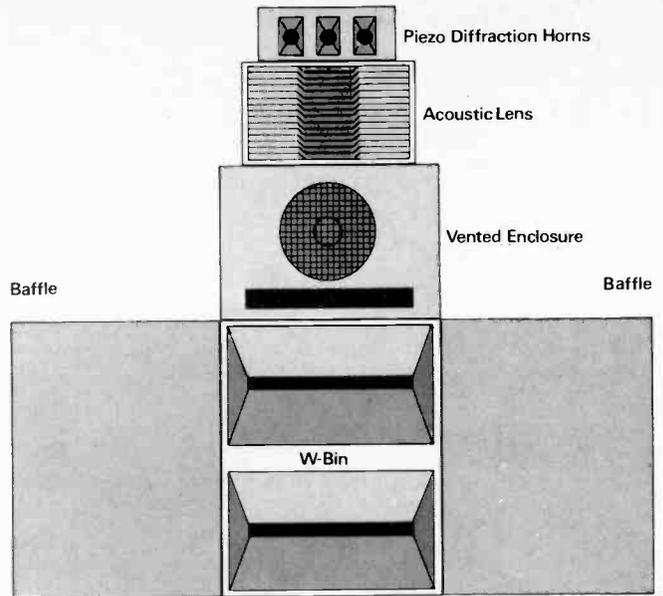
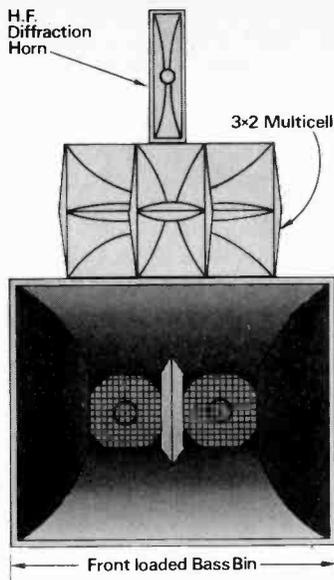


Fig. 11a (above) and 11b (right). Alternative approaches to horn stacks for small venues

absolutely necessary. Bass reflex enclosures do not have long throw properties, thus large numbers of bass bins will be required to project the low bass; when these are tightly stacked together, they provide highly effective mutual wall loading which greatly augments their bottom end response. Fortunately, the inevitable phase irregularities resulting from this arrangement will usually cause cancellation well above the bass crossover point.

The long throw horns should preferably be mounted well above the main stack, typically on the proscenium arch or on scaffolding, as shown in Fig. 12. In the side view of this stack note that the long throw horns are angled downwards, *into* the audience. Otherwise the sound is likely to hit the rear wall—and be reflected back! This slap-back echo is a perpetual problem in clubs with low ceilings and the need to *build stacks high* whenever possible cannot be overemphasised. As stack height increases, it becomes progressively easier to set the long throw horns at an angle that discriminates between the rear wall and the rear seats. If scaffolding is not available, it will be necessary to mount the long throw horns on top of the stack. A wedge provides the necessary 10 degrees to 15 degrees of downwards tilt.

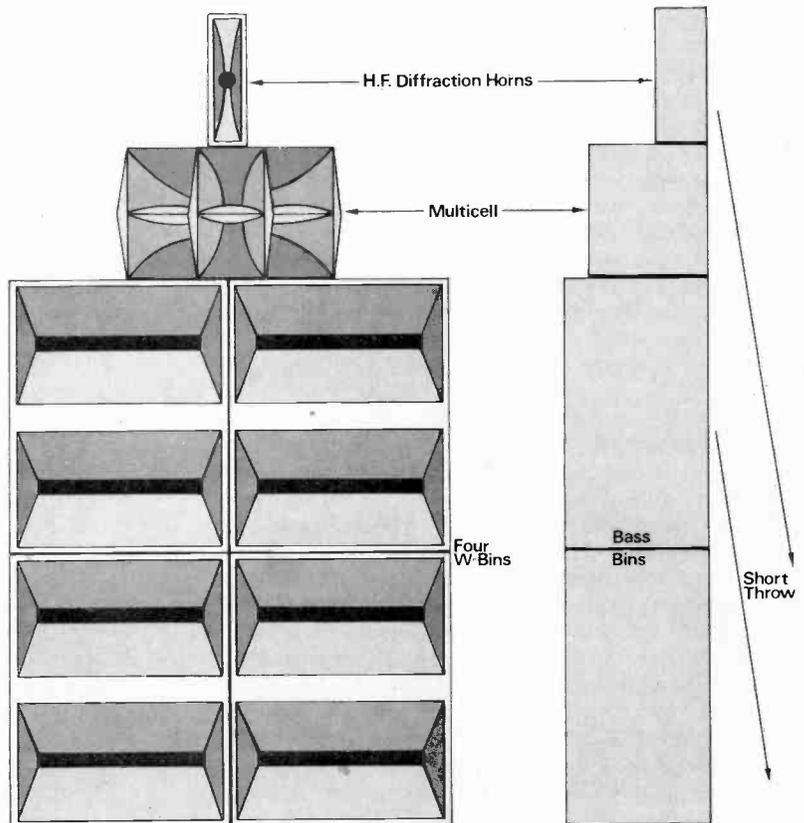
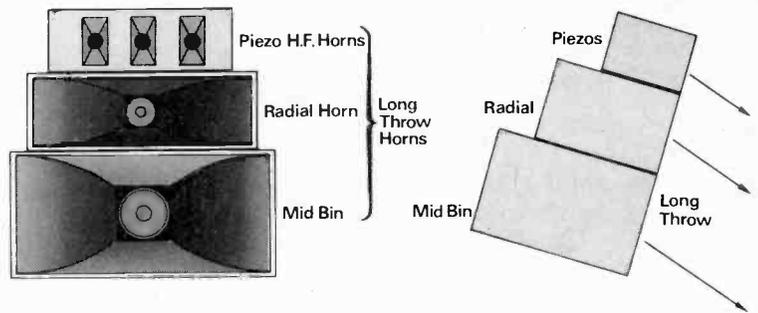
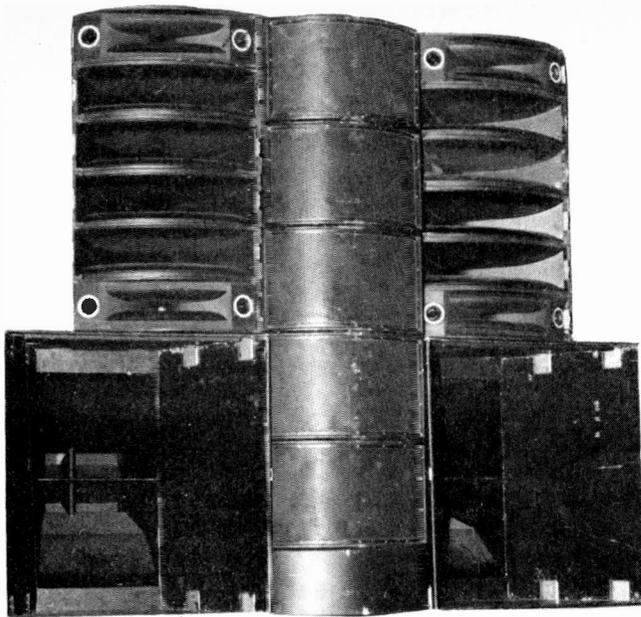
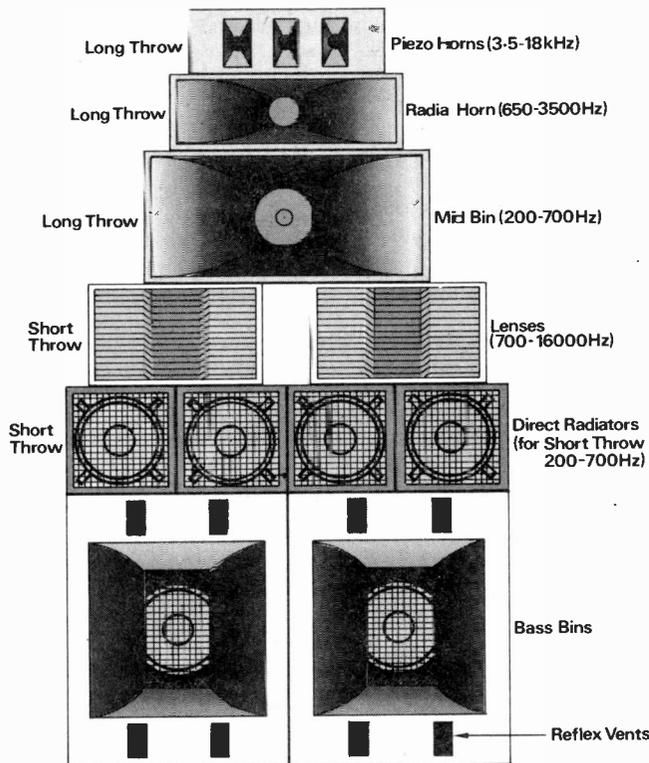


Fig. 12. A horn stack with long throw horns mounted above the main stack and angled downwards



A "5kW" horn loaded stack made up of: two Cerwin-Vega bass bins each with two 750W 18in drivers (frequency range 40-250Hz); five "Philishave" bins—shown in the centre—these are Martin 212 midrange horns, 250W each (frequency range 250-1500Hz); 8 JBL 2350 radial horns—80 degrees by 60 degrees dispersion—100W each (frequency range 1500-4800Hz); four JBL 2345 radial horns—90 degrees by 40 degrees dispersion—100W each (frequency range 4800Hz-16,000Hz); these incorporate four JBL Bullet treble horns which cover the same frequency range. (Courtesy Muscle Music)

Fig. 13. An impressive PA stack



An alternative, and very impressive looking stack is depicted in Fig. 13. It is currently fashionable to use acoustic lenses and direct radiators in place of the multicellular horn for short-throw midrange and treble. However, the low efficiency of these units takes us away from the minimum number of sources once again. When a stack of this kind is used, or several of the stacks illustrated in Fig. 12 are partnered, it is expedient to angle the high frequency speakers away from each other as much as possible to minimise interaction (Fig. 14). Excessive angling, however, will cause a lot of sound to hit side walls which is not helpful! Likewise, boxes containing arrays of piezo-electric horn tweeters usually have bevelled fronts.

STEREO

So far it has been assumed that the sound system has a stereo format, with stacks either side of the stage. This layout is far from ideal. A minority of the audience will be suitably seated to hear an acceptable stereo effect. Transient sounds from percussive instruments will sometimes be heard as two discrete signals out of time with the music. Many sound engineers limit stereo to drums and special effects, hence the stacks will be working largely in mono. If we dispense with stereo altogether, then phase anomalies between the two stacks can be eliminated. A central horn cluster on the proscenium arch is sometimes a viable solution, and works very well.

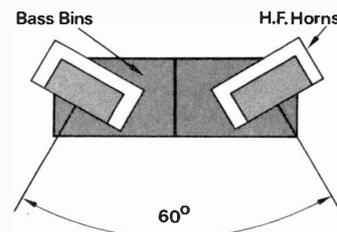
The heavy bass bins may have to remain on stage, but by a suitable choice of crossover frequency, their phase anomalies can be minimal. In theory, the vertical displacement of the mid/treble horn cluster is not readily sensed by the ears. However, people differ and the cluster can be distracting, particularly if it is more visible than the musicians!

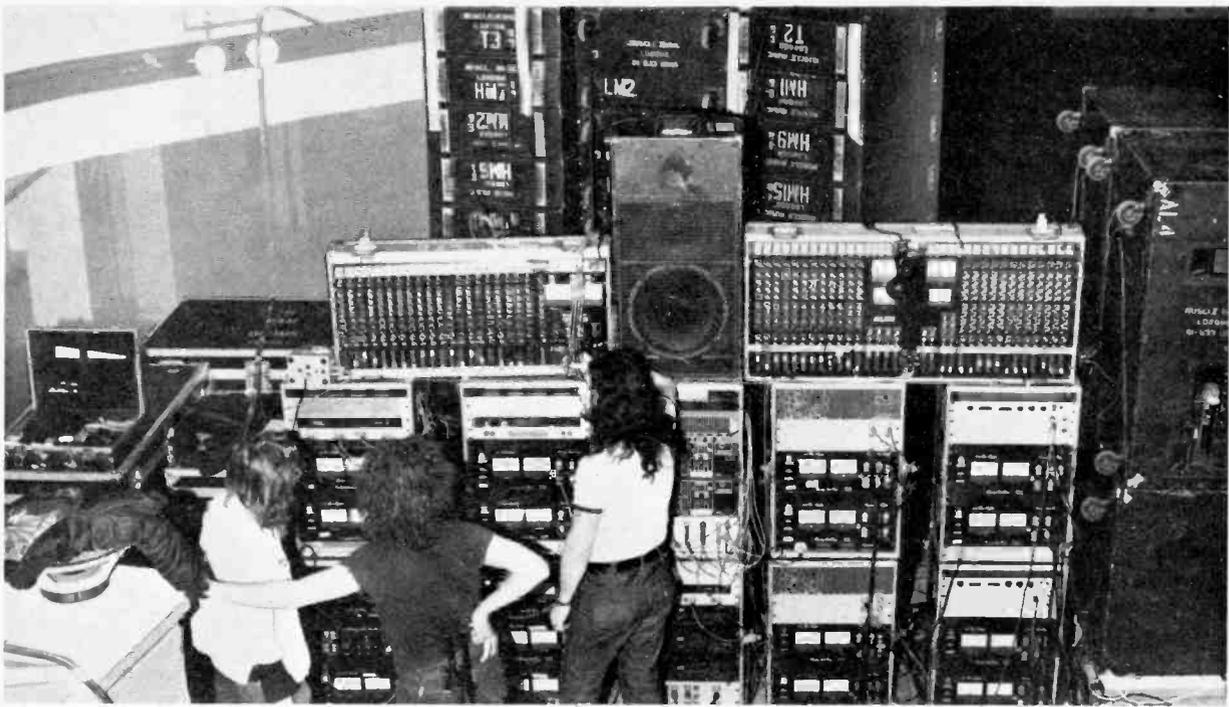
Another idea, akin to tri-amplification, is to split up a sound system such that separate amplifiers and loudspeakers are used for drums, keyboards, vocals, etc. The advantages are similar: the sound is subjectively louder, it is cleaner and the imagery is also greatly improved, giving a better impression of *live* performance rather than a glorified discotheque plus stage act. This is, of course, the situation in a small band without a "PA"!

MIXING

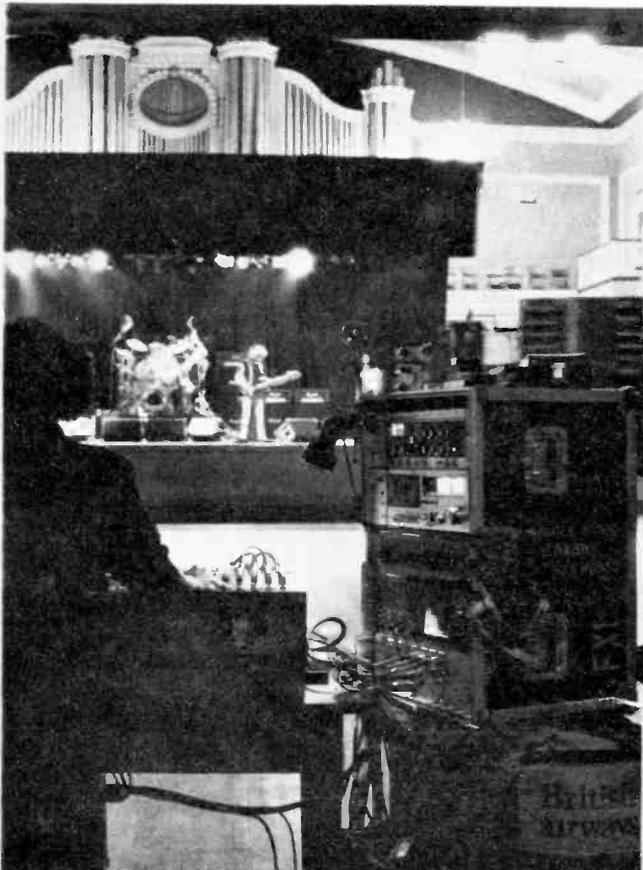
In a four piece jazz-rock band, for instance, it is possible to increase the power of the instrument amplifiers to around 300 watts before the drum kit requires amplification. At this point it would be usual to consider mixing the whole band and using a common sound system. If the advantages of mixing could be sacrificed for sound quality and imaging, an alternative step would be to use a "drums amplifier". Each instrument would retain its own separate "sound system", little intermodulation can occur and the music remains totally realistic in terms of imagery.

Fig. 14. Angling of h.f. horns for minimum interaction





A rear view of the 5kW stack, shown on the previous page, together with a 2kW sidefill stack (shown on the extreme right) for stage monitoring. Also shown are two 5kW amplifier and crossover racks. (Courtesy Muscle Music)



The mixing desk used with the equipment shown above and on the previous page. The group can be seen in the background together with the sidefill stack and 5kW stack which are just visible above the equipment on the right

With a little ingenuity and a few wires, sound balance could still be controlled by someone off stage. For small bands, the important point is to avoid using a common sound system until it is both absolutely necessary and sufficient funds are available to purchase good equipment of high power handling capacity. It is often far better to hire a good PA system when the need arises than to own cheap but inadequate equipment.

Always place your amplifiers as close as possible to the loudspeakers so that the shortest possible speaker cables can be used. Although it is feasible to have long speaker leads with little power loss by using 6mm² and similarly massive cables, the large capacitance and inductance of such cables may have insidious effects on sound quality, quite apart from the great cost. For lengths under 5 metres, 1mm² two core sheathed p.v.c. cable is ideal, though butyl rubber cables are somewhat tougher.

Budding sound engineers are reminded that in large PA rigs, unseen, and sometimes rather humorous, dangers can lurk. In 1972, a well-known British manufacturer equipped the Lincoln rock festival with a 10kW system. This promptly blew someone off the stage when an organist hammered on a chord miked through the system! ★

FURTHER READING

- Paul Klipsch—Loudspeaker performance (*Wireless World*, February 1970)
- Jack Dinsdale—Horn loudspeaker design (*Wireless World*, March-June 1974)
- Adrian Hope—Hearing Damage (*Studio Sound*, August & December 1975)
- Dave Martin—Speaker technology for sound reinforcement (*Studio Sound*, March 1976)
- Stephen Court—Quality performance (*Studio Sound*, November 1976)
- Richard Galbraith—Rock music and hearing loss (*J.A.E.S.*, March 1977)
- Ken Dibble—Design considerations for a PA speaker system (*Studio Sound*, May 1977)
- Terry Nelson—Sound on stage (*Studio Sound*, May 1978)

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4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
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7408	12p	7489	135p	74157	40p
7410	10p	7490	20p	74164	55p
7413	22p	7492	30p	74165	55p
7414	39p	7493	25p	74170	100p
7420	12p	7494	45p	74174	55p
7427	20p	7495	35p	74177	50p
7430	12p	7496	45p	74190	50p
7432	18p	74121	25p	74191	50p
7442	38p	74122	35p	74192	50p
7447	45p	74123	38p	74193	50p
7448	50p	74125	35p	74196	50p
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		74132	45p	74199	90p

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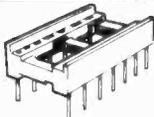
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AD162	38p	BD140	35p	2N3055	50p
BC107	8p	BFY50	15p	2N3442	135p
BC108	8p	BFY51	15p	2N3702	8p
BC108C	10p	BFY52	15p	2N3703	8p
BC109	8p	MJ2955	98p	2N3704	8p
BC109C	10p	MPSA06	20p	2N3705	9p
BC147	7p	MPSA56	20p	2N3706	9p
BC148	7p	TIP29C	60p	2N3707	9p
BC177	14p	TIP30C	70p	2N3708	8p
BC178	14p	TIP31C	65p	2N3819	15p
BC179	14p	TIP32C	80p	2N3820	44p
BC182	10p	TIP2955	65p	2N3904	8p
BC182L	10p	TIP3055	55p	2N3905	8p
BC184	10p	ZTX107	14p	2N3906	8p
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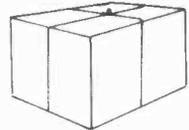
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CONSTRUCTION

THE SYSTEM is constructed on four boards, two of which are non clad Veroboard, and the remaining two are i.c. stripboards which have edge connector pads that are not used in the Modem. See Figs. 2.2, 2.3, 2.4 and 2.5.

APPLICATIONS INFORMATION

The following section deals with uses to which the acoustic modem may be put. It deals with various applications; many enabling things to be done over a telephone that could not normally have been achieved without the use of this device.

Data transfer from a data bus on any minicomputer, or for that matter any device that presents its output in parallel form is possible. Obtain and study the AY-5-1013A data sheet.

This Integrated circuit is probably the most useful device ever produced for data transmission and interfacing with microprocessors etc. Basically its function is to accept a parallel 8 bit word, and when it is told, clock that data out in serial format, inserting its own start, stop, and parity checking bits automatically. The device is split into two parts, transmitter and receiver. It is designed to interface directly a parallel output device to a modem.

Having incorporated this device in the acoustic modem system the possibilities are endless in terms of data that may be sent over long distances. A block diagram of the UART is shown in Fig. 2.1, as a transmitter with associated waveforms.

It so happens that General Instruments produce another Integrated circuit that is able to interface directly with the 'UART'. This i.c. is General Instruments 2376 Keyboard Encoder. This device is a Read-Only Memory (ROM) that will

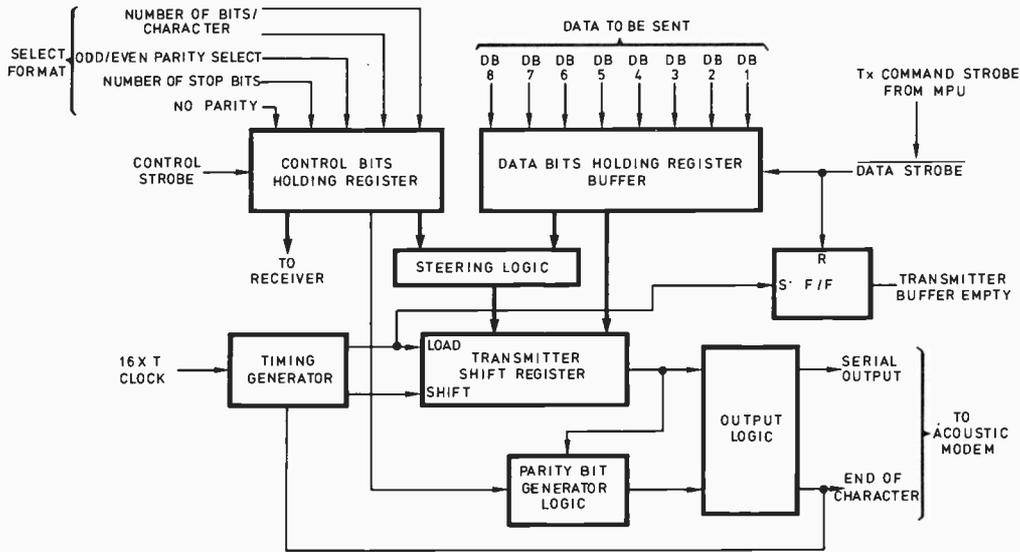
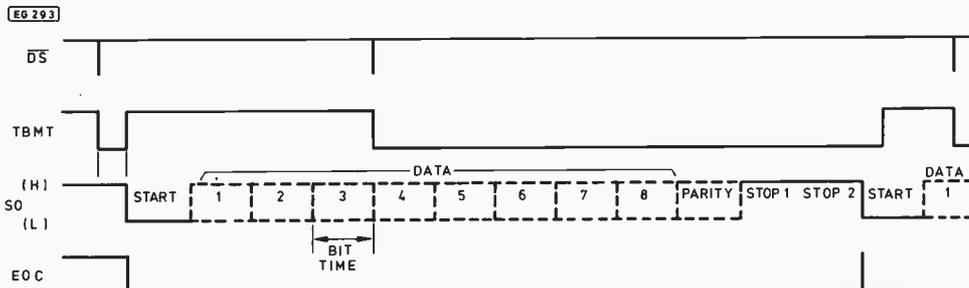


Fig. 2.1(a). UART Transmitter block diagram



(b) UART Transmitter waveforms

Fig. 2.2. Modem Transmitter board

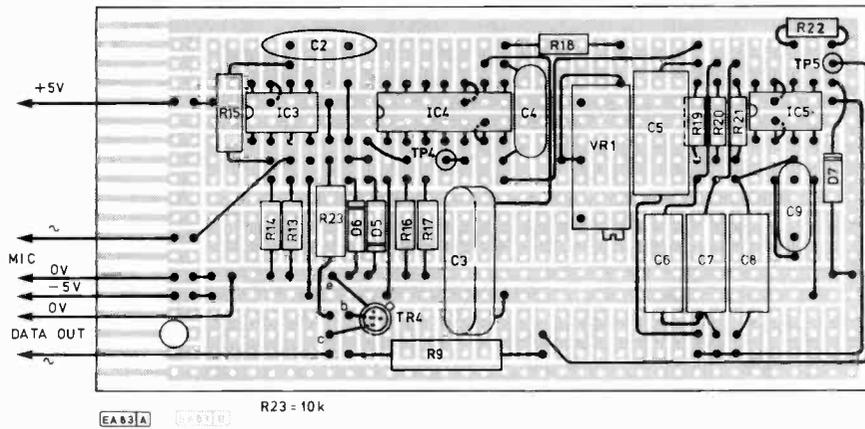
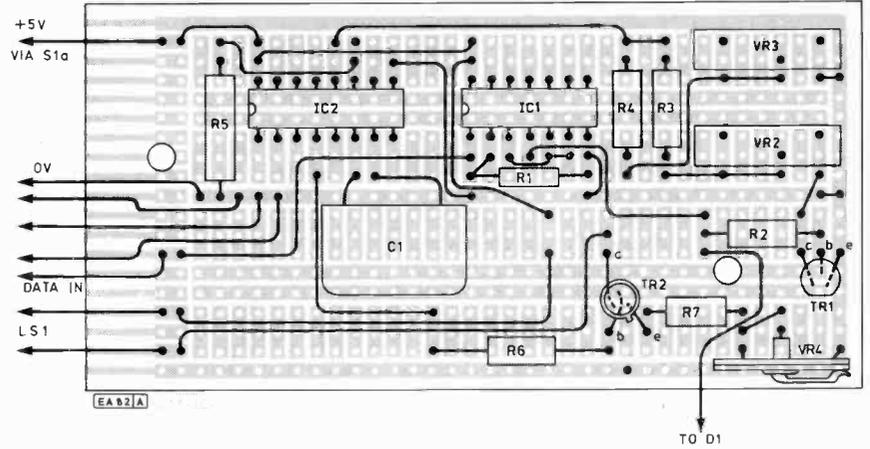


Fig. 2.3. Modem Receiver board

Fig. 2.4. LED Driver board

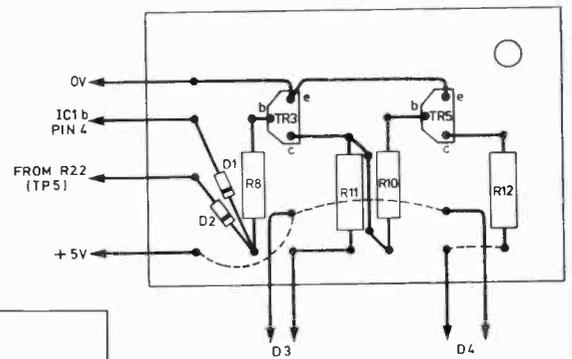
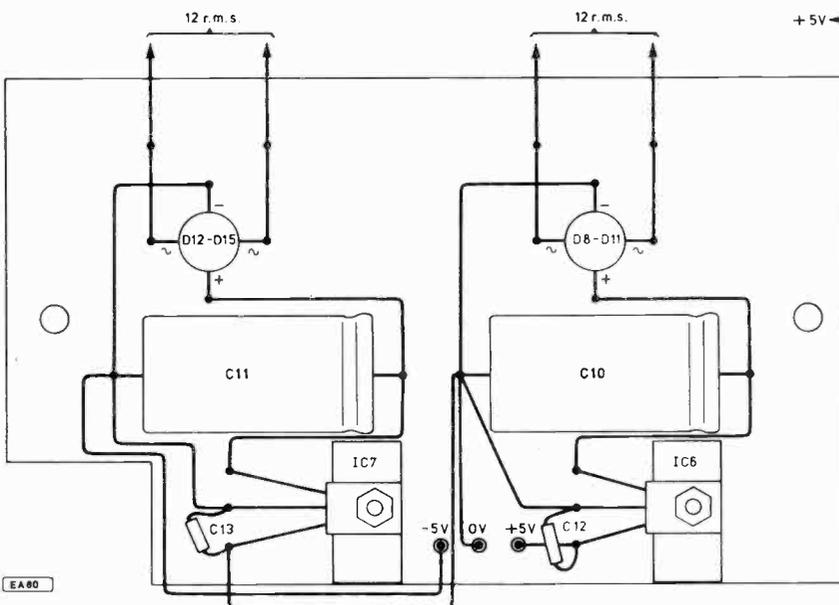


Fig. 2.5. Power Supply board



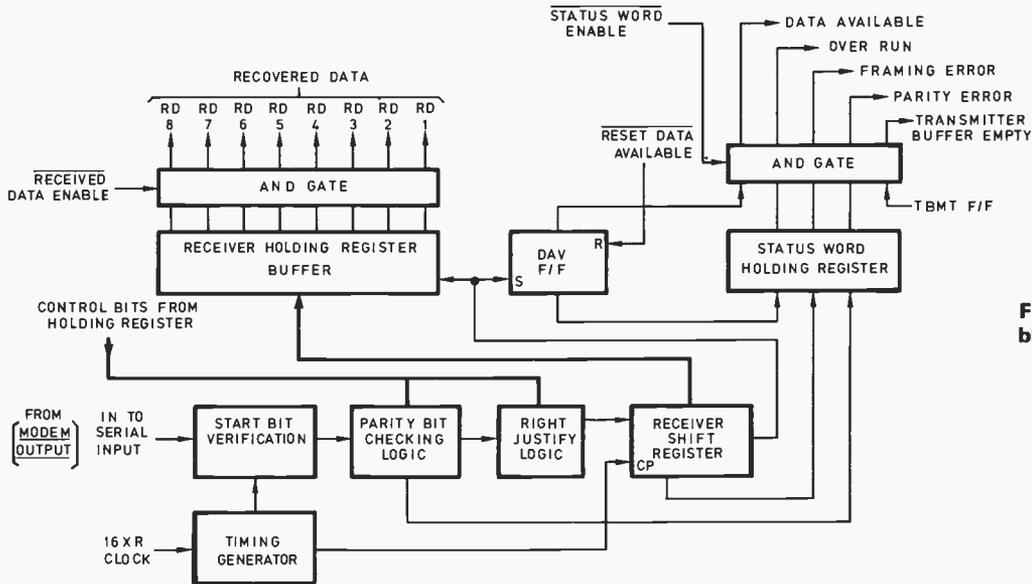
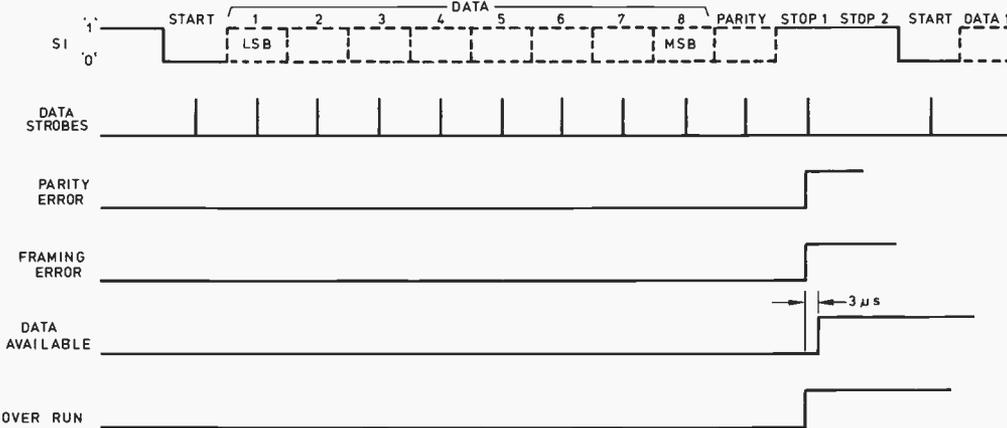


Fig. 2.6(a). UART Receiver block diagram

EG 263



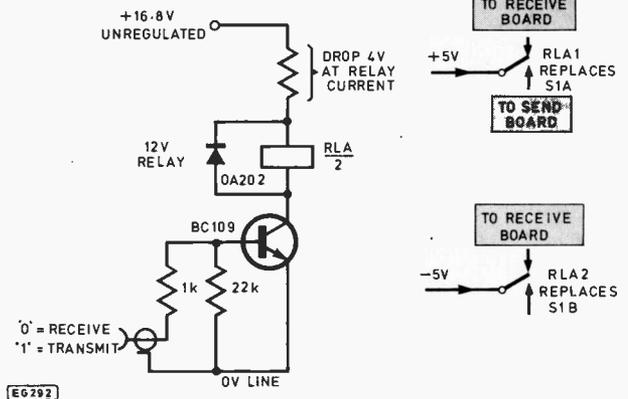
(b). UART Receiver waveforms

Fig. 2.7. Circuit for automatic Send/Receive

encode all the characters on a standard "QWERTY" (typewriter) keyboard and produce an output in parallel ASCII along with a strobe pulse. Keyboards have become inexpensive now and some of them are already encoded using the 2376 ROM. The Parallel output and strobe from such a keyboard may be used to directly load the AY-5-1013A UART with ASCII code and then send by FSK via the modem to the distant terminal.

SIGNALS IN DC LEVELS

It is even possible to send and receive low frequency signals, and d.c. may also be transmitted using Binary coded data, since our UART may be loaded with any 8 bit parallel data. From 8 bits of data we could resolve a quantity into $2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^7 + 2^8$ parts which decimally speaking = $1 + 2 + 4 + 8 + 16 + 32 + 64 + 128$ which is equal to 255. The method used to convert a d.c. voltage or a slowly changing signal to 8 bit binary is known as Analogue-to-Digital conversion. A very useful integrated circuit can be used to do just this. It is the Ferranti ZN425E. This chip will accept an analogue signal and decode it into 8 bit parallel data. It will also work in the reverse mode converting the digital data to an analogue signal.



EG282

There is a worthwhile modification to the acoustic modem to further improve its versatility. This is to do away with the Send/Receive switch and arrange for remote Send/Receive under the control of an external device. This modification is outlined in Fig. 2.7. ★

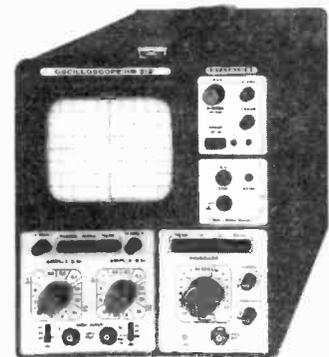
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A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

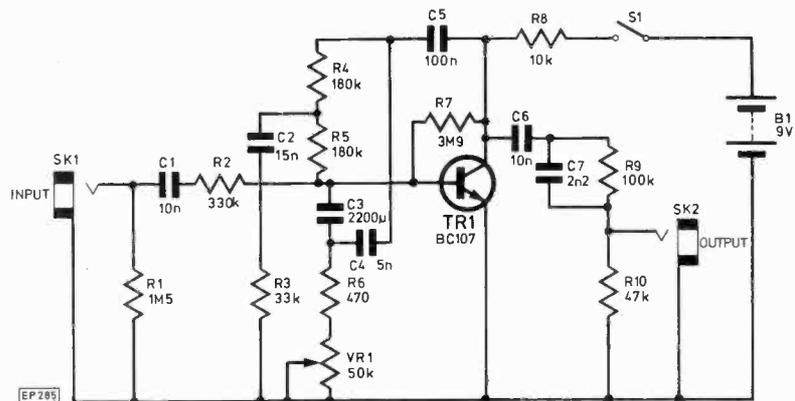
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

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.

WAH-WAH PEDAL

MANY guitarists will be familiar with the Wah-Wah pedal, but many of the available makes or published designs are often unsatisfactory—especially for professional use. As a guitarist, I have found that some units have a very small or uneven range, whereas others are too harsh—often with annoying 'clicks', which give a scratchy sound, which totally spoils higher notes. Even commercially available units have disadvantages—notably in background noise, changing in volume as the pedal is moved, and, of course, price.

So, with these problems in mind, it was decided to sit down to design a really high-quality unit, delicately balanced between the harsh and smooth sounds. This circuit produces a subtle but effective sound, perfect for guitars or other electric instruments, and may be used as a treble booster.



This unit is best built as a pedal. One of the jack sockets (usually the input) should be replaced with a switched socket to connect the negative supply when a plug is inserted. A foot-switch should be fitted to by-pass the circuit. The value of the potentiometer depends on the swing of the pedal, but it should be made to give a swing from 0 to 50k.

The unit is simple to construct and gives a really superb sound—especially if used with the recently published 'phaser'. A really worthwhile project.

Richard Fuller,
Much Hadham,
Herts.

200 WATT TEMPERATURE CONTROLLER

THE temperature controller described was designed for propagator heaters rated up to 200 watts, but can be used in many applications where good control is required. The stability is typically within 0.5°C of the set point and the temperature range is approximately 10 to 40°C.

For safety considerations, the temperature sensor is electrically isolated from the mains side of the controller and connected to earth. This means that if the device itself becomes damaged in any way, there would be no danger.

A National Semiconductor LX5700H integrated circuit temperature transducer is used as the sensor. This has an operational amplifier fabricated on the same chip and gives an output directly proportional to degrees Kelvin at 10mV/°K. (Note: °K = °C + 273.2.)

The output is compared with a stable reference voltage by means of the differential amplifier IC1. Potentiometer VR1 determines this reference voltage which thus sets the operating temperature of the controller.

If necessary, the lower and upper limits can be extended by altering R1 and R2 respectively. However, one should have in mind that the maximum permissible temperature is restricted by the operating temperature range of the sensor which is -85 to +125°C for the one used. The output from IC1 is applied via TR1 to the unijunction transistor (TR2) firing and triac switching circuit to provide full-wave, phase-controlled a.c. power to the load.

The 2.7V Zener diode D2 in series with the 10k base resistance is included to ensure TR1 can switch hard off even if the output voltage swing from IC1 does not fully approach the supply voltage.

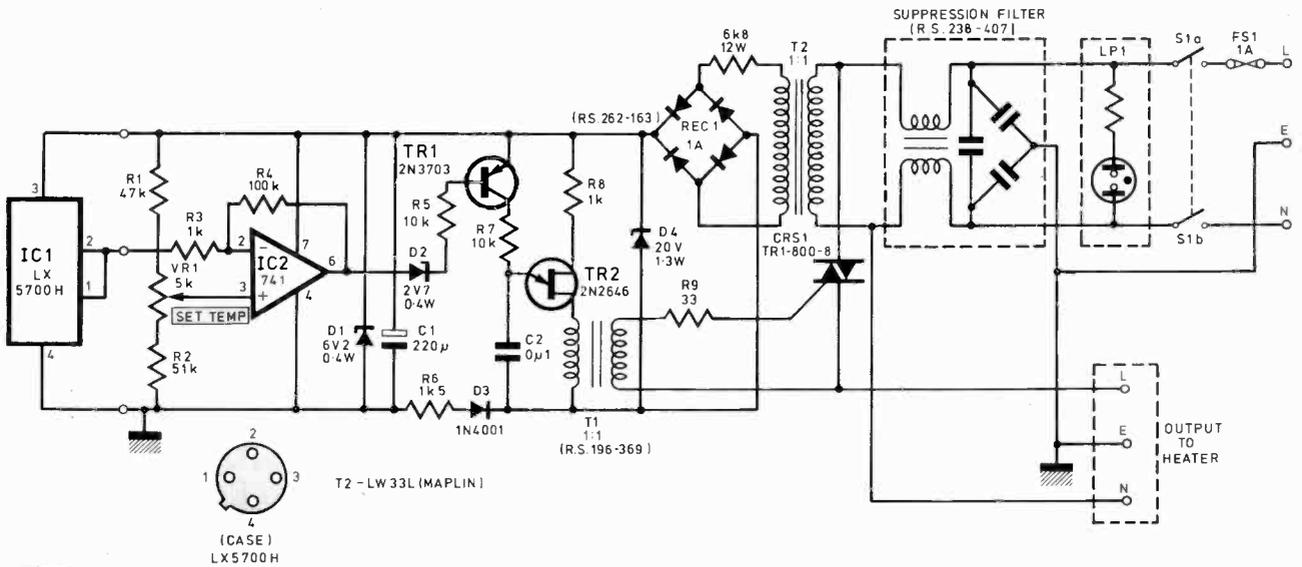
The pulse transformer T1 provides isolation for the triggering pulses and the supply to the unijunction trigger circuit is isolated from the mains with transformer T2. This supply is then rectified and clamped to 20 volts by the Zener diode D4. The Zener diode D1 and associated capacitor C1 provides a 6.2V smoothed d.c. supply for the preceding circuitry. As the reference voltage is taken off this supply

D1 should preferably be a temperature compensated Zener such as a Mullard 1N821 or RS 283-097.

The mains filter is provided to suppress radio frequency interference caused by triac switching. It should be mentioned that as the triac is rated at 8A it is only necessary to increase the rating of the filter to improve the maximum power capability of the controller (e.g. RS 238-435 for 2A or 238-390 for 5A load). However, if used at maximum power, the triac must be mounted on a heat sink having a thermal dissipation of 4°C/W (e.g. RS 401/497). Alternatively, as the tab is electrically isolated, it may be fixed directly to the chassis for heat dissipation.

The sensor itself can be made into the form of a probe by insulating with sleeving and encapsulating with silicon rubber compound or epoxy resin.

D. Wedlake,
University College,
Newport Rd.,
Cardiff,
CF2 1TA.



SIMPLE GUITAR TREMOLO

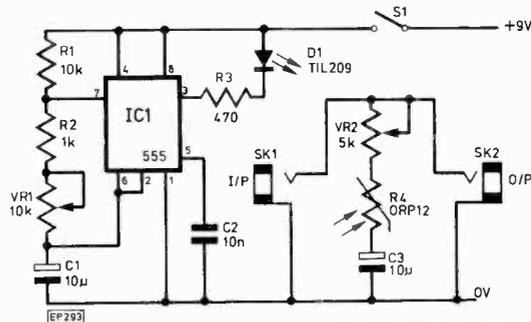
FROM switch-on, C1 starts to charge via R1, R2, and VR1 (VR1 determines the rate of charge/discharge and therefore the frequency of operation). When C1 reaches $\frac{2}{3}$ of the supply voltage, pin 7 switches to the low state, C1 then discharges through pin 7, via R2, VR1. Discharge stops when the voltage across C1 decreases to $\frac{1}{3}$ of the supply, this activates the trigger (pin 2) and the cycle starts again.

The output from pin 3 is used to drive the l.e.d. via a 470 ohm resistor. The light from this varies the resistance of R4 which via C3 and VR2, short-circuits the line and consequently attenuates the signal, VR2 controls the depth of attenuation.

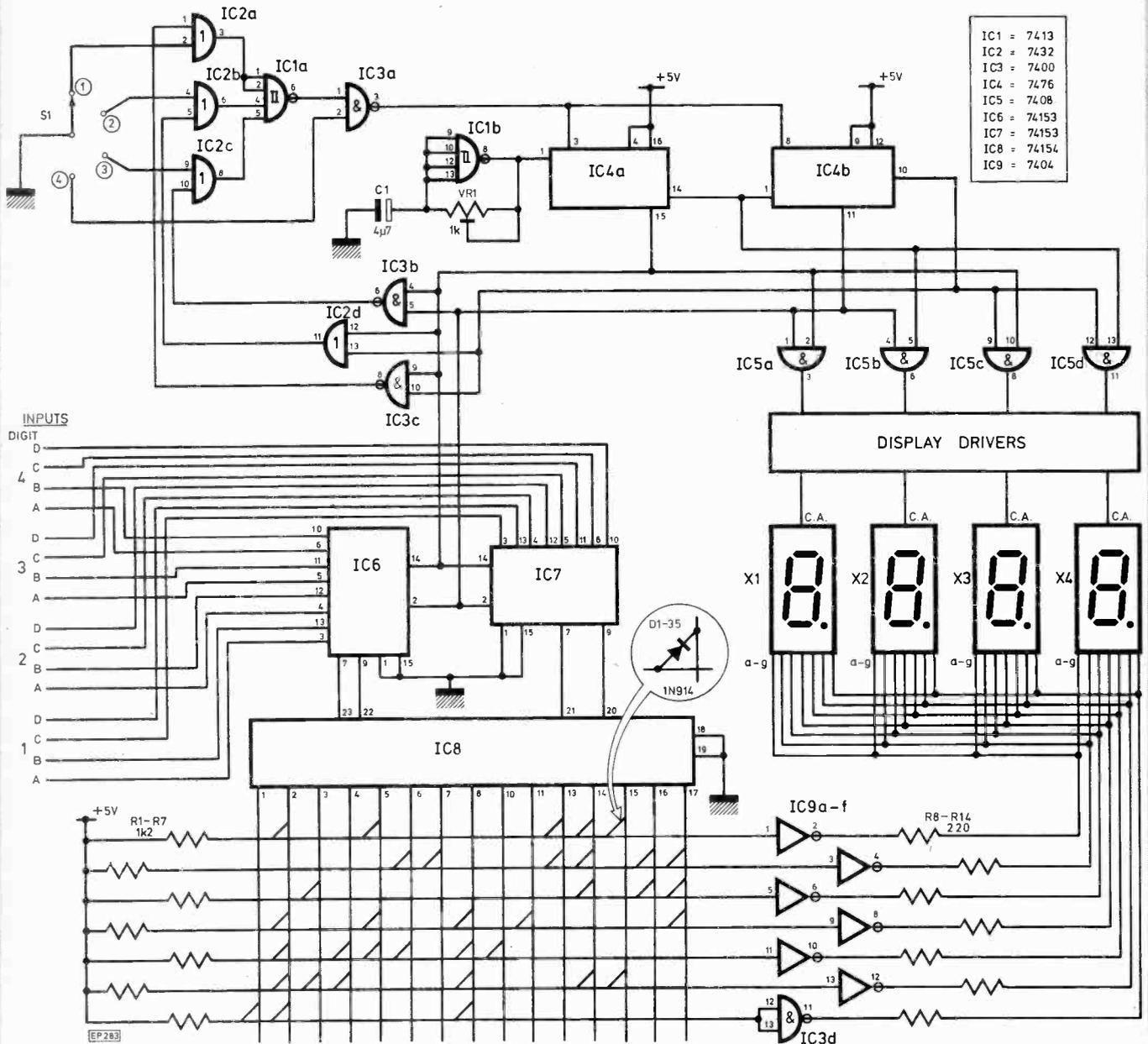
Although the output from the 555 is a square-wave this is not really noticeable except at low frequencies, which are not normally used for this application anyway.

It is important to house the unit in a light-proof box.

A.R. Curtis,
Bedhampton,
Hants.



HEXADECIMAL DISPLAY



THIS four-digit display is capable of displaying the letters A-F as well as the digits 0-9, making it ideal for use with microprocessors, in the monitoring of address buses for example. However, it may be used in frequency meters, clocks, etc., although using 7447s would be easier in these latter cases. It is designed to act as a direct drive display, but may be used as a multiplexed display by applying the inputs directly to IC8 and the display drivers, leaving out ICs 1-7.

IC1b, VR1, and C1 form an oscillator which clocks the two-stage counter IC4.

The outputs are decoded by IC5 to multiplex the display. IC1a, IC2, and IC3a-c reset the two flip-flops; S1 controls at which point in the count they reset. It is therefore possible to alter the number of operating digits in the display.

ICs 6 and 7 are multiplexers, controlled by IC4, which sequentially feed each of the four four-bit binary data inputs through to the decoder IC8. The sixteen outputs are fed to a diode matrix.

The seven diode matrix outputs are fed through invertors and current-limiting resistors to a common anode display (4 x

FND507, 2 x DL727, etc., etc.). Non-l.e.d. displays may be used, provided that suitable display drivers are used, and that no more than 16mA are required per segment. The decimal points may be separately driven, if they are required. L.c.d. displays should *not* be used.

R. G. Stubbs,
Dartford,
Kent.

Next Month...

30W I.C. STEREO AMPLIFIER

A hi-fi stereo amplifier producing 30W r.m.s. per channel and employing a new high quality hybrid power amplifier IC for ease of construction.

This design has switchable active filters for scratch and rumble giving 12dB per octave roll off. The filters are switched completely out of circuit when not in use to obtain excellent noise figures. The amplifier also has a tone defeat facility which switches the tone control network out of circuit. Other facilities are; inputs for phono, aux, tuner, tape and a mono/stereo switch.

A complete kit of parts will be available.

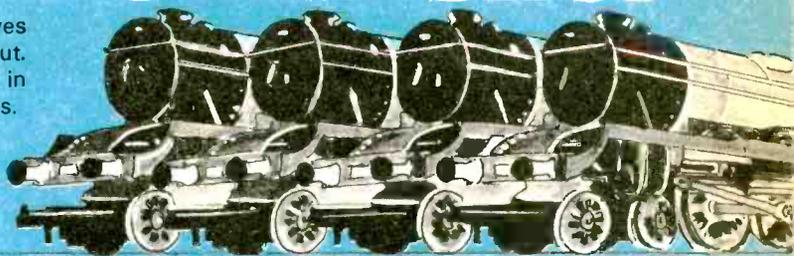
To enable a hi-fi system to be put together at an exceptional price we have also been able to arrange a **special offer** on a pair of Videotone GB3 bookshelf speakers.

This special offer is available on an individual basis to all readers.

The GB3 speakers are an improved version of the Videotone Minimax 2 which has been highly acclaimed by the hi-fi press over the past five years and has been favourably compared with monitor speakers.

2 Wire Train Controller

This unusual design enables a number of model locomotives to be individually controlled on one interconnected layout. Construction for a four channel controller will be described in detail but it is possible to extend the unit up to ten channels.



8 Page Supplement...

VIDEO for EVERYONE

PRACTICAL
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OUR APRIL ISSUE WILL BE ON SALE FRIDAY, MARCH 14



Simple Conversation Aid

J.M.Watt M.B. Ch.B.



DEAFNESS is one of the most disabling afflictions amongst the elderly. While not life endangering this condition causes considerable hardship and places many restrictions upon the sufferer. These mainly elderly people tend to miss vital parts of a conversation, misunderstanding the simplest of messages resulting in them being regarded as slow witted and dull. The effort of repeating a casual remark three or four times is enough to deter most of us from even attempting to hold a conversation with anyone who is 'hard of hearing'. The result is that the deaf often become isolated and ignored. Whereas the blind receive sympathy all too often the deaf receive nothing but contempt and irritation.

HEARING AIDS

The electronic design and construction of hearing aids is no problem in the age of microelectronics. However, conventional hearing aids while having the advantage of cosmetic concealment and portability are often inadequate when conversation rather than the stereotyped responses of everyday life is required. It is the striving for cosmetic acceptability (very important if they are to be worn and not rejected in embarrassment) which renders these hearing aids acoustically rather than electronically poor.

Moulded earpieces may be worn comfortably and inconspicuously, but are poor at reproducing the lower frequencies because of their size. The sound from such earpieces is of necessity distorted and may cause problems even for those of us with normal hearing.

The other acoustic/electronic interface is the microphone. Here again size may be the problem in the behind the ear type of hearing aid where the size of the sound receiving surface is limited. This restriction causes low sensitivity and distortion. The pocket type of hearing aid is less attractive to the wearer because of the unsightly cord leading to the ear, but it can incorporate a reasonably sized microphone with minimal distortion. The disadvantage of this type of aid is that it is usually hidden in the clothing and is liable to pick up the rustle of the fabric as the wearer moves.

In order to hold a conversation with a relatively deaf person, a device with better acoustic rather than electronic properties than the conventional hearing aid would be of use. A circuit was therefore built which would amplify a

signal from a microphone and supply a pair of earphones. In fact the results obtained using a cheap crystal microphone insert, and a pair of inexpensive headphones was quite encouraging, and the prototype unit is now in daily service being preferred by the patient to her NHS hearing aid for one-to-one conversation, and watching television.

THE CIRCUIT

The input from a high impedance microphone is fed to IC1 through C1. The 741 i.c. functions as a high gain pre-amplifier driving the push pull output stage. The gain obtained by the 741 may be varied by changing the value of R5, the gain increasing as the resistance is increased. Base bias for the output transistors is provided by the R3, R4, D1, network, the forward voltage across D1 separating the bases sufficiently to reduce crossover distortion.

The circuit diagram in Fig. 1 shows this simple unsophisticated device which is easily constructed by most people in a very short time, and costs little more than £1 (the microphone and earphones, may be bought for about £5).

COMPONENTS ...

Resistors

R1	33k
R2	33k
R3	10k
R4	10k
R5	180k
All $\frac{1}{2}$ W carbon 10%	

Capacitors

C1	0.33 μ
C2	100 μ 16V electrolytic

Semiconductors

D1	1N 4002
TR1	BC 142
TR2	BC 143
IC1	741

Miscellaneous

0.1in Veroboard. Stereo jackplug socket. PP7 battery. 3 $\frac{1}{2}$ mm jack plug and socket. Microphone (crystal insert is sufficient). Light coax. cable. Headphones

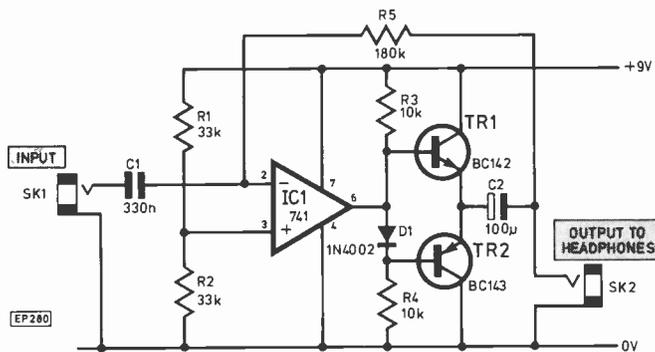


Fig. 1. Circuit of Conversation Aid

A Veroboard layout is presented in Fig. 2, the output of the mono amplifier being supplied to the headphones.

The whole unit including a PP7 battery was housed in a plastic box 5in x 2.5in x 2.5in and the microphone was attached using light weight coaxial cable, and a 3½mm jack plug and socket.

APPLICATION

Cheap and simple electronics can play a useful role in alleviating the problems of deafness once the idea of miniturisation is abandoned. Concealed hearing aids are a great benefit to the deaf, but they have their limitations. The

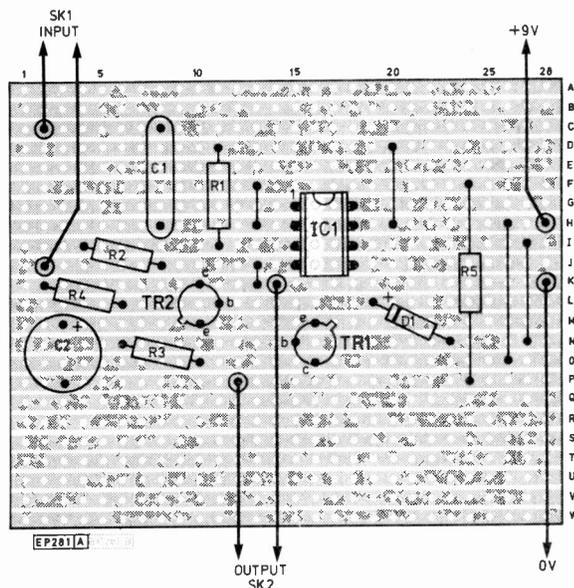


Fig. 2. Veroboard Layout

device described will not help the truly 'stone deaf', but may do much to retain or restore the domestic harmony and social life of the 'hard of hearing'. ★

Countdown

Waveform And Function Generators (mini) Feb. 19-21. National Microprocessor and Electronics Centre, London (close to Tower of London). All mini-exhibitions held at this centre run concurrently with a permanent exhibition of electronics. **L1**

BEX Feb. 20-21. Pavilion Bournemouth. **K**

IEA/Electrex Feb. 25-29. National Exhibition Centre, Birmingham. **I**

Wire Preparation (mini) Mar. 4-6. National Microprocessor and Electronics Centre, London. **L1**

Keyboards And Switches (mini) Mar. 18-20. National Microprocessor and Electronics Centre, London. **L1**

Viewdata March 26-28. Wembley Conference Centre, London. **O**

Computer-Aided Design (conference & exhibition) March 31-April 2. Metropole, Brighton. Details: CAD 80/0483-31261

Small ATE April 1-3. National Microprocessor and Electronics Centre, London. **L1**

Applying Microprocessors April 8-10. National Microprocessors and Electronics Centre, London. **L1**

Seminex April 14-18. Dept. Physics, Imperial College, London. **H1**

Communications 80 April 14-18. National Exhibition Centre. **I**

Calibration April 15-17. National Microprocessor and Electronics Centre, London. **E1**

Welsh Amateur Mobile Rally April 20. Memorial Hall. **C**

Electronic Test & Measuring Information April 22-24. Wythenshaw Forum, Manchester. **T**

International Conference On The Electronic Office April 22-25. London Penta Hotel. Organised principally by the Institute of Electronics & Radio Engineers. 99 Gower St., London WC1E 6AZ

North Midlands Mobile Rally April 27. Drayton Manor Park, Tamworth, Staffs. Details: Norman Gutteridge, 68 Max Rd., Quinton, Birmingham.

All-Electronics Show April 29-May 1. Grosvenor House, London. **E**

The Mersey Micro Show April 30-May 2. Adelphi Hotel, Liverpool. **O**

Compec Europe May 6-8. Centre International Rogier, Brussels. **L**

Great British Electronics Bazaar June 20-22. Alexandra Palace. **E**
Intel Fair June 24. Wembley Conference Centre, London. **U**
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**
Avionics (symposium) Sept. University of Surrey. **S1**
Harrogate International Festival of Sound Aug. 16-19 (18 & 19 trade). The Exhibition Centre + hotels. **X**

- E** Evan Steadman, 34-36 High st., Saffron Walden, Essex. ☎ 0799 22612
- C** Barry College of F.E. Radio Society, College of Further Education, Colcot Rd, Barry, S. Glam. CF6 8YJ.
- H1** Seminec Ltd., 79 High st., Tunbridge Wells, Kent. TN1 1XZ. ☎ 0892 39664/5
- I** Industrial Trade Fairs, Radcliffe Ho., Blenheim Court, Solihull, W. Midlands B91 2BG. ☎ 021-705 6707
- K** Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth, Dorset BH1 1LR. ☎ 020 20533
- L** Iliffe Promotion, Dorset Ho., Stamford St., London SE1 9LU. ☎ 01-261 8437/8
- O** Online Conferences, Cleveland Rd., Uxbridge, Middx. UB8 2DD. ☎ 0895 39262
- T** Trident International Exhibition, Abbey Mead Ho., 23a Plymouth Rd., Tavistock. Devon PL19 8AU. ☎ 0822 4671
- U** Brian Crank Associates, 58 London Rd., Southborough, Kent. ☎ 0892-31812 38414
- X** Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ☎ 0423-62677
- L1** P. Smith, London World Trade Centre, Europe House, London E1 9AA. ☎ 01-488 2400
- S1** Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ☎ 01-403 2351

PATENTS REVIEW...

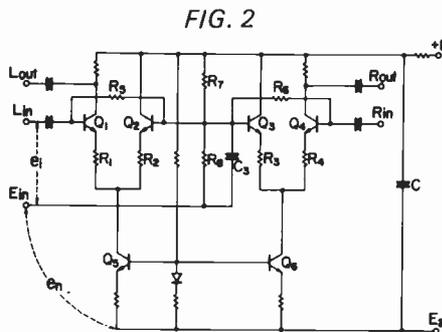
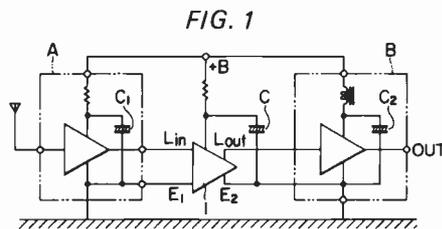
Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

NOISE ELIMINATOR

Pioneer of Japan has filed a British patent application (No. 2 020 131, dating back to March 1978 under the new laws) which describes an interesting idea for rejecting unwanted noise from audio circuits. The invention is directed primarily at car stereo systems but could have wider applications.

In a car system the cassette deck or radio receiver sections are coupled to the amplifier section by screened leads, but noise from the ignition, windscreen wipers and switches can still breakthrough and pollute the reproduced programme signal. Moreover if power supply current for the amplifier also flows in the screens, any ripple in the power supply will superimpose on the audio signal. These problems are especially noticeable with modern car systems, which are of very high amplification power and aim at true high fidelity. Interference can be rejected by the use of a transformer or photo coupler ahead of the amplifier, but the additional components are expensive if distortion or band limiting is to be avoided. Pioneer now claim that a differential amplifier system is the solution.

As shown in figures 1 and 2, audio source A (tape deck or radio receiver) feeds amplifier B via a pair of differential am-



plifiers. The first differential amp (for the left channel) is based on transistors Q1, Q2 with their emitters connected commonly through load resistors R1, R2. A constant current source transistor Q5 is collector coupled to the emitters of Q1 and Q2. The second diff amp (for the right channel) is similar i.e. transistors Q3, Q4, load resistors R3, R4 and transistor Q6 (Fig. 2).

If a noise voltage e_n is induced between the terminals E_{in} , E2 this voltage is directly applied to common input E_{in} and common terminal E2. So noise e_n is applied to the bases of transistors Q1, Q3. Audio signal e_i , on which the noise voltage e_n is superimposed is applied to the input terminals L_{in} and R_{in} , so a corresponding signal is applied to the bases of transistors Q1, Q4. A differential signal appears at the outputs L_{out} and R_{out} of the diff amps. This signal exactly corresponds to the audio signal output from the source A. So there is no trace of noise e_n at the output terminals L_{out} , E2, and R_{out} . Hence the amplifier B produces a noise-free signal.

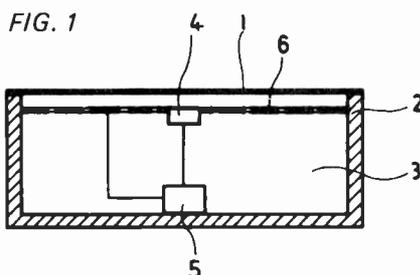
Pioneer point out that because the circuit does not rely on a bulky transformer or photocoupler it can be reduced to i.c. chip form and mass produced at low cost and of very compact size.

ANTI-SOUND

The concept of anti-sound is not new. For years engineers have been working towards a system which mimics ambient noise, but in anti-phase, so that the net result is silence. The Munich company Messerschmitt-Bolkow-Blohm GmbH already has several patents on inventions in this field and is now applying for protection on an interesting idea intended to overcome one of the major problems to date. This is non-linearity between the noise sensor and the anti-noise generator. UK patent application no. 2 019 695 (filed under the new laws and dating back, hopefully not significantly, to 1 April 1978), offers lengthy mathematical back up for Messerschmitt's claim to success with an apparently novel approach. This involves the integration of both the sound sensor and sound generator into a single unit.

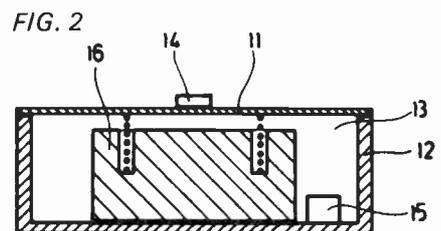
Figure 1 shows a combined sensor/generator with a thin walled diaphragm

1 which seals air space 3 in a housing 2. A capacitive distance measuring device 4 determines the time characteristics of the deflection of the diaphragm caused by arriving sound. A signal derived according to the maths in the patent is transmitted to a control 5 which applies a voltage proportional to the deflection signal to a grid electrode 6 beneath the diaphragm. The diaphragm generates appropriate sound waves to interfere with those which it



senses, thereby reducing the ambient sound level in the immediate vicinity.

Figure 2 shows a slightly different combined unit, with a rigid plate diaphragm 11 buckled into housing 12 to seal a vacuum 13. A control force is derived from an accelerometer 14 and applied to the diaphragm 11 via control circuit 15 for a magnet and moving coil arrangement 16. The diaphragm is thus again driven to transmit sound waves which interfere with those which it senses.



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FRANK W. HYDE

INDIA AND HER SATELLITES

Since the first satellite coverage of India, when a geostationary craft was moved to a position to serve for a trial period, plans were finalised for the future of the continent's own system. The geostationary craft was the ATS-6 and was used to test the use of television educational methods. This craft was moved back to its position about a year later and proceeded with its normal tasks.

India has now leased one quarter of an Intelsat 4A transponder which has been operating with the first of the Insat ground stations. Testing of the first domestic link, between Madras and Delhi began operation in August 1979 and completed its task in November. Another experiment aboard the *Ariane* as a passenger payload, is an Indian built two transponder experimental satellite which is due for launching in 1980.

In addition to the transponder India has built two scientific satellites. These were launched by Russia.

At the present time the finalising of the design of a remote sensing satellite for dealing with natural resources to be launched in the 1983-1984 period in a polar orbit, is in progress.

COVERAGE AND CONTROL

The whole continent including remote islands, Andamans and Nicobar, will be covered with levels of ground facility. These are large earth stations with two 14.6m antennae, medium stations with one 14.6m antenna and remote area terminals. In addition to these principle stations there will be more than 100 meteorological platforms for data collection and six mobile ground stations. There will also be a number, not defined, of low cost ground stations which will be used for direct television coverage.

The Master Control Facility will be at Hassan in Southern India, a Network Control

Facility will be at New Delhi and the third major facility will be the Meteorological Data Utilisation Centre also at Delhi.

The Master Control Facility will provide orbit raising as well as in-orbit control. It is expected that this will be completed by October 1980. The Meteorological Facility will be completed before first launch.

Insat 1-A is expected to reach full utilisation by mid 1982. Insat 1-B will be launched in the second half of 1982.

Insat is a joint venture of the nation's Space Department, Posts and Telegraph Department of the Ministry of Communications, Indian Meteorological Department of the Ministry of Tourism and Civil Aviation, and Door-darsham, the Television section of the Ministry of Information and Broadcasting.

The Space Department is the responsible body for establishment of the space facilities. The Post and Telegraph Department is responsible for the telecommunications ground system and for the utilisation of the ground systems whilst the Meteorological Department is responsible for similar facilities in regard to meteorology.

LAUNCH OF INSAT 1-A and 1-B

Insat is designed so that it may be launched either by shuttle or by the NASA/McDonnell Douglas Delta 3910 expendable booster. India's agreement with NASA provides for a Delta back-up option should a shuttle slot not be available. In either case a McDonnell Douglas payload assist module will be used to boost the satellite from a low earth orbit to the geostationary orbit. One of the Satellites will be at final orbit longitude 74°E and the other at longitude 94°E.

The satellites will have twelve transponders for telecommunications and two for television and radio direct broadcasting. The telecommunications transponders will receive ground signals at 5935-6425MHz. and transmit on down link frequencies of 3710-4200MHz. The minimum output will be 32 dbw equivalent isotropic radiated power after seven years in orbit.

The television transponders will receive at 5855-5935MHz. and will transmit at 2555-2635MHz. They are designed to have a final life output of 42 dbw. All the transponders will have a bandwidth of 36MHz.

The telecommunications transponders will provide 6,000 channels interconnecting a network of 35 fixed and mobile earth stations of various sizes and capacities. Conventional systems will be used in heavily populated areas but in remote or sparsely populated areas small receiver aerials only will be employed. The low cost receiving aerials will be between three and four metres in diameter. Disaster warnings and ordinary radio programmes could be given in this direct broadcast network.

RADIOMETER

The satellites will carry a high resolution radiometer which will make available at two hourly intervals visible and infra red images of the whole Earth. The visible images 0.55-0.75 micrometres will have a resolution of 2.5km and the infra red 10.5-12.5 micrometres a resolution of 11km.

The other facilities are 100 unattended land

and sea based data collection platforms. These will transmit meteorological data, hydrological and oceanographic data to the Delhi centre. Radiometric data will be down linked on a discrete channel at 4034.55MHz. Collection platform data will have a 200kHz bandwidth at 4038.1MHz. The up-link for this data will be 402.75MHz.

Observations of weather systems will include cyclones, sea surface and cloud top temperatures, water bodies, snow and other terrain changes which will include areas adjacent to India. Thus the close watch of cyclones will enable forecasts up to 12-24 hours in advance of other available methods. This will advance warning times by the direct broadcast system.

The snow coverage facilities are expected to assist the regulation of reservoirs for irrigation, irrigations control and flood control. The sea surface temperature is expected to make it possible to make earlier forecasts of the onset of monsoon periods. In fact there are all the facilities for the Indian continent to control the utilisation of its own natural resources and agriculture.

The meteorological information will be transmitted in real time from the Delhi Earth Station to the New Delhi Data Centre over a microwave link. The New Delhi Centre will analyse process and store data from the platforms and transmit processed images over telecommunications lines to the forecasting offices of the Meteorological Centre.

THE EARTH STATIONS

Five of the stations will have very high gain facilities of the order of 31 db/°K. These will be located at the main switching centres of the National Communications system. They will provide remote area communications and an up-link for feeding the ordinary television networks. They will also provide the telephone trunk service. All but the station at Shillong will have two antennae so that there can be simultaneous links with Insat 1-A and 1-B.

Twelve medium sized stations will be erected at Leh and Jullunder in the north of India, Lucknow, Patna, Bhubaneswar, Ahmedabad and Jaipur in the centre, Hyderabad and Ernakulam in the south, the Laccadive Islands in the Southwest and the Andaman and Nicobar Islands in the southeast. These will provide trunk telephone service and Television up-link feed. The gain of these stations will be 27.5 db/°K.

Twelve remote area terminals with a gain of 19.7 db/°K will be used for the telephone service only. These will be at Srinagar in the north, Arunachal Pradesh, Nagaland, Imphal, Mizoram, Agartala and Gangtok (Sikkim) in the north east, Bujand Johpur in the west, Goa and Pondicherry in the south and Mimicoy south of the Laccadives, in the southwest.

Six mobile terminals are also to be included in the system. Four of them will be stations which are transportable having gains of 19.7 db/°K. The remaining two will be emergency stations which can be airlifted or moved on jeelike vehicles. These will be capable of providing both telephone and television uplink feed service. All the high frequency (4-6 GHz) earth stations will be linked via the control centre at New Delhi.

THE SATELLITES

The satellites will use three axis stabilisation with a precision momentum bias attitude control system. Two off-axis momentum wheels will be used in the primary mode and a single pitch and yaw wheel. Two-axis infrared earth sensors and a digital sun sensor provide attitude reference. Spacecraft thrusters will fire to unload the wheels.

The antennae reflectors will be deployed when the satellite is in orbit. The circular reflector 1.4 metres in diameter will be used for all the 6-GHz up link reception. Down link will use half of the 4-GHz channels. This reflector will use dual band horns for transmit and receive.

A 1.5 x 1.6 metre reflector at the opposite end of the satellite will transmit the remaining 4GHz channels and also the 2.5GHz down link signals. The antennae produce circular beams but are so designed that the edges limit the flux outside the territory of India. Four printed circuit crossed dipole antennae will be mounted on the earth viewing face of the satellite for the reception of UHF signals from the data collection platforms.

The satellite will weigh 1,279lbs when in geostationary orbit. The overall dimensions, when all the arrays, antennae, and solar sail are extended, will be 5.8 x 1.4 x 17.9 metres.

The solar sail, to counteract the effect of the

solar wind on the asymmetrical solar array, is a ten foot high conical array.

POWER ARRAY

The solar power array is made up of five panels arranged with a vacant panel area to allow a clear view for the meteorological sensor. The array is 11.5 sq metres and designed to produce 900W at the end of the spacecraft's seven year life design.

A boost motor for control at apogee uses liquid propellant. This together with the solar sail and the microprocessor control system are innovations not in operation in any earlier design.

REACTION TO UFOs

Two CHAMP Programs have been submitted by Peter Davies of Birmingham.

The first program is a "Reaction Timer" which records the time between a signal on the display and the microprocessor being interrupted by one of the keys on the keyboard being pressed. The program first clears RAM register 0 which is used to store the display data. The index registers are cleared and stored with data for the subsequent delay. A delay of approximately 10 seconds follows, after which, eights are displayed to signal the user to press one of the keys. After a delay of approximately ten milliseconds a three digit counter is incremented. The counter is continually incremented every ten milliseconds until the microprocessor is interrupted.

When an interrupt occurs the contents of the three digit counter are converted to 7-segment code using the subroutine in CHOMP, LOKY. The code is then continually displayed until the reset button is pressed.

Since there is a three digit counter, times between 10 milliseconds and 4.44 seconds are recorded. If a key is pressed before the first delay has run out, the display will show 000 making it very difficult to cheat. Also after 4.44 seconds the display will show 000 to prevent the counter from starting again.

Reaction Timer

Address	Data	P'memir	
200	42	JUN 2	
1	05	05	
2	00	KLF	
3	47	JUN 2	Interrupt Vector
4	4A	4A	
5	20	FIM 0	
6	00	00	
7	20	SRC 0	Clears RAM register 0
8	FC	CLB	
9	30	WPM	
A	70	152 0	
B	07	07	
C	2C	FIM C	
D	00	00	Clears registers for counter
E	2E	FIM E	
F	00	00	
210	20	FIM 0	
1	00	00	loads registers for delay
2	22	FIM 2	
3	00	00	
4	24	FIM 4	
5	AA	AA	
6	20	152 0	
7	16	16	
8	71	152 1	10 second delay
9	16	16	
A	72	152 2	
B	16	16	
C	73	152 3	
D	16	16	
E	74	152 4	
F	16	16	

MICRO PROMPT

The hardware and software exchange point for PE computer projects

SECRET POLLING

Here is a suggestion for a "secret" key polling subroutine on the UK101, sent in by J. M. Leach of Deal, Kent.

```
100 POKE 11, 0 : POKE 12, 253 :
    X=USR (X) ; A=PEEK (531)
    : RETURN
```

Now try

```
10 GOSUB 100 : PRINT CHR$
    (A) ; GOTO 10
```

The routine described will return any single character from the keyboard without the need to press the RETURN key. This is useful in computer games. However, we should point out that this routine will wait until a key is pressed before commencing execution.

The method suggested in *PE November 1979*, on page 30, whereby the keyboard buffer address (57088) is POKEd with the appropriate Row number, and the PEEKed for the expected Column number, has one major advantage. With this method, the machine will sweep past the statement and ignore it if no key is pressed. The more dynamic, or real-time games need this feature, so that if there is no operator response, the machine will continue to animate the screen graphics.

When the latter is used, Control C must first be disabled by POKeing 530, 1. Use the keyboard matrix diagram of page 14 in the *Compukit Manual* for Row and Column numbers. You will soon discover the relative merits of these two methods.

101 USERS' GROUP

Sir—Having read your magazine for some years now I have always been interested in your many and varied projects. In the last few months I have followed with great interest your series on the *Compukit UK101*. I own one of these and it was very reassuring to see a magazine of your standing devoting so much space to this item.

Recently I have started a user group for

the UK101 and all the members have at some time read the series. For this reason, when I decided to expand the club, I thought it wise to contact you.

The group serves as a clearing house for programs as well as providing useful hints on construction and most other aspects of the 101. We hope to be able to produce a newsletter in the very near future, and perhaps a cassette or two of the most popular programs.

Adrian Waters,
101 Users Group.

For further information, contact: Mr. Waters, Cadover, 117 Haynes Rd., Hornchurch, Essex.

DODGEY DIMENSIONS

Sir—I have built the UK101 and consider it to be superb value. However, recently I discovered a bug in my machine. If during a program I DIMension a string array with the first subscript having one of the following values: 1, 3, 4, 6, 7, 9, 10, etc., the machine hangs up when the program has been run, followed by ?FRE(0). When reset, Warm Start ?FRE(0) gives 0 □ ERROR.

eg.

```
10 DIM A$(3)
RUN
?FRE(0) . . . hangs up
Warm Start
?FRE(0) 0 □ ERROR
```

```
10 DIM A$(5, 3)
```

```
RUN
?FRE(0) 7302
OK
```

Not dimensioning means the machine defaults to 10 and is therefore expensive on memory. My solution at the moment is to DIM at the next highest acceptable number. This results in a loss of memory. All other statements perform normally. I would appreciate any advice on this problem.

Our *Compukit* does the same. Does anyone have a solution to this?

220	DF	LDM F	
1	>P	PIB 8	
2	80	80	Displays eights on screen.
3	29	SAC 8	
4	E5	WR1	
5	E6	WR2	
6	E0	WRM	
7	0C	ZIN	
8	20	PIB 0	
229	05	05	Data for ten millisecond delay
A	P7	PIB 2	
B	E0	E0	
C	7F	7F 0	
D	2C	2C	
E	71	15P 1	ten millisecond delay
F	2C	2C	
23X	72	15P 2	
1	2C	2C	
2	FD	INC D	
3	AD	LD D	
4	F1	CLC	
5	F3	DAA	
6	3D	XCH D	3 - digit decimal counter
7	1A	INC	
8	2P	2P	
9	F1	CLC	
A	E0	INC C	
B	AC	LD C	
C	FB	DAA	
D	3C	XCH C	
E	1A	INC	
F	2P	2P	
240	F1	CLC	
1	6E	INC E	
2	A2	LD E	
3	FB	DAA	
4	BE	XCH E	
5	1A	INC	
6	2P	2P	
7	0		
8			
9			
A	0A	SBO	Interrupt routine
B	50	JMS 0	- Jump CHOMP
C	CE	JE	subroutine LOKY
D	50	JMS 0	- CHOMP subroutine
E	B1	B1	DDRV
F	42	JM? P	
250	42	42	

The initial 10 second delay can be altered by having different values at address 215.

The second program is a game called "Destroy". The idea is that the user controls a ground base and must destroy U.F.O's flying overhead. This program will be shown in the next Micro Prompt.

TORPEDO RUN

This program in BASIC, simulates a submarine attack on a ship which moves across the screen from left to right, disappears from the screen, then reappears on the left but slightly lower down. A torpedo is fired by pressing 1 on the keyboard. The number of torpedoes used is displayed on the screen. A maximum of nine torpedoes may be fired, after which the computer comments on your performance.

Hits are achieved by the torpedo striking amidships. The ship then stops in its tracks and an explosion is seen. The number of hits achieved is also displayed on the screen.

```

4 CLEAR
5 FOR Z = 1 TO 30 : PRINT :
  NEXT
10 A = 53248 : C = 54240
15 FOR I = 1 TO 1024
20 A1 = A+1 : A2 = A+2 : A3 =
  A+3 : A4 = A+4
25 A5 = A+5 : A6 = A+6 : A7 =
  A+7 : A8 = A+8
30 A9 = A+9 : B1 = A+10 : B2 =
  A+11 : B3 = A+12
32 POKE 54123 , 84 : POKE 54134 ,
  72
35 POKE B3 , 196 : POKE B2 , 158 :
  POKE B1 , 158
40 POKE A9 , 159 : POKE A8 , 160
  : POKE A7 , 161
45 POKE A6 , 160 : POKE A5 , 159
  : POKE A4 , 158
50 POKE A3 , 158 : POKE A2 , 198
  : POKE A1 , 32
52 POKE 530 , 1
55 POKE 57088 , 254 : POKE 57088
  , 127
60 IF Q = 1 THEN 500
65 IF PEEK (57088) = 127 THEN V
  = V+1 : GOTO 500
70 A = A+1 : FOR G = 1 TO 50 :
  NEXT G
71 POKE 54125 , (48 + V)
72 IF C2 = A9 THEN 600
73 IF C2 = A8 THEN 600
74 IF C2 = A7 THEN 600
75 IF C2 = A6 THEN 600
78 NEXT I
80 Q = 0 : GOTO 10
500 Q = 1
510 C1 = C : C2 = C1 - 64 : C3 = C1
  + 64
520 POKE C1 , 149 : POKE C2 , 193
  : POKE C3 , 32
530 C = C - 64 : T = T+1 : IF T = 17
  THEN 550
540 GOTO 70
550 C = 54240 : T = 0 : Q = 0
560 IF V = 9 THEN 700
570 GOTO 70
600 POKE (C2 - 64) , 9
610 P = P+1
620 POKE 54136 , (48 + P)
630 FOR D = 1 TO 2000 : NEXT D
640 GOTO 78
700 FOR Z = 1 TO 30 : PRINT :
  NEXT
710 IF P < 3 THEN PRINT " STAY
  A CIVILIAN ! " : GOTO 770
720 IF P < 5 THEN PRINT "
  REPORT FOR AN EYE TEST "
  : GOTO 770
730 IF P < 7 THEN PRINT " YOU
  DID WELL " : GOTO 770
740 IF P < 9 THEN PRINT " VERY
  IMPRESSIVE " : GOTO 770
750 PRINT " EXCELLENT . . . .
  CAPTAIN SIR "
770 PRINT : PRINT : PRINT :
  PRINT : PRINT
780 INPUT " ANOTHER PATROL
  ? " ; P $
790 IF P $ = "Y" THEN 4
800 FOR Z = 1 TO 30 : PRINT :
  NEXT
810 PRINT " ENJOY YOUR SHORE
  LEAVE "
820 PRINT : PRINT : PRINT :
  PRINT : PRINT
830 END

```

Lines 5, 700 and 800 clear the screen. X = USR (X) could be used instead, to cause a jump to a machine code routine resident in a protected area of RAM. A suitable machine language routine for clearing the screen was published in *PE September 1979*.

Lines 35 - 50 dictate the shape of the ship

Lines 72 - 76 detect a hit

Line 520 dictates the shape of the torpedo

Lines 500 - 570 controls the torpedo travel

The program is a result of experimenting with the graphics on the Compukit 101 and is certainly not meant to be a lesson in the art of programming. It is a program that runs on less than 2K of memory, and may be of some use to the newcomer to the 101.

M. D. E. Connor,
Swansea.

COMPUKIT UPDATE

By Dr. A. A. BERK

NOW that many people are running Compukits, it is possible to sit back and take stock of the situation. As with any new device teething troubles have emerged, but are now mostly resolved by modification to the p.c.b.. The main purpose of this column is to keep Compukit owners, and anyone else interested, abreast of current developments in software and hardware. There are several updates which will be of interest to readers, and these are presented below.

CASSETTE TAPE SPEED

The cassette interface has provoked a large number of questions and comments on the Compukit, and I shall attempt to answer the most frequent one here.

The speed of transfer of cassette information is dependent upon the clock frequency sent to the ACIA (IC14). If you double this frequency, each byte sent serially from it, will appear in half the time and hence recording will occur at twice the rate (600 BAUD). If the clock speed is doubled again, 1200 BAUD will be achieved. There is one major problem, however. Reading information back from the tape and converting audio frequency signals to digital waveforms, depends upon the tape speed being reasonably constant both in the short term and over a long period of time. The ACIA's normal clock speed, producing 300 BAUD, is quite consistent with all normal variations, and even tolerates most speed variations between different machines. If you refer to the cassette interface diagram in your Compukit

Manual, you will notice that data acquisition depends upon the time-constant of monostable IC69, and a comparator, effectively, IC63.

The timing of this arrangement is independent of tape speed, and as the speed of data retrieved is increased, the tolerances in this system must be more and more exact. The device cannot be expected to function reliably at, say, 1200 BAUD.

Some speed variation does seem possible, however, and doubling the frequency of the Tx clock has produced some reliable results. If you would like to try faster cassette storage, perform the following modification (refer to cassette interface diagram).

At present, pin 9 of IC63 (7474) is connected to Tx clock (pins 4 and 3 of IC14). Take Tx clock from pin 11 of IC63 instead of pin 9. This bypasses IC63's divide by two function. This modification is worth experimenting with, as several people claim full success. Try modifying and then recording and playing back on the same machine.

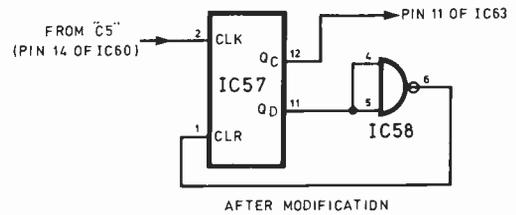
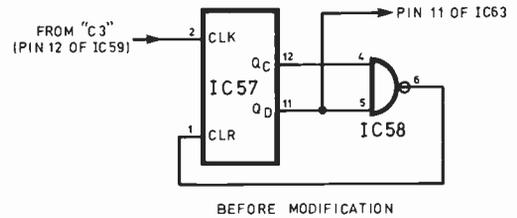
The Software of the Compukit takes care of cassette handling automatically for any Tx clock frequency, as it handshakes with the ACIA during the process. Some adjustment to the value of R53 and C11 may prove fruitful if the above modification remains unsuccessful.

110 BAUD TELETYPE

The cassette interface is also used to run serially interfaced printers such as the Anadex. Many people have asked if it is possible to run standard 110 BAUD Teletypewriters. The answer now appears to be *yes*. This is something new, and hence apologies to those who have asked this question before and been given a negative answer.

The problem is that doubling or halving frequencies to change from 300 BAUD to 600, 1200, 150, 75 etc. is easy. Multiplying by 110/300, however, is not so simple. It requires an interesting calculation around the design characteristics of the 74163 synchronous presettable binary counter. In the present system, a frequency of 125kHz (output C3 from IC59) is divided by 13 using IC57 and one NAND gate (IC58). IC63 then divides this by 2 to supply a frequency of 4.8077kHz to the Tx clock of IC14. 4.8kHz is the correct frequency for a 300 BAUD rate. This is derived from $\text{Freq./BAUD rate} = 16$. Here, a 10-bit frame is used consisting, technically, of one start bit, one byte and one stop bit.

To derive the correct rate for 110 BAUD teletypes, a Tx clock of 1.76kHz is necessary. IC57 may be fed with 31.25kHz from output C5 of IC60 (pin 14) and then made to divide this by



EO288

Fig. 1. Before and after TTY modification

nine. IC63 then divides by two and forms a Tx clock frequency of approximately 1.736kHz which is within about 1.4 per cent of the required frequency and quite accurate enough for this application.

The only problem lies with the format of each frame sent to the teletype. 110 BAUD machines expect two stop bits along with the byte being sent, and the Compukit software sends just one, via IC14's internal registers. However, I have an old RO35 working beautifully from the Compukit with the following mod., and I should be most grateful for any feedback on its success in general. This is at present a *send only* mod., and no thought has been given to receiving from a teletype as the Compukit has its own full keyboard.

The mod. is shown in Fig. 1, and consists of:

- (1) cutting the connection between IC58 pin 4 and IC57 pin 12.
- (2) joining pins 4 and 5 of IC58 (still joined to pin 11 of IC57).
- (3) joining pin 11 of IC63 to pin 12 (instead of pin 11) of IC57.
- (4) feeding pin 2 (CLK) of IC57 from output C5 (pin 14 of IC60) instead of C3.

It is worth making this modification switchable if it is to be used to any extent.

Fig. 2. Compukit's screen address map

DECIMAL	HEX.	0	11	12	23	24	35	36
53248	D000	0	B	C	17	18	23	24
53312	D040							
53376	D080							
53440	D0C0							
53504	D100							
53568	D140							
53632	D180							
53696	D1C0							
53760	D200							
53824	D240							
53888	D280							
53952	D2C0							
54016	D300							
54080	D340							
54144	D380							
54208	D3C0							54254 (DEC.)

**U
K
1
0
1

C
H
A
R
A
C
T
E
R

S
E
T**

0	NU	I	(	X	W	□	□	L	□	△
10	LF	^	≡	CR	♠	♠	♠	♠	♠	♠
20	↓	↘	←	↙	£	~	‡	□	+	△
30	Y	∇	SP	!	"	#	\$	%	&	'
40	(	)	*	+	,	-	.	/	θ	1
50	2	3	4	5	6	7	8	9	:	;
60	<	=	>	?	@	A	B	C	D	E
70	F	G	H	I	J	K	L	M	N	O
80	P	Q	R	S	T	U	V	W	X	Y
90	Z	[	\	\]	↑	_		a	b	c
100	d	e	f	g	h	i	j	k	l	m
110	n	o	p	q	r	s	t	u	v	w
120	x	y	z	()	_	÷	~	-	-
130	-	-	-	-	-	-	|	|	|	|
140	|	|	|	|	-	-	|	|	-	|
150	-	-	|	|	■	■	|	|	■	■
160	■	■	■	■	■	■	■	■	■	■
170	■	■	■	■	■	■	■	■	■	■
180	←	◊	△	■	■	■	■	■	X	/
190	\	∇	<	^	>	/	/	/	/	/
200	\	/	/	ˆ	ˆ	ˆ	ˆ	ˆ	ˆ	ˆ
210	┌	└	└	•	z	±	†	†	†	+
220	ˆ	ˆ	ˆ	ˆ	(	)	O	C	C	♥
230	♣	♠	♦	♣	♠	♠	♠	♠	♠	♠
240	♠	α	β	ω	δ	ψ	ϖ	ϕ	π	Σ
250	λ	φ	θ	ε	ν	γ				

Fig. 3. UK101 character set. Note that CHR\$ 183-187 are chequered (i.e. half-tones)

GRAPHIC CHARACTER SET AND VDU

To change the subject entirely many people have asked for a copy of the graphic character set with the numbers by which they can be "reached". For instance, if you type:

```
PRINT CHR$(53)
```

the character "5" appears on the screen.

The diagram in Fig. 3 shows the complete character set with numbers to be placed inside the CHR\$ function for their printing. To select the correct value of a given character, add its row and column numbers together. For instance, PRINT CHR\$(179) gives the "⇒" sign.

The manual supplies a program to help with identifying these characters, but the diagram presents them for "hard copy" reference.

As to the screen address of each character slot, Fig. 2 shows the VDU address map in decimal and hexadecimal for reference. The map has 16 lines and 48 character positions per line. Your TV may show less—experiment with the following to find out:

The first character on each line is given an address, and the top of the map supplies an offset to be added to this for addressing each character on a given line. To simplify the diagram, the 48 characters on each line are split into fields of 12 characters, each with decimal and hexadecimal ranges of offset for each field. For instance, at the centre of the screen there is a square of four character positions. These are addressed as shown in Fig. 4.

Fig. 4. Addresses of centre block of characters

D1D7 (HEX) 53719 (DEC)	D1D8 53720
D217 53783	D218 53784

Try printing the numbers: 1,2,3,4, as below, in these positions before reading on:

```
1 2
3 4
```

There are two ways to do this:

- (a) Use the machine code monitor and load the numerical code for 1,2,3,4 in hexadecimal addresses: D1D7, D1D8, D217, D218.

- (b) Use POKE as follows:

```
POKE 53719,49
POKE 53720,50
POKE 53783,51
POKE 53784,52
```

In (a), the codes for 1,2,3,4 are determined by changing the decimal codes in Fig. 2 to hexadecimal: i.e., 49 (decimal) for "1" becomes 31 in hexadecimal, 50 (decimal) becomes 32 (hex) and so on. In order to use the machine code monitor in any application, it is essential to be fully conversant with hexadecimal numbering, and its conversion to and from the decimal system. This subject is quite large and complex, and will be dealt with in the next edition of this column, to appear in two months time.

If you examine the end of each line in Fig. 3, you will notice that the address of each line ending (the 48th character on a line) is not contiguous with the address of the start of the next line. For instance, the last character on the first line has address 53248 + 47 which equals 53295 (decimal). The second line starts at address 53312 and not 53296. There are 16 character addresses missing, in fact, on the end of each line. These addresses are valid Read/Write memory locations, but do not appear on the screen. They could be used as scratchpad memory by your own machine code routines. Be a little careful how you re-enter BASIC after a low level routine, as BASIC prints "OK" followed by the cursor as well as at least one line of spaces and possibly a screen scroll-up if the cursor is on the lowest line.

A final note concerns a problem mentioned by two people: it appears to be a rare condition, but if the characters on your VDU display seem to flicker after an hour or two of use, several actions are worth trying. First and foremost, clean all the solder flux from your board using methylated spirit or one of the excellent flux solvents on the market. Pay special attention to IC28 and any areas where there is an 8MHz signal line. If this does not work fully, try changing IC28 and/or adjusting the values of R81 and C60. This capacitor may not be supplied as a small disc ceramic and it may help to change it for one.

It only remains for me to wish all of you who have a CompuKIT, the very best of luck with your programming, especially if this is your first contact with the art. My feeling is that the ability to program and use a computer, as well as the basic skills of soldering and familiarity with silicon chips, etc., will form a most important area of general knowledge in the future. The CompuKIT has already played an important part in accelerating this process.

POINTS ARISING

CORRECTION TO SOFTY REVIEW IN JANUARY ISSUE.

A note of correction is in order for the *SOFTY Review* (January issue). The origin of the word "Firmware" in that article is stated in a manner which has often been heard—perhaps erroneously. The more common meaning, which should have been included, is that it is firm and unchangeable if stored in ROM. Many thanks to those who have been so PROMpt to point this out!

We would also like to correct two other inaccuracies in the review. Firstly Phil Morris is not "of Videotime Products" but provided a limited design service for the interface board—he is chief designer of PCL Ltd. Secondly Videotime Products market Softy but do not manufacture it.

CONSTANT DISPLAY FREQUENCY METER

(August 1978)

It has recently come to light that 74123 devices from some manufacturers are not compatible with the requirements of the Frequency Meter, and will not oscillate correctly with the circuit as published. In order to achieve correct oscillation it may be necessary to disconnect the end of R2 that is on Pin 13 of IC1 and take it direct to the +5V line.

COMPUKIT—4 (November 1979)

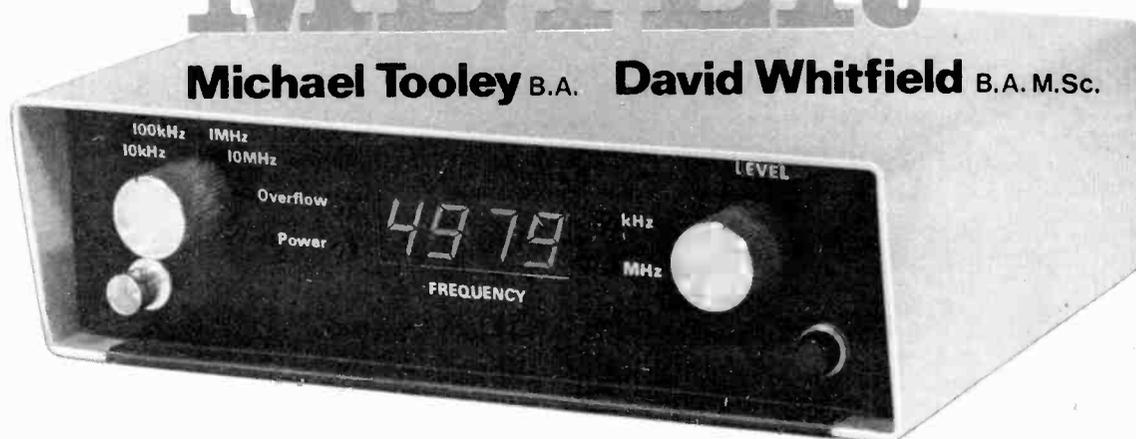
Two corrections to PIA, Fig. 4.1. Reset (pin 34) should go to +5V, pulsed to OV for reset. Pin 25 should go to 02 (pin 31 on J1). Also, current amplification is necessary to drive the l.e.d.s.

The address decoding of Fig. 4.3 is incorrect. The two lower NOR gates should be OR gates.

ACOUSTIC MODEM (February 1980)

The Test Oscillator "earthy" o/p line, shown in Fig. 4, should be taken from OV and not the bottom end of the 10µF capacitor.

FREQUENCY METER



THE digital frequency meter to be described here is a general purpose low-cost unit. It has been designed using some recently available devices to allow the meter to be used for portable applications. The facilities available to the user may easily be extended beyond the basic needs of portable applications, and the performance may be enhanced by the addition of the v.h.f. prescaler which will be described next month.

DESIGN FEATURES

The specification of the portable DFM is shown opposite. Only two front panel controls are provided; range selection, and a combined power switch and level control. The display readout is limited to 4 digits in order to minimise power dissipation and cost.

A block diagram for the complete instrument is shown in Fig. 1. The input amplifier and all of the logic is included on a single p.c.b. (shown by the dotted line), with only the controls, displays and input/output sockets external to the board. The circuit is simple to set up, requiring only one preset adjustment (adjustment of the time standard oscillator frequency to exactly 1 MHz).

CIRCUIT DESCRIPTION

The circuit diagram of the input amplifier, level shifter and waveform shaper is shown in Fig. 2.

The input amplifier consists of a voltage limiter followed by a high impedance amplifier. The peak amplitude of the signal applied to the gate of the junction FET, TR1, is limited to approximately ± 600 mV by the action of R1, D1 and D2. The FET itself is used in a self-biasing circuit. The gate is tied to ground by R2, and the stage presents a high impedance to the signal. The d.c. source potential is produced by the current flowing in R3, and this provides the necessary negative bias. The source load is decoupled to a.c. by C2 to give a low frequency roll-off at approximately 10 Hz, while the high frequency performance is enhanced by C1.

The excursion limits of the voltage waveform at the emitter of TR2 are varied by the setting of VR1, allowing variation of the level as required for the level shifting function. The actual switching levels of the waveform shaper are preset by the characteristics of the Schmitt-input gate, IC1c.

Fig. 3 shows the overall response characteristics of the input stages to sinewave signals.

CONTROL LOGIC AND SIGNAL GATE

The circuit diagram of the control logic and signal gate is shown in Fig. 4.

The control logic governs the sampling rate of the instrument (the rate at which the input frequency is re-measured), and performs all of the necessary "housekeeping" functions,

SPECIFICATION

Frequency Range:	10 Hz to 5 MHz (minimum) 8 Hz to 7 MHz (typical performance)
Input Sensitivity:	Better than 200 mV r.m.s. 10 Hz to 5 MHz 10 mV r.m.s. at 1 kHz (typical)
Display Ranges:	1. 1 Hz to 9.999 kHz (kHz units) 2. 10 Hz to 99.99 kHz (kHz units) 3. 100 Hz to 999.9 kHz (kHz units) 4. 1 kHz to 9.999 MHz (MHz units)
Front Panel:	Display range selector switch (S1) Input level control (VR1)/power switch (S2) Signal measurement inlet (SK1) TTL power indicator (D18) kHz display units indicator (D4) MHz display units indicator (D8) Display over-range indicator (D3) 4-digit decimal point display Mains indicator
Rear Panel:	6 volt d.c. inlet sockets (SK4 and SK5) D.c. supply fuse (F2) 1 MHz TTL outlet (SK2) 1 kHz TTL outlet (SK3) Mains inlet socket
Power Requirements:	+5 volts d.c. at 160 mA (standby) +5 volts d.c. at 250 mA (maximum) Power from 6V battery supply or mains regulator

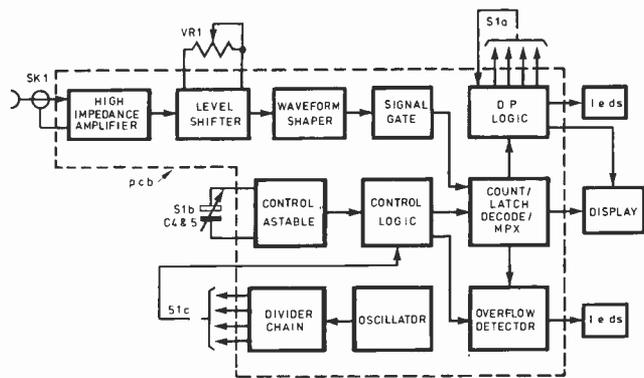


Fig. 1. Block diagram of the D.F.M.

ensuring, for example, that the display counters are all reset to zero before the input signal is re-sampled. The signal gate acts on commands from the control logic and provides the counting/display circuitry with the number of pulses which is appropriate to the range selected and to the input signal frequency.

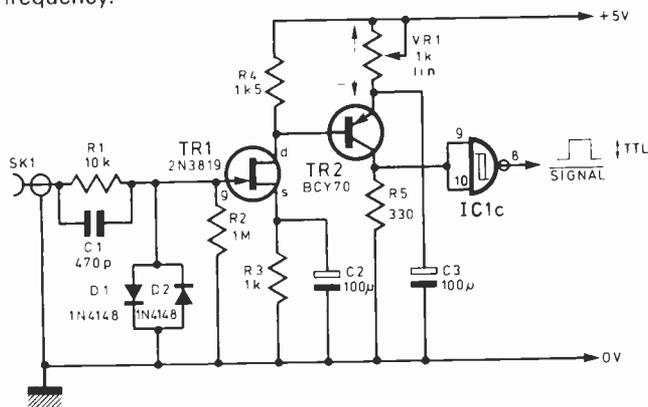


Fig. 2. Circuit diagram of the input amplifier, level shifter and waveform shaper

A 555 timer, IC2, is arranged as a control astable which has an output with a HIGH:LOW ratio of approximately 7:2. The signal sampling sequence is initiated by HIGH-to-LOW transition of the astable output. This transition causes the next LOW-to-HIGH transition of the selected clock signal to invert the normal output states of IC3a, driving the Q output HIGH, and opening signal gate, IC1a. The next LOW-to-

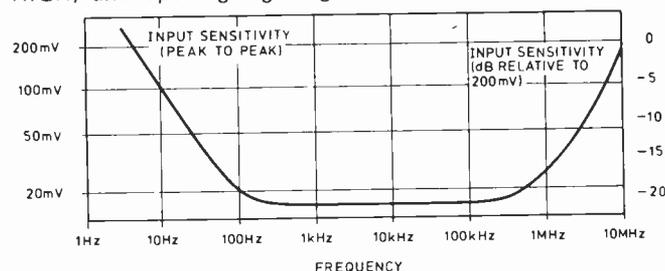


Fig. 3. Input stage response characteristic

HIGH clock edge restores the state of the outputs on IC3a, thereby closing the signal gate. The Q output on IC3b is also driven HIGH, and this allows the accumulated count to be transferred to the display latches, as well as inhibiting IC3a until the start of the next sampling period. The LOW-to-HIGH transition of the control astable output completes the display latching and, after a short delay introduced by R9 and C6, clears the counters ready for the next sampling period. The circuit is then dormant until the next HIGH-to-

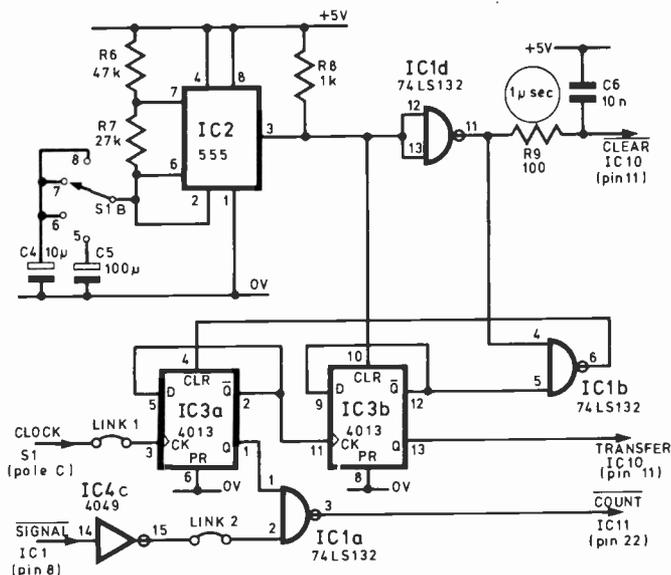


Fig. 4. Circuit diagram of the control logic and signal gate

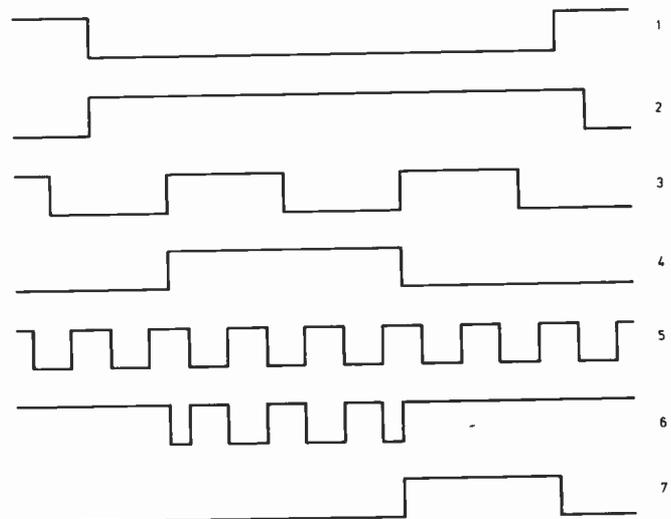


Fig. 5. Timing diagram

LOW astable transition, when the whole sequence is repeated. A timing diagram for the operational sequence is shown in Fig. 5.

The rate at which the signal is re-sampled is set by the combination of R6, R7 and C4/C5. The values of these components have been chosen, within the other design constraints, to give a sampling rate which, on ranges 2 to 4, is slow enough to allow the display to be easily read, yet fast enough to allow alterations to be made to the input signal frequency without the display becoming tedious. The resolution of range 1 requires that a much longer re-sampling interval is used, hence the different value of capacitor.

TIME STANDARD OSCILLATOR AND DIVIDER CHAIN

The portable DFM is designed to provide the user with display resolutions of between 1 Hz and 1 kHz, and employs gate sampling periods of between 1 second and 1 msec, respectively, for this purpose. The signals used to generate these sampling intervals are pulse trains of frequencies 1 Hz, 10 Hz, 100 Hz, and 1 kHz, to give display resolutions of 1Hz,

COMPONENTS . . .

Resistors

R1, R11, R12, R13	10k (4 off)
R2, R10	1M (2 off)
R3, R8	1k (2 off)
R4	1k5
R5	330
R6	47k
R7	27k
R9	100
*R14	270 (7 off)
*R15	150 (7 off)
R16, R17, R18	470 (3 off)

All resistors $\frac{1}{4}$ W 5% carbon.

*See text.

Capacitors

C1	470p polystyrene
C2, C3, C5	100 μ elect. (3 off)
C4, C10, C13, C14, C16, C22	10 μ elect. (6 off)
C6, C9, C11, C12, C15, C17, C18, C21	10n ceramic (8 off)
C7, C8	22p polystyrene (2 off)
C19	2200 μ elect.
C20	220n polyester
VC1	2-22p trimmer

Semiconductors

D1, D2	1N4148 (2 off)
D3, D4, D8, D18	TIL209 (4 off)
D5, D6, D7, D9, D10, D11, D12	IN914 (7 off)
D13, D14, D15, D16, D17	IN4001 (5 off)
D19	BZY88 C6V2
TR1	2N3819
TR2	BCY70
IC1	74LS132
IC2	555
IC3	4013
IC4	4049
IC5	4068
TR3-TR6	2N3906 (4 off)
IC6	4020B
IC7, IC8, IC9	40160 (3 off)
IC10	74LS74
IC11	ZN1040E
IC12	74LS32
IC13	5V 1A i.c. regulator

Miscellaneous

SK1	BNC or similar coaxial socket to mount on front panel
SK2-5	4mm sockets or similar to mount on rear panel
S1	3P 4W rotary switch
S2	2P mains switch (combined with VR1 1k linear)
F1	100 mA fuse and holder
F2	500 mA fuse and holder
T1	9-0-9V 500 mA transformer
N1	Mains neon
4-digit multiplexed l.e.d. display (see text)	
Display filter	
Printed circuit board, Veroboard	
Case (Vero G-range 3G)	
X1	1MHz crystal

Constructor's Note

Components and p.c.b. are available from **Howard Associates, 59 Outlands Avenue, Weybridge, Surrey KT1 9SU.**

10 Hz, 100 Hz, and 1kHz, respectively. In this case, it is the pulse repetition frequency (p.r.f.) of the generating signals which is important, rather than the individual mark and space intervals.

The time standard oscillator is used to generate a reference signal at a p.r.f. of 1 MHz. A 1 kHz gating signal is derived from this reference, and the remaining signals are then produced from this by a chain of decade dividers. The circuit details for the time standard oscillator and divider chain are shown in Fig. 6.

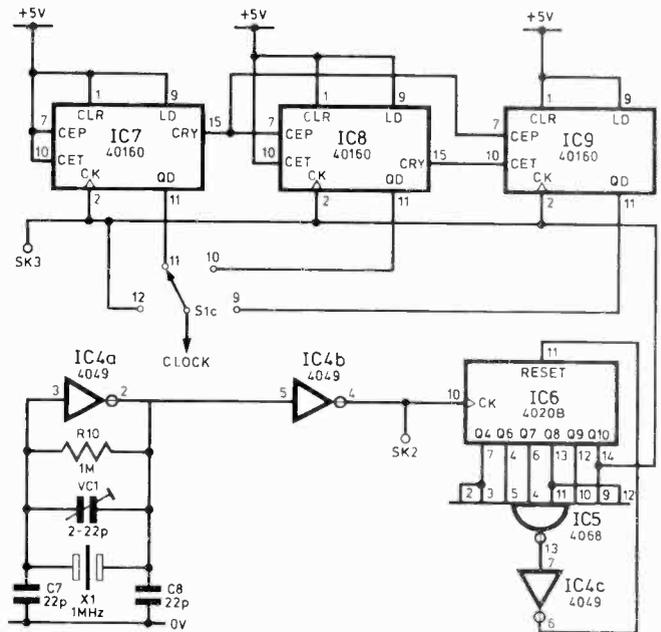


Fig. 6. Circuit diagram for the standard oscillator and divider chain

The oscillator circuit uses a single inverter, IC4a, in a feed-back loop with a 1 MHz crystal, X1, used to determine the frequency of oscillation. Fine frequency adjustment is provided by VC1, and the d.c. path around the loop is completed by R10. A second inverter, IC4b, is used to buffer the oscillator output and to improve the waveform shape. The resulting 1 MHz reference signal is brought out to SK2 on the rear panel for external use.

The oscillator output from IC4b is applied to the input of a 14-stage ripple counter, IC6. This counter, in combination with the decoder IC5, is arranged to produce an output at 1 kHz p.r.f. This is achieved by configuring the decoder to detect a count of 2000. A reset pulse is then generated to the counter, giving the stage an overall division ratio of 1000:1. The output, which is also brought out to SK3, is then at a p.r.f. of 1 kHz, and mark: space of approximately 1:1.

The pulse trains at 100 Hz, 10 Hz and 1 Hz are generated successively by the decade synchronous counters, IC7, IC8 and IC9, respectively. The use of CMOS devices throughout the oscillator and divider stages improves the stability, guarantees oscillator startability, and reduces the power dissipation when compared to equivalent TTL designs.

COUNTING AND DISPLAY CIRCUITS

The pulse counting and display circuits are shown in Fig. 7. A single VLSI device is used to perform all of the functions of a 4-digit counter, memory latch, 7-segment decoder, and display driver. The use of a multiplexed display drive also allows the constructor a wide choice of display devices. Four

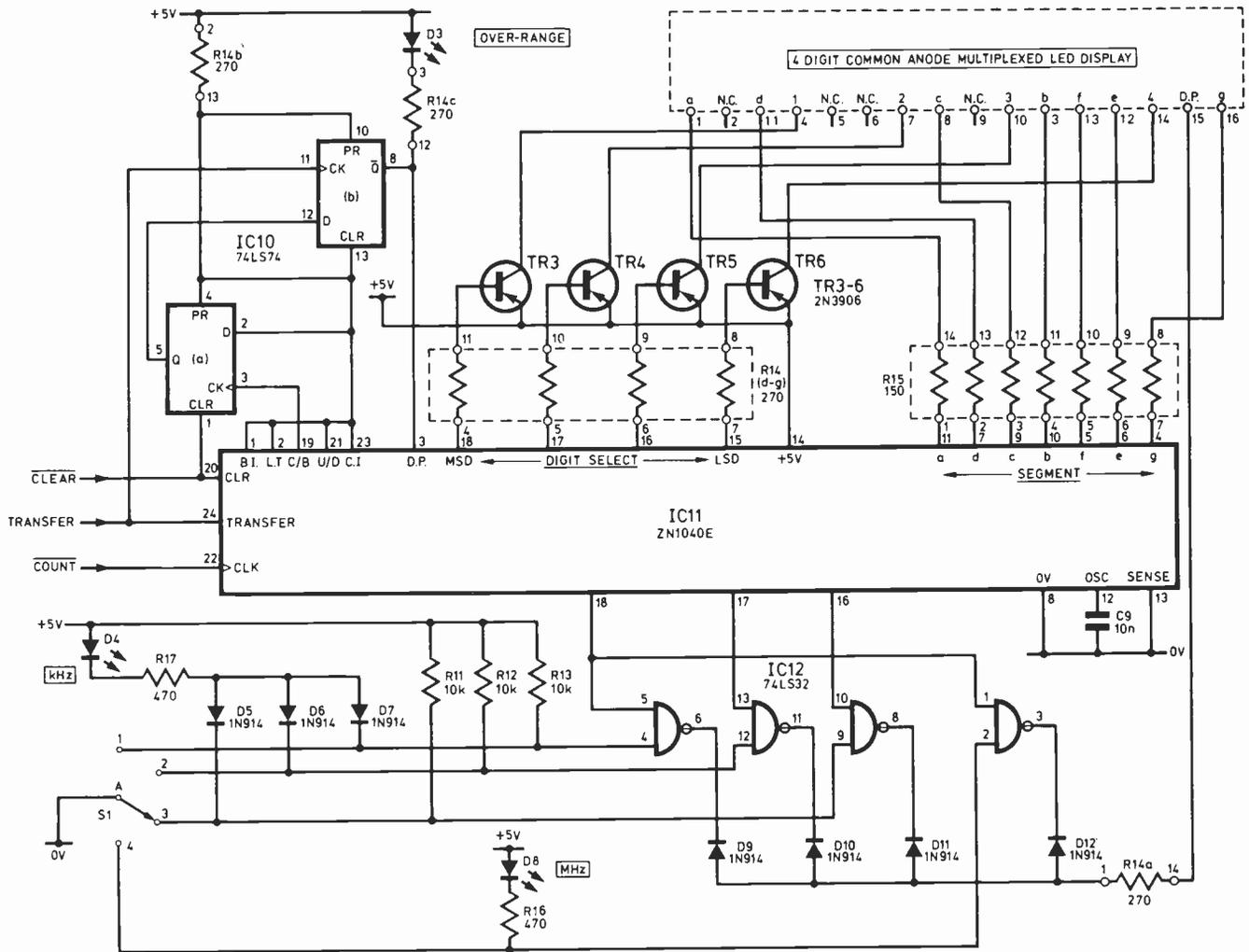


Fig. 7. Circuit diagram of the pulse counting and display circuit

discrete 7-segment i.e.d. displays or a 4-digit multiplexed display may be used. Further, the ZN1040E may be programmed to drive either common anode or, with slightly more external components, common cathode types of display.

The pulse train periodically produced by the signal gate (COUNT) is counted by the decade counters within IC11. The resulting count is then saved in the memory latches following the TRANSFER command from the control logic. The decade counters are then cleared down ready for the next measurement cycle. The latched count value is decoded into an equivalent 7-segment drive format. The internal multiplexing circuits then cause this segment drive information to be presented at the segment drive outputs; each of the 4 digits being strobed in turn. The appropriate "digit select" output is enabled synchronously with the segment outputs, causing only the required segments of the selected digit to become illuminated. In this way, each of the 4 displays are scanned in turn; the scan rate being set by C9. The brightness of the displays is set by R15, with the transistors TR3 to TR6 being used to enable each of the 4 common anode displays in turn. The circuit thus causes the number of pulses presented on the COUNT input line to be displayed to the user. The remaining circuitry is used to handle display over-ranging, decimal point control, and range indication functions.

The maximum number of pulses which may be counted and displayed by the circuit shown is 9999. If an "overflow" indicator is fitted, then this could also be used as an extra "half" digit in the display. For example, a 12 kHz signal may be displayed on range 1 by using the display to show "2000", while the overflow indicator provides the missing leading "1".

IC10a is used to detect any over-range indication from IC11 and IC10b is used as a memory latch, causing D3 to be illuminated in the event of overflow. As with the remainder of the circuits, the detector and latch are cleared and re-loaded each time the input signal is re-sampled. Correct operation of the display in overflow mode is ensured by using the \bar{Q} output of IC10b to disable the leading-zero suppression facility whenever an over-range condition is detected.

The decimal point logic required to illuminate the decimal point is arranged for common anode displays having the decimal point to the right of the digit. The negative-AND gates of IC12, together with the discrete OR function provided by D9 to D12, allow S1A to enable the appropriate decimal point cathode synchronously with the related segment cathodes. The steering diodes, D5 to D7, ensure correct operation of the decimal point while illuminating the "kHz" i.e.d. on ranges 1, 2 and 3. An advantage of this circuit configuration is that the complication of a multi-wafer

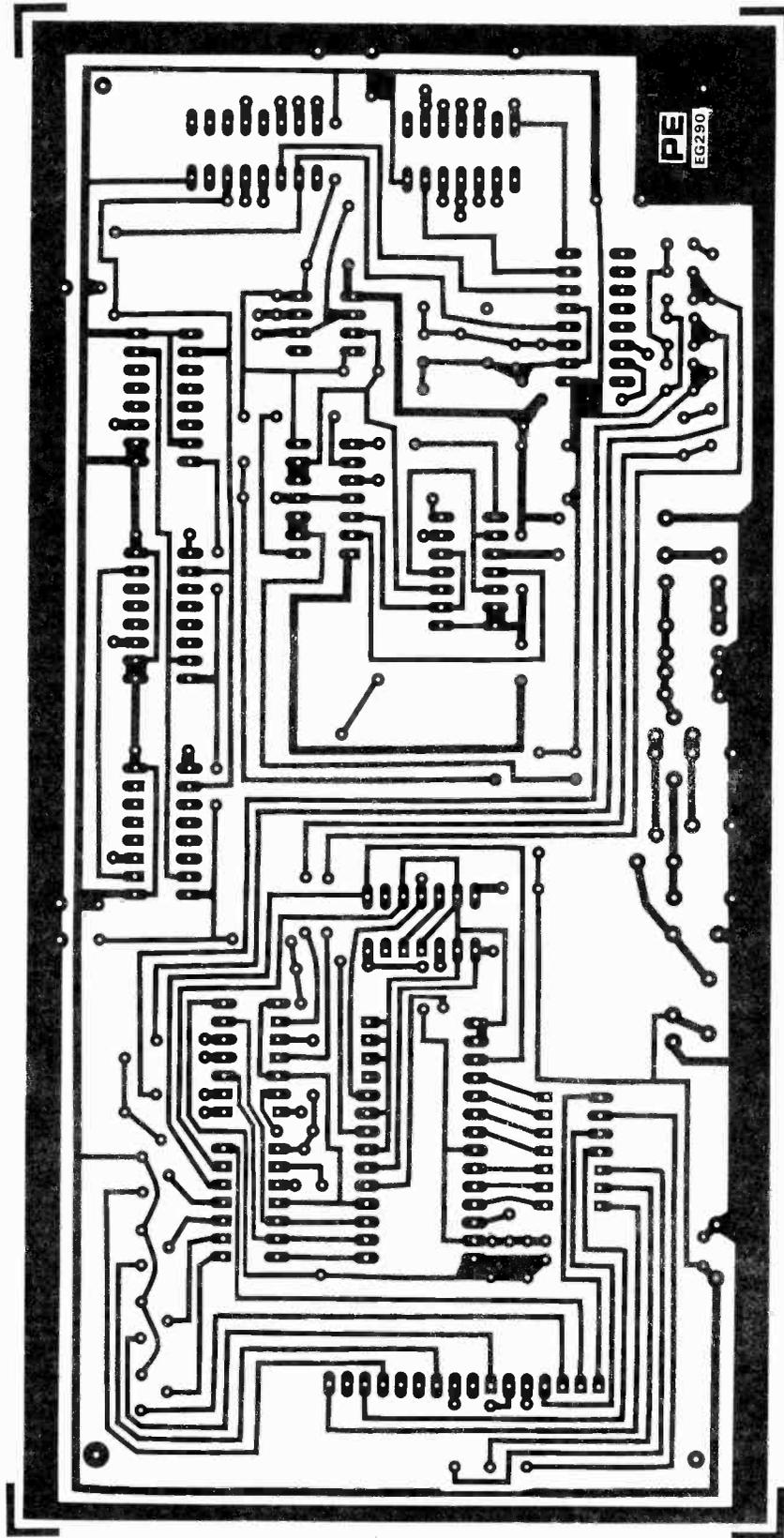


Fig. 10. P.c.b. design for the D.F.M.

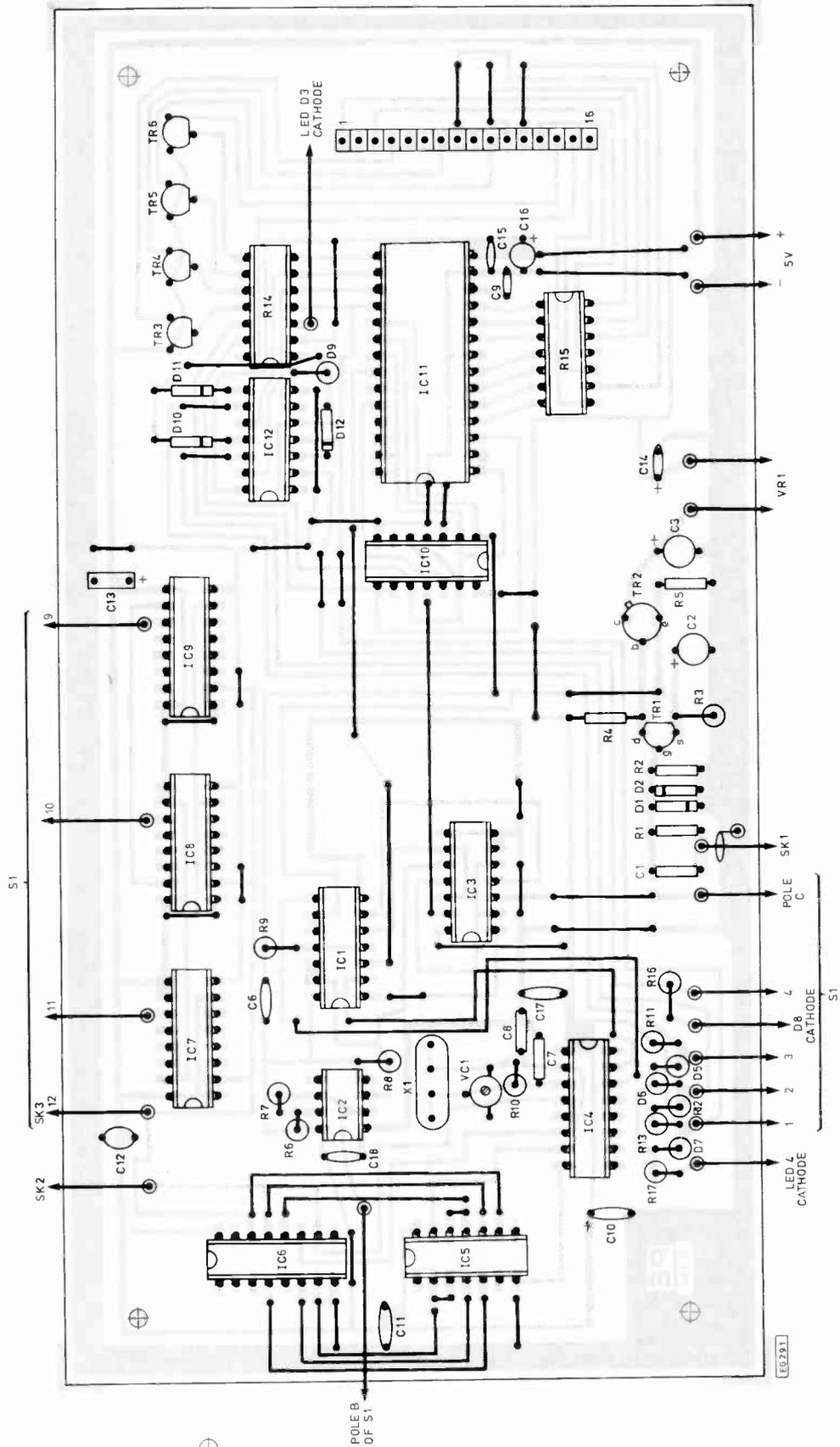


Fig. 11. Component layout

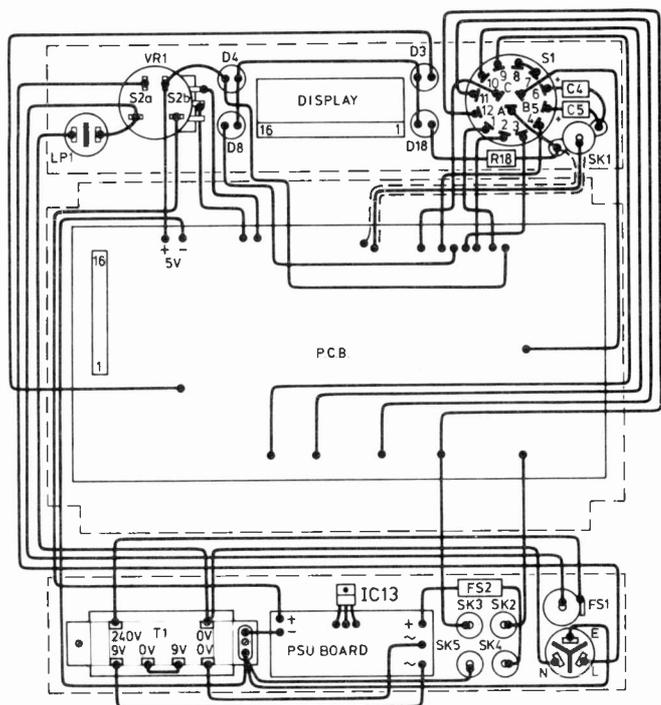
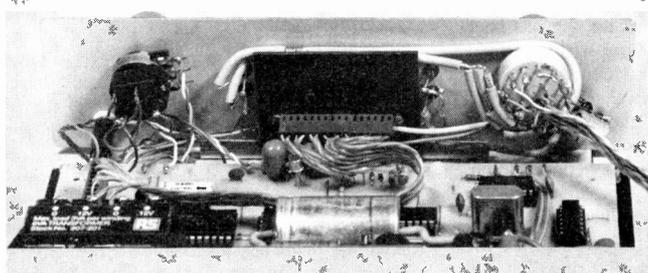
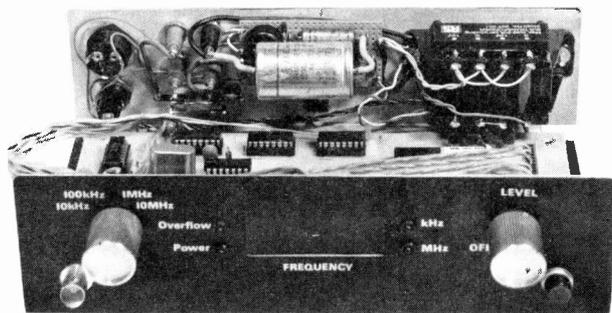


Fig. 13. D.F.M. wiring diagram

CONSTRUCTION

The p.c.b. design for the D.F.M. is shown in Fig. 10, with the corresponding component layout in Fig. 11. It is recommended that the i.c.s and any thick film resistor networks are mounted in d.i.l. sockets. Constructors should also note that many of the i.c.s are CMOS types, and these should be handled with the usual care.



The p.c.b. has been designed to allow thick film resistor networks to be used for R14 and R15. In the case of R15, the substitution of different networks provides a simple method of adjusting the display brightness. Thus, the use of higher-valued (220Ω , 270Ω or higher) or lower-valued

(100Ω) networks allows the display characteristics to be tailored to the particular application. Lower resistance values will increase the brightness of the display, but will also have the effect of increasing the current consumption correspondingly, and vice versa. The value of R14 should not be varied significantly from the value specified.

The input signal frequency is displayed to the user on a 4-digit seven-segment l.e.d. display. The display requires only 12 connections between the p.c.b. and the display hardware; these may conveniently be made with a short length of ribbon cable (with or without 0.1" pitch plugs and sockets). Alternatively, the multiplexed display may be synthesized from four discrete common anode displays. Fig. 12 shows how four typical displays should be interconnected; the simplification in wiring effort offered by the multiplexed display is self-evident! Whichever type of display is adopted, the operational characteristics will be identical.

The printed circuit board is mounted on the base plate of the case with four pillars, while the remainder of the components and controls are mounted either on the front or on the rear aluminium panels. The interconnection wiring is illustrated in Fig. 13.

The power supply components are mounted on the rear panel, with the regulator attached to the panel (using an insulating kit) to provide the necessary heatsink. The Veroboard circuit is mounted in the case on four small pillars. ★

News Briefs

TELESOFTWARE

A NEW way of using the Oracle Teletext service will enable future teletext receivers to play games, calculate mortgages and tax returns, run educational courses and a lot more.

The electronic signals which are used to carry the teletext information within the TV broadcast are very similar to those used in computer technology, so by replacing pages of written text with pages of a computer program a viewer has simply to select the program of his choice from Oracle. And like the information already on Oracle, these telesoftware programs would be free of charge.

In the future, by adding a microprocessor to the design of TV sets, they will be able to receive, decode and execute telesoftware programs in addition to receiving normal Oracle information. No special technical knowledge will be needed as operating telesoftware will be as easy as selecting pages on Oracle.

The applications of telesoftware on Oracle are almost as varied as the imagination. For example, it will allow future TV sets to play a wide range of video games. And by simply selecting a new program the set can instantly become a highly specialised but simple-to-use calculator. The same TV can become a flexible home educational unit, with a wide range of subjects, which may be learnt as fast or as slowly or as often as required by the individual. It could let you know your social security entitlements or even help detect credit card fraud. Telesoftware will also permit future Oracle receivers to display higher definition graphics and handle different alphabets, such as Russian or Greek—perhaps even still-pictures.

In co-operation with ITV, Mullard Applications Laboratory have designed and built an experimental telesoftware receiver.

Further research is under way already to establish compatible technology standards for a future telesoftware service. ITV is now investigating many areas of application for the system, including its use in education, work on which is being given a high priority. It is hoped that in the future telesoftware will become as integral of the Oracle service as the news headlines or weather forecast are today and will provide the viewer with even more value for money from his television screen.

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.

AY3 Anybody?

Sir—May I, through your columns, make mention of an anomalous situation that has come to my notice. Following Mr. Lenton-Smith's article in PE (September 1978) on the TDA 1008 gating/divider i.c., I was anxious to use these in an organ I am building, only to find that no supplier stocks any of the AY3 series which is necessary for the full range of pitches. I have searched catalogues and many advertisements, but every firm which stocks the 1008 only has the AY1 top octave generator, which is inadequate.

I have enquired of the manufacturers, General Instruments, who tell me that the AY3 series is still made, and it would therefore seem that amateur suppliers do not bother to read data sheets before deciding what to stock.

If I have missed any supplier who does stock the AY3, perhaps they would let me know. Otherwise, I can only advise your readers that they should save their money by not buying the TDA 1008, and go back to the tedious business of hand-building diode gates.

B. D. Arnold,
Worthing.

Hazard

Sir—I wondered if through your magazine I may draw attention to a small but definite radiation hazard originating in certain ex-Government equipment which was available for a considerable period after the last War.

The specific item which caused me to write this letter is a revolution counter which contains two large moving coil meters with edgewise scales about 10mm long, scaled 6-14-18-22-26-30 and marked "Engine Speed Hundreds of r.m.p.". The graduations and numbers are filled with Radium activated luminous paint very thickly applied. From previous experience with an ex-Government watch which had burn marks on the dial from the paint on the fingers I decided recently to do some tests on the meters. (I work at the University of Birmingham). The results confirmed my suspicions. At (10cm 4 inches) from the scales a Geiger counter registered 1000 counts per second. Interposing 1½mm aluminium sheet to remove beta and alpha emission reduced this to 100 c.p.s. However, since a Geiger counter is only one or two per cent efficient for gamma rays the true rate would be several thousand per second. Although I am not qualified to make an accurate assessment of the activity a rough calculation indicates several millicuries which I believe is a quantity that would require a licence if used for teaching purposes.

I therefore suggest that anyone having old

ex-Government equipment with luminous type dials or pointers (warning, it will no longer be luminous because of degeneration of the phosphor) should have them properly disposed of—not burned, buried or dumped on the local tip.

Radium is dangerous if ingested and burning will simply spread it about as most readers will realise.

B. Manning,
Kidderminster.

Coded

Sir—R. W. Coles, in Semiconductor Update, seems less than au fait with codes and cyphers.

There certainly are unbreakable codes despite the best computers. Both in theory, and in practice, there is no way of breaking ciphers based on true random numbers as long as each number sequence is used only once.

The codes that are broken are based on pseudo random numbers, or similar, but even here long sequences of messages are necessary to break into a new sequence of code.

The real gem of modern ciphers is the "trap door" cipher. Each user will publish his own code for anyone to send messages to him. Using a secret second code he will decipher the messages but no one else can succeed in this aim. A further technique is double encoding which gives 100 per cent proof that the message is from the named sender not a fraudulent source. The sender uses his secret code and the others published code. The receiver uses the others published code and his own secret code. No one else can use this combination.

In theory the trap door method can be decoded by computer by well known techniques. The snags are that the biggest and fastest of possible computers would take many millions of years to do what the known code will solve in seconds. So far no one has been able to find a short cut. Those wishing to use their own random number techniques should beware of most published and commercial methods. These collapse under quite simple analysis. For example many always end in odd or even digits or alternate between them, on a regular basis.

To begin to have any value, even in less esoteric uses, a random series should pass the basic test that, in any base, any one digit will be followed by all possible other digits, and itself, in approximately equal proportion when averaged over a few thousand digits. A simple program, using a two dimensional array, will soon show up any fault here.

R. G. Silson,
Tring.

Career

Sir—I read with interest your section on industry in the November issue of *Practical Electronics* and it seems to me that you could maybe supply me with some information.

Starting in October, 1980, I will be entering university to study one of the following courses, so could you advise me which course of study would lead an honours graduate to the best possible position on entering industry (involved with microprocessor systems, which seem to be playing an ever increasing role in industry) in terms of pay and promotion prospects. Either an honours graduate from Strathclyde University in one of their new degrees, first instituted in 1979, or an honours graduate in physics who has undergone "post-graduate" study in "microprocessors and digital electronics", which I know Glasgow University offers.

Unbiased advice from particular companies and universities is hard to come by.

Vincent Farrelly,
Glasgow.

We asked our Industry Notebook contributor Nexus to offer Mr Farrelly some advice:

You will realise that it is equally as difficult for us to forecast employment prospects in the mid-80s, when you will have qualified in your chosen profession, as it is for yourself to do so. What can be said with absolute certainty is that any degree student in electronics will be in demand, both in the United Kingdom and overseas. There is an acute shortage of such people now and this is likely to continue to the end of this century and beyond. So you need have no fear of unemployment in the future, whatever specialised discipline you embark upon.

As to the choice of courses open to you, this in our opinion depends very much on your personal interests. If you read Computer Science and Microprocessor Systems then you are firmly in the computer sector, admittedly very broad including industrial automation but with emphasis on applications.

The course in Electronic and Microprocessor Engineering appears to be more broadly based in electronics with microprocessors and their design and application coming as a speciality later. You will observe that there is a great deal of overlap, the difference between the two courses being one of emphasis, the first towards application, the second towards engineering.

Your third option, a physics degree, gives you many openings for specialisation as a post-graduate including, of course, microprocessors. This would provide, one imagines, much greater flexibility if, for example, you decided after the first year or two that microprocessors were rather boring and that you might prefer to be a nuclear engineer or enter some other branch of electronic engineering.

Only you can make the choice but any science-based degree will stand you in good stead for the future. Provided you have a good grounding in electronics you will find that most industrial companies or organisations, if you prove your capability and are clearly keen to advance, will encourage you in your chosen specialisation at a later date.

Nexus

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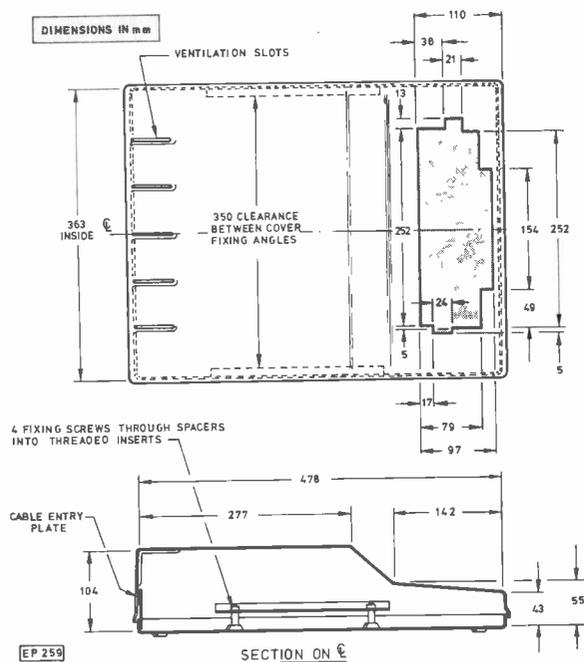
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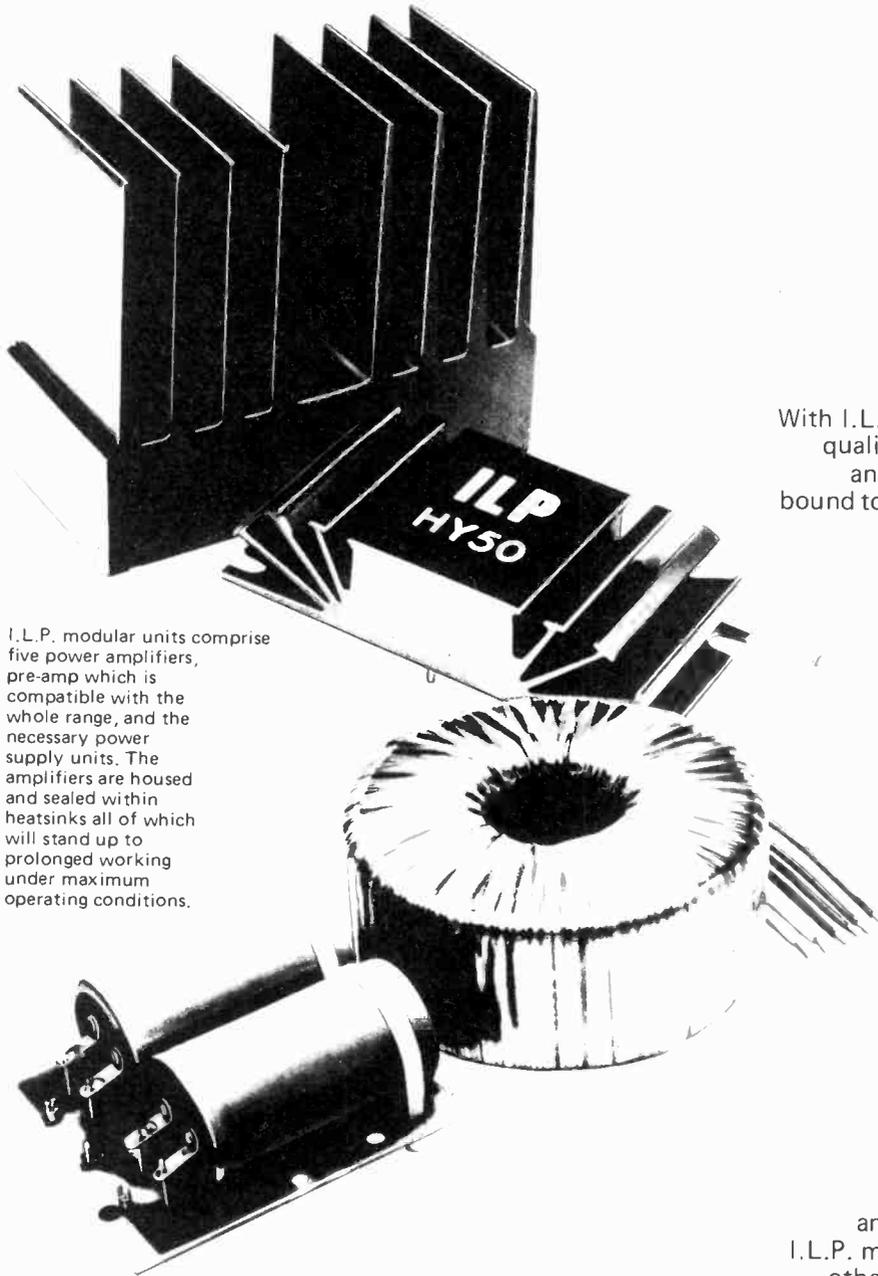
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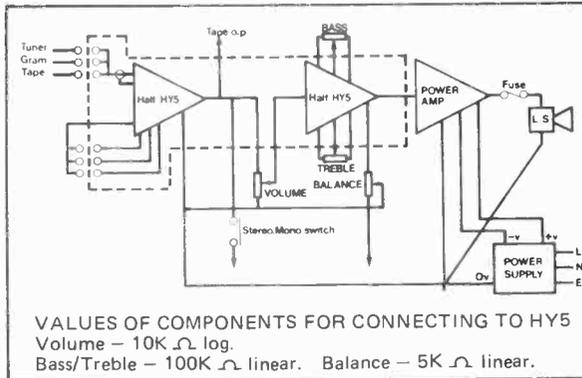
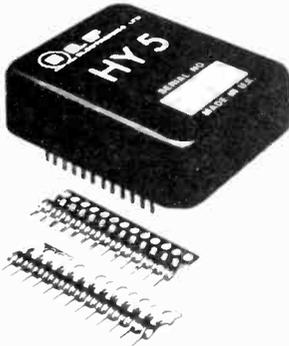
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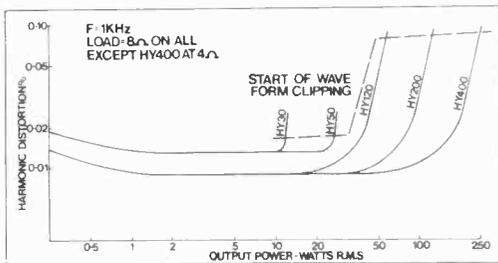
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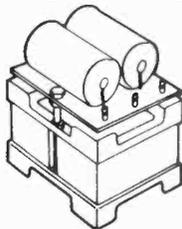
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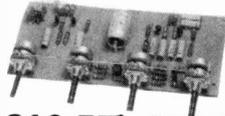
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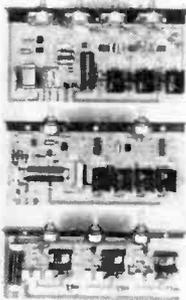
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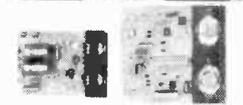
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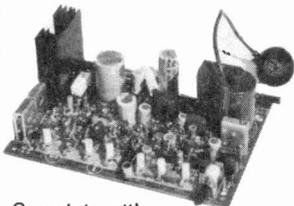
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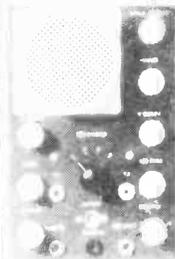
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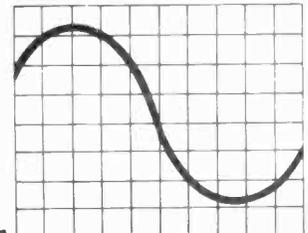
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AF115	0.86	BF159	0.23	OC24	1.15	2N1302	0.40	7456	0.21
AF116	0.86	BF160	0.18	OC25	1.04	2N1303	0.40	7470	0.40
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ASZ21	2.30	BF195	0.10	OC73	1.15	2N2219	0.28	7491AN	0.69
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BA154	0.10	BF257	0.28	OC81Z	1.38	2N269A	0.24	74100	1.73
BA155	0.12	BF258	0.30	OC82	0.74	2N2484	0.23	74107	0.52
BA156	0.10	BF259	0.37	OC83	0.74	2N2646	0.63	74109	0.81
BAW62	0.06	BF336	0.35	OC84	0.74	2N2904	0.29	74110	0.58
BAK13	0.07	BF337	0.35	OC122	2.02	2N2905	0.29	74111	0.81
BAK16	0.10	BF338	0.38	OC123	2.02	2N3053	0.58	74112	2.42
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BC109	0.15	BF561	0.23	OC141	3.74	2N2925	0.25	74120	0.95
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BC117	0.20	BFX85	0.26	OC202	2.02	2N3440	0.69	74126	0.63
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BC149	0.10	BSX20	0.23	R2009	2.59	2N3707	0.15	74148	2.02
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BC171	0.12	BU208	2.30	TP30A	0.48	2N3711	2.02	74156	0.97
BC172	0.12	BY100	0.52	TP31A	0.51	2N3712	2.30	74157	0.86
BC173	0.10	BY126	0.16	TP32A	0.55	2N3713	3.45	74159	2.42
BC177	0.17	BY127	0.19	TP33A	0.79	2N3819	0.41	74170	2.86
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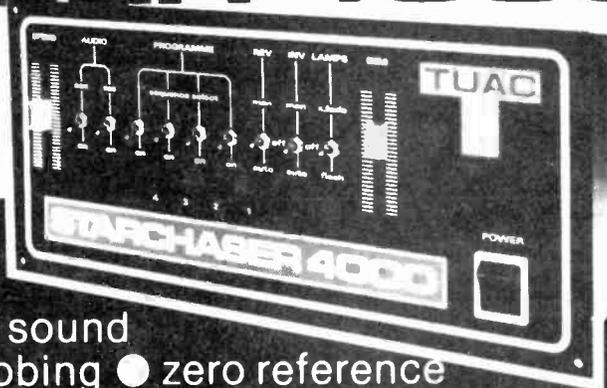
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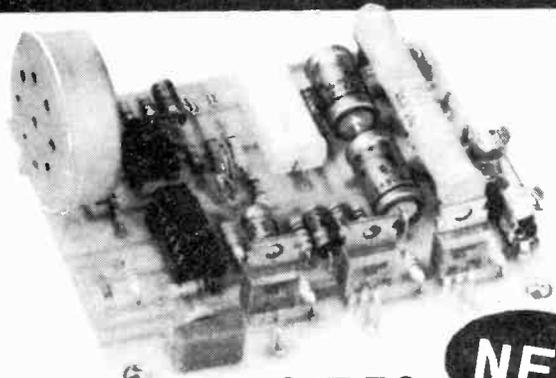
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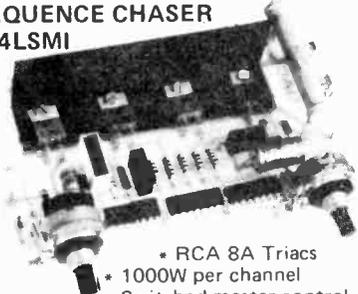
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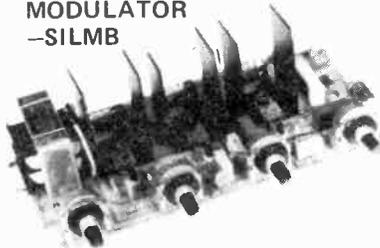
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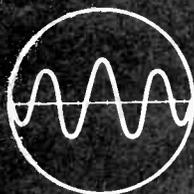
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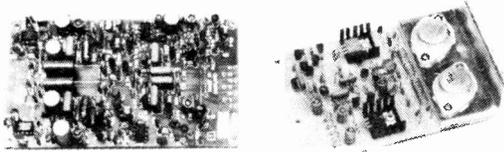
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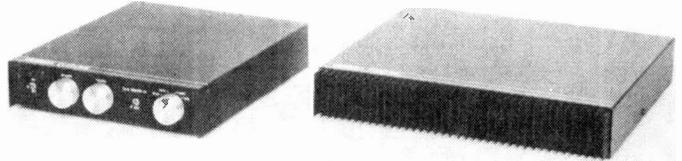
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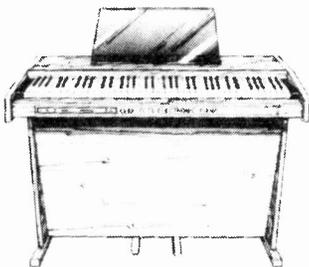
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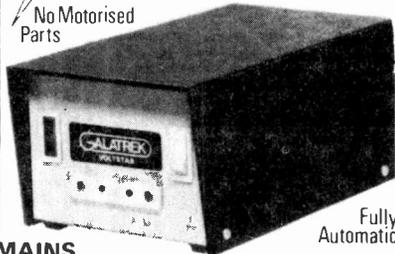
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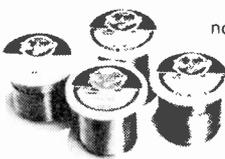
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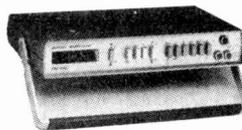
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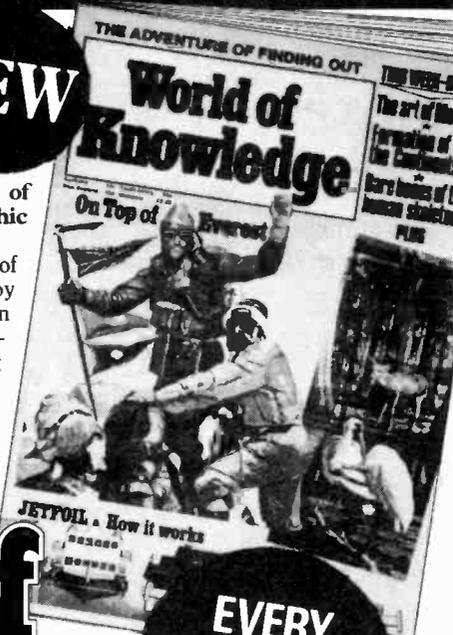
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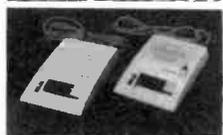
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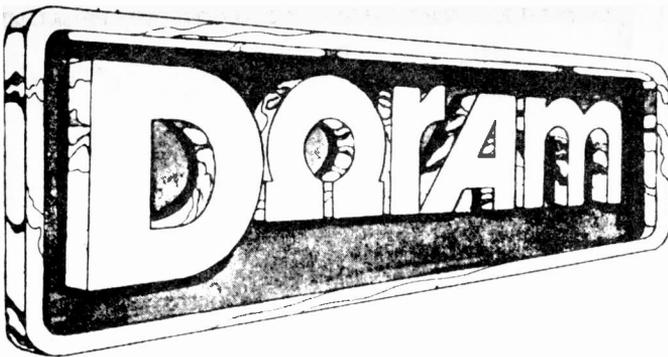
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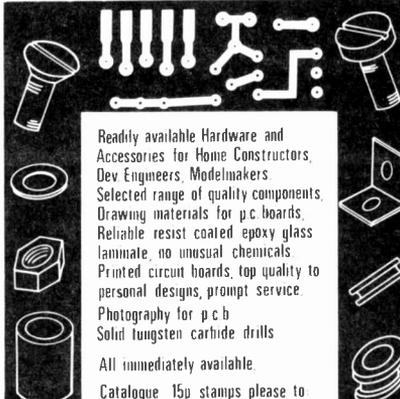
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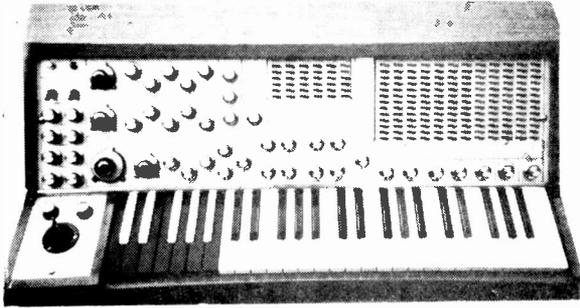
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INDEX TO ADVERTISERS

Abbey Leisure 100	E.D.A. 98	Pawbooks 100
Acom 20	Electronics Mail Order Ltd. 100	Phonosonics 6, 7
Adam Hall (P.E. Supplies) 102	Electrovalue 4	PKG Electronics 101
Aitken Bros. 94	Ferranti 12	Positron Computers 99
Aura Sounds 12	Fiadar 95	Progressive Radio 99
Automated Homes 101	Galatrek 92	Proto Design 102
Bamber 57	George, David Sales 95	Radio Component Specialists 88
Barrie Electronics 8	G.M.T. 11	R.S.T. Valve Mail Order 90
Bell Systems 10	G.R. International 57	Radio & T.V. Components 9
BIET 94	Hameg 3	Ramar Constructor Services 101
Bib Hi-Fi Accessories Ltd. 85	Heathkit 102	Safgan 10
Bi-Pak 84	Hiykin Ltd. 90	Saxon Entertainments 5
Bi-Pre-Pak 97	Home Radio 7, 101	Service Trading Cover III
Birkett, J. 101	I.L.P. Electronics 82, 83	Science of Cambridge 14, 15
Boffin Projects 89	J.B. Enterprises 102	Scientific Wire Co. 101
British National Radio & Electronic School 102	Jayen Development 8	Seahore Electronics 101
Cambridge Kits 86, 87	J. Birkett 97	Sentinel Supply 90
Cambridge Learning 93	Jones Electronic Supplies 84	Solid State Security 101
Chromasonic Electronics 97	J.W.B. Radio 100	Sonic Sound Audio 84
C.J. Communications 92	L & B Electronics 86	Stevensons Electronic Components 53
Clef Products 96	Litesold 16	Swanley Electronics 99
Codespeed 31	London Electronics College 101	Tandy 24
Commodore Cover II	LB of Hillingdon 98	T.K. Electronics 86
Computer Components (Teleplay) 28	Maplin Electronics Cover IV	Technomatic 104
Concept Elec. 92	Marshall, A. 8	Transam Components 32
Continental Spec. 88	Memory Mart 102	T.U.A.C. 91
Crimson Elektrik 100	Metac 13	Vero 12
Crofton Electronics 84	Millhill 88	Watch Battery Replacement Co. 102
C.R. Supply Co. 100	Modem Book Co. 96	Watford Electronics 2, 3
Davian Electronics 97	Monolith 88	West London Direct Supplies 96
Delta Tech 103	Newbear 10	Wicca Electronics 4
Dewtron 99		Williamson Amplification 101
Doram Electronics 95		Wilmslow Audio 98
Dziubas 102		Wirral Semiconductors 100
Ecoscope Instruments Ltd. 102		

TLabyTEXAS 7400 11p 74182 90p 7401 12p 74184A 150p 7402 12p 74185 150p 7403 12p 74186 500p 7404 12p 74186 500p 7405 12p 74190 90p 7406 18p 74191 90p 7407 32p 74193 90p 7408 19p 74195 95p 7409 15p 74196 95p 7410 15p 74197 95p 7411 20p 74198 150p 7412 20p 74201 150p 7413 30p 74211 150p 7414 30p 74221 150p 7415 27p 74225 250p 7416 27p 74229 250p 7417 27p 74235 250p 7418 27p 74239 250p 7419 27p 74243 250p 7420 17p 74245 250p 7421 20p 74247 250p 7422 22p 74248 400p 7423 34p 74248 400p 7424 30p 74248 400p 7425 30p 74248 400p 7426 30p 74248 400p 7427 34p 74290 150p 7428 36p 74293 150p 7429 30p 74300 150p 7430 17p 74298 200p 7431 30p 74365 150p 7432 30p 74365 150p 7433 40p 74366 150p 7434 35p 74367 120p 7435 35p 74368 150p 7436 35p 74390 150p 7437 40p 74393 180p 7438 40p 74393 180p 7439 40p 74393 180p 7440 70p 74490 225p 7441 40p 74490 225p 7442 40p 74490 225p 7443 112p 74LS00 14p 7444 112p 74LS02 14p 7445 100p 74LS02 14p 7446 93p 74LS05 25p 7447 60p 74LS08 25p 7448 90p 74LS10 20p 7449 90p 74LS10 20p 7450 17p 74LS11 30p 7451 17p 74LS11 30p 7452 17p 74LS13 90p 7453 17p 74LS14 90p 7454 17p 74LS20 20p 7455 36p 74LS20 20p 7456 36p 74LS27 38p 7457 36p 74LS27 38p 7458 34p 74LS30 20p 7459 24p 74LS32 27p 7460 30p 74LS42 70p 7461 150p 74LS47 70p 7462 36p 74LS55 30p 7463 36p 74LS55 30p 7464 80p 74LS74 38p 7465 80p 74LS74 38p 7466 84p 74LS75 40p 7467 84p 74LS76 48p 7468 100p 74LS83 110p 7469 100p 74LS85 100p 7470 94p 74LS90 40p 7471 175p 74LS90 40p 7472 90p 74LS93 60p 7473 80p 74LS107 45p 7474 46p 74LS112 100p 7475 30p 74LS123 60p 7476 30p 74LS123 60p 7477 30p 74LS125 60p 7478 70p 74LS125 60p 7479 85p 74LS126 60p 7480 85p 74LS132 95p 7481 130p 74LS133 60p 7482 130p 74LS136 50p 7483 130p 74LS138 75p 7484 130p 74LS138 75p 7485 130p 74LS151 100p 7486 130p 74LS151 100p 7487 130p 74LS153 60p 7488 130p 74LS154 200p 7489 130p 74LS155 90p 7490 210p 74LS157 80p 7491 210p 74LS158 90p 7492 210p 74LS161 100p 7493 48p 74LS162 140p 7494 48p 74LS163 100p 7495 48p 74LS164 120p 7496 75p 74LS165 78p 7497 75p 74LS173 110p 7498 75p 74LS174 90p 7499 75p 74LS174 90p 7500 200p 74LS175 90p 7501 200p 74LS181 320p 7502 190p 74LS190 90p 7503 190p 74LS191 90p 7504 150p 74LS192 90p 7505 100p 74LS193 90p 7506 100p 74LS195 90p 7507 100p 74LS196 90p 7508 100p 74LS240 175p 7509 70p 74LS241 175p 7510 190p 74LS242 170p 7511 100p 74LS243 170p 7512 100p 74LS244 195p 7513 100p 74LS245 250p 7514 100p 74LS253 80p 7515 130p 74LS257 120p 7516 100p 74LS259 180p 7517 200p 74LS266 100p 7518 240p 74LS273 130p 7519 240p 74LS274 90p 7520 120p 74LS324 200p 7521 80p 74LS367 100p 7522 85p 74LS373 180p 7523 90p 74LS374 190p 7524 170p 74LS378 200p 7525 180p 74LS393 200p	4000 SERIES 4000 15p 9301 160p 4001 17p 9302 175p 4002 17p 9308 318p 4003 95p 9310 275p 4004 80p 9311 160p 4005 80p 9312 160p 4006 40p 9314 165p 4007 50p 9316 225p 4008 17p 9321 225p 4009 40p 9322 225p 4010 50p 9323 225p 4011 17p 9324 225p 4012 15p 9325 225p 4013 40p 9368 200p 4014 84p 9370 200p 4015 84p 9374 200p	93 SERIES 9301 160p 9302 175p 9308 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MPSU06 63p MPSU65 78p MPC305 70p OC35 130p R2008B 200p R2010 200p TIP29A 40p TIP29C 55p TIP30A 48p TIP30C 48p TIP31A 58p TIP31C 62p TIP32A 68p TIP32C 82p	*8FR80 25p *8FR81 25p 8FX20 30p 8FX30 30p 8FX84/5 30p 8FX90 30p 8FX88 30p 8FW10 90p 8FV50 30p 8FV52 30p 8FV56 33p 8FV57 33p 8R109 225p 8R139 45p 8S19/20/24 50p 8U10/4 225p *8U105 190p *8U108 250p *8U109 225p *8U208 200p *8U209 200p *8U406 145p E300 50p E310 50p MJ2501 225p MJ2955 100p MJ3001 225p MJ3E40 65p MJ2955 100p MPC305 70p MPF103/4 40p MPF105/6 40p MPSA06 30p MPSA12 50p MPSA13 50p MPSA20 50p MPSA56 32p MPSA57 32p MPSU06 63p MPSU65 78p MPC305 70p OC35 130p R2008B 200p R2010 200p TIP29A 40p TIP29C 55p TIP30A 48p TIP30C 48p TIP31A 58p TIP31C 62p TIP32A 68p TIP32C 82p	TIP33A 90p TIP33C 114p TIP34A 110p TIP34C 150p TIP35A 225p TIP36A 290p TIP36C 340p TIP41A 65p TIP41C 78p TIP42A 70p TIP42C 82p TIP2955 70p TIP4055 70p *IS43 34p TIP54 150p *IS93 30p TZX108 12p TZX300 13p TZX500 15p *TX502 18p *TX504 30p 2N4574 250p 2N696 35p 2N697 55p 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FT23 NEON FLASH TUBE

High intensity multi turn high voltage neon glow discharge flash tube. Design for ignition timing. etc.
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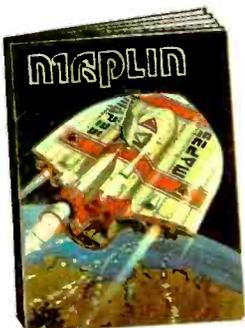
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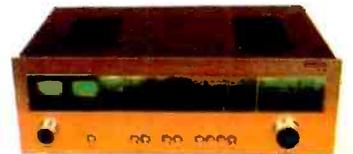
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