

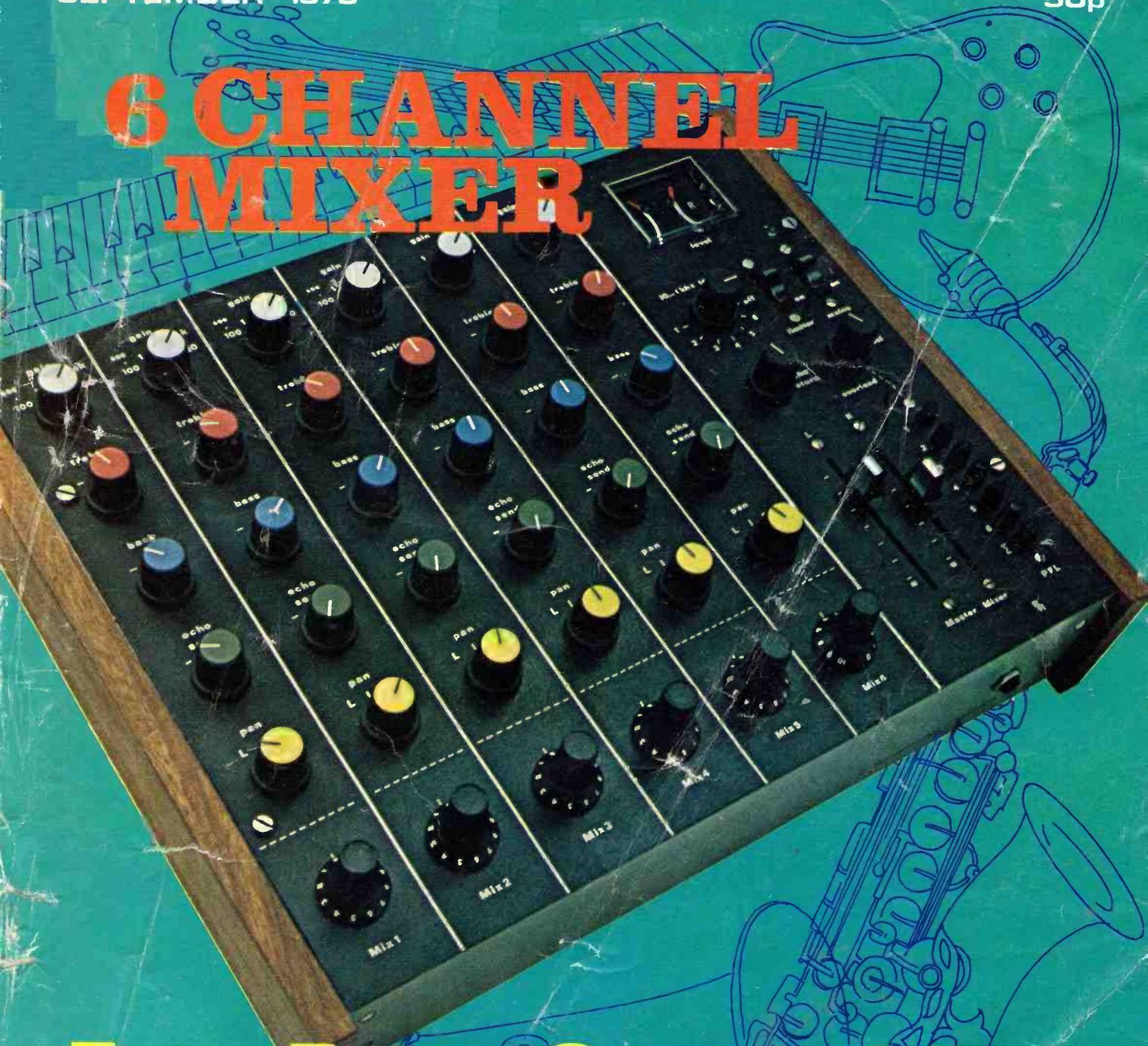
PRACTICAL

ELECTRONICS

SEPTEMBER 1979

50p

6 CHANNEL MIXER

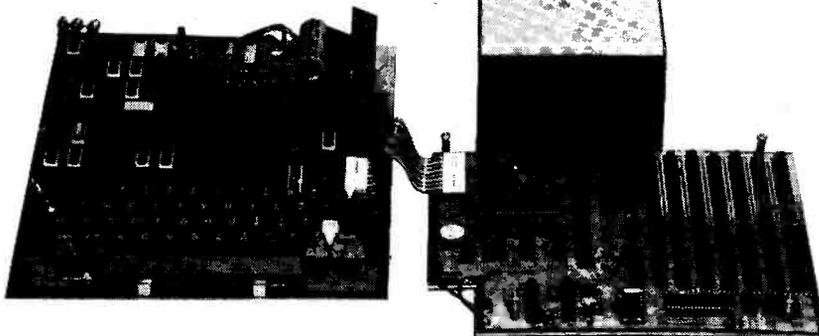


Free Entry Competition
OVER £300 WORTH OF BREADBOARDING
FROM **Lektrokit** TO BE WON!

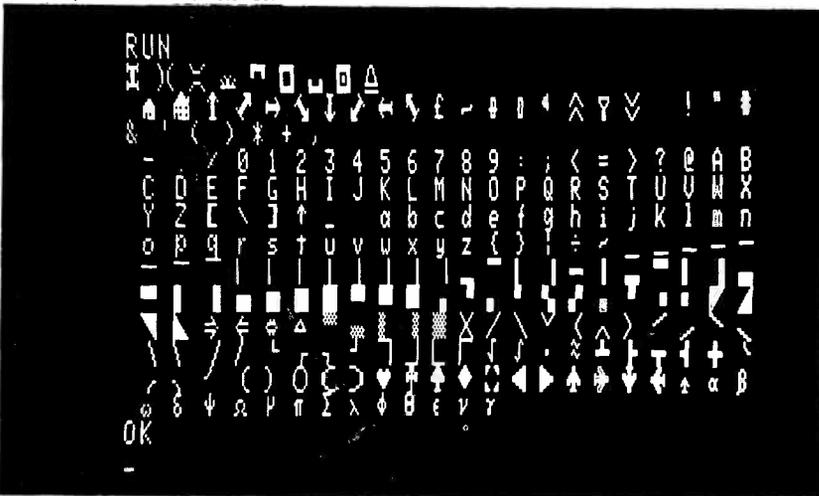
COMPUKIT UK101

LOW COST SUPERBOARD IN KIT FORM

**SAMPLE
TAPE
included
FREE**



The CompuKit UK101 Character Set



- The CompuKit UK101 has everything a one board 'superboard' should have.
- ★ Uses ultra-powerful 6502 microprocessor.
 - ★ 50Hz Frame refresh for steady clear picture (U.S.A. products with 60Hz frame refresh always results in jittery displays)
 - ★ 48 chars by 16 lines — 1K memory mapped video system providing high speed access to screen display enabling animated games and graphs.
 - ★ Extensive 256 character set which includes full upper and lower case alphanumerics, Greek symbols for mathematical constants and numerous graphic characters enabling you to form almost any shape you desire anywhere on the screen.
 - ★ 8K full Microsoft Basic in ROM compatible with PET, APPLE SORCERER hence taking the headache out of programming by using simple English statements. Much faster than currently available personal computers.
 - ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.
 - ★ Video output and UHF Highgrade modulator (8Mz Bandwidth) which connects direct to the aerial socket of your T.V. Channel 36 UHF.
 - ★ Fully stabilised 5V power supply including transformer on board.
 - ★ Standard KANSAS city tape interface providing high reliability program storage — use on any standard domestic tape or cassette recorder.
 - ★ 4K user RAM expandable to 8K on board £49 extra.
 - ★ 40 line expansion interface socket on board for attachment of extender card containing 24K RAM and disk controller. (Ohio Scientific compatible).
 - ★ 6502 machine code accessible through powerful 2K machine code monitor on board.
 - ★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.

**FULL CONSTRUCTION DETAILS
IN P.E. AUG 1979 EDITION**

Delivery date June 1979
at the 1979 MicroComputer Show
Customer orders in strict rotation only.

A tape of 10 programs on cassette —
educational games, etc. will be supplied free of
charge with each kit.

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

**NO EXTRAS NEEDED JUST HIT
'RETURN' AND GO.**

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

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

Due to the new prices of TTL this price will be
increased shortly. So order now to beat the
price increases and the rush.

SPECIAL CHARACTERS

- @ Erases line being typed, then provides carriage return, line feed.
- ⏏ Erases last character typed.
- CR Carriage Return — must be at the end of each line.
- ⋮ Separates statements on a line.
- CONTROL/C Execution or printing of a list is interrupted at the end of a line.
- "BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.
- CONTROL/O No outputs occur until return made to command mode. If an input statement is encountered, either another CONTROL/O is typed, or an error occurs.
- ? Equivalent to PRINT

COMMANDS

CONT	LIST	NEW	NULL	* RUN
STATEMENTS				
CLEAR	DATA	DEF	DIM	END FOR
GOTO	GOSUB	IF..GOTO	IF..THEN	INPUT LET
NEXT	ON..GOTO	ON..GOSUB	POKE	PRINT READ
REM	RESTORE	RETURN	STOP	

EXPRESSIONS

OPERATORS
+ * ^ / ↑ NOT..AND..OR, > < <> >=<= RANGE 10⁻³² to 10⁺³²

VARIABLES

A, B, C, ... Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus \$, e.g. A\$.

FUNCTIONS	ABS(X) LOG(X) SPC(I)	ATN(X) PEEK(I) SQR(X)	COS(X) POS(I) TAB(I)	EXP(X) RND(X) TAN(X)	FRE(X) SGN(X) USR(I)	INT(X) SIN(X)
STRING FUNCTIONS	ASC(X\$) RIGHT\$(X\$,I)	CHR\$(I)	FRE(X\$) STR\$(X)	LEFT\$(X\$,I)	LEN(X\$) VAL(X\$)	MID\$(X\$,I,J)

COMP COMPUTER COMPONENTS

Please make cheques and postal orders payable to COMP, or phone your order quoting BARCLAYCARD, ACCESS, DINERS CLUB or AMERICAN EXPRESS number.
14 STATION ROAD, NEW BARNET, HERTS. TEL: 01-441 2922 (Sales) 01-449 6596
OPEN — 10 am to 7 pm — Monday to Saturday



(Part of the Compshop Ltd. Group)

PRACTICAL ELECTRONICS

VOLUME 15 No. 9 SEPTEMBER 1979

CONSTRUCTIONAL PROJECTS

- 6 CHANNEL MIXER—1** by *S. R. W. Grainger and C. R. Harding*
Combines unbalanced signal sources for a well balanced output 18
- WAVEFORM GENERATOR** by *Michael Tooley B.A. and David Whitfield B.A., M.Sc.*
Sine, Square and Triangular Waves from 1Hz to 100kHz 28
- COMPUKIT UK101—Part 2** by *A. A. Berk B.Sc., Ph.D.*
Construction and BASIC definitions 40
- SMOOTH FUZZ** by *D. S. Gibbs and I. M. Shaw C.Eng.*
Refined distortion for the discerning musician 62

GENERAL FEATURES

INGENUITY UNLIMITED

- Adsr Envelope Shaper—Car Theft Alarm—Diode Tester 24
- ACORN COMPUTER** by *Mike Abbott*
Review of 6502 based micro housed on Eurocards 34
- STRICTLY INSTRUMENTAL** by *K. Lenton-Smith*
Synth Drums, Vocoder, P.E. Rhythm Unit, Chips 51
- V.L.F. SIGNALS AND THE MAGNETOSPHERE** by *C. R. Francis B.Sc.*
Learn about the magnetosphere in readiness for next month's v.l.f. receiver project 52
- SEMICONDUCTOR UPDATE** by *R. W. Coles*
A look at some recently released devices—74AS/74ALS 82S106/7 ICL7600/5 67
69

NEWS AND COMMENT

- EDITORIAL** 17
- MARKET PLACE**
New products 26
- POINTS ARISING** 32
- INDUSTRY NOTEBOOK** by *Nexus*
What's happening inside industry 33
- NEWS BRIEFS**
Countdown—Move—Colour without mask 37
Joint memories—Two new micro's—Carrot grows bigger—Babes in headphones—In depth defence 68
- SPACEWATCH** by *Frank W. Hyde*
Finding a clear window, Radio and optical studies, Red shift key to quasars, Solar power satellites 38
- MOTOROLA MICROCOMPUTER FORUM** by *D.J.D.*
Technological progress since the 6800 39
- FREE ENTRY COMPETITION**
Win some breadboarding from Lektrokit 67
- PATENTS REVIEW**
Auto-Focus—Stereo via Cable TV 70

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, 14 SEPTEMBER 1979
(for details of contents see page 61)

© IPC Magazines Limited 1979. Copyright in all drawings, photographs and articles published in PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or part are expressly forbidden. All reasonable precautions are taken by PRACTICAL ELECTRONICS to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

WATFORD ELECTRONICS

33 35, CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER CALLERS WELCOME. Tel Watford 40588 9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY 10.00 AM. TERMS OF BUSINESS: CASH/CHEQUE/P.O. OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED. TELEPHONE ORDERS BY ACCESS NOW ACCEPTED (Minimum order £10.00 please). TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 30p TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% to the total cost.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/Br. Rail Station: Watford High Street. Open Monday to Saturday 9 a.m.-6 p.m. Ample Free Car Parking space available.

POLYESTER CAPACITORS: (Axial Lead Type)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p; 150n, 220n 24p; 330n, 470n 41p; 680n 48p; 1µF 64p; 2.2µF 82p
100V: 10n, 12n, 39n, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1µF 22p; 2.2µF 32p; 4.7µF 36p
1000V: 10n, 15n 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1µF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V: 10n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1µF 22p; 2µF 34p.

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF)
500V: 10 40p; 47 68p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8.2, 10, 15, 22 8p; 47, 50 12p; 63, 10n, 15p; 50V: 1.0 7p; 5.0, 10.0, 22.0 25p; 47.0 33p; 100.0 50p; 40V: 22, 33p 6p; 100 12p; 2200 300 68p; 4700 85p; 35V: 10, 33 7p; 330, 470 32p; 1000 60p; 25V: 10, 22, 47, 68p; 80, 100 16p; 200, 220 13p; 470, 640 25p; 1000 27p; 1500 30p; 2200 30p; 3300 62p; 4700 74p 16p; 10, 40, 47, 68 7p; 100, 125 8p; 220, 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 100 6p; 640 12p; 1000 14p.

TAG-END TYPE: 70V: 4700 135p; 64V: 2200 95p; 50V: 10,000 225p; 3300 95p; 2500 85p; 1500 70p; 4700 70p; 15,000 299p; 25V: 4700 74p; 2200 48p; 40V: 2000-2000 95p.

TANTALUM BEAD CAPACITORS: 35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8, 25V: 1.5, 1.0, 20V: 1.5µF, 1.0µF, 10µF 13p each.
18V: 15p, 22 20p; 47, 100, 220 40p.
10V: 15p, 22, 33 10p; 100 35p; 6V: 47µ, 68, 100 20p; 33µ, 100 20p.

MYLAR FILM CAPACITORS: 100V: 0.001, 0.002, 0.005, 0.01µF 8p
0.015, 0.02, 0.03, 0.04, 0.05, 0.056µF 7p
0.1µF, 0.2µF. 50V: 0.47µF 12p

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10nF 3p
15nF, 22nF, 33nF, 47nF 4p 100nF 6p

POLYSTYRENE CAPACITORS: 10pF to 1nF, 6p. 1.5nF to 47nF 10p.

SILVER MICA (pF)
3.3, 4.7, 6.8, 8.2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 68, 75, 82, 85, 100, 220, 300, 1500, 1800, 250, 270, 300, 330, 360, 390, 470, 600 & 820pF 16p each.
1000, 2000pF 20p.

TRIMMERS miniature
2.5pF to 10pF 10p
3-30pF; 3-50pF 22p
6-25pF; 6pF 88pF 30p

COMPRESSION
3-40pF; 10-80pF 30p
25-200pF 35p
100-500pF 43p

POTENTIOMETERS (AB or EGEN)
Carbon Track, 0.25W Log & 0.5W Linear values.
5K00Ω, 1K & 2K (LIN ONLY) Single 27p
5K0-2MΩ single gang 17p
5K0-2MΩ single gang D/P switch 65p
5K0-2MΩ dual gang stereo 78p

SLIDER POTENTIOMETERS
0.25W Log and linear values 60mm track
5K0 500KΩ Single gang 70p
10K0 500KΩ Dual gang 80p
Self-Stick graduated Alum. Bezels 25p

PRESET POTENTIOMETERS
0.1W 500-2.2M Mini. Vert. & Horiz. 8p
0.25W 1000-3.3M Horiz. larger 10p
0.25W 2500-4.7M Vert. 10p

RESISTORS - Eric make 5% Carbon
Miniature High Stability, Low noise
RANGE VAL 199 100+
1W 2-20-47M E24 2p 1.5p
1W 2-20-47M E12 2p 1.5p
1W 2-20-10M E12 5p 4p

2% Metal Film 10Q 1MΩ 8p 4p
1% Metal Film 51Q 1M 8p 10p
100 - price applies to Resistors of each type not mixed values.

VDU IC'S
AY-3-1015 550
AY-5-1013 450
SFF96364E 1050
SFC71301 820
SFS80102 205
SN74285 63
SN74ALS163 118
SN74S262 895
SN74S450 325
SN74S475 825
SN74S512 110
SN74S519 115
SN74S527 115
SN74S540 115
SN74S541 115
SN74S542 115
SN74S543 115
SN74S544 115
SN74S545 115
SN74S546 115
SN74S547 115
SN74S548 115
SN74S549 115
SN74S550 115
SN74S551 115
SN74S552 115
SN74S553 115
SN74S554 115
SN74S555 115
SN74S556 115
SN74S557 115
SN74S558 115
SN74S559 115
SN74S560 115
SN74S561 115
SN74S562 115
SN74S563 115
SN74S564 115
SN74S565 115
SN74S566 115
SN74S567 115
SN74S568 115
SN74S569 115
SN74S570 115
SN74S571 115
SN74S572 115
SN74S573 115
SN74S574 115
SN74S575 115
SN74S576 115
SN74S577 115
SN74S578 115
SN74S579 115
SN74S580 115
SN74S581 115
SN74S582 115
SN74S583 115
SN74S584 115
SN74S585 115
SN74S586 115
SN74S587 115
SN74S588 115
SN74S589 115
SN74S590 115
SN74S591 115
SN74S592 115
SN74S593 115
SN74S594 115
SN74S595 115
SN74S596 115
SN74S597 115
SN74S598 115
SN74S599 115
SN74S600 115
SN74S601 115
SN74S602 115
SN74S603 115
SN74S604 115
SN74S605 115
SN74S606 115
SN74S607 115
SN74S608 115
SN74S609 115
SN74S610 115
SN74S611 115
SN74S612 115
SN74S613 115
SN74S614 115
SN74S615 115
SN74S616 115
SN74S617 115
SN74S618 115
SN74S619 115
SN74S620 115
SN74S621 115
SN74S622 115
SN74S623 115
SN74S624 115
SN74S625 115
SN74S626 115
SN74S627 115
SN74S628 115
SN74S629 115
SN74S630 115
SN74S631 115
SN74S632 115
SN74S633 115
SN74S634 115
SN74S635 115
SN74S636 115
SN74S637 115
SN74S638 115
SN74S639 115
SN74S640 115
SN74S641 115
SN74S642 115
SN74S643 115
SN74S644 115
SN74S645 115
SN74S646 115
SN74S647 115
SN74S648 115
SN74S649 115
SN74S650 115
SN74S651 115
SN74S652 115
SN74S653 115
SN74S654 115
SN74S655 115
SN74S656 115
SN74S657 115
SN74S658 115
SN74S659 115
SN74S660 115
SN74S661 115
SN74S662 115
SN74S663 115
SN74S664 115
SN74S665 115
SN74S666 115
SN74S667 115
SN74S668 115
SN74S669 115
SN74S670 115
SN74S671 115
SN74S672 115
SN74S673 115
SN74S674 115
SN74S675 115
SN74S676 115
SN74S677 115
SN74S678 115
SN74S679 115
SN74S680 115
SN74S681 115
SN74S682 115
SN74S683 115
SN74S684 115
SN74S685 115
SN74S686 115
SN74S687 115
SN74S688 115
SN74S689 115
SN74S690 115
SN74S691 115
SN74S692 115
SN74S693 115
SN74S694 115
SN74S695 115
SN74S696 115
SN74S697 115
SN74S698 115
SN74S699 115
SN74S700 115
SN74S701 115
SN74S702 115
SN74S703 115
SN74S704 115
SN74S705 115
SN74S706 115
SN74S707 115
SN74S708 115
SN74S709 115
SN74S710 115
SN74S711 115
SN74S712 115
SN74S713 115
SN74S714 115
SN74S715 115
SN74S716 115
SN74S717 115
SN74S718 115
SN74S719 115
SN74S720 115
SN74S721 115
SN74S722 115
SN74S723 115
SN74S724 115
SN74S725 115
SN74S726 115
SN74S727 115
SN74S728 115
SN74S729 115
SN74S730 115
SN74S731 115
SN74S732 115
SN74S733 115
SN74S734 115
SN74S735 115
SN74S736 115
SN74S737 115
SN74S738 115
SN74S739 115
SN74S740 115
SN74S741 115
SN74S742 115
SN74S743 115
SN74S744 115
SN74S745 115
SN74S746 115
SN74S747 115
SN74S748 115
SN74S749 115
SN74S750 115
SN74S751 115
SN74S752 115
SN74S753 115
SN74S754 115
SN74S755 115
SN74S756 115
SN74S757 115
SN74S758 115
SN74S759 115
SN74S760 115
SN74S761 115
SN74S762 115
SN74S763 115
SN74S764 115
SN74S765 115
SN74S766 115
SN74S767 115
SN74S768 115
SN74S769 115
SN74S770 115
SN74S771 115
SN74S772 115
SN74S773 115
SN74S774 115
SN74S775 115
SN74S776 115
SN74S777 115
SN74S778 115
SN74S779 115
SN74S780 115
SN74S781 115
SN74S782 115
SN74S783 115
SN74S784 115
SN74S785 115
SN74S786 115
SN74S787 115
SN74S788 115
SN74S789 115
SN74S790 115
SN74S791 115
SN74S792 115
SN74S793 115
SN74S794 115
SN74S795 115
SN74S796 115
SN74S797 115
SN74S798 115
SN74S799 115
SN74S800 115
SN74S801 115
SN74S802 115
SN74S803 115
SN74S804 115
SN74S805 115
SN74S806 115
SN74S807 115
SN74S808 115
SN74S809 115
SN74S810 115
SN74S811 115
SN74S812 115
SN74S813 115
SN74S814 115
SN74S815 115
SN74S816 115
SN74S817 115
SN74S818 115
SN74S819 115
SN74S820 115
SN74S821 115
SN74S822 115
SN74S823 115
SN74S824 115
SN74S825 115
SN74S826 115
SN74S827 115
SN74S828 115
SN74S829 115
SN74S830 115
SN74S831 115
SN74S832 115
SN74S833 115
SN74S834 115
SN74S835 115
SN74S836 115
SN74S837 115
SN74S838 115
SN74S839 115
SN74S840 115
SN74S841 115
SN74S842 115
SN74S843 115
SN74S844 115
SN74S845 115
SN74S846 115
SN74S847 115
SN74S848 115
SN74S849 115
SN74S850 115
SN74S851 115
SN74S852 115
SN74S853 115
SN74S854 115
SN74S855 115
SN74S856 115
SN74S857 115
SN74S858 115
SN74S859 115
SN74S860 115
SN74S861 115
SN74S862 115
SN74S863 115
SN74S864 115
SN74S865 115
SN74S866 115
SN74S867 115
SN74S868 115
SN74S869 115
SN74S870 115
SN74S871 115
SN74S872 115
SN74S873 115
SN74S874 115
SN74S875 115
SN74S876 115
SN74S877 115
SN74S878 115
SN74S879 115
SN74S880 115
SN74S881 115
SN74S882 115
SN74S883 115
SN74S884 115
SN74S885 115
SN74S886 115
SN74S887 115
SN74S888 115
SN74S889 115
SN74S890 115
SN74S891 115
SN74S892 115
SN74S893 115
SN74S894 115
SN74S895 115
SN74S896 115
SN74S897 115
SN74S898 115
SN74S899 115
SN74S900 115
SN74S901 115
SN74S902 115
SN74S903 115
SN74S904 115
SN74S905 115
SN74S906 115
SN74S907 115
SN74S908 115
SN74S909 115
SN74S910 115
SN74S911 115
SN74S912 115
SN74S913 115
SN74S914 115
SN74S915 115
SN74S916 115
SN74S917 115
SN74S918 115
SN74S919 115
SN74S920 115
SN74S921 115
SN74S922 115
SN74S923 115
SN74S924 115
SN74S925 115
SN74S926 115
SN74S927 115
SN74S928 115
SN74S929 115
SN74S930 115
SN74S931 115
SN74S932 115
SN74S933 115
SN74S934 115
SN74S935 115
SN74S936 115
SN74S937 115
SN74S938 115
SN74S939 115
SN74S940 115
SN74S941 115
SN74S942 115
SN74S943 115
SN74S944 115
SN74S945 115
SN74S946 115
SN74S947 115
SN74S948 115
SN74S949 115
SN74S950 115
SN74S951 115
SN74S952 115
SN74S953 115
SN74S954 115
SN74S955 115
SN74S956 115
SN74S957 115
SN74S958 115
SN74S959 115
SN74S960 115
SN74S961 115
SN74S962 115
SN74S963 115
SN74S964 115
SN74S965 115
SN74S966 115
SN74S967 115
SN74S968 115
SN74S969 115
SN74S970 115
SN74S971 115
SN74S972 115
SN74S973 115
SN74S974 115
SN74S975 115
SN74S976 115
SN74S977 115
SN74S978 115
SN74S979 115
SN74S980 115
SN74S981 115
SN74S982 115
SN74S983 115
SN74S984 115
SN74S985 115
SN74S986 115
SN74S987 115
SN74S988 115
SN74S989 115
SN74S990 115
SN74S991 115
SN74S992 115
SN74S993 115
SN74S994 115
SN74S995 115
SN74S996 115
SN74S997 115
SN74S998 115
SN74S999 115
SN74S1000 115

TTL 74 (TEXAS)
7400 11
7401 11
7402 11
7403 12
7404 12
7405 18
7406 28
7407 38
7408 17
7409 17
7410 11
7411 20
7412 17

VDU IC'S
AY-3-1015 550
AY-5-1013 450
SFF96364E 1050
SFC71301 820
SFS80102 205
SN74285 63
SN74ALS163 118
SN74S262 895
SN74S450 325
SN74S475 825
SN74S512 110
SN74S519 115
SN74S527 115
SN74S540 115
SN74S541 115
SN74S542 115
SN74S543 115
SN74S544 115
SN74S545 115
SN74S546 115
SN74S547 115
SN74S548 115
SN74S549 115
SN74S550 115
SN74S551 115
SN74S552 115
SN74S553 115
SN74S554 115
SN74S555 115
SN74S556 115
SN74S557 115
SN74S558 115
SN74S559 115
SN74S560 115
SN74S561 115
SN74S562 115
SN74S563 115
SN74S564 115
SN74S565 115
SN74S566 115
SN74S567 115
SN74S568 115
SN74S569 115
SN74S570 115
SN74S571 115
SN74S572 115
SN74S573 115
SN74S574 115
SN74S575 115
SN74S576 115
SN74S577 115
SN74S578 115
SN74S579 115
SN74S580 115
SN74S581 115
SN74S582 115
SN74S583 115
SN74S584 115
SN74S585 115
SN74S586 115
SN74S587 115
SN74S588 115
SN74S589 115
SN74S590 115
SN74S591 115
SN74S592 115
SN74S593 115
SN74S594 115
SN74S595 115
SN74S596 115
SN74S597 115
SN74S598 115
SN74S599 115
SN74S600 115
SN74S601 115
SN74S602 115
SN74S603 115
SN74S604 115
SN74S605 115
SN74S606 115
SN74S607 115
SN74S608 115
SN74S609 115
SN74S610 115
SN74S611 115
SN74S612 115
SN74S613 115
SN74S614 115
SN74S615 115
SN74S616 115
SN74S617 115
SN74S618 115
SN74S619 115
SN74S620 115
SN74S621 115
SN74S622 115
SN74S623 115
SN74S624 115
SN74S625 115
SN74S626 115
SN74S627 115
SN74S628 115
SN74S629 115
SN74S630 115
SN74S631 115
SN74S632 115
SN74S633 115
SN74S634 115
SN74S635 115
SN74S636 115
SN74S637 115
SN74S638 115
SN74S639 115
SN74S640 115
SN74S641 115
SN74S642 115
SN74S643 115
SN74S644 115
SN74S645 115
SN74S646 115
SN74S647 115
SN74S648 115
SN74S649 115
SN74S650 115
SN74S651 115
SN74S652 115
SN74S653 115
SN74S654 115
SN74S655 115
SN74S656 115
SN74S657 115
SN74S658 115
SN74S659 115
SN74S660 115
SN74S661 115
SN74S662 115
SN74S663 115
SN74S664 115
SN74S665 115
SN74S666 115
SN74S667 115
SN74S668 115
SN74S669 115
SN74S670 115
SN74S671 115
SN74S672 115
SN74S673 115
SN74S674 115
SN74S675 115
SN74S676 115
SN74S677 115
SN74S678 115
SN74S679 115
SN74S680 115
SN74S681 115
SN74S682 115
SN74S683 115
SN74S684 115
SN74S685 115
SN74S686 115
SN74S687 115
SN74S688 115
SN74S689 115
SN74S690 115
SN74S691 115
SN74S692 115
SN74S693 115
SN74S694 115
SN74S695 115
SN74S696 115
SN74S697 115
SN74S698 115
SN74S699 115
SN74S700 115
SN74S701 115
SN74S702 115
SN74S703 115
SN74S704 115
SN74S705 115
SN74S706 115
SN74S707 115
SN74S708 115
SN74S709 115
SN74S710 115
SN74S711 115
SN74S712 115
SN74S713 115
SN74S714 115
SN74S715 115
SN74S716 115
SN74S717 115
SN74S718 115
SN74S719 115
SN74S720 115
SN74S721 115
SN74S722 115
SN74S723 11

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES	
AA119	18
AA129	25
AA130	25
AA135	15
BA100	10
BY100	24
BY126	12
BY127	12
CRO33	148
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA80	6
OA91	6
OA95	8
OA200	8
OA202	8
IN914	4
IN916	5
IN4002	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

BRIDGE RECTIFIERS	
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	34
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	55
4A/100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
6A/600V	86
VM18 DIL	40

SPEAKERS	
8Ω 0.3W	74
2" 2.5"	74
4" 2.5"	74
4Ω 2.5"	74
8Ω 5W	250
8Ω 3W	160
6" x 4"	160

ALUM. BOXES	
3x2x1"	54
2x5x1 1/2"	72
4x4x1 1/2"	72
4x2x1 1/2"	72
4x2 1/2x1 1/2"	85
5x4x2 1/2"	98
6x4x2 1/2"	108
7x5x2 1/2"	145
8x6x3"	185
10x7x3"	210
10x4x3 1/2"	178
12x5x3"	215
12x8x3"	265

OPTO ELECTRONICS	
LEDS Plus, Clip	13
TIL209 Red 125°	15
TIL211 Grn 125°	15
TIL32 Infra Red	15
0.2" Red	58
0.2" Yellow	19
Grn. Amber	48
OCPT1	120
ORP12	63
2N5777	45

OPTO Isolators	
IL74	45
TIL111/2	85
TIL114	85
TIL117	110

7 Segment Displays	
LS400	255
TIL307	675
TIL312 & 313.3"	105
TIL321 .5" C.An	115
TIL322 .5" C.Ch	99
DL704 .3" C.Ch	123
DL707 .3" C.Anod	99
DL747 .6" An	180
FND357	120
MAN3640	185
XAN351 .3" Green	180

VOLTAGE REGULATORS	
1A TO3 +ve	—ve
5V 7805	145p 7905 220p
12V 7812	145p 7912 220p
15V 7815	145p —
18V 7818	145p —
1A TO220 Plastic Casing	—
5V 7805	80p 7905 90p
12V 7812	80p 7912 90p
15V 7815	80p 7915 90p
18V 7818	85p 7918 90p
24V 7824	85p 7924 90p

SWITCHES	
SLIDE 250V	—
1A DPDT	14
1A DPDT C/OFF	15
1A DPDT	13
4 pole 2-way	24

PUSH BUTTON	
Spring loaded	59
Latching	59
SPST on off	65
SPDT C/over	60
DPDT 6 Tag	85

MINIATURE	
Non Locking	—
Push to make	215
Push Break	25
ROCKER: 5A, 250V, SPST	23
ROCKER: (white) 5A 250V SP change-over centre off	30
ROCKER: Lights red when on. Chrome Bezel. 3A 250V. SPST	52

ROTARY: "Make-A-Switch"	
Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodates up to 8 Wafers	75
Mains Switch DPST to fit	34
Break Before Make Wafers. 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way	47
Spacer and Screen	5
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

VEROBOARD	
Pitch	0-1 0-15
0-1 (copper clad)	(plain)
2 1/2 x 3 1/2"	46p 31p 24p
2 1/2 x 5"	55p 50p 31p
3 1/2 x 3 1/2"	85p 80p —
3 1/2 x 5"	82p 67p 50p 43p
4 1/2 x 1 1/2"	215p 185p 141p
4 1/2 x 1 1/2"	285p — 183p
Pkt of 36 pins	20p VQ Board 90p
Spot face cutter	85p DIP Board 285p
Pin insertion tool	120p 'S' Board 1270p

VERO WIRING PEN	
Spare Wire (Spool) 80p	Combs 7p ea.

FERRIC CHLORIDE	
1lb bag Anhydrous 70p + 35p p. & p.	—

DALO ETCH RESIST PEN	
Plus spare tip	75p

COPPER CLAD BOARDS	
Fibre Single-Sided	SRBP
Glass sided	8-5" x 8-5"
6" x 6"	75p 80p
6" x 12"	130p 175p

SOLDERCON PINS	
100 pins 50p	500 pins 200p

OHIO SUPERBOARD II

Now available from Stock at knockdown price. Only £229.00. Fully assembled and tested. Requires +5V at 3A and a Video Monitor or TV with RF converter to be up and running. (Data sheets supplied). 8K Microsoft BASIC in ROM. 4K Static RAM on Board expandable to 8K. Full 53 Key Keyboard with Upper/Lower Case & user programmability and a lot more. See it for yourself. Continuous demonstration on at our retail Shop.

TEXAS TM990/189M UNIVERSITY BOARD MICROCOMPUTER Only £249.00

This new single board computer is designed as a learning aid for hands-on experience plus instruction in microcomputer fundamentals. Supplied with comprehensive user's guide. Ideal for Colleges and Universities as a primary Course book for a 16 bit microcomputer class.

CRYSTALS	
100kHz	385p 6-5536MHz 200p
455kHz	385p 7-680MHz 323p
1MHz	323p 9-375MHz 323p
1.008MHz	323p 10-7MHz 323p
1-80MHz	385p 12MHz 392p
1-832MHz	382p 14-3181MHz 300p
1-6MHz	395p 18MHz 323p
3-2768MHz	323p 18-432M 323p
4MHz	290p 20MHz 362p
4-002MHz	323p 27-648MHz 350p
4-433619M	135p 48MHz 323p
5.0MHz	355p 100MHz 300p

VDU BOARD	
Thompson SFKEX 68364-1-1, ready built & tested £69.00.	—
UHF Modulator 250p. Wide Bandwidth Special for computer	470p

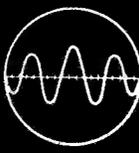
Full Ascii KEYBOARD Model 756	
Low cost, ready-built, tested & Guaranteed. Full technical details supplied. Only £49.75.	—

KEYPADS	
4x4 matrix, push button read switches assembly. Extremely reliable. Only £45.00.	—

PE Projects: Rhythm generator, Sound to Light, Sound Operated Switch, Capacitance Meter etc. Send SAE for list.

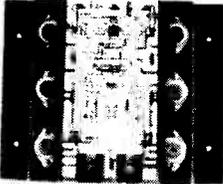
DIL SOCKETS (TEXAS)	
8 pin	Low profile 10p Wire wrap 25p
14 pin	12p 36p
16 pin	13p 46p
18 pin	18p 52p
20 pin	22p 55p
22 pin	25p 70p
24 pin	36p 75p
28 pin	39p 85p
36 pin	— 105p
40 pin	80p 105p

TRANSFORMERS (mains Prim. 220-240V)	
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA	95p
8VA type: 6V-5A 6V-5A; 9V-4A 9V-4A; 12V-3A 12V-3A; 15V-2.5A 15V-2.5A 195p	—
12VA: 4.5-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A 12V-5A 12V-5A 220p (20p p&p)	—
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A 290p (45p p&p)	—
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-8A 30V-8A 350p (50p p&p)	—
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A 650p (60p p&p)	—
(N.B. P & P charge to be added above our normal postal charge.)	—

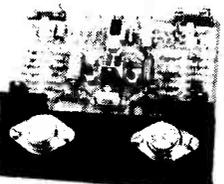


TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO. LTD.
PHONE 01-672 3137/672 9080
MANUFACTURERS OF QUALITY AMPLIFICATION AND LIGHTING CONTROL SYSTEMS



TD500



TD150

NEW FROM TUAC

7" x 9" x 1 1/2" ULTRA QUALITY HIGH POWER 5" x 5" x 2" New D.C. Coupled Design AMPLIFIERS

Featuring—Electronic Short Open and Thermal Overload Protection.
Brief Spec.—Input Sensitivity 0.775 v. R.M.S. (O.D.B.) at 25K Ohms. Frequency Response 20 Hz - 20 KHz. T.H.D. at full power 0.1%. Hum and Noise—100 dB Relative full output.

T.D. 500 300W into 2 Ohms. 220W into 4 Ohms. 140W into 8 Ohms.	£47.95
Power supply P.S.300	£31.95
T.D.150 150W into 4 Ohms. 100W into 8 Ohms.	£27.95
Power supply P.S. 150	£21.00
T.D. 150 60 Version 60W into 8 Ohms. 40W into 15 Ohms.	£21.00
Power supply P.S. 60	£16.50

Note—P.S. 300 will drive 2 T.D. 150 amplifiers
All output ratings are R.M.S. continuous sine wave output.

TO ORDER BY POST
Make cheques/P.O.s payable to TUAC LTD., or quote Access/Barclay Card No. (We accept holders phone orders 01-672 9080.)
Post to—
TUAC LTD., 119 CHARLTON ROAD, LONDON SW17 9AB.
Send stamp for our free 28 page catalogue of LIGHTING & AMPLIFIER MODULES, etc.



4 1/4" x 3 1/4" METER. 30µA, 50µA or 100µA, £8.40. 19p P. & P.

2 1/2" x 2 1/2" meters 500µA, £4.14. 16p P. & P.

60 x 45mm meters 50µA, 100µA, 500µA and 1mA VU meter, £6.16. 11p P. & P.

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

MICROPHONES FOR TAPE RECORDERS

DM228R 200 ohm with 3-5 and 2-5mm Jack Plugs **£1.70**

DM229R 50K with 3-5 and 2-5mm Jack Plugs **£2.25**

DM18D 200 ohm with 5 and 3 pin Din Plugs **£1.99**

Postage on above microphones 11p

MULTI-METER

Model IT1-2
20,000 ohm/volt.
£13.29.
33p P. & P.



CARDIOID DYNAMIC MICROPHONE

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

TRANSFORMERS Primary 240V

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

Post on above transformers 30p.

9-0-9V	1A	£1.80
12-0-12V	1A	£2.15
15-0-15V	1A	£2.51
30-0-30V	1A	£3.10
6-3V	1 1/2A	£1.80
6-0-6V	1 1/2A	£2.20

Post on above transformers 45p.

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

M. DZIUBAS

158 Bradshawgate · Bolton · Lancs. BL2 1BA

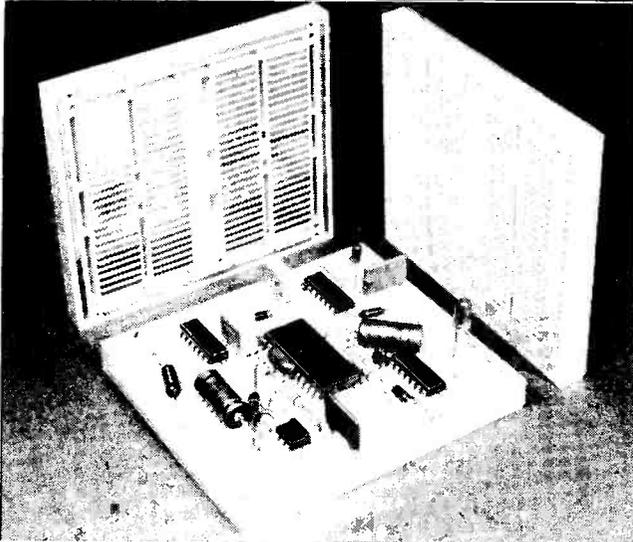
THE NEW

EUROSOLDERSUCKER

The 195mm long, all metal, high suction, desoldering tool with replaceable Teflon tip enables removal of molten solder from all sizes of pcb pads. Primed and released by thumb, it incorporates an anti-recoil system and built in safety guard. Only £7.25 inc. VAT & P.P.

THE UNIQUE

EUROBREADBOARD



Logically laid out to accept both 0.3" and 0.6" pitch DIL packages as well as Capacitors, Resistors, LED's, Transistors and components with leads up to .85mm dia.

500 individual connections in the central breadboarding area, spaced to accept all sizes of DIL package without running out of connection points, plus 4 Integral Power Bus Strips around all edges for minimum inter-connection lengths.

All connection rows and columns are now numbered or lettered enabling exact location indexing.

Double-sided nickel silver contacts for long life (10K insertions) and low contact resistance (< 10m. ohms).

Easily removable, non-slip rubber backing allows damaged contacts to be rapidly replaced.

No other breadboard has as many individual contacts, offers all these features and costs only £6.20 each or £11.70 for 2 - inclusive of VAT and P.P.

Snip out and Post

David George Sales, r/o 74 Crayford High St., Crayford, Kent DA1 4EF

David George Sales
r/o 74 Crayford High Street,
Crayford, Kent, DA1 4EF.

PE9/79

Please send me 1 EuroSolderSucker @ £7.25 Please
or 1 EuroBreadBoard @ £6.20 Tick
or 2 EuroBreadBoards @ £11.70

(All prices are applicable from July 1st 1979 and include VAT & P.P. but add 15% for overseas order.)

Name

Company

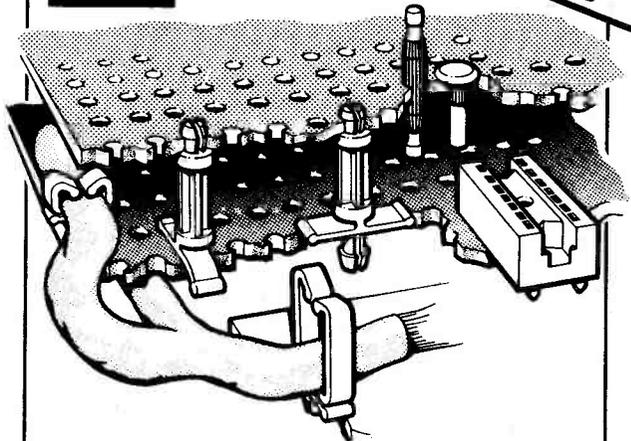
Address

Tel. No.

Please make cheque/P.O.'s payable to David George Sales

VERO

OUR RANGE OF
PRODUCTS ARE NOW INDIVIDUALLY
AND ATTRACTIVELY PACKAGED



Our new catalogue lists circuit board accessories for all your projects - DIP sockets, pins, stand-offs, cable clips, hand tools. And we've got circuit boards, module systems, cases and boxes - everything you need to give your equipment the quality you demand. Send 25p to cover postage and packing, and the catalogue's yours.

VERO ELECTRONICS LTD. RETAIL DEPT.
Industrial Estate, Chandlers Ford, Hants. SO5 3ZR
Telephone Chandlers Ford (04215) 2956

Another Crofton First Brand New Full Specification

10" Metal Cased Industrial Video Monitor

£115.00
Total to Personal
Callers - Subject to
availability.

Video Bandwidth 8MZ (3db down).
Ideal for Computer Terminal or General
Video Monitor.

Complete With Own Power Supply.
Input Sensitivity IV Composite.

2102 RAM	£1-05	6402 UART	£3-65
2114 RAM	5-50	2111 RAM	1-50
6800 CPU	5-20	1-008Mhz XTAL	2-50
68A10 RAM	2-25	8T26 Bus Driver	1-05
2513 Char Gen	4-50	81LS95	1-30
96364 Crt Gen	12-10	2516 +5vROM	30-00
96364 ROM	4-50	74LS374	1-40

and CMOS at Competitive Prices • Qty Discounts
can be agreed • Plus VAT 15% + P&P

CROFTON
Electronics Limited
35 Grosvenor Road, Twickenham
Middlesex • Tel: 01-891 1923

PRIME TTL & CMOS AT LOWEST PRICES

ALL NEW

REAL-STATE OF-THE-ART

NEW LOW PRICES

Two new 10Hz to 600MHz frequency counters from Optoelectronics USA each c/w built-in Nicads + charging circuits.

MODEL OPTO 8000.1A
ONLY £260 (was £320)



- Precision TCXO time base 0.1 PPM stability
- Super sensitivity with preamps in both HI-Z & 50 ohm inputs <10mV to 50MHz 25mV @ 150 MHz <50mV to 600MHz
- Auto decimal point
- Aluminium case
- Sockets IC's
- Three position attenuator X1, X10, X100 (avoids false counting)

MODEL OPTO 7000
ONLY £123 (was £155)



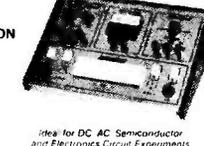
- TCXO time base 0.08 PPM/°C
 - Aluminium case
 - HI-Z & 50 ohm inputs
 - 1 sec & 1/10 sec gate times
 - Auto decimal point
 - Built-in preamps & prescaler standard
- Frequency Counter Accessories
 P 100 50 ohm 1X £12
 P 101 Lo Pass £12
 P 102 Hz 2.3K £13
 Rubber duck RF pick up aerials 146.5 or 450MHz £12 each

7400 100	74126 35u	74182/91 60u	74515 85u
7401 100	74127 35u	74183 60u	74520 90u
7402 100	74128 35u	74184 60u	74525 90u
7403 100	74129 35u	74185 60u	74530 90u
7404 100	74130 35u	74186 60u	74535 90u
7405 100	74131 35u	74187 60u	74540 90u
7406 100	74132 35u	74188 60u	74545 90u
7407 100	74133 35u	74189 60u	74550 90u
7408 100	74134 35u	74190 60u	74555 90u
7409 100	74135 35u	74191 60u	74560 90u
7410 100	74136 35u	74192 60u	74565 90u
7411 100	74137 35u	74193 60u	74570 90u
7412 100	74138 35u	74194 60u	74575 90u
7413 100	74139 35u	74195 60u	74580 90u
7414 100	74140 35u	74196 60u	74585 90u
7415 100	74141 35u	74197 60u	74590 90u
7416 100	74142 35u	74198 60u	74595 90u
7417 100	74143 35u	74199 60u	74600 90u
7418 100	74144 35u	74200 60u	74605 90u
7419 100	74145 35u	74201 60u	74610 90u
7420 100	74146 35u	74202 60u	74615 90u
7421 100	74147 35u	74203 60u	74620 90u
7422 100	74148 35u	74204 60u	74625 90u
7423 100	74149 35u	74205 60u	74630 90u
7424 100	74150 35u	74206 60u	74635 90u
7425 100	74151 35u	74207 60u	74640 90u
7426 100	74152 35u	74208 60u	74645 90u
7427 100	74153 35u	74209 60u	74650 90u
7428 100	74154 35u	74210 60u	74655 90u
7429 100	74155 35u	74211 60u	74660 90u
7430 100	74156 35u	74212 60u	74665 90u
7431 100	74157 35u	74213 60u	74670 90u
7432 100	74158 35u	74214 60u	74675 90u
7433 100	74159 35u	74215 60u	74680 90u
7434 100	74160 35u	74216 60u	74685 90u
7435 100	74161 35u	74217 60u	74690 90u
7436 100	74162 35u	74218 60u	74695 90u
7437 100	74163 35u	74219 60u	74700 90u
7438 100	74164 35u	74220 60u	74705 90u
7439 100	74165 35u	74221 60u	74710 90u
7440 100	74166 35u	74222 60u	74715 90u
7441 100	74167 35u	74223 60u	74720 90u
7442 100	74168 35u	74224 60u	74725 90u
7443 100	74169 35u	74225 60u	74730 90u
7444 100	74170 35u	74226 60u	74735 90u
7445 100	74171 35u	74227 60u	74740 90u
7446 100	74172 35u	74228 60u	74745 90u
7447 100	74173 35u	74229 60u	74750 90u
7448 100	74174 35u	74230 60u	74755 90u
7449 100	74175 35u	74231 60u	74760 90u
7450 100	74176 35u	74232 60u	74765 90u
7451 100	74177 35u	74233 60u	74770 90u
7452 100	74178 35u	74234 60u	74775 90u
7453 100	74179 35u	74235 60u	74780 90u
7454 100	74180 35u	74236 60u	74785 90u
7455 100	74181 35u	74237 60u	74790 90u
7456 100	74182 35u	74238 60u	74795 90u
7457 100	74183 35u	74239 60u	74800 90u
7458 100	74184 35u	74240 60u	74805 90u
7459 100	74185 35u	74241 60u	74810 90u
7460 100	74186 35u	74242 60u	74815 90u
7461 100	74187 35u	74243 60u	74820 90u
7462 100	74188 35u	74244 60u	74825 90u
7463 100	74189 35u	74245 60u	74830 90u
7464 100	74190 35u	74246 60u	74835 90u
7465 100	74191 35u	74247 60u	74840 90u
7466 100	74192 35u	74248 60u	74845 90u
7467 100	74193 35u	74249 60u	74850 90u
7468 100	74194 35u	74250 60u	74855 90u
7469 100	74195 35u	74251 60u	74860 90u
7470 100	74196 35u	74252 60u	74865 90u
7471 100	74197 35u	74253 60u	74870 90u
7472 100	74198 35u	74254 60u	74875 90u
7473 100	74199 35u	74255 60u	74880 90u
7474 100	74200 35u	74256 60u	74885 90u
7475 100	74201 35u	74257 60u	74890 90u
7476 100	74202 35u	74258 60u	74895 90u
7477 100	74203 35u	74259 60u	74900 90u
7478 100	74204 35u	74260 60u	74905 90u
7479 100	74205 35u	74261 60u	74910 90u
7480 100	74206 35u	74262 60u	74915 90u
7481 100	74207 35u	74263 60u	74920 90u
7482 100	74208 35u	74264 60u	74925 90u
7483 100	74209 35u	74265 60u	74930 90u
7484 100	74210 35u	74266 60u	74935 90u
7485 100	74211 35u	74267 60u	74940 90u
7486 100	74212 35u	74268 60u	74945 90u
7487 100	74213 35u	74269 60u	74950 90u
7488 100	74214 35u	74270 60u	74955 90u
7489 100	74215 35u	74271 60u	74960 90u
7490 100	74216 35u	74272 60u	74965 90u
7491 100	74217 35u	74273 60u	74970 90u
7492 100	74218 35u	74274 60u	74975 90u
7493 100	74219 35u	74275 60u	74980 90u
7494 100	74220 35u	74276 60u	74985 90u
7495 100	74221 35u	74277 60u	74990 90u
7496 100	74222 35u	74278 60u	74995 90u
7497 100	74223 35u	74279 60u	75000 90u
7498 100	74224 35u	74280 60u	
7499 100	74225 35u	74281 60u	

ELENCO ELECTRONIC/DIGITAL DESIGN STATIONS

Elenco's electronic or digital design stations contain the essential equipment for quick and easy breadboarding of circuits. All power supplies are regulated and protected by a special current limiting circuit. Oscillator outputs are protected against shorts. Whether a novice or pro, our fail-safe circuits assures against users errors. Ideal for use in schools; labs, homes and industry.

MODEL XK-1000 ELECTRONIC DESIGN STATION
 • Dual DC Power Supply 0 to 15V 0 to 15V 2 Amps
 • Fully Regulated
 • Short Circuit Protection
 • Sine or Square Wave waves from 0.2Hz to 200KHz
 • Gen 100Hz to 200KHz
 • AC Power Supply 15.0V
 • Solderless Breadboard Sockets



BOTH MODELS £85 EACH

MODEL XK-2000 DIGITAL DESIGN STATION
 • Three Power Supplies 5V 1A 12V 1A 12V 1A
 • Fully Regulated
 • Short Circuit Protection
 • Four Clock Frequencies 1MHz 60KHz 100KHz
 • Four LED Logic Indicators
 • Logic & Data Switches
 • Solderless Breadboard Sockets

Comparable with most IC Logic Families including RTL, DTL, TTL, CMOS, PMOS, NMOS, Linear

BRAND NEW FROM EICO MODEL 390 Function / Sweep Generator £135.00



- Offers linear, logarithmic sweeps
- Six position calibrated attenuator
- BNC front panel output jack
- Generates discrete sine, square and triangle waves from 0.2Hz to 200KHz
- Ideal for checking frequency response of audio amplifiers, driving digital circuits and servo systems
- Features 1000:1 ratio, variable control, 10 volts peak to peak into 50 ohms

ELENCO PRECISION Digital multimeter 1200B

The most versatile DMM we have ever offered at lowest ever price!



- 3 1/2 digits jumbo LED display 0.05% basic accuracy
- Measures AC/DC voltages from 100 microvolts to 1000 volts, AC/DC current from 1 microamp to 2 Amp, resistance from 0.01 ohm to 20 Megohm
- Fully overload protected to 1000 Volts
- High input impedance 10 Meg ohm
- Means (with adaptor) or battery operation (both disposable and Nicads)
- Uses 1% precision resistors & not unstable trimmers
- High low power ohms for 1000s, 10 for resistors in circuit (on low many DMM's costing less than £100 do you find this feature?)

MICROPROCESSORS

CPU's	£	RAM's	£
8080A	10.00	SY2P114	6.50
Z80	5.00	2120L/FPC	1.50
E PROM	11.00	4060	4.50
	4.00	4027	3.50

Texas Instruments Low Profile Sockets

Contacts	Price	Contacts	Price
8 PIN	08	22 PIN	22
14 PIN	12	24 PIN	24
16 PIN	14	28 PIN	28
18 PIN	16	40 PIN	40
20 PIN	20		

FAIRCHILD RED LED LAMPS

FLV5057 Medium Size Clear Case RED EMITTING These are not retested off spec units as sold by some of our competition. These are factory prime first quality new units



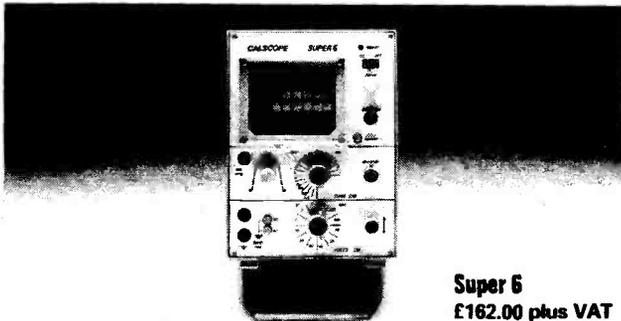
9p each 1 off
6p each 100 off

FND 847 Common Anode £2 each
FND 850 Common Cathode £1.50 each 100 off

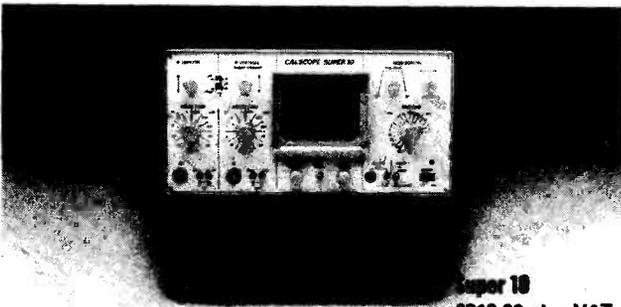
7 SEGMENT DISPLAY LEDS AT LOWEST PRICES

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 70	Common Anode orange	300	125u	MAN 6730	Common Cathode red D	560	99u
MAN 71	Common Anode yellow	300	99u	MAN 6740	Common Cathode red D D	560	99u
MAN 72	Common Cathode red	300	125u	MAN 6750	Common Cathode red D	560	99u
MAN 74	Common Cathode red	300	99u	MAN 6760	Common Cathode red	560	99u
MAN 82	Common Anode yellow	300	99u	MAN 6780	Common Cathode red	560	99u
MAN 84	Common Cathode yellow	300	99u	DL 701	Common Anode red D	600	125u
MAN 85	Common Cathode orange	300	99u	DL 702	Common Anode red	600	125u
MAN 86	Common Anode orange	300	99u	DL 703	Common Anode red	600	125u
MAN 87	Common Cathode orange	300	99u	DL 704	Common Anode red	600	125u
MAN 88	Common Cathode orange	300	99u	DL 705	Common Anode red	600	125u
MAN 89	Common Cathode orange	300	99u	DL 706	Common Anode red	600	125u
MAN 90	Common Cathode orange	300	99u	DL 707	Common Anode red	600	125u
MAN 91	Common Cathode orange	300	99u	DL 708	Common Anode red	600	125u
MAN 92	Common Cathode orange	300	99u	DL 709	Common Anode red	600	125u
MAN 93	Common Cathode orange	300	99u	DL 710	Common Anode red	600	125u
MAN 94	Common Cathode orange	300	99u	DL 711	Common Anode red	600	125u
MAN 95	Common Cathode orange	300	99u	DL 712	Common Anode red	600	125u
MAN 96	Common Cathode orange	300	99u	DL 713	Common Anode red	600	125u
MAN 97	Common Cathode orange	300	99u	DL 714	Common Anode red	600	125u
MAN 98	Common Cathode orange	300	99u	DL 715	Common Anode red	600	125u
MAN 99	Common Cathode orange	300	99u	DL 716	Common Anode red	600	125u
MAN 100	Common Cathode orange	300	99u	DL 717	Common Anode red	600	125u
MAN 101	Common Cathode orange	300	99u	DL 718	Common Anode red	600	125u
MAN 102	Common Cathode orange	300	99u	DL 719	Common Anode red	600	125u
MAN 103	Common Cathode orange	300	99u	DL 720	Common Anode red	600	125u
MAN 104	Common Cathode orange	300	99u	DL 721	Common Anode red	600	125u
MAN 105	Common Cathode orange	300	99u	DL 722	Common Anode red	600	125u
MAN 106	Common Cathode orange	300	99u	DL 723	Common Anode red	600	125u
MAN 107	Common Cathode orange	300	99u	DL 724	Common Anode red	600	125u
MAN 108	Common Cathode orange	300	99u	DL 725	Common Anode red	600	125u
MAN 109	Common Cathode orange	300	99u	DL 726	Common Anode red	600	125u
MAN 110	Common						

The professional scopes you've always needed.



Super 6
£162.00 plus VAT



Super 10
£219.00 plus VAT

When it comes to oscilloscopes, you'll have to go a long way to equal the reliability and performance of Calscope.

Calscope set new standards in their products, as you'll discover when you compare specification and price against the competition.

The Calscope Super 10, dual trace 10 MHz has probably the highest standard anywhere for a low cost general purpose oscilloscope. A 3% accuracy is obtained by the use of stabilised power supplies which cope with mains fluctuations.

The price £219 plus VAT.

The Super 6 is a portable 6MHz single beam model with easy to use controls and has a time base range of 1µs to 100ms/cm with 10mV sensitivity. Price £162 plus VAT.

Prices correct at time of going to press

CALSCOPE DISTRIBUTED BY

Watford Electronics,
33-35 Cardiff Road,
Watford, Herts.
Tel: 0923 40588

Audio Electronics,
301 Edgware Road, London W.2.
Tel: 01-724 3564

Access and Barclay card facilities
(Personal Shoppers)

Maplin Electronics Supplies Ltd.
P.O. Box 3
Rayleigh, Essex.
Tel: 0702 715 155
Mail Order

CALSCOPE

ELECTROVALUE

Your leading direct suppliers for



**NASCOM MICROCOMPUTERS
AND FULL SUPPORTING RANGE
OF ITEMS TO ENABLE YOU TO
WORK AT PROPER
PROFESSIONAL LEVELS**

- ★ At newest reduced prices.
- ★ Widest possible range stocked
- ★ Information on request
- ★ Enquiries from trade, industrial and educational users invited

**Appointed distributors for the
fine products of:**

**SIEMENS, ISKRA, RADIOHM,
VERO AND MANY OTHER
FAMOUS MANUFACTURERS**

It's a good deal better from

ELECTROVALUE LTD

Dept. PE6, 28 St. Jude's Road, Englefield Green, Egham, Surrey TW20 0HB.

Phone: Egham 3603. Telex 264475.

Northern Branch (Personal shoppers only), 680 Burnage Lane,
Burnage, Manchester M19 1NA, Phone (061) 432 4945.

● We pay postage
in U.K. on orders list value
£5 or over. If under, add
27p handling charge.

● We give discounts
on C.W.O. orders, except
items marked Net or N in
our catalogues.

5% on orders, list value
£10 or more

10% on orders list value
£25 or more.
Not on Access or Barclay
orders

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

● We guarantee
all products brand new,
clean and to maker's spec.
No seconds, no surplus.

● WE WILL SEND YOU
OUR 120-PAGE
CATALOGUE No. 9
FREE ON REQUEST.

Comprehensive, informative,
very well produced. Write, phone
or call for your free copy,
together with latest
price list.

Newtronics



The Newtronics Keyboard Terminal is a low cost stand alone Video Terminal that operates quietly and maintenance free. It will allow you to display on a monitor 16 lines of 64 characters or 16 lines of 32 characters on a modified TV (RF Modulator required).

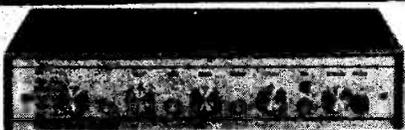
The characters can be any of the 96 ASC11 alphanumerics and any of the 32 special characters. In addition to upper-lower case capability it has scroll up features and full X-Y cursor control. All that is required from your microcomputer is 300 baud, RS232-C or 20ma loop, serial data, plus a power source of 8v DC & 6.3v AC. The steel cabinet is finished in IBM Blue-Black. And if that is not enough the price is only £135.55 + VAT as a kit, or £175.00 + VAT assembled and tested. Plus £2.00 P & P. (Monitor not included)

Dealer and O.E.M. enquiries invited.

To order phone or write:-

138 Kingsland Road, London E2 8BY
Telephone: 01 739 1582.

Access/Barclaycards accepted



20 x 20 WATT STEREO AMPLIFIER
 Viscount IV uni-stytek 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! **£31.90**
 a built in four channel stereo sound facility. **£3.00 p&p**

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

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

EMI SPEAKER BARGAIN
 Stereo pair 350 kt. System consists of 13" x 8" approx. woofer with rolled surround, 2 1/2" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS 20 watts max. 8 ohm impedance.
£15.25
 Per stereo pair **£3.65 p&p**

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

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

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

UNIT AUDIO STAND
 Can be used with TV too! Finish in chrome with decorative wood spacer fitted with 4 Kerrick Mini Meteor castors
£3.95 **£1.50 p&p**

BARGAIN FOR PERSONAL SHOPPERS ONLY
Altone UA4 Stereo System
 Features 8 watt total output. Full size BSR manual turntable with cueing and auto return. Socket for tape in and out and stereo headphones
 complete with speakers. **£37.75**

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

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

Mullard

AUDIO MODULES IN BARGAIN PACKS
CURRENT CATALOGUE

PRICE £ AT OVER 25 PER PACK
SEE OUR PRICES

- 1** PACK 1 2 x LP1173 10w RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input.
OUR PRICE £5.00
 p+p £1.00
- 2** PACK 2 2 x LP1173 10w RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for magnetic, ceramic and auxiliary inputs.
illus. OUR PRICE £7.65
 p+p £1.00



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

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

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

10 + 10 AMPLIFIER KIT
 An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit.
 Size approximately 9 1/4" x 8 3/4" x 4"
p&p **£2.25** **£12.75**



BARGAINS FOR PERSONAL SHOPPERS

- LCD Solar 5 function with backlite stainless steel finish case and strap** **£7.40**
- LCD Solar Chrono 9 function with backlite stainless steel finish case and strap** **£9.55**
- Chrome stop watch 9 function with back lite stainless steel finish case and strap.** **£8.95**
- Solar Alarm LCD stainless steel case and strap.** **£21.95**
- AM/FM DIGITAL CLOCK RADIO** Accurate 4 Digit Electronic Clock with 7" LED display Buzzer and snooze timer **£12.20**
- 125 Watt Power Amp Module** **£14.25**
- Mains power supply for above unit** **£3.60**
- DECCA 20w Stereo speaker kit** comprising 2 8" approx. bass units + 2 3 1/2" approx. tweeter inc crossovers **£20.45**
- VIDEOMASTER Super Score TV Game** with pistol mains operation **£15.95**
- PORTABLE RADIO/CASSETTE RECORDER, AM/FM** with clock. LW, MW, SW, VHF mains/battery operation **£42.90**
- ISP Radio Cassette recorder Mains/Battery AM/FM** built in mic auto stop. **£24.50**

50 WATT MONO DISCO AMP
£30.60
 p&p £2.70

Size approx. 13 1/2" x 5 1/4" x 6 1/4"
 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.
SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P, 8" speakers. Package price **£45.00 + £4.00 P&P**



100 WATT MONO DISCO AMP
 Size approx. 14" x 4" x 10 1/4"
 Brushed aluminium fascia and rotary controls.
 Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level, contol (PFL) lets YDU hear next disc before fading it in. VU meter monitors output level.
 Output 100 watts RMS 200 watts peak.

70 watt **£57**
140 watt peak **p&p** **£4.05**
100 watt **£66.45**



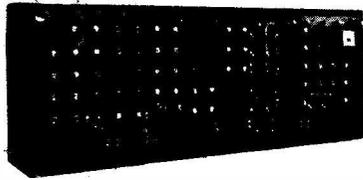
DUO II SPEAKERS
 Attractive teak finish, modern design, incorporating 2 speaker units—8" approx. woofer and 2 1/2" approx. tweeter. 45 to 1800 Hz. Impedance 8 ohms. Power 15 watts RMS
 18 1/2" x 13 1/2" x 7 1/4" Per stereo pair approx.
£16.50
 £6.50 p&p



323 EDGWARE ROAD, LONDON W2 HIGH STREET, ACTON W3 6NG
 ACTON: Mail Order only. No callers
ALL PRICES INCLUDE VAT AT 15%
 All items subject to availability. Price correct at and subject to change without notice.
NOTE: Persons under 16 years not served without parent's authorisation.

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

KITS FOR SYNTHESISERS, SOUND EFFECTS



PHONOSONICS

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

P.E. MINISONIC Mk. 2 SYNTHESIZER

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

Set of basic component kits (excl. KBD R's and tuning pots - see list for options available). from **£61.00**
Set of printed circuit boards **£8.99**

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

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

FORMANT SYNTHESIZER (Elektor 1977/78)

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

128-NOTE TUNE-PROGRAMMABLE SEQUENCER

(P.E. Nov/Dec 77)

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

Main Circuit (Nov) excl. sw's (KIT 76-1) **£10.03**
Power Supply (KIT 76-3) **£4.72**
Trigger Inverter and Alt. Output (KIT 76-2) **£1.15**
LED Counter (KIT 76-4) **£2.10**
PCB (as published) for KITS 76-1 & 3 (PCB 76A) **£2.61**
PCB for KITS 76-2 & 4 (PCB 76B) **£2.54**

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

The new keyboard string-instrument synthesizer.

Basic component sets:

Power Supply (KIT 77-1) **£8.77**
Tone Generator (KIT 77-2) **£14.66**
Diode Gates (KIT 77-3) **£18.81**
Chorus Generator (KIT 77-4) **£19.08**
Voicing System (KIT 77-5) **£7.38**

Printed Circuit Boards:

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

Fuller details of kits & PCBs are in our lists.

P.E. JOANNA PLUS ORGAN VOICING

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

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5) **£99.25**
Set of PCBs (Order as PCB SET 71-6) **£29.18**

GUITAR EFFECTS PEDAL (P.E. July 75)

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

Component set with special foot operated switches **£7.69**
Alternative component set with panel switches **£5.06**
Printed circuit board **£1.43**

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

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

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

ELEKTOR ELECTRONIC PIANO (Elektor Sept 78)

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

DIGITAL REVERBERATION UNIT (Elektor May 78)

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

Main component set (KIT 78-1) **£45.45**
Extension component set (KIT 78-2) **£43.36**
PCB for Kit 78-1 (PCB 78A) **£2.86**
PCB for Kit 78-2 (PCB 78B) **£1.06**

ANALOGUE REVERBERATION UNIT (Elektor Oct 78)

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

Main component set (KIT 83-1) **£26.18**
Additional Delay Set (KIT 83-2) **£18.26**
PCB (as published) to hold both above kits (PCB 9973) **£4.31**

RESONANCE FILTER (Elektor Oct 78)

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

Basic component set (KIT 82-1) **£15.10**
PCB (as published) (PCB 9951) **£3.29**

SYNTHESIZER EXTERNAL INPUT INTERFACE

(P.E. Oct 78)

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

Basic component set (incl PCB) (KIT B1-1) **£2.94**

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

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

RHYTHM GENERATOR KITS

Several available - details in our lists.

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

A modified and extended version of the circuit published. Component set and PCB **£4.62**

GUITAR SUSTAIN (P.E. Oct 77)

Maintains the natural attack whilst extending note duration. Component set, PCB and foot switches **£5.13**
Component set, PCB and panel switches **£3.71**

WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds. Component set (incl. PCB) **£4.26**

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

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

Component set using dual slider pot **£7.58**
Component set using dual rotary pot **£6.89**
Printed circuit board **£1.62**

FUZZ UNIT

Simple Fuzz unit based upon P.E. "Sound Design" circuit. Component set (incl. PCB) **£2.05**

TREMOLO UNIT

Based upon P.E. "Sound Design" circuit. Component set (incl. PCB) **£2.94**

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

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable. Component set (incl. PCB) **£2.51**

WAVEFORM CONVERTER

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

Component set (incl. PCB but excl. sw/s) **£8.40**

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

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

Component set (incl. PCB) (Order as Kit 65-1) **£7.17**

RING MODULATOR (P.E. Jan. 75)

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

Component set (incl. PCB) (Order as Kit 59-1) **£5.50**

NOISE GENERATOR (P.E. Jan. 75)

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

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

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

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

Component set (incl. PCB) **£4.77**

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

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

Component set (incl. PCB) **£6.68**

TRANSIENT GENERATOR (P.E. Apr. 77)

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

Component set **£4.87**
Printed circuit board **£1.82**

SOPHISTICATED PHASING AND VIBRATO UNIT

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

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

PHASING UNIT (P.E. Sept. 73)

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

Component set (incl. PCB) **£3.20**

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

For use with the above Phasing Unit to automatically control the rate of phasing. Component set (incl. PCB) **£4.74**

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

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

Component set (incl. PCB) **£3.63**

AUTOWAH UNIT (P.E. Mar. 77)

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

Component set, PCB, special foot switches **£7.67**
Component set and PCB, with panel switches **£4.83**

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

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

Component set (incl. PCB) **£3.97**

10% DISCOUNT VOUCHER (PE 74)

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

ADD: POST & HANDLING

U.K. orders - Keyboards add £2.00 each plus VAT. Other goods: under £15 add 25p plus VAT, over £15 add 50p plus VAT. Recommended: optional insurance against postal mishaps, add 50p for cover up to £50, £1.00 for £100 cover, etc. pro-rata. N.B. Eire, C.I., B.F.P.O. and other countries are subject to higher export postage rates.

ADD 12½% VAT

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

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

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

AND OTHER PROJECTS

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

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

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



KIMBER-ALLEN KEYBOARDS AND CONTACTS

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

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

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

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 67p

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

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

Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB)	£14-83
Power supply set (incl. PCB)	£6-28

SYNTHESIZER TUNING INDICATOR (P.E. July 77)

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

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

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)

A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set	£24-06*
Printed circuit board	£3-03*

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

TAPE NOISE LIMITER

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

Standard tolerance set of components	£2-96
Superior tolerance set of components	£3-76
Regulated power supply (will drive 2 sets)	£4-89

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

Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4-68
---------------------------	-------

DISCOSTROBE (P.E. Nov. 76)

4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

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

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

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

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

Details in lists.

SOPHISTICATED POWER SUPPLIES

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

NEW PCB SERVICE

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

LIMITED QUANTITIES ONLY FOR AN EXPERIMENTAL PERIOD.

LET US KNOW YOUR NEEDS AND WE WILL ADVISE YOU OF AVAILABILITY AND PRICES.

INTEGRATED CIRCUITS

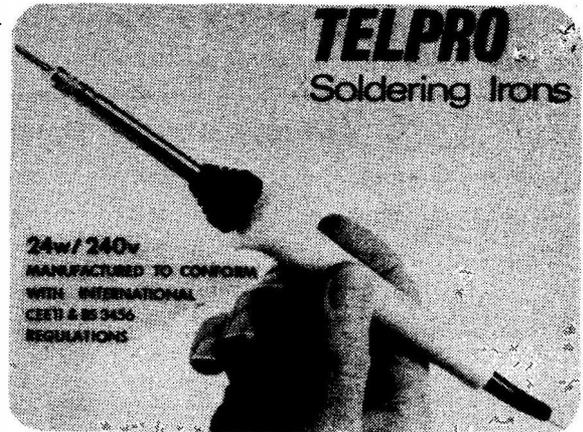
301 8-pin DIL	48p
318 8-pin DIL	220p
320-16	185p
324 14-pin DIL	87p
341-15	87p
709 8-pin DIL	48p
723 T05	87p
723 14-pin DIL	51p
728 T05	1095p
741 8-pin DIL	24p
748 8-pin DIL	57p
4007 14-pin DIL	17½p
4011 14-pin DIL	17½p
4024 14-pin DIL	48½p
4089 14-pin DIL	18p
4136 14-pin DIL	128p
AM2833 8-pin DIL	360p
AY10212 16-pin DIL	817p
AY16721/6	188p
CA3046 14-pin DIL	71p
CA3080 8-pin DIL	83p
CA3084 14-pin DIL	205p
FX209 16-pin DIL	728p
LM323	562p
M252 16-pin DIL	880p
MC3340 8-pin DIL	150p
MCM8810 24-pin DIL	870p
SG3402N 14-pin DIL	282p
STK025	585p
TDA1022 16-pin DIL	882p
XR2207 14-pin DIL	430p
ZN425E 16-pin DIL	378p

TRANSISTORS

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

PHONOSONICS

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



INTRODUCTORY OFFER

To launch the high quality TELPRO IRON (fitted with Long-Life Iron-Clad Tip) into the discerning Amateur & Enthusiast Market, we are giving away FREE:-

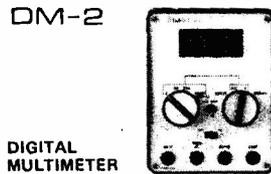
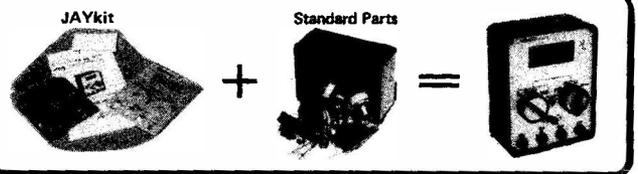
- 1 REEL SPIRIG DE-SOLDER WICK (VALUE 75p)
 - 1 PAIR NICKEL PLATED FORCEPE CLAMPS (VALUE £2.00)
 - 1 PAIR PLASTIC TWEEZERS FOR MOS/FET'S ETC. (VALUE 60p)
- (TOTAL VALUE £3.85 INC. V.A.T.)

WITH EVERY SOLDERING IRON ORDER (For limited period only)

SEND £5.50 per iron plus 83p V.A.T.

Tele-Production Tools Ltd

Stiron House, Electric Avenue, Westcliff-on-Sea, Essex S50 9NW Tel: (0702) 352719



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, a Circuit Diagram and Instruction Sheet and a comprehensive and up to date Component List showing suppliers and current prices. Difficult pieces of hardware such as screws, washers etc. are supplied with the kit.

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

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

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

TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS

STEREO PRE-AMPLIFIER POWER AMPLIFIER



CPR 1—THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slew rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.J.A.A. is accurate to 1dB, signal to noise ratio is 70dB relative to 3mV; distortion < 0.05% at 30dB overload 20kHz. Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power-amp signal levels. Signal to noise ratio 66dB; slew-rate 3V/μS. T.H.D. 20Hz—20kHz < 0.08% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138 x 20mm. Supply to be ± 15 volts.

MC 1—PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Send for details.

X02 : X03 — ACTIVE CROSSOVERS

X02 — two way, X03 — three way. Slope 24dB/octave. Crossover points set to order within 10%.

REG 1—POWER SUPPLY

The regulator module, REG 1 provides 15.0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically 0.1% any power 1kHz 8 ohms, T.L.D. insignificant; slew rate limit 25V/μS; signal to noise ratio 100dB; frequency response 10Hz-36kHz, —3dB, stability unconditional; protection—drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 x 80 x 28mm.

POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

PRE-AMPLIFIER KIT

This includes all metalwork, pots, knobs etc. to make a complete pre-amp with the CPR 1 (S) module and the MC 1 (S) if required.



ACTIVE CROSSOVERS

X02 £15.18 X03 £23.58
POWER AMPLIFIER MODULES
 CE 608 60W/8 ohms 35-0-35V £19.52
 CE 1004 100W/4 ohms 35-0-35V £23.02
 CE 1008 100W/8 ohms 45-0-45V £25.96
 CE 1704 170W/4 ohms 45-0-45V £31.00
 CE 1708 170W/8 ohms 60-0-60V £33.97

TOROIDAL POWER SUPPLIES

CP51 for 2 x CE 608 or 1 x CE 1004 £16.56
 CP52 for 2 x CE 1004 or 2 x CE 608 £18.90
 CP53 for 2 x CE 1008 or 1 x CE 1704 £19.75
 CP54 for 1 x CE 1008 £17.12
 CP55 for 1 x CE 1708 £24.15
 CP56 for 2 x CE 1704 or 2 x CE 1708 £26.83
 MC1S £23.28
 MC1S £23.17

HEATSINKS

Light duty, 50mm, 2°C/W £1.44
 Medium power, 100mm, 1.4°C/W £2.35
 Disco/group, 150mm, 1.1°C/W £3.04
 Fan, 80mm, state 120 or 240V £19.70

POWER SUPPLY

REG 1 £6.90
 TR 6 £1.97
BRIDGE DRIVER, BDI
 Obtain up to 340W using 2 x 170W amps, and this module BDI £5.75
THERMAL CUT-OUT, 70°C £1.54

Pre-amp Kit

£38.07

POWER AMP KIT

£35.03

PRE-AMPS:

These are available in two versions—one uses standard components, and the other (the S) uses MO resistors where necessary and tantalum capacitors.

CPRI £31.65

CPRI £40.87

MC1 £21.28

MC1S £23.17

POWER SUPPLY

REG 1 £6.90

TR 6 £1.97

BRIDGE DRIVER, BDI

Obtain up to 340W using 2 x 170W amps, and this module BDI £5.75

CRIMSON ELEKTRIK

1A STAMFORD STREET, LEICESTER, LE1 6NL

Tel: (0533) 553508

U.K.—please allow up to 21 days for delivery.

All prices shown are UK only and include VAT and post. COD 90p extra, £100 limit. Export is no problem, please write for specific quote. Send large SAE or 3 International Reply Coupons for detailed information.

Distributors—BADGER SOUND SERVICES LTD.

"MINIC TELEPRODUKTER BOX 1935: S-730 12 UPPSALA 12, SWEDEN"

TRANSFORMERS

30 VOLT RANGE
 Pri 220/240 sec 0-12-15-20-24-30V
 Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V 0-12V and 15V 0-15V

Ref	Amps	Price	P & P
112	0.5	2.84	0.78
115	1.0	3.57	0.86
2	2.0	5.77	0.96
3	3.0	6.20	1.14
21	4.0	7.89	1.14
51	5.0	9.87	1.32
117	8.0	11.17	1.45
88	8.0	14.95	1.64
89	10.0	17.28	1.64
90	12.0	19.17	1.95
91	15.0	21.96	2.08
92	20.0	29.45	2.08

CONTINUOUS RATING

EX-STOCK—

+ VAT 15%

TRANSFORMERS

END OF LINE OFFERS

Ref Isolator 240V:240V 200VA P-P £4.54 £1.04

£2-isolator 240V:240V 250VA £5.62 £1.04

£3-isolator 240V:240V 500VA £11.50 £2.15

6-250-0-250 e 100ma 1) Sec 6-3V e 3-5A 2) Sec 0-5V, 6-3V e 2/1 amp £3-20 78p

7-350-0-350V e 100ma 1) Sec 6-3V e 3-5A 2) Sec 0-5V, 6-3V e 2/1 amp £4-10 96p

218-250-0-250V e 0-15V CTII) Sec 6-3V e 4A 2) 0-5V, 6-3V e 2/1 amp £3-50 78p

27-250-0-250 e 60ma 1) Sec 6-3V e 2.5A 2) Sec 6-3V e 1 amp £3-00 78p

220-410-0-410V e 180ma 1) Sec 6-3V e 4 amp CT 2) Sec 6-3V e 2A 5V e 2 amp £5-30 96p

£2-4 amp Battery Charger transformer £4-81 £1.04

£8-6 amp Battery Charger transformer £5-80 £1.04

M184 — To match EL84 15W £1-62 32p

M1616 — 0-240V. Screen 1) 13-0-13 1A. 2) 12V 150ma £2-10 60p

M489 — 0-240V; 1400V e 150ma, 6-3V e 4A £5-50 £1.04

M708 — 6K to 3KΩ matching transformer 5V 90p 40p

M679 — 120V x 2; 36V 1-6A £3-00 78p

M865 — 100V Line to 40 10 watts £1-90 60p

M973 — 100V Line to 80 40 watts £2-90 60p

M1015 — Choke 8A e 5mH 150A Surge £1-50 45p

M1020 — 0-240V 12-0-12V e 50ma 97p 41p

M1126 — 120/240V; 9-0-9V e 1A £2-40 71p

M1130 — 0-240 4500V e 10ma £4-88 £1.08

M1165 — 0-115-240V; 14V 50ma 75p 30p

M824 — 0-380V; 110V e 13-6A £10-70 £1.40

P.W. Purbeck oscilloscope transformer 250-0-250 6-3V; 12-9V £7-51 90p

Solderless bread boarding U. Dec B for ICs etc. £6-99 P&P 40p VAT 15%

12 OR 24V OR 12-0-12V
 Pri 220-240 volts

Ref	12V	24V	Price	P&P
111	0.5	0.5	2.80	0.45
213	1.0	0.5	2.64	0.78
71	2	1	3.81	0.78
18	4	2	4.03	0.98
85	0.5	2.5	6.00	0.96
108	8	4	6.35	0.96
72	10	5	7.42	1.14
116	12	6	8.99	1.32
17	16	8	10.72	1.32
115	20	10	13.98	2.08
187	30	15	17.93	2.08
226	60	30	36.74	0.A.

AUTO TRANSFORMERS

Ref	VA	Watts	Price	P&P
113	15	0-115-210-240	2.48	0.71
44	75	0-115-210-240	4.41	0.98
4	150	0-115-200-220-240	6.35	0.98
67	500	0-115-200-220-240	18.90	1.64
84	1000	0-115-200-220-240	18.76	2.08
93	1500	0-115-200-220-240	23.36	2.08
575	2000	0-115-200-220-240	34.32	0.A.
73	3000	0-115-200-220-240	48.21	0.A.
605	4000	0-115-200-220-240	78.84	0.A.
618	6000	0-115-200-220-240	98.80	0.A.

High Quality Amplifier Modules

10W (AL30)	£3.75
25W (AL60)	£4.96
35W (AL80)	£7.79
125W (AL250)	£15.74

F.M. Tuner-4 push buttons £23-60
 Pre-Amps & Power Supplies available. P&P 35p. VAT 15%

ABS PLASTIC BOXES inset brass nuts, internal slots to take P.C. cards, flush fitting lid.

P81 180mm x 82 x 40	65p
P82 100mm x 75 x 40	72p
P83 120mm x 100 x 45	87p
*P84 215mm x 130 x 85	£2.84

P & P 25p. VAT 15% *P & P 40p

AVO TEST METERS

AVO 8 MK5	£88-10
AVO 71	£36-00
AVO 73	£48-70
AVO MM5 minor	£32-95
Wee Megger	£74-25
TT189 in circuit transistor tester	£39-53
EM272 316K 1 volt	£57-80
DA116	£108-90
BMT Megger	£51-76
Clamp Meter to 300A	£51-90

All Avo. Meggers & Accessories available.
 P&P £1.15 15% VAT

NEW RANGES VAT 15%

Pri 0-220, 240V Sec 0-35-48 twice. To give 36-0-36, 48-0-48 72V or 96V.

Pri 0 120 or 220-240V.

3 amp	14-70	1.48
4 amp	18-77	1.84
5 amp	26-84	2.15

O-C Tap 15V

171	2-09	0.45
172	2-86	0.78
173	3-58	0.78
174	3-75	0.86
175	5-73	0.96

U4315 Budget Meter
 200μV Ranges to 1000V, 2-5A AC/DC 500kΩ Res. In steel case £15-85 P&P £1.15 VAT 15%

TM500 30KΩ/V Meter Mirror Scale, overload protected, resistance to 60 MegΩ AC/DC to 1000V, OC to 12A 26 ranges £26-95 P&P £1.05 VAT 15%

Plug In Save Batteries
 Fits into a 13A sht 3-6-9-12V multiplug outlet £4-00 P&P 55p. VAT 15%

ELECTROSIL metal oxide low noise resistors.

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	2.57	0.55
212	1A, 1A	0-6-0-6	2.85	0.78
13	100	9-0-9	2.14	0.38
235	330, 330	0-9-0-9	1.99	0.38
207	800, 500	0-8-8-0-8-8	2.07	0.71
208	1A, 1A	0-6-0-6-9-9	3.53	0.78
236	200, 200	0-15-0-15	1.98	0.38
214	300, 300	0-20-0-20	2.80	0.78
211	7000CD	20-12-0-12-20	3.41	0.78
206	1A, 1A	0-15-20-0-15-20	4.63	0.96
203	500, 500	0-15-27-0-15-27	3.98	0.96
204	1A, 1A	0-15-27-0-15-27	6.04	0.96
239	50	12-0-12	2.57	0.38

ELECTRONIC CONSTRUCTION KIT
 Home electronics teacher. Start simply and progress to a TRF radio or electronic organ. No soldering, all parts included in presentation box. Full instructions and clear diagrams.
 Price £28.29 P&P 96p. VAT 15%

PANEL METERS

43mm x 43mm	6-20	0-50kΩ	6-70
0-50mA	6-95	0-500kΩ	6-70
0-1mA	6-95	0-1mA	6-70
0-30V	6-95	0-30V	6-70
VU ind. Panel 48mm x 45mm	2-60		
VU ind. Edge 90mm 50μA	2-36		
VU ind. Edge 54 x 14mm	2-60		
250μA F.S.D.	2-60		
Carriage 85p. VAT 15%			

50 VOLT RANGE
 Pri 220/240V Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V and 25V-0-25V

Ref	Amps	Price	P & P
102	0.5	3.41	0.78
103	1.0	4.57	0.96
104	2.0	7.16	1.14
105	3.0	8.56	1.32
106	4.0	11.41	1.45
107	6.0	15.06	1.64
118	8.0	20.28	2.08
119	10.0	24.98	2.08
109	12.0	28.90	2.08

MAINS ISOLATORS (SCREENED)
 PM 120/240 Sec 120/240V CT

Ref	VA	Price	P & P
*07	20	4.40	0.79
149	50	6.70	0.96
150	100	7.62	1.14
151	200	11.16	1.14
152	250	13.28	1.50
153	350	18.43	1.84
154	500	20.47	2.15
155	750	29.06	0.A.
156	1000	37.20	0.A.
157	1500	51.38	0.A.
158	2000	61.81	0.A.
159	3000	86.66	0.A.

*Pri 0-220-240V Sec 115 or 240V. State sec. volts required

CASED AUTO TRANSFORMERS
 240V cable in 115V USA flat pin outlet

VA	Price	P & P
20	5-95	0.90
75	7-73	1.14
150	10-01	1.14
200	10-92	1.45
250	11-58	1.45
500	19-17	1.64
1000	27-86	2.30
1500	36-02	0.A.
2000	49-97	0.A.

Barrie Electronics Ltd.

LOOK!

Here's how you master electronics.

.... the practical way.

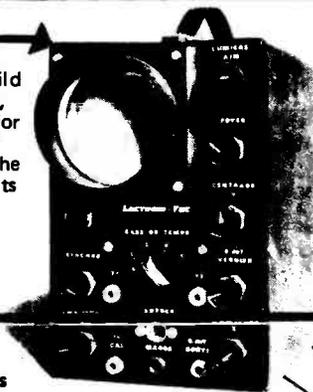
This new style course will enable anyone to have a real understanding by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.

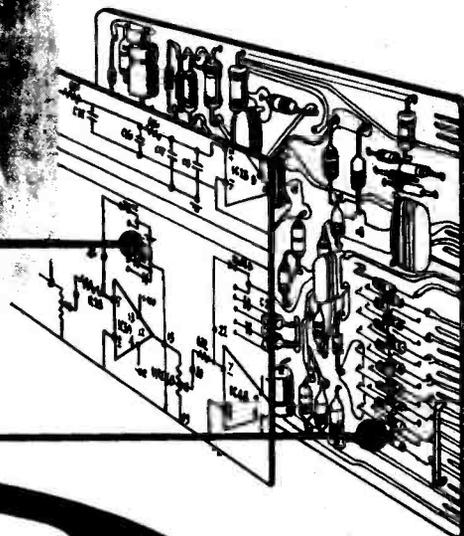
1. Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.



2. Read, draw and understand circuit diagrams.

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



3. Carry out over 40 experiments on basic circuits.

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

4. Free Gift.

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

FREE

Post now, without obligation, to:-

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL

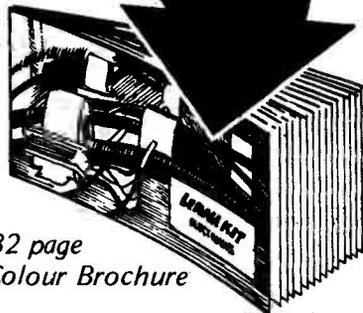
P.O. Box 156, Jersey, Channel Islands.

NAME _____

ADDRESS _____

PEB 9/79

Block caps please



32 page
Colour Brochure



**Make
your
hobby
more
Constructive
and
Profitable!**

Become an
**ELECTRONICS
ENGINEER**
or a
**TECHNICIAN
ENGINEER**

At PNL we offer two
interesting full-time courses.

* B.Sc. in Electronic and Communications
Engineering.

2 'A' levels, usually Maths and Physics
could qualify you for this 3 year full time
degree. Specialise in Acoustics, Digital
Electronics and/or Radar and Microwaves
in the final year.

* Technician Engineer Certificate.

3 'O' levels, usually Maths, Physics and
English, are the entry requirements for this
two year full time certificate, specialising
in Computer Engineering, Sound Studio
Engineering and Radar and Microwaves.

Details from:
**Secretary, DECE, PNL,
Holloway Road,
London N7 8DB.**

The Polytechnic of North London



**Wilmslow
Audio**

THE firm for speakers!

SEND 15p STAMP FOR THE WORLD'S BEST CATALOGUE OF
SPEAKERS, DRIVE UNITS, KITS, CROSSOVERS, ETC. AND
DISCOUNT PRICE LIST

AUDAX ● AUDIOMASTER ● BAKER
BOWERS & WILKINS ● CASTLE ● CELESTION
CHARTWELL ● COLES ● DALESFORD
DECCA ● EMI ● EAGLE ● ELAC ● FANE
GAUSS ● GOODMAN ● I.M.F. ● ISOPHON
JR ● JORDON WATTS ● KEF ● LEAK ● LOWTHER
McKENZIE ● MONITOR AUDIO ● PEERLESS
RADFORD ● RAM ● RICHARD ALLAN ● SEAS
SHACKMAN ● STAG ● TANGENT ● TANNOY
VIDEOTONE ● WHARFEDALE ● YAMAHA

**WILMSLOW AUDIO (Dept. P.E.)
SWAN WORKS, BANK SQUARE, WILMSLOW,
CHESHIRE SK9 1HF**

Discount Hi-Fi, etc. at 5 Swan Street and 10 Swan Street
Tel.: Wilmslow 529699 for Speakers Tel.: Wilmslow 526213 for Hi-Fi

KONTAKT 60

EUROPE'S LEADING CONTACT CLEANING SPRAY

Kontakt products 60-61 and WL provide
an unsurpassed cleaning capability for
contacts and switchgear.



KONTAKT 60

Safely dissolves oxides and sulphides and
disposes of resinated contact greases and
dirt, but does not attack plastics or any
standard production materials

Is silicone free

Contains a light lubricant to avoid possible
corrosion of contact paths — and obviates
further oxidation and 'creep' currents

**Quality Industrial Sprays from Kontakt
Chemie**

K70 Protective Plastic Spray K72 Insulating Spray K75 Cold Spray

K80 Siliconised Polish K90 Video Spray K100 Antistatic Spray

K101 Dehydrating Spray and Pos. 20 POSITIVE PHOTO RESIST
VARNISH

Distributed by

**SPECIAL PRODUCTS DISTRIBUTORS
LTD.**

81 Piccadilly, London W1V 0HL

Tel 01-629 9556

Cables Speciproduct, London W1

Descriptive leaflets of the above products are freely available on
request.

Largest range of quality components in the U.K. - over 8,000 types stocked

Marshall's

Head Office and Mail Order to Dept. P.E.,
A. Marshall (London) Ltd.,
Kingsgate House, Kingsgate Place,
London NW6 4TA. Tel: 01-624 0805.
Telex: 21492.

Retail Sales: London: 40-42 Cricklewood Broadway, NW2 3ET. Tel: 01-452 0161/2. ALSO 325 Edgware Road, W2. Tel: 01-723 4242.
Glasgow: 85 West Regent Street, G2 2QD. Tel: 041-332 4133 AND Bristol: 108A Stoke's Croft, Bristol. Tel: 0272 426801

BRIDGE RECTIFIERS

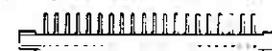
Type	Rating	Price	Type	Rating	Price	Type	Rating	Price
11T005	1A 50V	0.28	PW01	6A 100V	0.95	SD05	2A 50V	0.39
W01	1A 50V	0.30	PW02	6A 200V	0.97	SD2	2A 100V	0.44
W02	1A 200V	0.22	PW04	6A 400V	1.06	SD4	2A 400V	0.60
W03	1A 400V	0.40	PW06	6A 600V	1.18	SD6	2A 600V	0.70
W06	1A 600V	0.80	PW10	6A 800V	1.29	SD8	2A 800V	0.84
W09	1A 800V	0.90	PW16	6A 1000V	1.50	SD10	2A 1000V	1.35
W18	1A 100V	0.40	K005	25A 50V	2.20	BK01	500A 15A 100V	2.20
W18A	1A 200V	0.40	K01	25A 100V	2.37	BK02	300A 100V 20A	1.00
W18B	1A 400V	0.40	K02	25A 200V	2.75	BK03	150A 15A 200V	0.82
W18C	1A 800V	0.75	K04	25A 400V	3.40	BK04	300A 32A 200V	1.26
W17B	1A 800V	0.70	K06	25A 600V	3.99	PW005	6A 50V	0.90

CMOS (see catalogue for full range)

74C00N	0.24	74C76N	0.64	74C160N	1.11	74C221N	1.36	74C911N	2.70
74C02N	0.24	74C83N	1.30	74C181N	1.11	74C373N	1.87	74C112N	7.70
74C04N	0.24	74C05N	1.30	74C181N	1.11	74C374N	1.87	74C814N	1.41
74C08N	0.24	74C88N	0.64	74C183N	1.11	74C801N	0.54	74C815N	1.11
74C10N	0.24	74C89N	0.64	74C184N	1.04	74C802N	0.64	74C816N	1.10
74C14N	0.24	74C90N	0.85	74C185N	1.04	74C803N	0.64	74C822N	3.15
74C20N	0.24	74C93N	0.85	74C173N	0.80	74C804N	0.64	74C823N	3.74
74C30N	0.24	74C95N	1.04	74C174N	0.80	74C805N	7.28	74C825N	5.22
74C32N	0.24	74C107N	1.23	74C175N	0.80	74C806N	0.54	74C826N	5.22
74C42N	0.82	74C150N	4.14	74C192N	1.11	74C807N	0.54	74C827N	5.22
74C48N	1.30	74C151N	2.47	74C193N	1.11	74C808N	0.86	74C828N	5.22
74C73N	0.54	74C154N	3.68	74C195N	1.04	74C809N	1.63	74C832N	1.56
74C74N	0.54	74C157N	2.21	74C200N	0.70	74C810N	0.70		

MULTI-WAY EDGE CONNECTORS

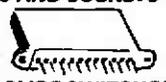
2.54mm (1 inch)	Price
16 Way Single	£3.00
24 Way Single	£3.95
32 Way Single	£5.25



3.68mm	Price
6 Way Double	£2.03
10 Way Double	£2.66
15 Way Double	£3.08
22 Way Double	£4.60

SINGLE IN LINE PLUGS AND SOCKETS

Providing a simple and economical alternative to edge connectors for bringing cable into a pcb.
12 Way £0.50, 24 Way £1.20



Now - SIEMENS TURN-SLIDE SWITCHES

This new version of the rotary switch is especially suitable for setting programs. The rotary switch is of a 1 element no stops.
Voltage rating 50 V AC
Current rating 0.5 A AC
Fixed contacts gold-plated £2.65

RESISTORS

Carbon Fixed	Price
0.25 watt ±5% Tol. Available in E12 range 10Ω to 1 meg	2p each
0.5 watt ±5% Tol. Available in E12 range 10Ω to 10 meg	3p each
1.0 watt ±10% Tol. Available in E12 range 10Ω to 10 meg	5p each
2.0 watt ±10% Tol. Available in E12 range 10Ω to 10 meg	5p each

Wire Wound	Price
2.5 watt ±5% Tol. 22 to 330 ohms	10p each
5 watt ±5% Tol. 5 to 12K	12p each
10 watt ±5% Tol. 1 to 25K	14p each

Metal Oxide	Price
0.5 watt ±2% Tol. E24 range 10Ω to 1 meg	4p each

*See catalogue for full list of available values.

BRINDLEY TOOLS AND CUTTERS

General Purpose	Price
100mm (4 inch) Diagonal Cutters	£3.40
Round Nose Pliers	£3.25
Flat Nose Pliers	£3.20
Snipe Nose Pliers	£3.20
End/Tail Cutters	£3.60

Also in stock - BAHCO Quality Tool range.
See catalogue for full details.



TTL (see catalogue for full range)

SN74A05N	0.60	74LS175N	0.58	74LS184N	0.70	74LS490N	0.90
SN74A10N	0.55	74LS181N	0.42	74LS186N	0.80	74LS187N	1.30
SN74A11N	0.55	74LS187N	0.42	74LS188N	0.80	74LS490N	0.77
SN74A20N	0.55	74LS189N	0.90	74LS197N	0.80	SN74S03N	0.77
SN74A21N	0.55	74LS189N	0.95	74LS221N	1.00	SN74S04N	0.94
SN74A30N	0.55	74LS186N	0.44	74LS240N	1.50	SN74S10N	0.77
SN74A40N	0.55	74LS300N	0.76	74LS241N	1.50	SN74S20N	0.77
SN74A51N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A52N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A54N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A55N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A60N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A62N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A65N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A68N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A70N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A74N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A75N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A76N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A77N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A78N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A79N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A80N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A81N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A82N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A83N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A84N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A85N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A86N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A87N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A88N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A89N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A90N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A91N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A92N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A93N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A94N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A95N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A96N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A97N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A98N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A99N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85
SN74A00N	0.55	74LS109N	0.62	74LS249N	1.05	SN74S157N	2.85

NEW 1979 CATALOGUE

40 page catalogue - new enlarged micro section - largest range of quality components from franchised suppliers available in U.K. All VAT inclusive prices. Over 8,000 line items plus more than 450 special paid or 35p to callers at any of our four branches.
* MAIL ORDER *
Quick service on all orders - please add 40p for p/p to all orders. Telephone orders on credit cards £10.00 minimum.



3 1/2 DIGIT LCD AND LED PANEL METER KITS

Interisil's 7106 is the first single-chip CMOS A/D for driving LCD displays - including backplane - directly. The 7107 is the first single-chip CMOS A/D for driving instrument-size LED displays directly without buffering. Each provides parallel seven segment outputs, ideal for DVMs, DPMs and anywhere modern digital displays are needed. Both have internal reference and clock, and both are CMOS so you get low noise (12 to 15 μV) comparable with the finest bipolar devices, and low power (10 mW max @ 10V). Kits provide all materials...
Including PC board, for a functioning panel meter. Assembly time is only 1/2 hour.
ICL 7106EV (LCD) £26.99 SPECIAL OFFER £19.90
ICL 7107EV (LED) £21.99 SPECIAL OFFER £15.90
CHIP ALONE ICL 7106CP SPECIAL OFFER £8.90
New Prices
Due to increases in prices and the recent VAT increase, please add 6% to ALL prices.

TRANSISTORS (see catalogue for full range)

2N135	3.00	2N708	0.30	2N1420	0.55	2N2219	0.36	40081	1.20
2N369	0.80	2N718	0.30	2N1483	1.86	2N2219A	0.39	40232	0.40
2N388A	0.77	2N718A	0.54	2N1485	2.20	2N2220	0.39	40233	0.70
2N390	0.80	2N720A	0.85	2N1507	0.35	2N2221	0.25	40235	0.65
2N456	2.20	2N721	1.05	2N1524	0.80	2N2221A	0.25	40237	0.65
2N480	2.20	2N721A	1.05	2N1553	1.24	2N2222	0.42	40242	0.86
2N489A	5.40	2N727	0.56	2N1613	0.30	2N2222A	0.25	40251	1.15
2N498B	6.80	2N744	0.36	2N1637	0.72	2N2223	0.78	40254	0.66
2N490	4.99	2N753	0.35	2N1638	0.70	2N2223A	0.80	40264	0.96
2N490B	5.90	2N780	0.35	2N1771	0.30	2N2220	0.40	40280	3.70
2N490C	5.90	2N789	0.35	2N1889	0.30	2N2203	1.54	40308	0.80
2N491A	5.75	2N814	0.48	2N1950	0.30	2N2222	0.37	40310	0.85
2N491B	6.25	2N816	0.33	2N1983	0.30	2N2268	0.27	40311	0.85
2N491	5.70	2N817	0.34	2N1970	0.85	2N2268A	0.27	40312	1.38
2N492	6.25	2N818	0.45	2N1974	0.86	2N2405	0.66	40313	1.38
2N492A	6.75	2N829	0.37	2N1990	0.45	3A81	3.50	40315	1.00
2N492B	7.75	2N829A	0.37	2N1991	1.10	3A83	2.25	40316	0.85
2N492C	10.00	2N930	0.37	2N2006	0.70	2N28	1.37	40319	0.85
2N493A	7.59	2N930A	0.56	2N2102	0.50	3N159	1.60	40324	0.85
2N493B	8.75	2N1131	0.32	2N2147	1.56	3N140	1.10	40325	1.35
2N494	6.90	2N1132	0.35	2N2					

U.K. RETURN OF POST MAIL ORDER SERVICE also WORLDWIDE EXPORT SERVICE

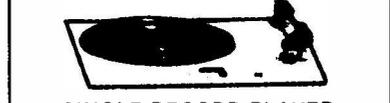
BAKER "BIG-SOUND" SPEAKERS Post £1.60 each
 'Group 100' 'Group 35' 'Group 50/15'
 12 inch £29 12 inch £15 15 inch £35
 100 watt 40 watt 75 watt
 8 or 16 ohm 4 or 8 or 16 ohm 8 or 16 ohm

BAKER LOUDSPEAKER, 12 INCH, 60 WATT
 GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER.
 FULL RANGE PROFESSIONAL QUALITY.
 RESPONSE 30-16,000 CPS £23
 MASSIVE CERAMIC MAGNET
 WITH ALUMINIUM PRESENCE CENTRE DOME.

4 CHANNEL TRANSISTOR MONOMIXER
 Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated. £7.50
 Two channel stereo version £8.

HEATING ELEMENTS WAFER THIN
 Size 10 1/2 x 8 1/2 in. Operating voltage 200/250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or similar. ALL POST PAID - Discounts for quantity. ONLY 40p EACH (FOUR FOR £1.50)

MINI MODULE BAFFLE KIT Post 75p
 EMI 15 x 8 1/2 in. 3-way Loudspeaker System 5in. Bass 5in. Middle 3in Tweeter with 3-way Crossover & Ready Cut Baffle. Full assembly instructions supplied. Response-60 to 20 000 C.P.S. 12 watt RMS. 8 ohms. £10.95 per kit. Two kits £20. Suitable Bookshelf Cabinet £8.50 each.



SINGLE RECORD PLAYER
 Fitted with auto stop, stereo cartridge, Baseplate, Size 11 x 8 1/2 in. Turntable, Size 7in. diameter a.c. mains 220V 3 speeds. Plays all size records. £7.95 Post 45p
 Two for £15. Post 75p.

NEW BSR SINGLE PLAYER £22.50
 Model P182 3-speeds flared aluminium turntable. Post £1. "S" shaped arm, cueing device, stereo ceramic cartridge.
 B.S.R. De-Luxe Autochanger with stereo cartridge, plays all size records. P. & P. £1. £20.00

BAKER 160 WATT ALL PURPOSE TRANSISTOR MIXER AMPLIFIER
 Ideal for Groups, Discos, P.A. and Musical Instruments. 4 inputs speech and music. 4 way mixing. Output 4/8/16 ohm, a.c. Mains 240V. Separate treble and bass controls. 100 volt line model £14 extra. £85 Post £1.60



BAKER COMPACT 50 WATT AMPLIFIER
 IDEAL FOR DISCOS, GROUPS, PUBLIC ADDRESS
 Two inputs with volume controls. Master treble bass and volume controls. Suitable for all loudspeakers. £63 Post £1.60

R.C.S. SOUND TO LIGHT DISPLAY MK II
 Complete kit of parts with R.C.S. printed circuit. Three 1000W channels Will operate from 200mV signal source. CABINET extra £4. KIT = £18.00

R.C.S. 10 WATT AMPLIFIER KIT
 This kit is suitable for record players, tape play back, guitars electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductor. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume bass and treble controls. Spec: 10W output into 8 ohms 7W into 15ohms. Response 20c/s to 30Kc/s. Input 100mV. high imp. Size 3 1/2 x 2 1/2 in. A/C mains operated. Mono kit £12.50 Stereo kit £20 Post 45p
 Easy to build. Full instructions supplied

LOW VOLTAGE ELECTROLYTICS
 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p, 500mF 12V 15p; 25V 20p; 50V 30p; 100mF 12V 17p; 25V 35p; 50V 47p; 100V 70p; 200mF 6V 25p; 25V 42p; 250mF 50V 62p; 3000 mF 2V 47p; 500V 6p; 3900mF 100V £1. 4700mF 83V £1. 200mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 5600mF 76V £1.75; 1200mF 76V 80p.

HIGH VOLTAGE ELECTROLYTICS
 8/350V 22p 8-1/4 50V 50 50-50/300V 50p
 16/350V 30p 8-1/4 50V 50 32-32/450V 75p
 32/500V 75p 16-1/4 50V 50 100-100/275V 65p
 50/350V 50p 32-32/350V 50p 150-200/275V 70p
 MANY OTHERS IN STOCK

TINTED PLASTIC COVERS ONLY
 Size 14 1/2 x 12 1/2 x 4 1/2 in. £3. 16 1/2 x 14 x 3 1/2 in. £5.
 15 1/2 x 13 1/2 x 4 in. £4. 17 1/2 x 9 x 3 1/2 in. £3.
 14 1/2 x 14 1/2 x 2 1/2 in. Rosewood sides £4.
 18 x 13 1/2 x 3 in. £6. 18 x 12 1/2 x 3 in. £6.
 Ideal for record decks, tape decks, etc. Post £1.60

R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS £2-95 Post 45p
 All parts and instructions with Zener diode printed circuit, rectifiers and double wound mains transformer input 200 240V a.c. Output voltages available 6V 5 or 9 or 12V d.c. up to 100mA or less Size 3 x 2 1/2 x 1 1/2 in. Please state voltage required.

ELECTRO MAGNETIC PENDULUM MECHANISM 95p Post 30p
 1.5V d.c. operation over 300 hours continuous on SP2 battery fully adjustable swing and speed Ideal displays teaching electro magnetism or for metronome strobe etc

MAINS TRANSFORMERS ALL POST 75p each
 250-0-250V 70mA 6 3/2A £4.45
 250-0-250 80mA 6 3V 3 5A 6 3V 1A £4.60
 350-0-350 80mA 6 3V 3 5A 6 3V 1A £5.80
 300-0-300 120mA 2-6 3V 2A C T 6 3V 2A £8.50
 220V 45mA 6 3V 2A £1.75
 GENERAL PURPOSE LOW VOLTAGE Tapped outputs at 2A 3A 4 5 6 8 9 10 12 15 18 24 and 30V
 1A 6 8 10 12 15 18 20 24 30 35 40 45 60 £5.30
 2A 6 8 10 12 15 18 20 24 30 35 40 45 60 £8.50
 3A 6 8 10 12 15 18 20 24 30 35 40 45 60 £11.00
 5A 6 8 10 12 15 18 20 24 30 35 40 45 60 £14.50
 5 6 8 10 12 15 18 20 24 30 35 40 45 60 £1.20
 12V 750mA £1.30 40V 2A tapped 10V or 30V £2.85
 10-0-10V 2A £2.80 40V 2A £2.85 30V 5A 24V 2A ct £3.75
 2 x 19V 6A £9. 12-0-12V 2 amp £2.95 25-0-25V 2 amp £4.
 20-0-20V 1A £2.95 30V 1A £2.75 20V 1A £2.20
 9V 3 amp £2.75 60V 40V 20V or 20-0-20V 1A £3.50
 30-0-30 2A £7. 9V 250mA £1.20 30V 2 amp £3.
 AUTO TRANSFORMERS: 115V to 230V or 230V to 115V 150W £7; 250W £8; 400W £9; 500W £10.
 CHARGER TRANSFORMERS: Inout 200/250V for 6 or 12V 1A £2. 1A £2.50
 FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs 1 1/2A 50p; 4A £1.25. HALF WAVE 12V 1 1/2A 25p.

BLANK ALUMINIUM CHASSIS, 18 s.w.g. 2 1/2 in. sides, 6 x 4 in. 95p; 8 x 6 in. £1.40; 10 x 7 in. £1.55; 12 x 8 in. £1.70. £1.85; 12 x 3 in. £1.20; 16 x 10 in. £2.20, 12 x 8 in. £1.70.
ALUMINIUM PANELS, 18 s.w.g. 6 x 4 in. 24p; 8 x 6 in. 38p; 10 x 7 in. 54p; 12 x 8 in. 60p; 12 x 8 in. 70p; 16 x 6 in. 70p; 14 x 9 in. 94p; 12 x 12 in. £1; 15 x 10 in. £1.18.
ALUMINIUM ANGLE BRACKET, 6 x 2 x 1 in. 20p.
ALUMINIUM BOXES, MANY OTHER SIZES IN STOCK
 4 x 2 x 2 in. 55p; 3 x 2 x 1 in. 65p; 8 x 2 x 2 in. 85p; 8 x 6 x 3 in. £1.80; 9 x 4 x 4 in. £1.70; 10 x 7 x 3 in. £2.30; 12 x 8 x 3 £2.50.

THE "INSTANT" BULK TAPE ERASER
 Suitable for cassettes and all sizes of tape reels a.c. mains 200 240V £6.00
 Leaflet SAE. Post 50p.
Head demagnetiser £5.00

RADIO COMPONENT SPECIALISTS 337 WHITEHORSE ROAD, CROYDON, U.K.

Minimum post 30p. Access and Barclaycard Same day despatch Radio Books and Components Lists 20p Open 9-6 Sat. 9-5 (Closed Wednesday all day). Tel. 01-884 1668

FLADAR TRANSFORMERS

PRIMARY 0-240V 50HZ

IF YOUR REQUIREMENT IS NOT FEATURED BELOW SEND FOR OUR TRANSFORMER CATALOGUE PRICE 40p

Type	Voltage	Current	£	p/p	Type	Voltage	Current	£	p/p
08FE06	6+6	0.5A EACH	1.82	60p	80FE24	24+24	1.2A EACH	4.58	102p
08FE06	6+6	0.5A EACH	2.19	60p	80FE24	24+24	1.5A EACH	5.66	120p
12FE06	6+6	1.0A EACH	2.43	72p	80FE28	28+28	0.75A EACH	3.74	84p
20FE06	6+6	1.6A EACH	3.06	84p	80FE28	28+28	1.1A EACH	4.58	102p
50FE06	6+6	3A EACH	3.74	84p	80FE28	28+28	1.4A EACH	5.66	120p
60FE06	6+6	4A EACH	4.58	102p	20FE30	30+30	0.35A EACH	3.06	84p
08FE09	9+9	0.3A EACH	1.82	60p	50FE30	30+30	0.75A EACH	4.58	102p
08FE09	9+9	0.5A EACH	2.19	60p	60FE30	30+30	1A EACH	4.58	102p
12FE09	9+9	0.75A EACH	2.43	72p	80FE30	30+30	1.2A EACH	5.66	120p
20FE09	9+9	1A EACH	3.06	84p	MULTITAP RANGE VOLTAGES AVAILABLE 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30				
50FE09	9+9	2.5A EACH	3.74	84p					
60FE09	9+9	3A EACH	4.58	102p	30FE30	1A	4.00	84p	
06FE12	12+12	0.25A EACH	1.82	60p	60FE36	2A	4.80	102p	
08FE12	12+12	0.3A EACH	2.19	60p	80FE36	3A	5.88	120p	
12FE12	12+12	0.5A EACH	2.43	72p	CENTRE TAP SECONDARY				
20FE12	12+12	0.75A EACH	3.06	84p					
50FE12	12+12	1.8A EACH	3.74	84p	06FE30	6-0-6	1.80A	1.80	60p
60FE12	12+12	2.5A EACH	4.58	102p	08FE40	8-0-8	1A	2.16	60p
80FE12	12+12	3A EACH	5.66	120p	12FE50	12-0-12	1A	2.40	72p
06FE15	15+15	0.2A EACH	1.82	60p	20FE12	20-0-20	1A	2.40	72p
08FE15	15+15	0.25A EACH	2.19	60p	50FE80	20-0-20	2A	3.70	84p
12FE15	15+15	0.4A EACH	2.43	72p	80FE100	28-0-28	2.2A	4.50	102p
20FE15	15+15	0.6A EACH	3.06	84p	80FE70	24-0-24	3A	5.66	120p
50FE15	15+15	1.5A EACH	3.74	84p	90FE70	15-0-15	6A	5.80	120p
80FE15	15+15	2A EACH	4.58	102p	90FE80	30-0-30	3A	5.80	120p
06FE20	20+20	0.15A EACH	1.82	60p	100FE28	26-0-26	3.5A	6.05	138p
12FE20	20+20	0.25A EACH	2.43	72p	100FE28	28-0-28	3.5A	6.05	138p
20FE20	20+20	0.5A EACH	3.06	84p	100FE30	30-0-30	3A	6.05	138p
50FE20	20+20	1.2A EACH	3.74	84p	100FE36	36-0-36	3A	6.05	138p
80FE20	20+20	1.5A EACH	4.58	102p	150FE15	15-0-15	7A	7.47	150p
80FE20	20+20	2A EACH	5.66	120p	150FE26	26-0-26	5A	7.47	150p
06FE20	20+20	0.15A EACH	1.82	60p	150FE30	30-0-30	4A	7.47	150p
12FE20	20+20	0.25A EACH	2.43	72p	150FE36	36-0-36	4A	7.47	150p
20FE20	20+20	0.5A EACH	3.06	84p	150FE42	42-0-42	3A	7.47	150p
50FE20	20+20	1.2A EACH	3.74	84p	250FE28	28-0-28	8A	8.60	175p
80FE20	20+20	1.5A EACH	4.58	102p	250FE30	30-0-30	7A	8.60	175p
80FE20	20+20	2A EACH	5.66	120p	250FE42	42-0-42	5.5A	8.60	175p

CHARGER TRANSFORMERS
 48FE12 0-6-12 4A 4.58 102p
 66FE12 0-6-12 6A 5.30 102p
 70FE12 0-6-12 6A 5.66 120p
 90FE12 0-6-12 8A 6.75 138p
 12FE24 24+24 0.2A EACH 12.43 72p

FLADAR ELECTRIC
 P.O. BOX 19
 WESTCLIFF-ON-SEA
 ESSEX. 0702-613314

TRADE ENQUIRIES WELCOME

PAYMENT TERMS:
 C.W.O. Cheques,
 Postal Orders
 All Prices include 15% V.A.T.

PE PHASER UNIT P.E. APRIL 1979
 A superb six stage phaser that really gives your guitar lift off. Equals the best commercial models. Uses latest FET op-amps. Glassfibre p.c.b.
COMPLETE KIT OF ALL PARTS AS SPECIFIED.....£15.95*
 Pack 1. All semiconductor devices.....£8.00*
 Pack 2. Resistors, capacitors & preset pot.....£3.78*
 Pack 3. Footswitch, jacks, pot, knob, printed circuit & hardware.....£4.28*
 Pack 4. Diecast box and feet.....£2.00*
 Separate parts: TL062 80p, BF245B 50p, PCB £1.50, 8 pin sockets (not included in kit) 21p each.

DESIGNER APPROVED KITS

PE SUSTAIN UNIT P.E. OCT. 1977
 Superb quality, low noise, low distortion sustain unit to the very best commercial models. Suits all guitars. Glassfibre p.c.b.
COMPLETE KIT OF ALL PARTS AS SPECIFIED.....£7.95*
 Pack 1. Resistors, capacitors & p.c.b.....£1.75*
 Pack 2. All semiconductor devices.....£1.75*
 Pack 3. Footswitch, jacks, pot, knob, and battery clip.....£2.75*
 Pack 4. Diecast box and feet.....£2.00*
 Separate parts: XC053R 50p, RPY58A 75p, Printed circuit board 95p, Footswitch £1.50 each.

ORION AMPLIFIER
 Complete set of semiconductors.....£9.75
 Quality glass fibre p.c.b., printed with component locations.....£3.50

PE TV SOUND SEPARATOR
 Complete set of semiconductors.....£2.30
 High quality glass fibre p.c.b.....£1.50
 Murata filters: SFE6.0MA 50p, CDA6.0MC 50p.

STOP PRESS!

PE FUZZ UNIT
 This is the Fuzz unit you have been waiting for! Smooth, clean tone with low noise and low current drain. Uses glassfibre p.c.b. and latest FET op-amp.
COMPLETE KIT OF ALL PARTS AS SPECIFIED £7.95

POSTAGE & PACKING 15p per order. Orders over £5.00 post free.
 All devices are top grade, brand new and to full manufacturers spec.
 Send S.A.E. for our data sheet and price list of Ferranti semiconductors.

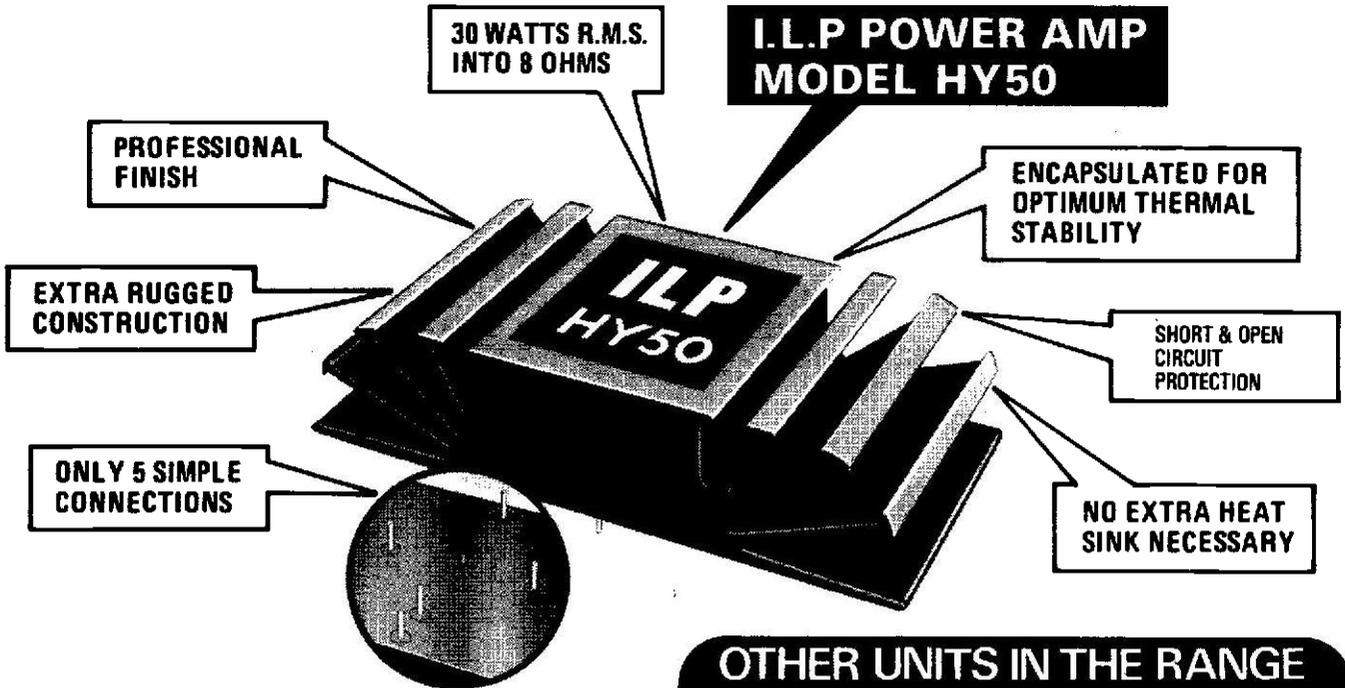
PRICES DO NOT INCLUDE VAT. Add 15% to all prices.

MAIL ORDER ONLY
 CALLERS BY APPOINTMENT

DAVIAN ELECTRONICS
 13 DEEPALE AVENUE, ROYTON, OLDHAM OL2 6XD.

Simply ahead!

**HIGH PERFORMANCE MODULAR UNITS
BACKED BY NO-QUIBBLE 5 YEAR GUARANTEE**



Of all the purpose-built power amplifier modules by I.L.P., the HY50 is understandably the most popular with those wanting to build or up-grade a hi-fi system, run a small high quality P.A. system, amplify a musical instrument (say for practise or small range use) or use it for lab work. Its useful 30 watts RMS output into 8 ohms, its rugged construction and freedom from heatsink worries make HY50 the ideal all-purpose quality power amp – and it is unconditionally guaranteed for five years. Tens of thousands are in use throughout the world.

... and a spec that means just what it says!

Encapsulated power amp with integral full-rated heatsink.
Input – 500mV
Output 30 watts RMS/8 Ω
Load Impedance – 4 to 16Ω
Distortion – 0.04% from 100mW to 25 watts at 1KHz/8Ω
Supply Voltage – ±25V. Size 105 × 50 × 25mm
Inc. V.A.T. and postage in U.K.

£8.33

Nothing has been overlooked in the design and manufacture of I.L.P. Modular Units. Heavy duty heatsinks, encapsulated circuitry, no-compromise production standards and true professional finish ensure world leadership for I.L.P. Now we have up-graded output ratings and down-graded prices to bring I.L.P. within easier reach of all who want the best.

New production techniques enable us to reduce prices apart from VAT by an average of 20%, making I.L.P. a better buy than ever.

Guaranteed 7 days despatch on all products

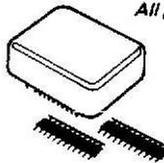
USE OUR FREE POST SERVICE for sending your orders, requests for information sheets etc. Simply address envelope.
NO STAMPS REQUIRED.



FREEPOST 2
Graham Bell House, Roper Close, Canterbury. Kent CT2 7EP
Phone (0227) 54778 Telex 965780

OTHER UNITS IN THE RANGE

All prices inc. V.A.T. & Postage in the U.K.

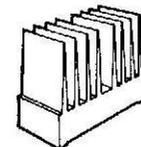


HY5 PRE-AMPLIFIER

Compatible with all I.L.P. power amps. and P.S.U.'s. In a single pack, needs external pots and switches. Multi-function equalization. 5 inputs. High overload margin. Active tone controls, 500 mV out. Distortion at 1 KHz – 0.01%.

Two connect easily for stereo.

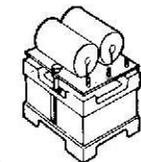
£5.34



THE POWER AMPS

With heatsinks, full load line and thermal protection. Distortion typically 0.05% at 1 KHz.

HY120 60 Watts RMS/8Ω 114 × 50 × 85mm **£17.48**
HY200 120 Watts RMS/8Ω 114 × 50 × 85mm **£21.21**
HY400 240 Watts RMS/4Ω 114 × 100 × 85mm **£31.83**



THE POWER SUPPLY UNITS

(Split line outputs to suit I.L.P. power amps and HY5)

PSU50 for 1 or 2 × HY50 **£9.32**
PSU70 for 1 or 2 × HY120 **£16.66**
PSU90 for one HY200 **£16.66**
PSU180 for one HY400 or 2 × HY200 **£26.47**

Information sheets on application –
Use our FREEPOST Service.

★ NOW-PRICES DOWN BY 20%

Please supply
Total Purchase Price
 Enclose Cheque Postal Orders
Please debit my Access/Barclaycard Account number
Name
Address
Signature

Reg. Bus. No. 1032630 Eng.

FP 2/9

Top value test equipment from TANDY

LCD DIGITAL MULTIMETER.

Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance. Reading to ± 1999.

Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accurate).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1µA to 200mA (1% ± 1 digit accurate).
Resistance: 10hm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
 22-198

PRICE
53.19

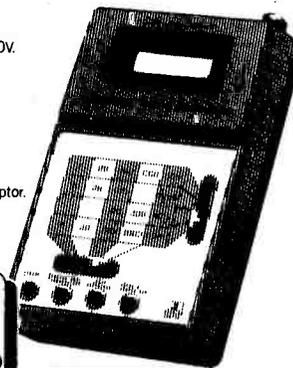


LOW-COST LCD MULTIMETER COMPONENTS AND PARTS

A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 MOhm Input impedance.

Scales:
DC volts: 2-20-200-1000V.
AC volts: 200-500V.
DC current: 2-20-200MA.
Resistance: 2-20-200-2000 KOHM.
Power source: 9V battery or AC adaptor.
Size: 37 x 85 x 130 mm.
 22-197

PRICE
39.93



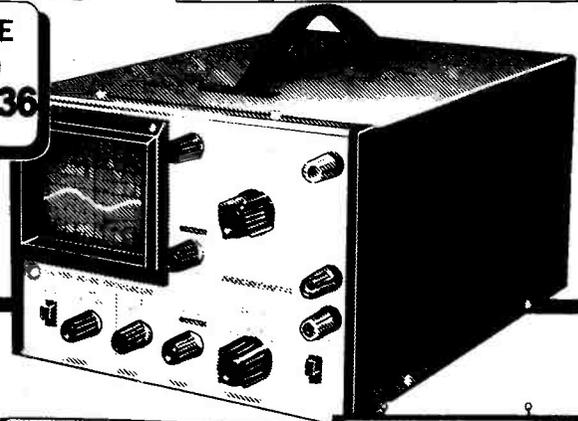
CAT. No.	DESCRIPTION	PRICE
276-032	LED	4 for 69p
276-033	LED	2 for 48p
276-034	LED	2 for 59p
276-142	Infra-Red Emitter Detector Pair	£1.37
277-1003	12V DC Automotive Digital Clock Module	£17.52
276-9110	6 pin edge connector for 277-1003	40p
276-1373	Power Transistor Mounting Hardware	50p
276-1363	TO-220 Heat Sink	60p
276-1364	TO-3 Heat Sink	81p

AC/DC 8 MHz OSCILLOSCOPE

A new approved 8MHz version of last years' winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

Specifications:
Horizontal axis: Deflection sensitivity better than 250mV/DIV. **Vertical axis:** Deflection sensitivity better than 10mV/DIV (1DIV-6mm). Bandwidth: 0.8MHz. **Input impedance:** 1MOhm parallel capacitance 35pF. **Time base:** Sweep range: 10Hz-100kHz (4 ranges). **Synchronization:** Internal (-) **Size:** 200 x 155 x 300 mm. **Supply:** 220/240/50Hz. 22-9501.

PRICE
137.36



You save because we design, manufacture, sell and service. Tandy have over 7,000 stores and dealerships worldwide. Over 2,500 products are made

specifically for or by Tandy at 16 factories around the world. The quality of our products has been achieved by over 60 years of continuous technological advancement.

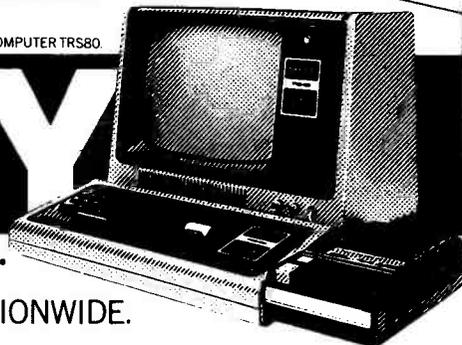
KNOWN AS RADIO SHACK IN THE U.S.A. MAKERS OF THE WORLD'S BIGGEST SELLING MICROCOMPUTER TRS80.

TANDY

The largest electronics retailer in the world.

Offers subject to availability. Instant credit available in most cases.

OVER 170 STORES AND DEALERSHIPS NATIONWIDE.



TANDY DEALER

Most items also available at Tandy Dealers. Look for this sign in your area.



Access, Barclaycard and Trustcard welcome.

NEWS?

OFTEN those who are involved in electronics development do not have any interest in publicity and sometimes even the impact of their developments is totally overlooked. We, of course, as a magazine try to put this to rights but sometimes it appears we totally fail in this quest.

Having recently watched a couple of television news pieces, one acclaiming the inventors of a digital m.p.g. meter and the other depicting a transmitter and receiver for blind runners, we are beginning to wonder where the news people have been burying their heads? This magazine published details of a *Digital Fuel Consumption Meter* by J. McCarthy, in the October '78 issue and way back in June 1974—yes FIVE years ago—we published an *M.P.G. Meter* by S. Jones. For the news people to claim this is a new invention is totally incorrect, not only have these designs been published but commercial units have been available for some time.

We cannot claim either of our designs give highly accurate figures but then they were cheap to construct (particularly in the case of the first design) and used an electric fuel pump to give fuel flow rate information. However, everyone appears to be jumping on the band wagon with equipment

and, especially if it is expensive, the accuracy of the information must be good in order to make the equipment pay for itself; at the present time this does not necessarily appear to be the case.

To go back to the second news item we mentioned, the use of electronics as an aid for the blind is very commendable and deserves all possible publicity but this equipment appears to be a hand operated transmitter and a simple miniature receiver—nothing to shout about technically and hardly a new "invention". In this very area we published full constructional details of an *Audio Compass* back in May 1976. This was developed in conjunction with *Yachting Monthly* to enable the blind to helm a boat with no human assistance. The unit could also be used as an off-course alarm for single-handed sailors. At the time *Tomorrow's World* expressed an interest but decided that the subject would not fit into their programme. Possibly it will be resurrected in a few years as a commercial unit and get news coverage then!

Maybe in the future people will be able to make or buy a complete computer on a single board for about £200 and the T.V. will bring you the news first! Or perhaps solid state car instruments will be available and the first

systems will receive much acclaim. We must wait and see!

INTEREST

Our own computer has created a fantastic interest and we are pleased to report that it is also now available as a ready built unit. This demand means that issues are selling fast and, as always, some people are failing to get a copy. Unfortunately, it is very difficult for us to judge such demand, and these days also expensive to print extra copies if they are not sold, so may we urge you to order a copy from your newsagent well in advance to ensure supply.

These supply problems may be further compounded by the free I.C. Removal Tool which will be presented with every copy next month. The Insertion Tool we presented last spring was in great demand and we anticipate a similar situation next month. The inclusion of the first of a series of five projects describing solid state analogue car instruments will also make next month's issue a popular one, so don't miss out.

We hope we can continue to keep you abreast of development and ahead of the mass media by as much as five years!
Mike Kenward

EDITOR

Mike Kenward

Gordon Godbold ASSISTANT EDITOR

Mike Abbott TECHNICAL EDITOR

Alan Turpin PRODUCTION EDITOR

David Shortland PROJECTS EDITOR

Jack Pountney ART EDITOR

Keith Woodruff ASSISTANT ART EDITOR

John Pickering SEN. TECH. ILLUSTRATOR

Isabelle Greenaway TECH. ILLUSTRATOR

Judith Kerley SECRETARY

Editorial Offices:

Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 71191

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

Advertising Offices:

King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
Telex: 915748 MAGD[V-G]

Make Up/Copy Dept.: 01-261 6601

ADVERTISEMENT MANAGER

D. W. B. Tilleard

01-261 6676

SECRETARY

Christine Pocknell

CLASSIFIED MANAGER

Colin Brown 01-261 5762

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, 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 £2.85 each to UK addresses, £3.45 overseas, including postage and packing, and VAT where ap-

propriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10.60 per 12 issues, from: *Practical Electronics*, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH.

Cheques and postal orders should be made payable to IPC Magazines Limited.

6 CHANNEL MIXER

S.R.W. Grainger & C.R. Harding Part 1

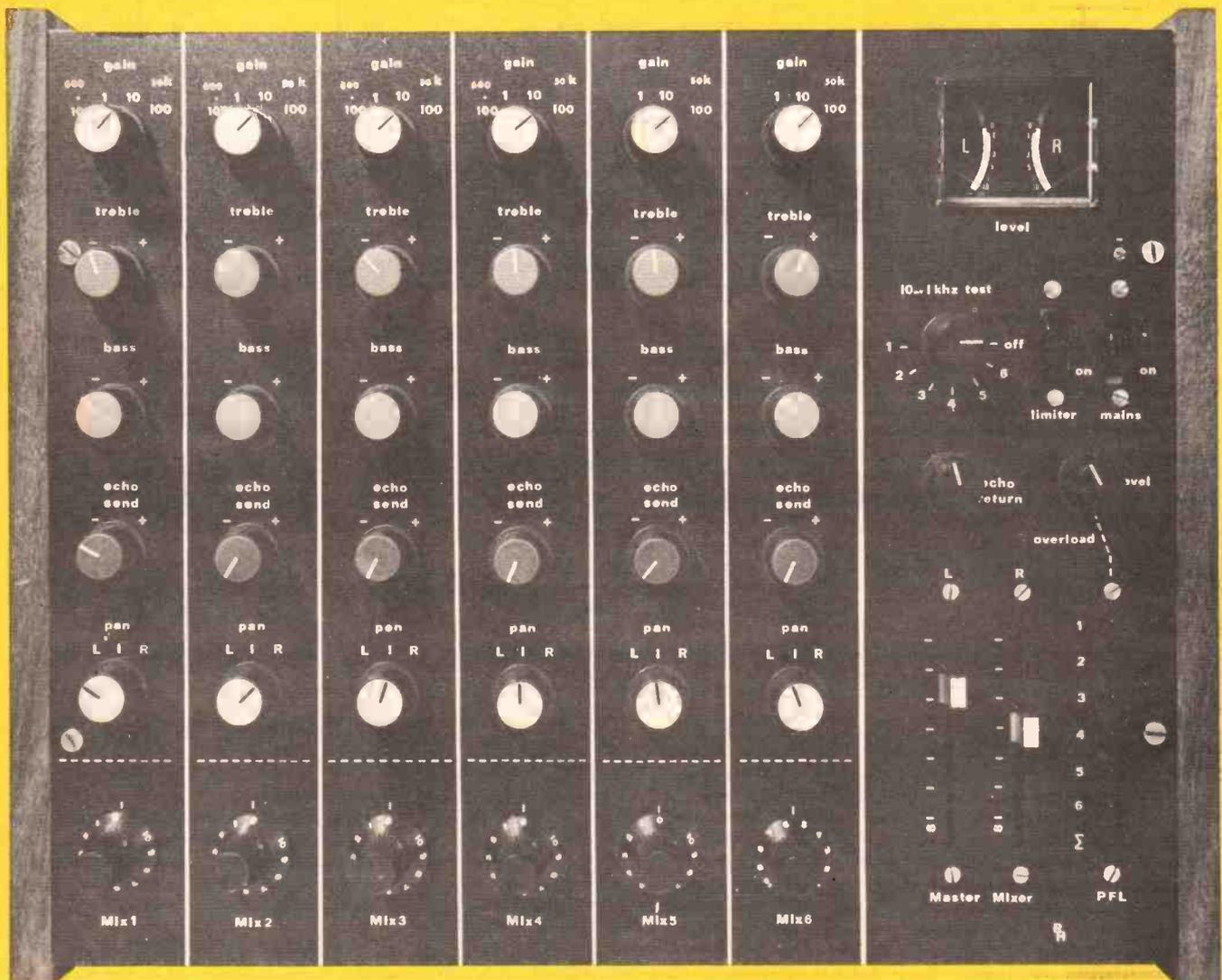
WITH the increase in popularity of home-recording studios and electronic musical instruments there is a demand for a mixer to combine several signal sources and provide a well-balanced sound for recording. Most users do not require mixers which have many input channels (as with some commercial units) but do require high enough specifications to suit semi-professional tape recorders and other sound processing equipment.

The design, illustrated has been used successfully with various organs, synthesisers, microphones and electric guitars. Although built as a six-channel unit it can be extended with additional input modules and a little modification to the output stages.

BLOCK DIAGRAM

The diagram (see Fig. 1) shows the unit in the basic six-channel configuration. The input channels are completely separate until linked on the pan buses via the pan pots. These buses are also fed by an additional stereo input (if required). This enables a separate stereo input or more input channels to be coupled in at a later date, into the output stages.

From the pan buses the signals are routed to the output stages. These recover the signal level, from the output of the input stages, which has been attenuated by the channel fader and pan pot network. They also provide a low impedance output to drive various other devices, and are terminated in master faders.



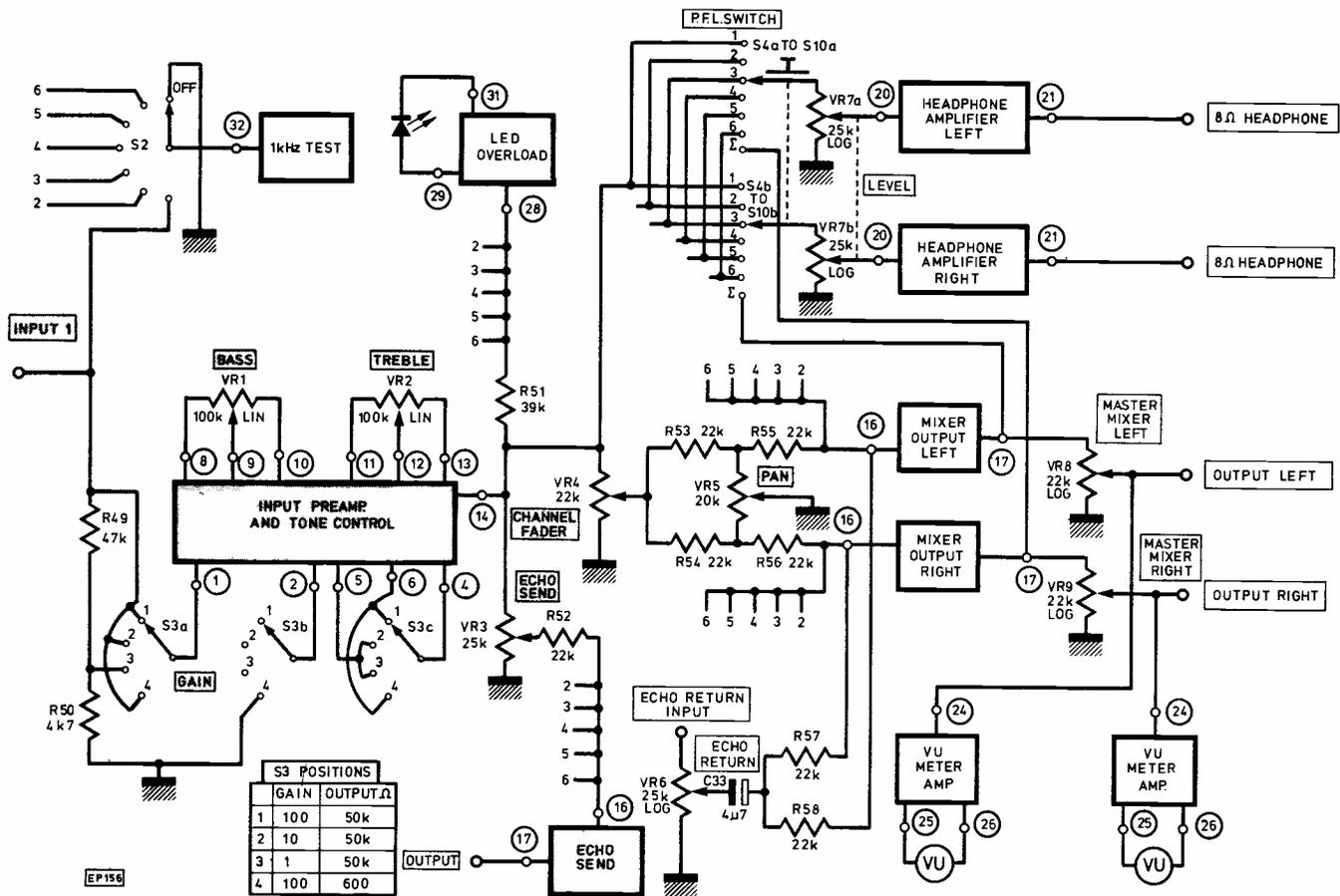


Fig. 1 Block diagram

VU meter drive is obtained from the mixed signals and a separate meter is provided for each output channel. Visual indication of signal level is also provided by an l.e.d. overload indicator which is driven either by a summed signal from the input channels or by switching each of the channels into its input separately the latter being an optional feature.

From each of the input channels a pre-fade listen signal is taken to a selector switch so that the user may listen to incoming signals before they are routed to the output stages. The output from the p.f.l. amps drives standard 8 ohm stereo headphones. A signal is also taken from each input channel via a level control to a summing amp which acts as an echo send signal driver. Echo send is only a mono signal since echo and reverberation and other effects give little or no

patial information to a signal. Signals from this output can be routed to echo chambers, reverb units and other sound processors such as the *Guitar Sound Multiprocessor*, etc. and routed back via the echo socket and control.

A 1kHz sine wave oscillator is provided in the design, and the output from this at a known level (10mV), can be injected into each of the input channels in turn for calibration purposes.

The mixer contains an internal mains powered supply which provides the $\pm 12V$ and $+12V$ rails.

The mixer in its published form can be built from readily available parts and the total construction cost should be approximately £55 including cabinet. The price quoted is for new components.

SPECIFICATION

Input Channels

Input impedance 47k Ω or 600 Ω (switchable)
 Input sensitivity 10mV or 100mV for 1V output (switchable)
 Overload margin 20dB
 Frequency response 20Hz–20kHz ± 1 dB
 S/N ratio 70dB
 Gain variable from 1–100 (or switchable 1, 10, 100)
 Pan Control input can be moved over entire stereo image width
 Bass Control ± 18 dB at 50Hz
 Treble Control ± 18 dB at 15kHz
 Echo Send directs some of channel output to main echo send output (up to 1V)
 Channel Fader 0 to ∞ attenuation of signal

Output Channels

Output Voltage Level up to 1V
 Echo Send Master Control up to 1V available
 Master Faders 0 to ∞ attenuation of signal
 Echo Return Control
 Stereo Auxiliary Input Control (optional)

VU Meters

Separate drive amps with calibration presets

Overload Indicator

Preset indication of clipping level on all channels via an l.e.d.

Headphone Monitor Amps

Headphone Volume Control up to 200mW available into 8 Ω

PFL

Switchable to each channel or summation of all channels

Power Supply

$\pm 12V$ at 40mA
 $+12V$ at 500mA

1kHz Test Oscillator

Provides a sine wave at 10mV at 1kHz for injection into each channel (separately) for calibration and test purposes

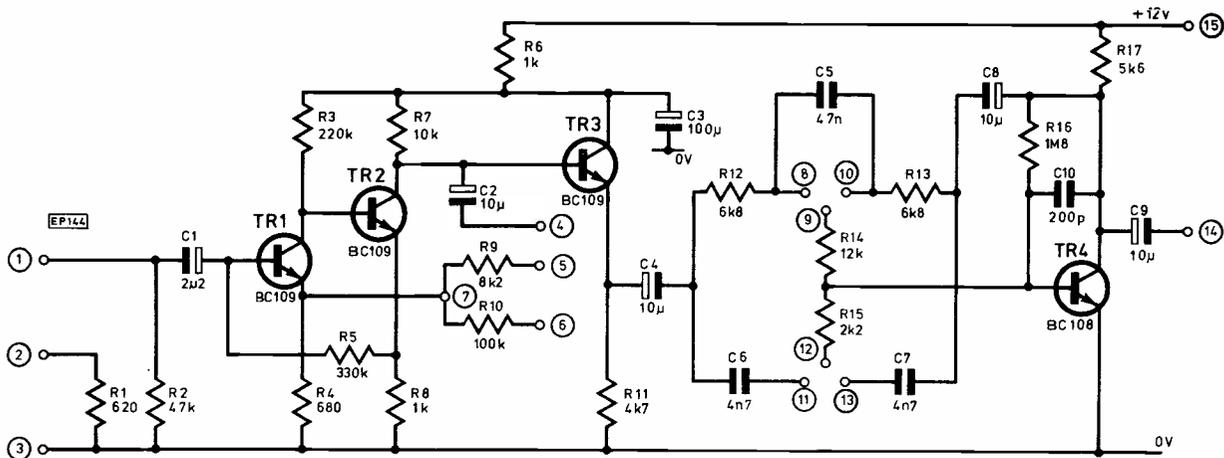


Fig. 2 Preamplifier and tone controls (6 required)

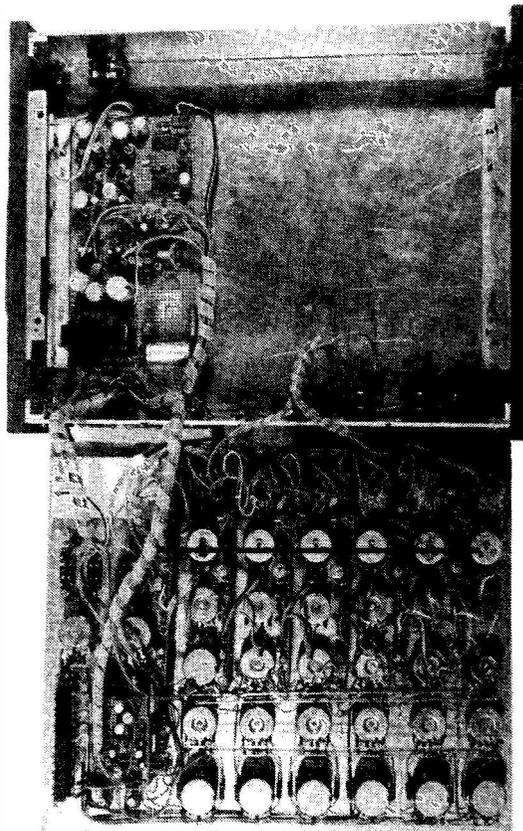
INPUT CHANNEL AMPLIFIERS

The design of the input channel amplifiers was given some careful consideration. It was originally intended to use operational amplifiers as the active elements, however these proved to be too noisy and lacking in bandwidth for serious work, and the low noise types proved to be too expensive.

The circuit diagram (Fig. 2) shows TR1 and TR2 in a high gain configuration with two a.c. feedback loops; one from the emitter of TR2 to the base of TR1 and the other from the collector of TR2 to the emitter of TR1. It is this second feedback loop which provides variation in gain in the circuit. With pin (4) connected to pin (7) there is total negative a.c. feedback via C2 therefore the gain is 1. With pin (4) connected to pins (5) or (6) there are gains of 10 or 100 produced respectively. R3, the source resistor for TR2 should be low noise metal oxide type for optimum low noise performance. R6 and C3 provide decoupling for the first three transistors. TR3 connected as an emitter follower buffers the output from TR2 to feed into the tone control network. This is of the standard Baxendall type with VR1 providing bass boost and cut and VR2 providing similar functions for treble.

TR4 provides a high impedance buffer for the tone control network and a low output impedance connected to the channel fader (VR4) via C9 and pin (14).

Input impedance variation on each channel is provided by switching pin (1) to pin (2) with S3 this gives an input impedance of approximately 600 ohms (or 47 kilohms with this connection not made). S3 also switches R9 and R10 in the gain feedback loop. If the gain is desired to be continuously variable, then a 100 kilohm linear potentiometer should be connected between points (7) and (4) and this will vary the gain between 1 and 100 (VR_x).



Looking Inside

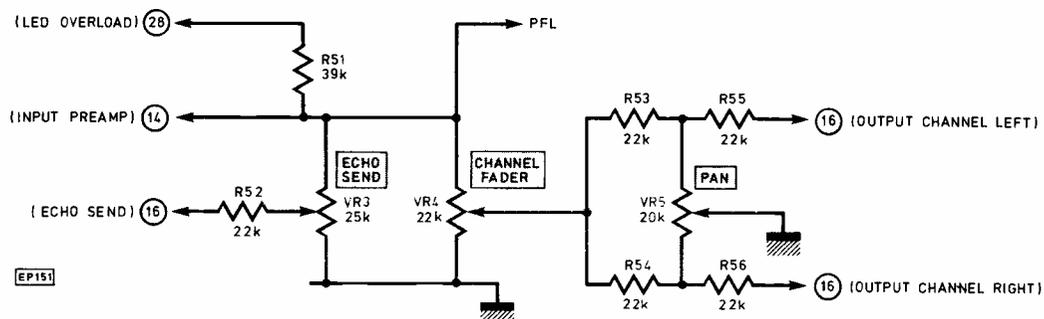


Fig 3 Pan pot and mixing network

PAN POTS

In the interests of economy and availability the pan pots used were single gang linear type. The configuration is shown in Fig. 3.

The signals from the pan pots are routed to the output channel buses via the two 22kΩ resistors for channel separation.

OUTPUT AMPLIFIERS

The output amplifiers (Fig. 4) consist of a standard common emitter configuration (TR5) which is coupled to an emitter follower (TR6). TR5 provides a voltage gain of about 30 which compensates for the signal attenuation in the mixing and pan resistor networks. The final output stage, TR6, provides a low output impedance drive for the master fader. These amplifiers are decoupled from the power supply rails by R22 and C12.

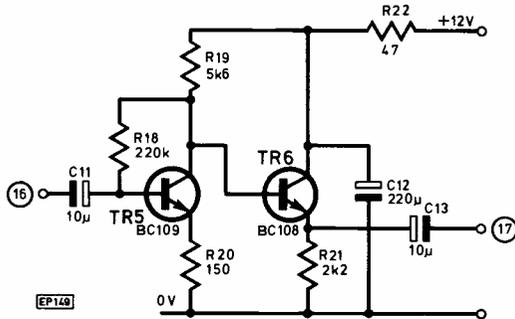


Fig. 4 Output and echo send amplifiers (3 required)

HEADPHONE AMPLIFIERS

The headphone amplifiers are of fairly standard design with TR7 providing drive for the bases of the complementary pair TR8/TR9. The output will drive an 8 ohm load (headphones) and is decoupled by C15 (Fig. 5).

The p.f.l. facility is switched to the output of the input channels via 2 pole 7 way interlocked push button switches or by a 2 pole 7 way rotary switch.

ECHO SEND AMPLIFIER

The design for this is the same as the output amplifier circuit. The inputs to this circuit are taken from the echo send pots on each channel through six 22 kilohm resistors to the input pin (16). The output is taken from the master echo capacitor—connected to pin (17)—to the echo send socket. The echo return signal is routed directly to the output channels via the Echo Return control and mixing network (see Fig. 1). As with the output channel amplifiers C12 and R22 provide power supply decoupling.

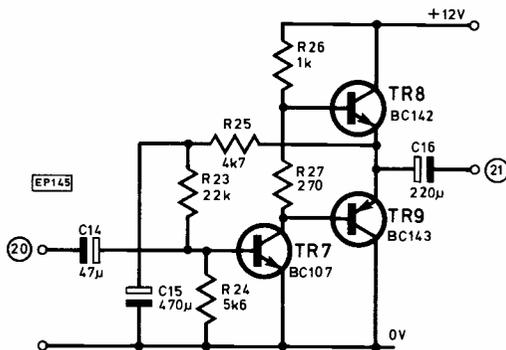


Fig. 5 Headphone amplifier (2 required)

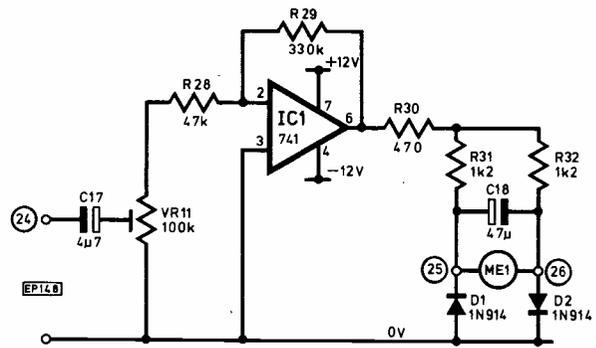


Fig. 6 VU meter amplifier (2 required)

VU METER DRIVE

Although the mixer uses exclusively transistors as the active elements for signal processing, monitoring of signal levels can be carried out quite satisfactorily using standard 741 op amps. The meter drive amps consist of a single op amp in an inverting mode with a gain of about 6. This is driven from the output of an output channel amp via C17 and VR11 which acts as a calibration control.

D1 and D2 provide rectification of the amplifier signal and C18 smooths the rectified signal. Standard VU meters are used, a double VU meter (if available), saves space on the front panel.

LED OVERLOAD INDICATOR

An overload circuit (Fig. 7) utilises an op amp as the active element. This is connected as a comparator with a d.c. bias set on the inverting input. While an a.c. coupled signal is applied to the non-inverting input. Signals from the six input channels are routed via mixing resistors to pin (28) and these are compared to the d.c. level on pin (3). Pin (2) also has a d.c. bias provided by R33 and R34, if the combined d.c. and a.c. levels on pin 2 are greater than the level on pin (3) the op amp switches into saturation. The op amp will switch at the input signal frequency but the l.e.d. will appear to be on continuously because of this high switching rate.

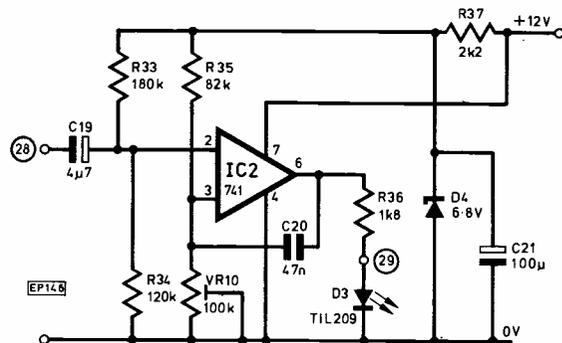


Fig. 7 Overload indicator

A reference voltage is provided in the circuit by R37 and D4 and decoupled by C21. C20 provides positive feedback at high frequencies causing the op amp to switch more rapidly. The preset pot VR10 adjusts the switching level and hence the level of input signal which illuminates D3.

TEST OSCILLATOR

The test oscillator (Fig. 8) provides a useful means of circuit calibration and signal routing testing. It consists of a one transistor phase shift oscillator with C22, C23, C24, R38 and R39 forming the phase shift and frequency

COMPONENTS ...

Input Amplifiers (6 off)

Resistors	
R1	620
R2	47k
R3	220k (2% Metal Oxide)
R4	680
R5	330k
R6, R8	1k (2 off)
R7	10k
R9	8k2
R10	100k
R11	4k7
R12, R13	6k8 (2 off)
R14	12k
R15	2k2
R16	1M8
R17	5k6
R49	47k
R50	4k7
(All $\frac{1}{3}$ W 5% unless otherwise specified)	

Potentiometers

VR1	100k linear
VR2	100k linear
VRx	100k linear (see text)

Capacitors

C1	2 μ 2 15V electrolytic
C2, C4, C8, C9	10 μ 15V electrolytic (4 off)
C3	100 μ 15V electrolytic
C5	47n polyester
C6, C7	4n7 polyester (2 off)
C10	200p polystyrene

Semiconductors

TR1, 2, 3	BC109
TR4	BC108

Miscellaneous

S3 3 pole 4 way rotary switch

1kHz Oscillator (1 off)

Switch	
S2	Single pole 6 way

Resistors

R38, R39	4k7
R40	22k
R41	220k
R42	1k5
R43, R44	220
R45	180k
(All $\frac{1}{3}$ W 5% carbon)	

Potentiometer

VR12	10k min preset
------	----------------

Capacitors

C22, C23, C24	10n polyester
C25	10 μ 16V electrolytic
C26	4 μ 7 16V electrolytic

Transistor

TR10	BC108
------	-------

Diode

D5	6-2V 300mW Zener
----	------------------

Mixer Output Stages (2 off) and Echo Send Amplifier (1 off)

Resistors

R18	220k
R19	5k6
R20	150
R21	2k2
R22	47
(All $\frac{1}{3}$ W 5%)	
VR8, VR9	22k log slider (2 only)

Transistors

TR5	BC109
TR6	BC108

Capacitors

C11, C13	10 μ 15V electrolytic (2 off)
C12	220 μ 15V electrolytic
C33	4 μ 7 25V electrolytic (1 only)

Meter Amplifiers (2 off)

Resistors

R28	47k
R29	330k
R30	470
R31, R32	1k2 (2 off)
(all $\frac{1}{3}$ W 5% carbon)	

Potentiometers

VR11	100k min preset
------	-----------------

Capacitors

C17	4 μ 7 electrolytic
C18	47 μ electrolytic

Integrated Circuit

IC1	741
-----	-----

Diodes

D1, D2	IN914
--------	-------

Miscellaneous

ME1	VU meter
-----	----------

Power Supply (1 off)

Resistors

R46, R47	1k
R48	270

Transistors

TR11	BC108
TR12	BC478
TR13	2N3053

Capacitors

C27, C28, C31, C32	1,000 μ 25V electrolytic (4 off)
C29, C30	220 μ 25V electrolytic (2 off)

Diodes

D6, D7, D8	12V 300mW Zeners
REC1, REC2	Bridge rectifiers 50V p.i.v. 1A (or 4 x 1N4001)

Transformer

T1	Mains (240V) primary 15-0-15V at 40mA; 8V at 500mA secondaries
----	--

Miscellaneous

FS1	500mA
S1	d.p.d.t. miniature rocker switch
LP1	mains neon

Headphone Amplifiers (2 off)

Resistors

R23	22k
R24	5k6
R25	4k7
R26	1k
R27	270
(all $\frac{1}{3}$ W 5%)	

Capacitors

C14	47 μ 15V electrolytic
C15	470 μ 15V electrolytic
C16	220 μ 15V electrolytic

Transistors

TR7	BC107
TR8	BC142
TR9	BC143

Potentiometer

VR7	25k log ganged
-----	----------------

Switches

S4-S10	2 pole 7way interlocked
--------	----------------------------

Overload Indicator (1 off)

Resistors

R33	180k
R34	120k
R35	82k
R36	1k8
R37	2k2
(all $\frac{1}{3}$ W 5% carbon)	

Potentiometers

VR10	100k min preset
------	-----------------

Capacitors

C19	4 μ 7 16V electrolytic
C20	47n polyester
C21	100 μ 16V electrolytic

Integrated circuit

IC2	741
-----	-----

Diodes

D3	TIL 209 (red)
D4	6-8V 300mW Zener

Pan Pot Networks (6 off)

Resistors

R51	39k
R52-56	22k (5 off)

Potentiometers

VR3	25k log
VR4	22k log
VR5	20k linear

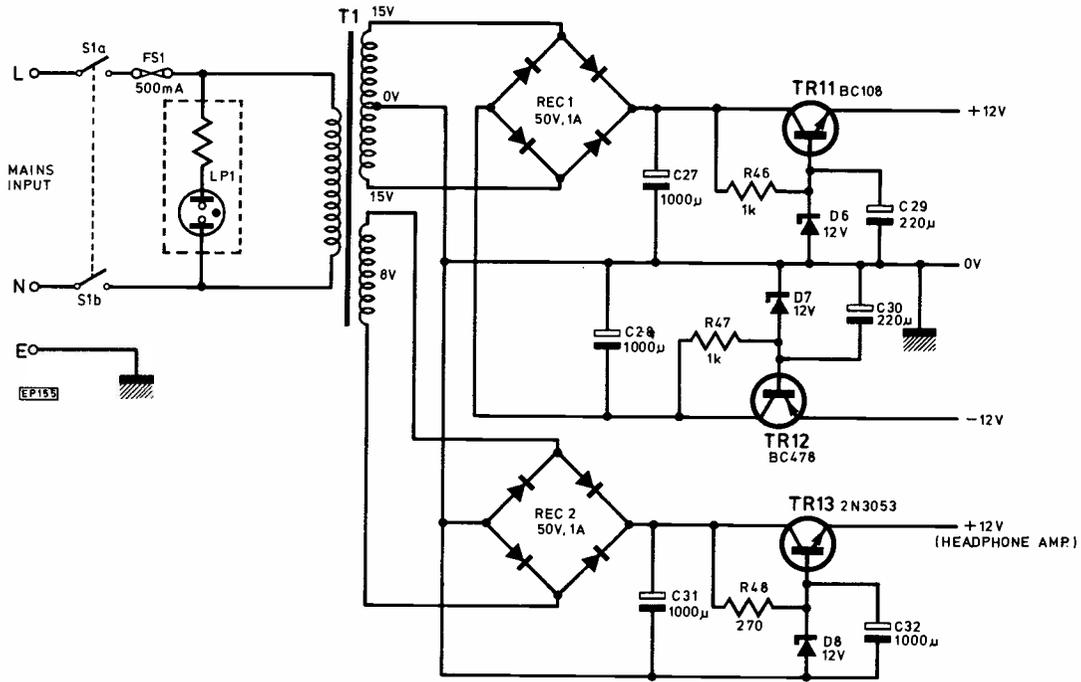
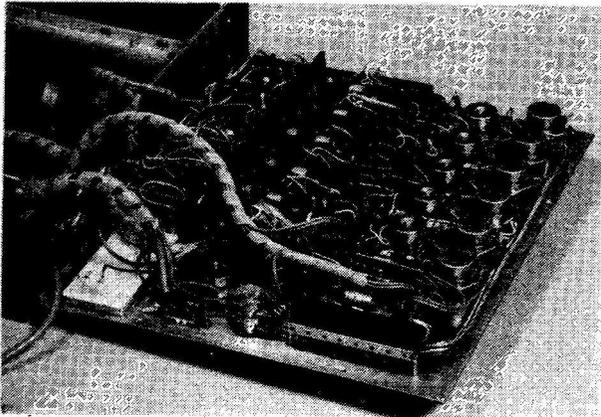


Fig. 9 Power supply



determining network. The circuit is decoupled from the supply via R44 and D5 provides a stable reference supply.

The output is taken via C26 from the attenuating network R45/VR12, and VR12 is used for calibration of the output which should be of 10mV level and a fairly pure sinusoid in shape.

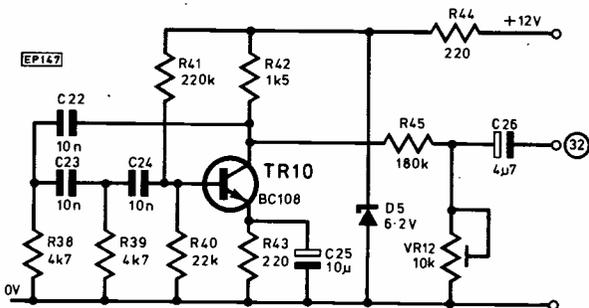


Fig. 8 Test oscillator

POWER SUPPLY

For serious purposes the mixer is made mains powered, and this is the function of the power supply in Fig. 9. It provides three voltage rails to drive the various circuits in the mixer.

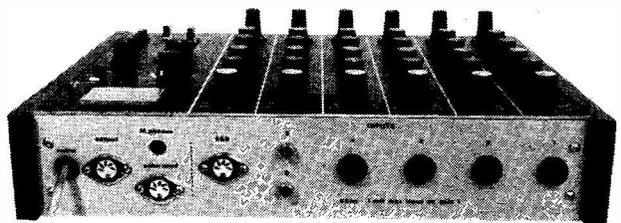
The transformer used on the prototype has secondaries of 15-0-15V at 50mA and 8V at 500mA. The 15-0-15V windings are fed via a diode bridge and smoothing capacitors to series pass transistors TR12 and TR11 which are biased by Zener diodes to give approximately $\pm 12V$ stabilised output.

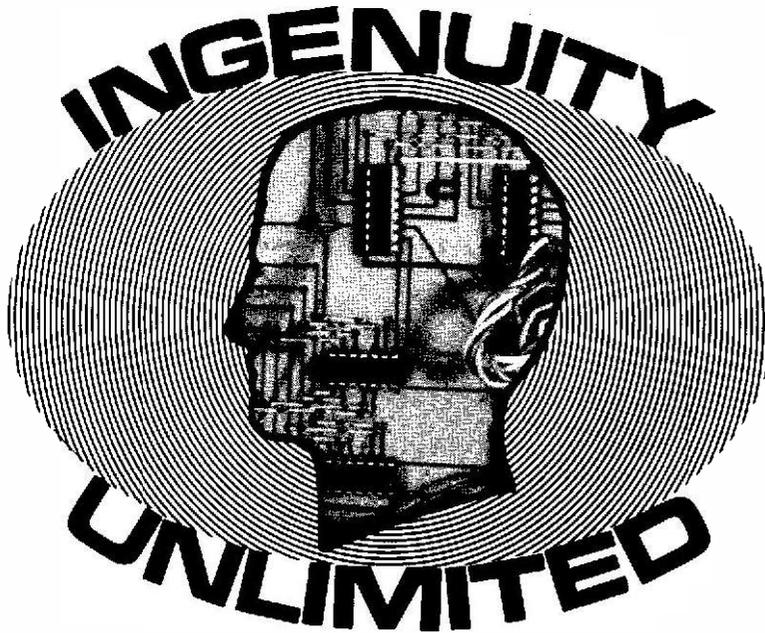
PHONE RAIL

The other secondary winding of the transformer is connected in a similar manner but the series regulating transistor is of a higher current rating. Although this power rail also provides +12V it only feeds the headphone amplifiers since they require a larger amount of power than the other circuits and would affect the operation of them if they were connected to the same power rails.

None of the power supply rails of the mixer have to be at an exact voltage, but regulation and adequate smoothing are essential for low ripple content of the processed signals. Most of the circuits in the mixer have decoupling resistors and capacitors to prevent unwanted signal leakage onto the power rails.

NEXT MONTH: Construction and setting up.





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

THE circuit functions as follows. On pressing the key S1, since the bilateral switch IC2b is on, the capacitor C1 can charge up via VR1. This gives the 'attack' part of the envelope. IC1a acting as an inverter, holds the switch IC2a off. IC2c is also held off by the RS latch consisting of IC1c and IC1d.

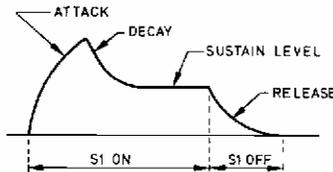
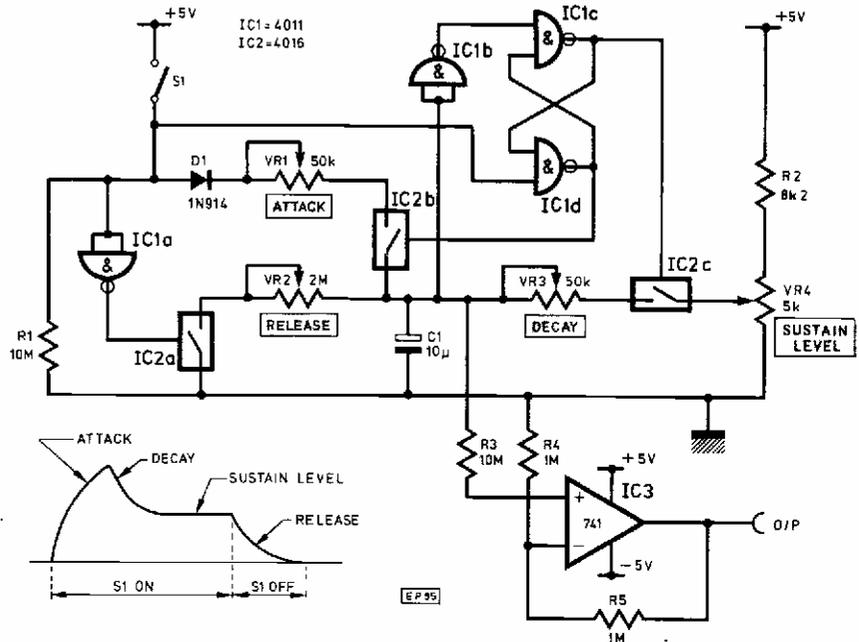
When C1 has charged up to 1.8 volts the inverter IC1b triggers and its output goes high. The outputs of the RS latch now change, switching IC2b off and IC2c on. C1 now discharges via IC2c at a rate set by VR3. This gives the 'decay' part of the envelope. The envelope settles down to the level set by VR4. This gives the 'sustain' part until the key is released. On releasing the key, IC2b switches off and IC2a switches on. D1 prevents any current flowing via IC2b and interfering with the inverter IC1a. The output of IC1a goes high switching IC2a on. The capacitor now finishes discharging via IC2a and VR2. This gives the 'release' part of the envelope.

By replacing the inverter with a Schmitt trigger with a hysteresis level of say 4 volts, a higher voltage output can be produced. VR4 should also be changed to give a comparable sustain level.

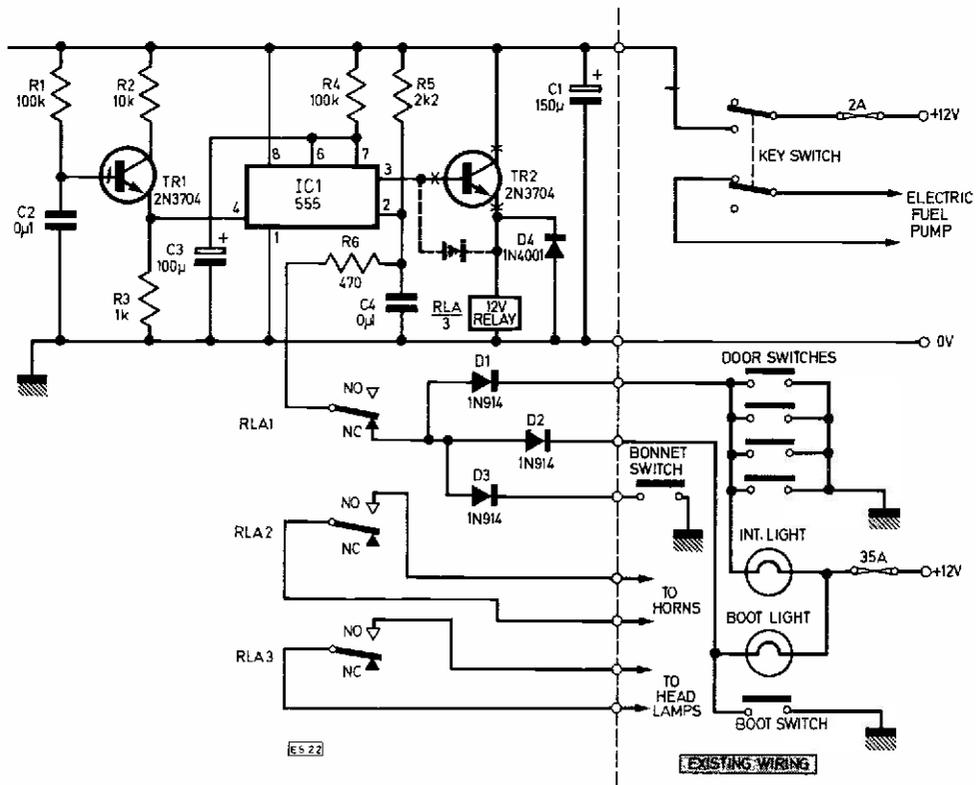
The output is buffered by a 741 acting also as a non-inverting amplifier of gain 2. This gives a voltage envelope of 3.6 volts at the output. Thus this unit could possibly be used with the *Minisonic's* VCA.

P. V. Saduikis,
East Park Grove,
Leeds.

ADSR ENVELOPE SHAPER



CAR THEFT ALARM



THE circuit will give both visual and audible warning of unlawful entry into your motor car, which should deter the car thief. If your car is fitted with an electric fuel pump, then this may be immobilised when the alarm unit is switched on. The alarm is essentially an electronic version of the more common mechanical alarms, based on a relay latch, in conjunction with a thermal delay switch, and costing over double the outlay for this unit.

When the circuit is triggered by any of the door, boot, or bonnet switches, the 555 latches for approximately 15S, determined by R4 and C3, during which TR2 conducts, closing RLA which sounds the

horns and lights the headlamps. If any of the switches are still closed after that period, IC1 is triggered by RLA1, and latches for a further 15S, this cycle repeating until all switches are open.

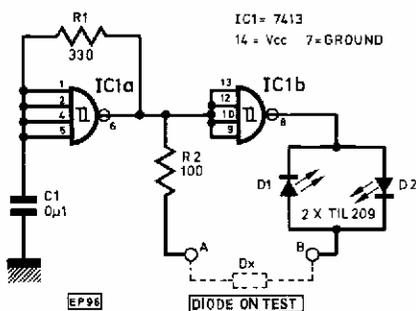
TR1, R1 and C2 hold pin 4 on IC1 (reset) at ground potential during switch on, thus preventing the timer from latching, R2 reduced the standing current to a minimum. R6 and C4 suppress interference spikes that would trigger IC1 even when all switches are open, due to strong pickup. This trigger input is very sensitive and a lot of false triggering occurred before fitting these components. Diodes D1, D2 and D3 prevent the bonnet and

boot switches operating the interior lights and also block the path of current to IC1 pin 2. TR2 is used to switch the 12V relay, but if the coil resistance is higher than 60 ohms, it may be replaced by the rectifier shown as dotted lines.

The main on/off switch is positioned on the car exterior.

M. A. Robertson,
Chelmsford,
Essex.

DIODE TESTER



THE tester shown was designed to test silicon or germanium diodes and indicates whether the diode is open circuit, short circuit or if working, its polarity.

The Schmitt trigger, IC1a, forms an oscillator and IC1b an inverter, thus producing an alternating voltage across the test terminals A,B. When a diode is placed across these, provided it is not dud, it will conduct every other half cycle and either D1, or D2 will light. If the diode is short circuited both l.e.d.s will light, and if open circuited neither will. The circuit has been used for testing ex-computer diodes and ones from "unmarked/untested" packs and is simple to use and reliable.

D1	D2	Dx
OFF	ON	OPEN CIRCUIT
OFF	ON	O.K.
ON	OFF	REVERSED
ON	ON	SHORT CIRCUIT

N. Sunderland,
Reading,
Berks.

Market Place

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

by
**Alan
Turpin**

and
**David
Shortland**

STEVENSON CATALOGUE

Exhibiting their wares at Bazaar were Stevenson. Over 250 types of items are mentioned in their 80 page catalogue. In stock items are normally dispatched by return of post, first class. A brief resumé of the index brings to light:—

- A/D Converters
- Battery Holders
- CMOS devices (a good list)
- Decoders
- EPROMs
- Ferric Chloride
- Grommets
- Hand held control boxes
- Insulating kits
- J-Fet op amps
- Keyboard cases
- Low power Shottky TTL
- Microprocessors (nine types)
- Ni-Cad cells
- Opto isolators
- Potting boxes
- Q-Max cutters
- Random noise generator
- SCR's
- Timers
- Ultrasonic transducers
- Voltage regulators
- Zeners

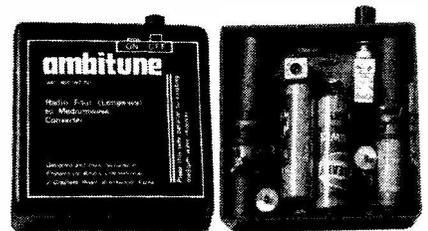
Send S.A.E. (min. 9 × 6½in.) to **Stevenson Electronic Components, 76 College Road, Bromley, Kent, BR1 3BR (01-464 2951).**

COME IN RADIO FOUR!

Radio Four is a networked broadcast on long wave. It is also available on VHF but during the day there are many breaks for schools and minority interest programmes.

Long wave reception is susceptible to interference from electric storms, unserviced electric motors, TVs and some designs of light dimmer. Also some imported sets are without long wave.

Ambit International provide an answer to these problems in the form of their Ambitune RF Transponder. It converts the 200kHz long wave signal to a frequency of around 850kHz in the medium wave.



The unit needs no direct coupling to a set, it just sits 6-10in from the receiver and gives of its best when directionally tuned to the transmitter (Droitwich). The unit is powered by two pen cells, life 1,000hrs.

Although the device itself transmits, or radiates, over a very short distance, Ambit say no licence is required. The official view of the Radio Regulatory Branch of the Home Office is that the usage of these devices is "under consideration".

Available at £6, inc. VAT and p&p, only from **Ambit International, 2 Gresham Road, Brentwood, Essex, CM14 4HN.**

METRAVO MULTIMETER

Consisting of just four basic parts, front and back cover, movement and printed circuit board, this instrument has no screws, with parts just clicking together and only two wires to solder between the movement and the printed circuit board.



Despite the simplicity of its design the meter offers no less than 36 ranges with a 20kΩ/V sensitivity, at just £22.00 plus VAT & Carr.

DC Voltage	0.15 to 1000V
AC Voltage	1.5 to 500V
DC Current	50µA to 5A
AC Current	0.5mA to 5A
Resistance	1Ω to 1MΩ

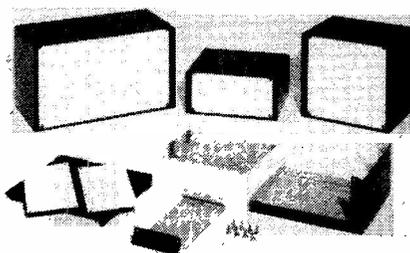
Precision Instrument Laboratories, Instrument House, 212 Ilderton Road, London, SE15 1NT. (01-639 4461). Available UK only.

NEW PROJECT CASES

News of an interesting new range of project cases was announced to Market Place at Bazaar.

The PACK-FLAT range of instrument cases has been designed to provide electronic equipment engineers with an attractively styled packaging medium, versatile enough to meet individual requirements, yet still be available from stock. The cases are made from "Colorcoat" (a textured PVC coated steel) and can be stored flat until required.

The separate chassis allows for easy component mounting. The case slots together in seconds. Eight screws retain the complete assembly; the top four allow removal of the lid, the other four hold the assembly together. Alternatively, the front or rear panel may be removed still leaving the assembly intact.



Supplied in a black grained finish with white front and rear panels, sizes range from 180 × 152 × 80mm to 307 × 152 × 156mm, with the 152mm dimension a constant throughout the range.

Full details from **Perancea Ltd., 131 First Avenue, Bush Hill Park, Enfield, Middlesex, EN1 1BP (01-366 3625).**

6500 BASED KEYBOARD

Like Elton John it's always worth knowing about another keyboard.

Rastra Electronics Ltd. of Hammersmith present the Synertek Systems KTM-2; a full ASCII keyboard and all the logic to display 24 lines of 40 characters each with full graphics.

The keyboard has 54 keys and generates 128 ASCII characters (upper and lower case alpha, numeric, special and control), graphic and alphanumeric characters being capable of simultaneous display.

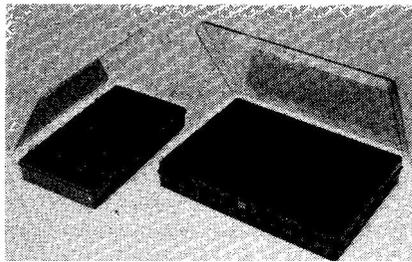
With relative and absolute cursor addressing, graphs, game pieces, etc. can be placed and moved about the screen with a minimal amount of software.

In addition Rastra offer the full range of Synertek Systems with special kit prices for integral systems based on SYM-1.

For further details and full price list contact **Rastra Electronics Limited, 275-281, King Street, Hammersmith, London, W6 9NF (01-748 3143)**. Callers welcome by appointment.

USER TRANSPARENT?

Away with the tobacco tins and egg boxes. You can keep your stock of components tidy and visible in these new storage cases. Each case has a compartment base moulded in high impact styrene, and a clear styrene lid. The case on the left is ideal for a range of small components and the case on the right will also hold tools.



The 18 compartment case (model 18M) measures 274 x 157 x 40mm. The 16 compartment case (model 16M) is 315 x 245 x 45mm. Prices are — (18M) £1.99 plus p&p — (16M) £2.99 plus p&p.

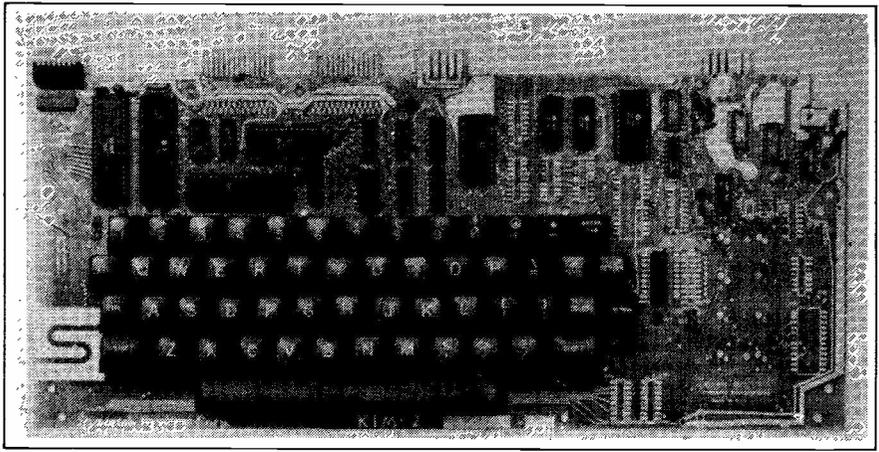
Both models are available direct from **Sumico Ltd., 7 Clarence Road, Clare, Sudbury, Suffolk CO10 8QN. (078727 7855)**.

NASCOM UPGRADE

A new Nascom has recently been announced; this computer, to be called Nascom 2, will not replace Nascom 1 but is an upgraded version. It still employs the Z80 but with selectable speed of 1, 2 or 4MHz and retains the Nasbus bus lines. The 8K BASIC is based upon the Microsoft BASIC and a 2K Monitor which is called Nas-Sys 1 is also used. The Monitor was written by a hobbyist to improve Nascom 1.

The board also contains 8K static RAM, Kansas City cassette interface at 300 or 1200 baud (link option), a 2K ROM character generator providing 128 characters plus a second 2K ROM socket for a graphics package which is software selectable. The unit will be available either as kit or ready built. We do not, however, expect to see many, if any, becoming available to the hobbyist before the late autumn. Kit price will be £295 plus VAT and that does not include the p.s.u. which will cost another £30 plus VAT.

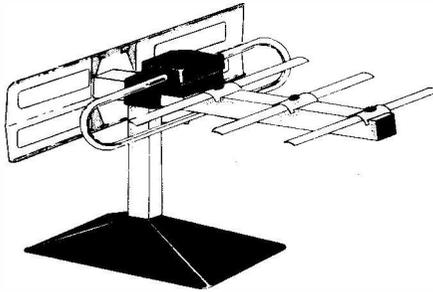
The monitor is a vast improvement over the original and although primarily designed for use with the new keyboard, all features can be used with the current Nascom 1 keyboard by using combinations of keys. Nascom 1 owners would do well to investigate this further as Nas-Sys 1 is one of the best monitors we have seen.



SECOND AERIAL

A second TV set may be required in a room such a distance from the first set that the cost of a splitter, plus co-axial cable and the routing of it may make a second aerial economic.

A six element UHF aerial, approved and tested by the British Aerial Standards Council, is one of several designed and made by Maxview. It is suitable for all present and future channels, can be used horizontally or vertically, and is of a modern anti-ghost design in aluminium.



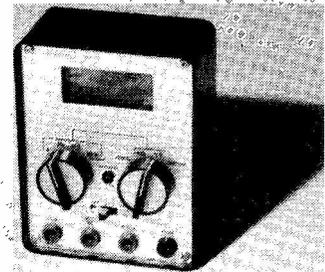
Although called a set-top aerial, it can be mounted outside with perhaps a little weatherproofing around the junction box where the co-ax joins the array.

The recommended retail price is £4.69 inc. VAT but they can be found at £3.75.

For your nearest outlet, or literature on their range of aerials contact **Maxview Aerials Ltd., Setch, King's Lynn, Norfolk. (0553 810 376)**.

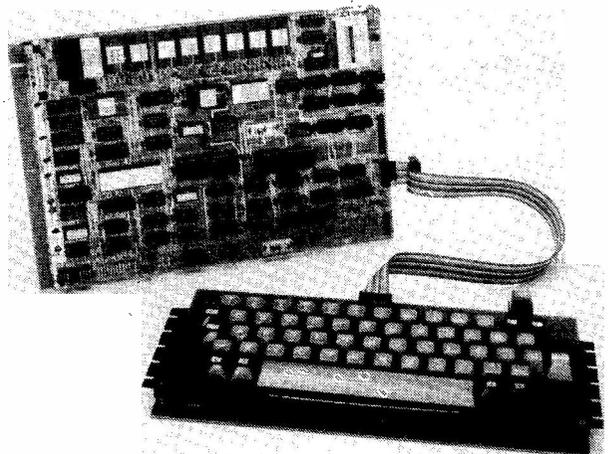
HYBRID KIT

Have you ever shelved a project for want of a component, or finished the circuitry but not made a very neat job of the housing? Jayen seem to have hit upon a good balance between a complete kit from a sole supplier and doing it all yourself. They supply a p.c.b., front panel (punched and lettered), circuit diagram, instruction sheet, and difficult pieces of hardware such as screws, washers, etc. They also supply an up to date components shopping list with several suppliers' prices, leaving the constructor the chance to shop around and buy his components at the best possible prices.



At present Jayen offer kits in this way for a digital multimeter and a function generator, and other Jaykits are to be introduced. See their ad. in previous issues.

Jayen Developments, 21 Gladeside, Bar Hill, Cambridge, CD3 8DY (0954 80285).



Waveform GENERATOR

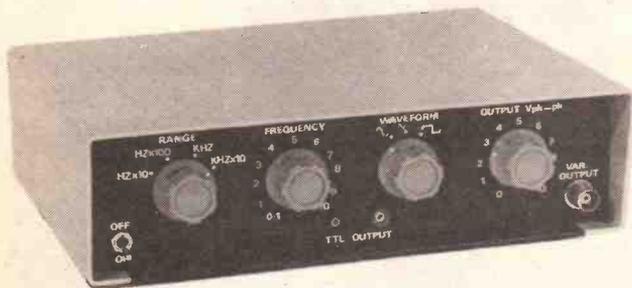
Michael Tooley B.A. David Whitfield B.A. M.Sc.

THIS versatile instrument provides sine, square, and triangular wave outputs of up to 10V peak-peak over a frequency range of 1Hz to 100kHz and is capable of driving resistive loads as low as 10Ω at full output. A separate 5V peak-peak square wave TTL-compatible output is available for testing logic circuits and for timing and synchronisation of the variable output where required. The instrument also incorporates a sweep facility which allows the output to be frequency modulated by an external signal. Thus permitting swept frequency response analysis and the generation of some interesting modulated tone effects.

The instrument uses four integrated circuits, three transistors and a handful of other components. Calibration is greatly simplified by the use of linear law frequency and output level controls. The specification more than adequately meets the electronic enthusiasts' requirements for a general purpose audio frequency signal generator. Furthermore, the added facilities make this an ideal project for constructors who wish to up-date their existing test equipment.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Waveform Generator is shown in Figs. 1 and 2. The circuit is based on the versatile 8038 waveform generator integrated circuit which provides sine, square and triangular outputs derived from an internal voltage controlled oscillator. The frequency range is selected by S1 and decade capacitors C9 to C12. The duty cycle is set to 50 per cent by making R1 and R2 equal



and fine frequency control is achieved by varying the d.c. potential at pin 8 of the 8038. Two pre-set resistors, VR2 and VR3, are used to set the maximum and minimum frequencies respectively at each end of VR1. Adjustment of the purity of the sine wave output is provided by VR4 and VR5. The desired output waveform is selected by S2 and fixed resistors, R4, R5 and R6, are included to provide equal peak-peak outputs with all three waveforms.

Control of the output amplitude is provided by VR6 with C13 included to remove the d.c. level from IC3 hence eliminating any d.c. off-set at the output of the direct coupled amplifier which follows. The TTL output is buffered by means of the emitter follower, TR3. Diode D2 provides protection from the reverse base-emitter voltage which occurs on negative half-cycles of the square wave output from IC3. The square wave output from TR3 emitter alternates between levels of 0V and +5V and is thus TTL compatible.

Operational amplifier, IC4, is used in non-inverting mode with pre-set gain adjusted by VR7 and frequency compensation provided by C16. Complementary symmetrical emitter followers, TR1 and TR2, provide current gain and reduce loading effects of the output on IC4. Fixed base bias for TR1

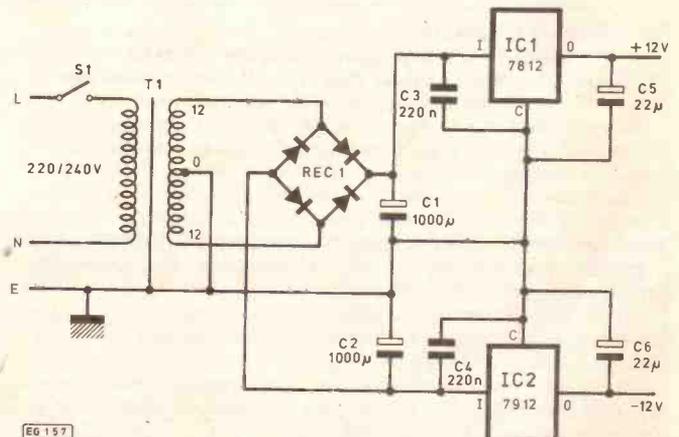


Fig. 1. Circuit diagram of the power supply

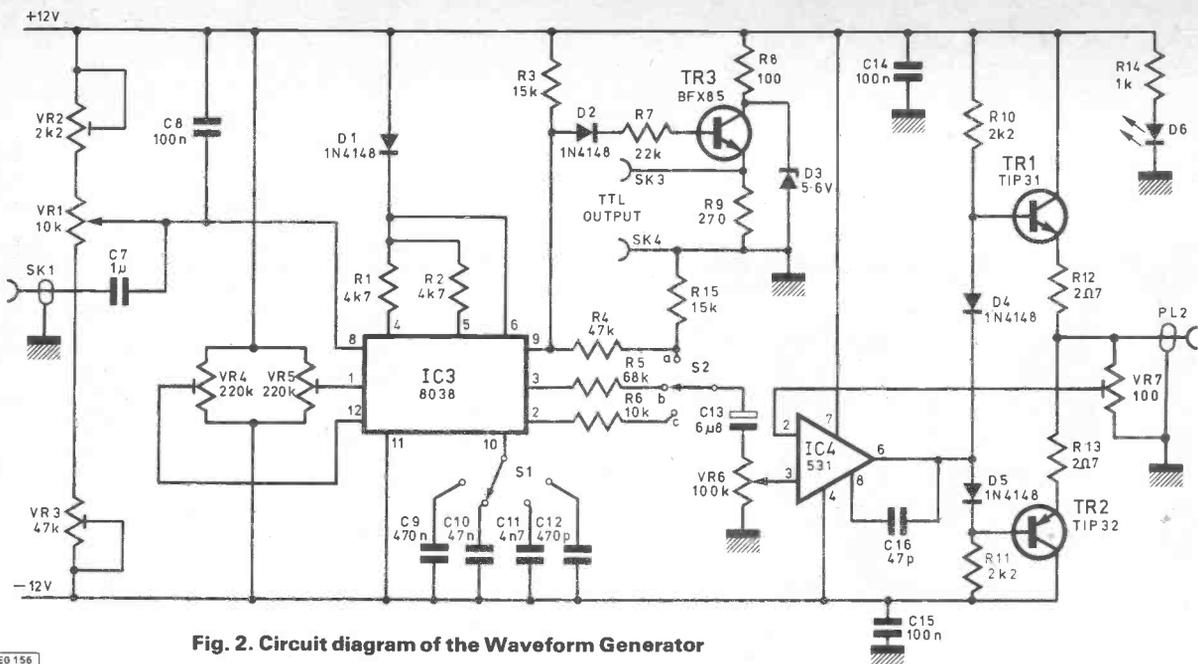


Fig. 2. Circuit diagram of the Waveform Generator

E0156

and TR2 is provided by forward biased silicon diodes, D4 and D5.

Two integrated circuit regulators, IC1 and IC2, are used to provide positive and negative 12V regulated supply rails. A conventional centre-tapped bridge rectifier arrangement provides a source of d.c. for the regulators.

CONSTRUCTION

With the exception of the front panel controls, sockets, mains transformer and capacitors, C1, C2, C7 and C9 to C13, all components are mounted on a single printed circuit board. The p.c.b. is shown in Fig. 3 and the component overlay in Fig. 4. When mounting components on the p.c.b.,

SPECIFICATION

Frequency Range

Continuously variable from 1Hz to 100kHz in four linear decade ranges:

- 1Hz to 100Hz
- 10Hz to 1kHz
- 100Hz to 10kHz
- 1kHz to 100kHz

Waveforms

Sine, square and triangle.
Separate TTL compatible square wave output.

Output voltage level

Variable up to 10V peak-peak in one linear range for pure resistive loads of greater than 100Ω. Maximum r.m.s. voltage developed into a 10Ω resistive load (sine wave at 1kHz) = 2.5V.
TTL output fixed at 5V peak-peak.

Output impedance (variable output)

Less than 0.25Ω measured at 1kHz sine wave.

Output impedance (TTL output).

100Ω measured at 1kHz.

Minimum recommended load impedance (variable output).

4Ω.

Optimum load impedance (variable output).

8Ω to 15Ω.

DC off-set at output (variable output).

Less than 10mV.

THD (sinewave).

Typically better than 3 per cent at 1kHz with full output developed into a 100Ω resistive load.

Ramp linearity (triangle wave).

Better than 3 per cent at 1kHz with full output developed into a 100Ω resistive load.

Rise time (variable output square wave)

typically better than 0.5µs at 1kHz measured using full output into a 100Ω resistive load.

Rise time (TTL output).

Typically better than 0.3µs at 1kHz measured using full output into a 100Ω resistive load.

FM sweep.

FM sweep input facility (a.c. coupled) provides frequency modulation of the output signal. The input impedance depends on the setting of the frequency control but is typically around 10kΩ. An input of 420mV peak-peak is sufficient to sweep the oscillator through approximately 10 per cent of the range selected. The FM sweep sensitivity on each range is as follows: 26.7Hz/V, 267Hz/V, 2.67kHz/V, 26.7kHz/V.

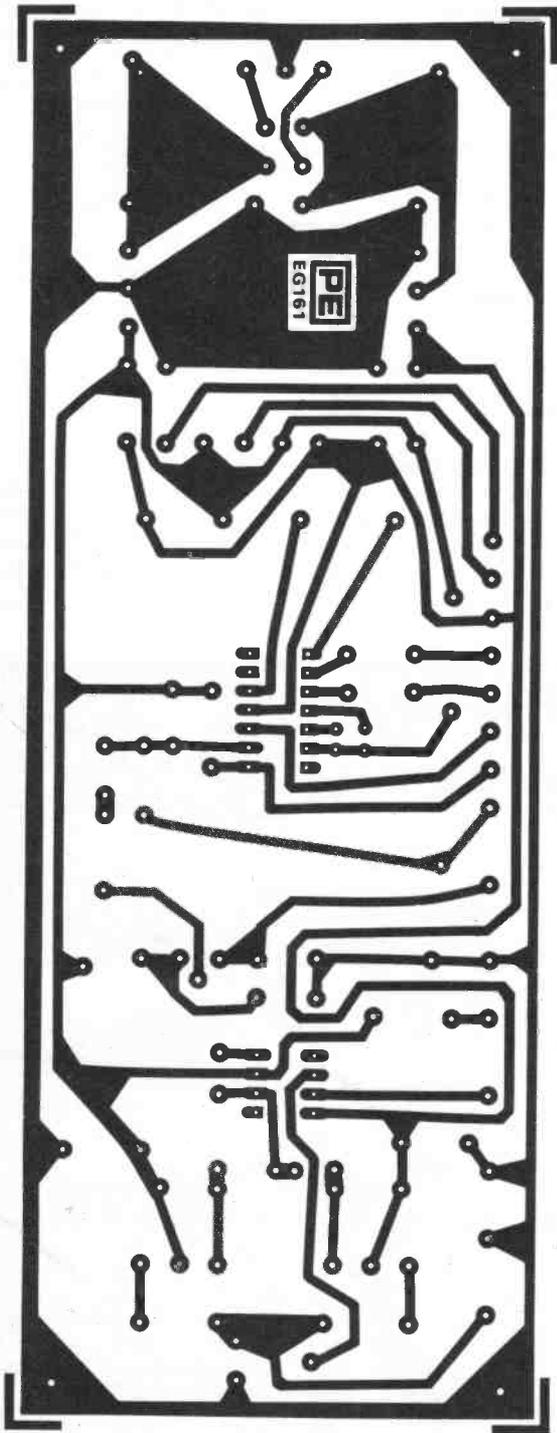


Fig. 3. Printed circuit board design

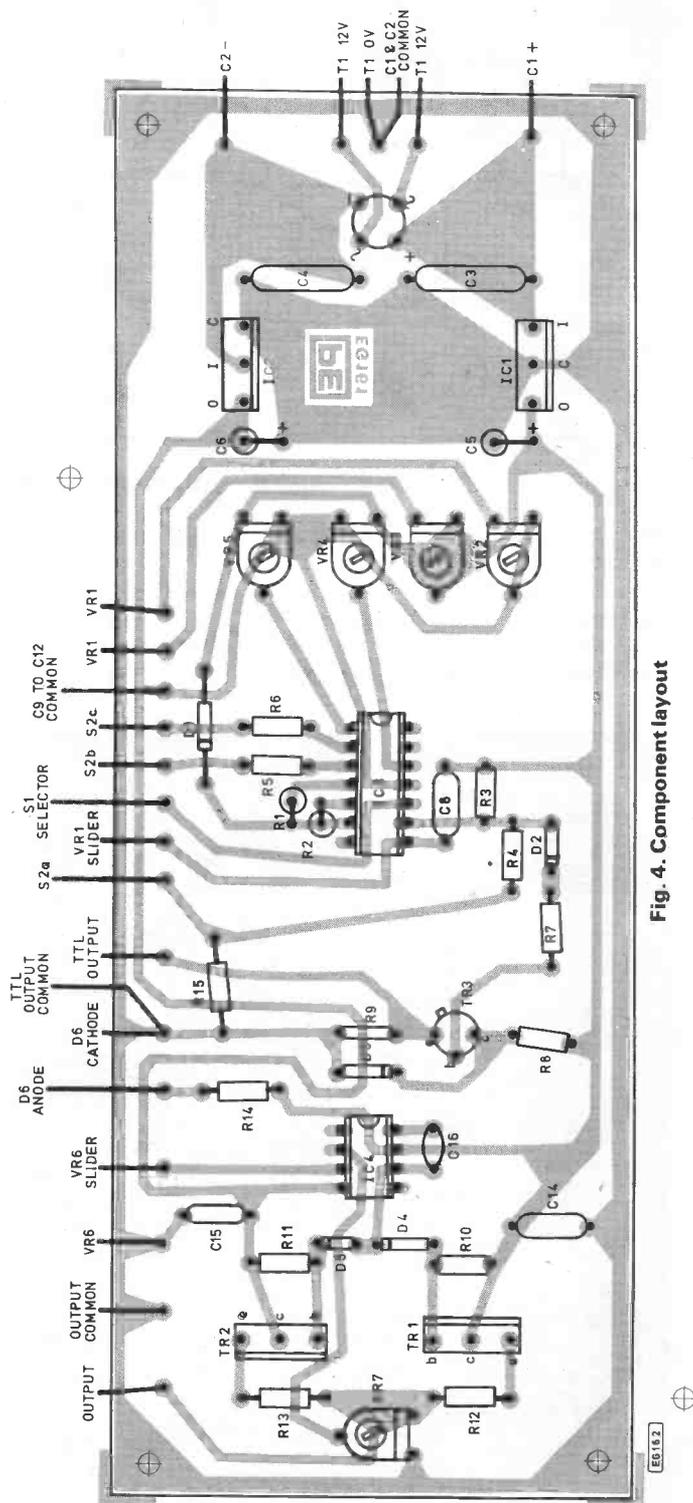


Fig. 4. Component layout

COMPONENTS . . .

Resistors

R1, R2	4k7 (2 off)
R3, R15	15k (2 off)
R4	47k
R5	68k
R6	10k
R7	22k
R8	100
R9	270
R10, R11	2k2 (2 off)
R12, R13	20k (2 off)
R14	1k

All resistors 1/2W 5% carbon

Capacitors

C1, C2	1 000µ 25V elect
C3, C4	220n polyester
C5, C6	22µ 25V elect
C7	1µ polyester
C8, C14, C15	100n polyester
C9	470n polystyrene
C10	47n polystyrene
C11	4n7 polystyrene
C12	470p polyester
C13	6µ 63V elect
C16	47µ ceramic

Potentiometers

VR1	10k lin
VR2	2k2 sub-min hor

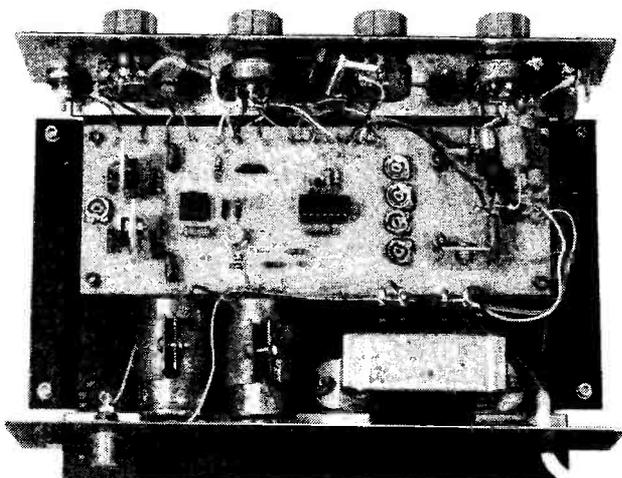
VR3	47k sub-min hor
VR4, VR5	220k sub-min hor
VR6	100k lin
VR7	100 sub-min hor

Semiconductors

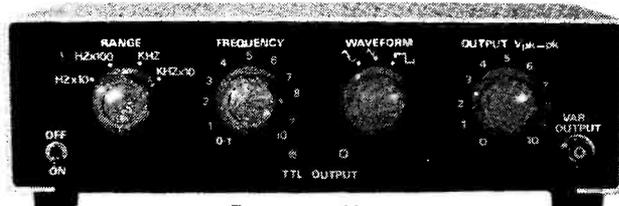
D1, D2, D4, D5	1N4148 (4 off)
D3	BZY88 5V6 Zener
D6	0-2 l.e.d.
REC1	1A 100V bridge rectifier (W01)
TR1	TIP31
TR2	TIP32
TR3	BFX85
IC1	7812 12V pos. reg.
IC2	7912 12V neg. reg.
IC3	8038
IC4	531

Miscellaneous

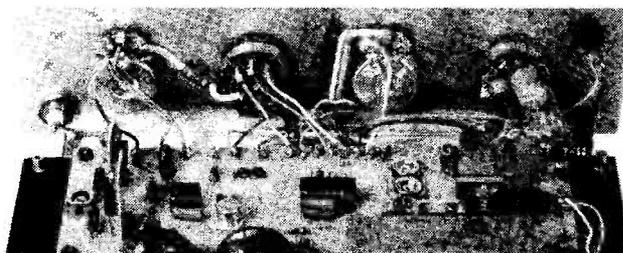
- S1 1 pole 4 way rotary switch (3P 4W switch with two poles ignored)
 - S2 1 pole 3 way rotary switch (4P 3W switch with three poles ignored)
 - S3 miniature toggle switch s.p.s.t. Heat sinks (4 off) (see text).
 - T1 12V-0-12V 0.5A mains transformer
- 2mm sockets for TTL output (1 red, 1 black), BNC (or similar co-axial sockets) for variable output and FM input (2 off), knobs (4 off), case (Vero G-range G), printed circuit board, capacitor fixing clips (2 off), spacers (4 off).



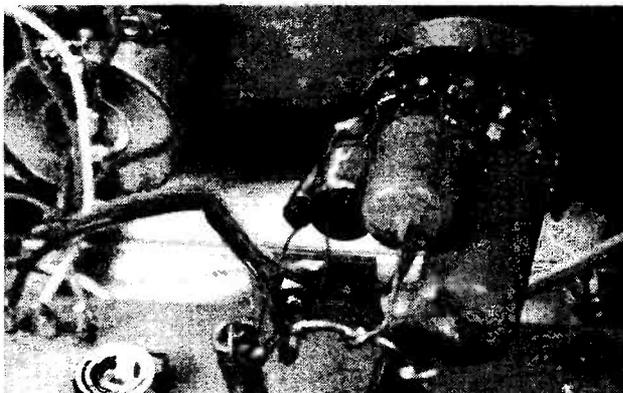
Internal view of the Waveform Generator



Front panel layout



Rear view of front panel

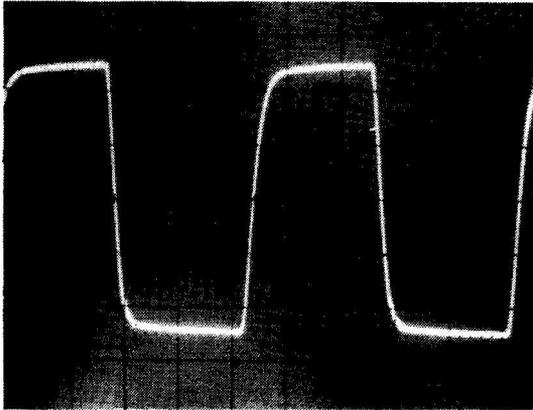


Capacitor mounting on switch one

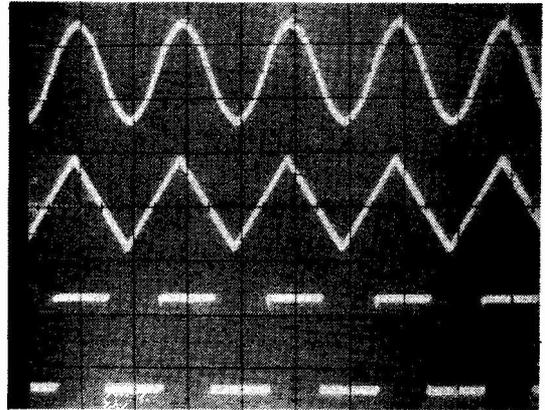
it is important to check the orientation of the transistors and integrated circuits. Four small heat sinks, consisting of around 900mm² 18 s.w.g. aluminium bent into a "U" shape (or proprietary types of between 15°C/W and 20°C/W), should be fitted to IC1, IC2, TR1 and TR2. The use of 14-pin and 8-pin dual in-line sockets in conjunction with IC3 and IC4 respectively is recommended. The p.c.b. is mounted using four short stand-off pillars located in the base of the instrument case. The reservoir capacitors, C1 and C2, are retained by two horizontal mounting clips.

Switch one has four capacitors (C9 to C12) soldered onto it with their ends soldered to a bus bar which can be formed out of 16 s.w.g. tinned copper wire as shown in the photograph.

All the wiring leads should then be soldered including the links shown in Table 1.



Square wave output at 100kHz. Vertical scale: 2V/cm; Horizontal scale: 2µs/cm



Sine, triangular and square wave outputs at 1kHz. Vertical scale: 2V/cm; Horizontal scale: 500µs/cm

WIRING LINKS (TABLE 1)

FROM	TO
VR1 slider	C7
S2 com.	C13 pos.
C13 neg	VR6
D6 cathode	Earth

INITIAL CHECKS AND CALIBRATION

After a careful visual examination of the p.c.b. and associated wiring, connect the mains supply and check that D6 is illuminated. The positive and negative supply rails should be checked using a d.c. meter. These should be within 0.5V of the nominal $\pm 12V$. Presets VR4, VR5 and VR7 should be set to mid-position. S1 should be set to position 2 (10Hz to 1kHz), S2 to "square", and VR6 set fully clockwise. VR3 and VR1 should be set fully anti-clockwise and VR2 adjusted to produce a square wave output at 8Hz as observed using either an oscilloscope or preferably a digital frequency meter. VR1 should then be set fully clockwise and VR3 adjusted for an output at 1.2kHz. The frequencies at the extreme ends of VR1 should then be checked on ranges 1, 3 and 4. If desired, calibration of the front panel control can be carried out at this stage. The 10Hz and 1kHz positions should be marked (these occurring

almost at the extreme settings of VR1) as should intervals of 100Hz from 100Hz to 900Hz. The scale should be linear between these values.

Return S1 to position 2 and set VR1 to 1kHz. Check the sine and triangular wave outputs. VR4 and VR5 should, if necessary, be adjusted for a distortion free sine wave output. VR7 should be adjusted for a peak-peak output, at the maximum setting of VR6, of 10V. This is best accomplished by selecting square wave output and using an oscilloscope. VR6 can then be calibrated in 1V steps from 0V to 10V peak-peak output. Again, the scale should be linear. Finally, the 5V TTL output should be checked. A list of voltages is provided in Table 2 to assist in trouble-shooting the instrument. This completes the initial checks and calibration and the instrument is now ready for use. ★

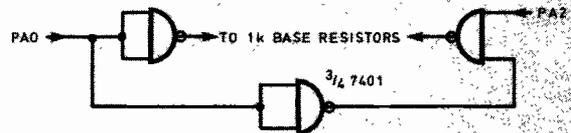
POINTS ARISING

METERMATE (July 1979)

Fig. 6. Positions 1 and 2 of S3a should be linked together. Also the numbered switch positions of S3c should be reversed.

MICRO-BUS (August 1979)

In the motor control circuit, if both inputs PA0 and PA2 are high, all the transistors are turned on and there is a risk of overheating. This state should be prevented using gates as shown:



E0173

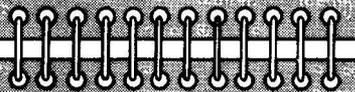
16 NOTE SEQUENCER (March 1979)

IC2-IC3 are reluctant to oscillate in certain circumstances. Experiment has shown that a 10kΩ resistor connected between pins 4/IC3a and 2/IC2a solves this. For full trigger function over VR4 track, C2 should be changed to 1µF. Two 1N914 diodes should be added at pin 3/IC10a and D24c and 4/IC10b and D25c each diode being connected anode to pin and cathode to cathode. In Fig. 3 13/IC11b should be connected to IC10c.

TEST VOLTAGES (TABLE 2)

IC1	1	16.1	TR1	c	11.6				
	0	11.6		b	0.6				
	C	0		e	0				
IC2	1	-16.6	TR2	c	-12.3				
	0	0		b	-0.6				
	C	-12.3		e	0				
IC3	1	1.8	8	7.0	TR3	c	5.5		
	2	-0.7	9	-2.3		b	2.6		
	3	-0.7	10	-0.7		e	2.1		
	4	7.0	11	-12.3	IC4	1	-11.9	5	-11.9
	5	7.0	12	-3.2		2	0	6	0
	6	10.8	13	0		3	0	7	11.6
	7	5.8	14	0		4	-12.3	8	-10.8

All of the voltages are measured relative to the common rail with the instrument adjusted to provide a sine wave at 1kHz and the variable output set to zero.



INDUSTRY NOTEBOOK

By Nexus



Outlook

The radical budget of the newly elected government was largely as anticipated in respect of handouts but depressing in its penalties. As I pointed out last month, a change of government can do nothing overnight. The two per cent rise in minimum lending rate announced on budget day was the main factor which tumbled share prices. And this on top of an increasingly grave oil shortage and consequent rise in price was enough to change high expectations into industrial gloom.

The central strategy, essentially long-term, of moving to indirect rather than direct taxation did little to fire the popular imagination although this principle, giving everyone more discretion on how they spend their money, is common on mainland Europe in countries whose performance and economic success are often quoted as an example we in Britain should emulate.

For the electronics industry the budget was both good and bad. No defence cuts, in fact the reverse with another £100 million for essential equipment programmes, clearly delighted those engaged in the high-technology end of the business. But it was a far from happy day for the already hard-pressed consumer sector with the added burden of the new 15 per cent VAT rate designed not only to counter-balance the reductions in income tax but also to discourage consumer spending, not least on imported products.

At the time of writing there was still no announcement on the future of the National Enterprise Board although it was confirmed in the budget that some of the assets held by NEB, and specifically BP shares, would be offered to investors. It is difficult to imagine much commercial excitement in, for example, the Microvision activity of Sinclair Radionics although it has been reported that at least one buyer is in negotiation. But blue-chip operations like Ferranti and ICL should find many bidders.

Under Secretary of State for Industry, David Mitchell, attending the Intel Fair held at Wembley, mused publicly why we have no Intels in Britain. Paying tribute to Intel's 10-year success story he pointed out that it was not due to government assistance or initiative but to a combination of technological and entrepreneurial genius in an environment which made it worthwhile for people to start and expand profitable businesses. It was central to Conservative philosophy that such a climate was created in Britain, he said.

This leaves us all still in a state of suspense on the future of Inmos, the best publicised of NEB's new ventures. If Inmos survives the axe will it, too, be offered to the private sector? Possibly. But it can be argued quite plausibly that ultimate ownership is irrelevant. None of the great electronics companies are owned by their bosses although most bosses have a shareholding in their enterprises which encourages them to do well. The Inmos bosses, too, have been given a personal stake. The only difference, it would appear, is that with a government as major shareholder and controlling investment policy, then political pressure can be exerted on a company to operate, say, in an area of high unemployment rather than close to the market it serves or in an area where skilled labour is readily available. But even private industry can no longer site itself exactly where it would like. Our mixed economy is indeed strange.

Astronomical

The arrival of the megabit bubble memory and the prospect, not too far distant, of a million devices on a single chip, not to mention picosecond switching speeds now quite common, makes it quite difficult to visualise what it really means when we glibly talk of such figures. Or to realise how far we have come in the past 30 years.

Years ago I remember Sir James Jeans writing in a plain man's guide to astronomy that the total number of stars in the universe is probably something like the total number of grains of sand on all the seashores of the earth. Just as startling is a comparison by Professor H. W. Barker talking recently on MPUs. He remarked that a valve-type computer equivalent roughly to the human brain would have been about the size of London. But that it may soon be possible to produce a package of silicon chips of equivalent performance to the brain, yet smaller.

Breakthrough?

It has been acclaimed as a breakthrough. It concerns the so-called 'electronic office', the introduction of word-processing, VDUs and all the other electronic paraphernalia designed to increase efficiency. The equipment has been installed since last year. Management/Union negotiations have taken a full year. Agreement has now been reached and the 600 office workers concerned can breathe again. There will be no redundancies, and present status and earn-

ings are guaranteed. In other words, no change except that VDU operators, in the interests of health and safety, are to get 20 minutes break after every 60 minutes work. So the equipment may now, at long last, be used.

If the claims for the electronic office are anywhere near honest it would seem that with the present workload most, if not all, the 600 staff will now be grossly under-employed. Presumably the benefits, if any, are in the future because it should be possible for the workload to expand without further staff recruitment. Perhaps a landmark of sorts, but hardly a breakthrough for productivity which is supposed to be what automation is all about. The story is true but the names have been omitted to avoid embarrassing the company and union involved.

Plessey

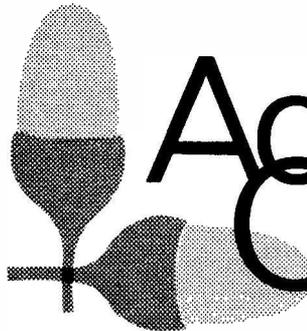
A new company, Plessey Defence Systems Ltd., has been formed as a subsidiary of Plessey Electronics Systems Ltd. It is to take on all the Plessey work for the Ptar-migan trunk communications network for the British Army and will now be offering Ptar-migan-like systems to other defence forces with a system for Australia as the first major prospect for overseas sales. As with the British Army project, Plessey is prime contractor heading a consortium for the Australian bid. Some elements now in Plessey Radar are also being transferred to the new company so it appears reasonable to suppose that activities will extend well beyond the pure communications sphere.

A turn-up-for the book in Plessey is the acquisition of Dr. Melvyn Larkin who has headed up Motorola's semiconductor operations in the UK ever since that company established itself in East Kilbride. Larkin has had vast experience in the USA and the UK on semiconductor research and latterly in top management. He has served with Mullard, Texas Instruments and Westinghouse as well as Motorola.

At Plessey he will be director of technology and strategic planning for all Plessey's components activities, not just the semi-conductor division which still awaits the appointment of a new MD following the departure of Derek Roberts to GEC.

Lecture Circuit

I would have imagined that saturation point had long since been reached on the number of lectures, symposia, colloquia and conferences devoted to the microprocessor and its business and social impact. Hardly a day goes by without one and by now every aspect should have been exhausted. But I had forgotten the ladies. The impact of the MPU on women's employment was said to be the key issue for debate at the recent National Conference of Labour Women. Will they throw out their MPUs as once they used to throw out their brassières? If they reject their use at work will they also have them taken out of their washing machines at home?



Acorn Computer

Reviewed by Mike Abbott

USING the increasingly popular 6502 micro' the basic Acorn microcomputer comprises two Eurocards each measuring 160 × 100mm mounted sandwich fashion, and requiring just one supply line of 7–35V. It costs £65 + VAT.

The MPU card (lower) houses the 6502 chip, 512 byte Acorn monitor, 1K byte RAM, 16-way RAM I/O (with 128 bytes), 1MHz crystal, 5V regulator, and sockets for 2K EPROM and second RAM I/O chip.

The Keyboard card (upper) holds a superbly clear keypad with 25 buttons which have a nice "clicky" action, arranged as 16 hex and 9 control keys. Mounted on this keypad is a pocket calculator type 7-segment display strip, specified as eight digits but in our case nine, with the extreme left-hand digit unconnected. The upper p.c.b. also contains a CUTS (Computer User's Tape Standard) crystal controlled tape interface circuit.

CONSTRUCTION

Although the Acorn is available in kit form, we received for review a ready built and tested unit, and so cannot comment on the ease of assembly, but I would say that anyone who can solder components to a p.c.b. could put it together without difficulty, the procedure being largely self-evident.

The glass-fibre plated-through p.c.b.s are clearly marked with component positions and numbers, and are immediately recognisable as being of excellent professional standard. First class d.i.l. sockets are used. The two boards are linked by a 20-way ribbon cable soldered at each end, which carries the keyboard and display signals down to the 8154 RAM I/O device on the MPU board. The MPU bus is available on a set of tinned contacts which can either be soldered to, or can accommodate a 64-way right-angled card edge connector (indirect type).

The only criticism I could muster concerning construction, albeit a minor one, is that the display unit is supported solely by its own ribbon cable—although this arrangement is probably adequate in the absence of maltreatment. After some debate I decided to "come clean" and confess to having given the Acorn a substantial jolt when its lead became entangled with another. The machine continued to work perfectly, and this admission is the best comment I can make on its robustness—but be warned, open systems evolved around interwired modules are at risk in this respect!

MANUALS

Documentation is a most important aspect, since even a *perfect* computer may end up collecting dust if there is nothing to tell the owner how to get the best from it. In my view the scales do not tip decisively either way when judging the Acorn User's Manual. Certainly, the way in which the manual leads from one 6502 instruction to the next as the need for it becomes apparent, is nice; building on, and modifying the same program as an introduction to the methodology of machine code programming.

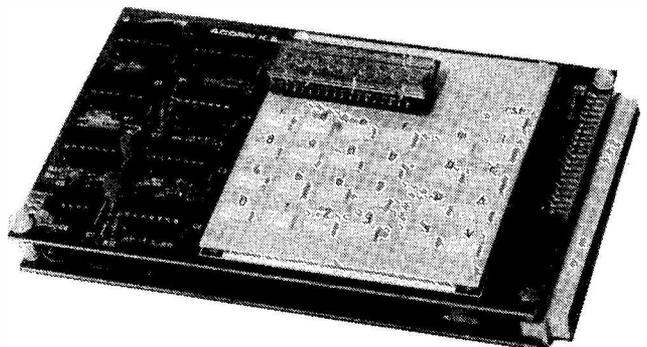
Sufficient description of the resident monitor program is given to show how subroutines contained therein can be jumped to, and from, to save effort and RAM space when writing your own programs. And it is pointed out that user programs should not start at the lowest memory address because the low addresses are used as a scratchpad for temporary data storage by the monitor. The monitor firmware is listed, complete with labels and comments, but what is lacking is a single overall picture of the memory map.

Although the User's Manual begins by briefly explaining binary, octal, decimal and hexadecimal, I feel that the contents may still become a little abstract for some; a situation possibly avoided by the addition of further diagrams showing where data is coming from and going to.

A major criticism of the manual from the beginner's point of view however, is that the text is in capital letters throughout. If this was an attempt to make the reading clearer, then in my view it failed. Sentences become lost, and confusion results **WHEN EXPLAINING AND AND OR FUNCTIONS ETC.** . See what I mean! The absence of page numbers was an irritation too.

These points aside, the User's Manual has all the information and help one would expect, plus a number of mathematic program routines, and games.

The twenty page Acorn Technical Manual contains not only constructional details, but a suggested p.s.u. design and full circuit diagrams on separate sheets giving all the information you could wish for. Among other things a thoughtful feature is described whereby a 16-pin d.i.l. socket is used as a patch-panel to allow alternative memory address mapping. Links inserted in the socket can be altered to re-configure the chip select lines to suit your requirements, and various options are illustrated, such as the example shown in Fig. 1. Before one can appreciate the value of this facility it is necessary to understand the nature of the memory structure, and for this purpose there is a preceding description explaining how the memory is divided into 16 blocks and 256 pages, each page consisting of 256 bytes.



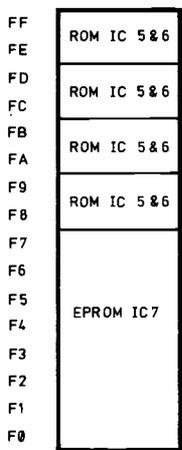


Fig. 1. An example of an address decoding option illustrated in the Acorn manual. Here, a 2048 byte EPROM is fully decoded, but ROM i.c.s 5 and 6 appear four times. The EPROM can be 2704, -08, -16 or -32. With minimal track cuts the triple rail 2704 may also be used.

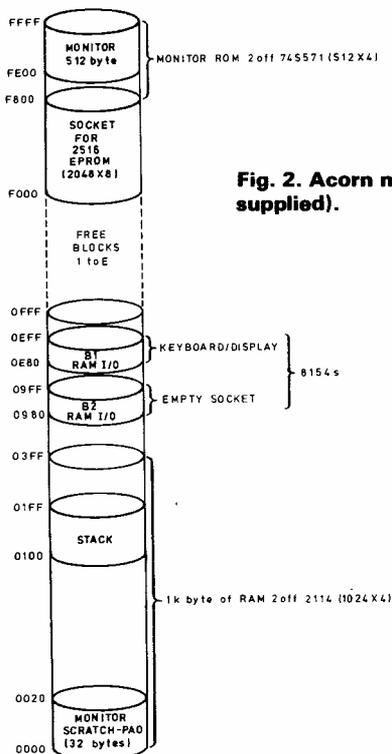
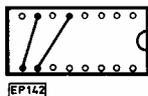


Fig. 2. Acorn memory map (as supplied).

For the benefit of those, who like myself prefer to see the memory addressing graphically mapped out, I have included the diagram in Fig. 2. This is how the Acorn is supplied, and of course can be changed.

It is here in the Technical Manual that you will discover snips of information, such as, that it is the bottom 32 bytes of page 00 that are used as the monitor scratchpad, and that page 01 is used by the 6502 for the stack, starting at address 01FF extending downwards. Incidental information such as this is far handier compiled into a "finger-tip" reference or memory map diagram, especially when program writing or interfacing.

FIRMWARE

The monitor program occupies addresses FFFF down to FE00, and its purpose in life is to scan the keyboard for instructions and data, and strobe the seven segment displays with specified information. Because of its function, the monitor naturally contains useful routines, or more specifically subroutines—terminated by the RTS (return from subroutine) instruction, and as mentioned before, it is explained in the User's Manual how to access these.

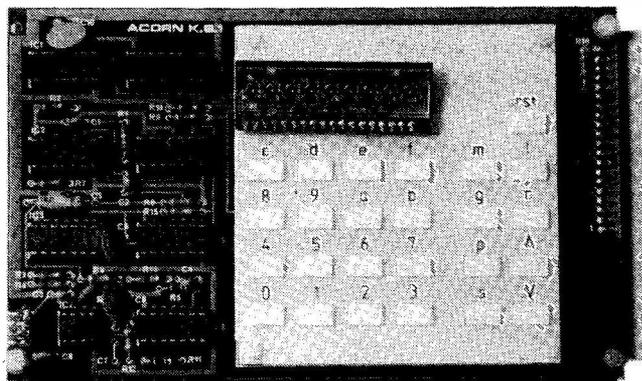
There is no 7-segment decoding as such, since the RAM I/O device simply couples the segment lines a through g to the data bus lines D0 to D6; thus allowing simple binary data statements of zeros and ones to be remembered in ROM and called up by straightforward memory addressing. These are located at FFEA-FFF9 (FONT), an example being the contents of location FFF3 which is 6F hex. This gives 0110 1111 binary, and if segment "a" relates to the least significant bit then it follows that a 9 will be produced on the display. Freedom to produce any combinations of segment display results from this technique, and the User's Manual gives a complete 64 character ASCII format attainable on the seven segment display—if somewhat abstract!

A feature of the monitor which might affect anyone susceptible to *hypnosis*, is the low display strobe rate, which produces a constant flicker, and the *direction* of which is just perceivable to the corner of the eye. To be honest though, this is something I became accustomed to, and unaware of very quickly.

KEYPAD

Apart from hex Keys 0-9 and a-f, a number of control keys exist, and the layout of these can be seen in the photograph:

- rst** Reset.
- m** Memory inspect. Allows you to inspect and modify the contents of any memory location. Can be used with the ^ and v keys.
- l** Load from tape, explained later.
- g** Go. Execute program.
- r** Restore from break. See Debug Firmware.
- p** Set or clear break point. See Debug Firmware.
- ^** Step up (through memory).
- s** Save on tape, explained later.
- v** Step down (through memory).



CASSETTE INTERFACE

It is possible to save a program on cassette with the Acorn by use of the s key, which simply allows you to "dump" the contents of an occupied section of memory serially on to tape using a domestic cassette recorder. The firmware requires that you press key s, after which it prompts you (F. XXXX on the display) to enter the start address of the program you wish to save. The Xs signify that those display digits will probably be meaningless garbage; keying in the start address will override these, and any command key will enter this new data. Having

done so Acorn will now prompt you for the end address—you should in fact enter the end address + 1. The second prompt may also be garbage, which will again be overwritten, but this time you do not press any command key until you have all your connections made to the recorder, and the cassette running.

The display goes blank while Acorn busies itself with recording, and then when the finish address reappears, recording is complete and you are back at the monitor “entry” point FF04.

The name of the program etc. can be recorded verbally before commencing with the digital signals.

To load a program from tape-to-Acorn, the tape is replayed until the continuous pilot tone (2403.8Hz = all 1s) is heard, and then the **rst** and **l** keys are pressed. The display blanks out until data is encountered, whereupon the left-most digit displays a symbol for each byte as it enters (recording/replay speed is 30 bytes per second). As an example, the manual shows how to save and reload a program called *Duck Shoot*, which, with 68 bytes plus the necessary 4 bytes of address information takes two seconds to load. When the program has completed loading the previous display reappears. Programs can be self-priming after being loaded, and immediately seize control, a feature found on high level machines running in BASIC for example.

Under normal conditions a program once restored to Acorn will occupy the addresses at which it was stored on tape. The Acorn tape interface falls within 0.2 per cent of the CUTS standard (2400/1200Hz).

An important aspect of saving hex code programs on tape, when you have expended much concentration keying in all those dazzling statements, is the reliability and ease with which the operation can be carried out. I found Acorn more communicative and less critically dependent on recorder level setting than a multi-level BASIC home computer recently reviewed in P.E. I soldered a twin screened lead to Acorn’s tape in/out connections (no connector supplied), and hooked it up first of all to a BASF cassette recorder. Then I recorded *Duck Shoot* on auto-level and on a wide range of record sensitivities with no problem, and successfully recovered it again with output signals ranging from 15mV to 300mV (max. from recorder). At around 20mV and below the occasional statement would go astray, but even then it never took more than two attempts to load it accurately.

I transferred the recorded cassette to a SONY TC-207 recorder and happily recovered the program again. On this cassette recorder, and no doubt others, the only available output is the earphone socket, which unfortunately mutes the speaker. It was thus necessary to keep removing the plug in order to hear the pilot tone; however, this criticism is not confined to the Acorn.

The two-board computer can be powered from a “calculator style” p.s.u. available from Acorn at £5.00 + VAT

DEBUG FIRMWARE

A large chunk of the Acorn Monitor, starting at FFB3, is devoted to providing a debug facility. Using the **p** key in much the same way as the **m** key it is possible to display an address, but instead of showing the contents of that location, the 6502 BREAK instruction is inserted (00) which when executed, puts a “1” on the microprocessor’s IRQ (Interrupt Request) line. This is known as a software interrupt, and the MPU jumps to a location vectored at FFFE and FFFF in the monitor. This then jumps the PC to a scratchpad location where you will have entered the start address of your new task (interrupt routine) for the microprocessor.

All this is standard 6502 interrupt technique, but if the debug firmware start address FFB3 is inserted into these scratchpad locations (001E & 001F), then the machine will jump into the diagnostic mode. I stated that key **p** could be used to insert or over-write a 00 instruction at a particular location; in fact, the original instruction is saved at address 0018, and by pressing **p** again it is returned. With this BREAK instruction inserted at a point in your program where you suspect something is going awry, the machine will run to that point, stop and display the contents of the Accumulator, X and Y registers, and P register (Process status). Press **p** again and the Program Counter and Stack Pointer will be displayed. Escape from this condition is by the **r** (Restore) key.

FIRST DISPLAY

A	X	Y	P
PC	SP		

SECOND DISPLAY

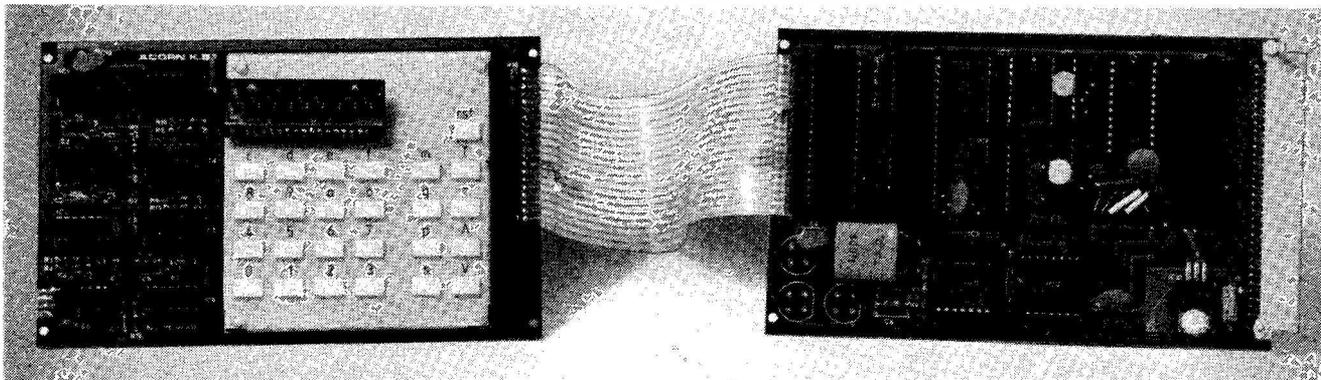
During debugging the **^** and **v** keys can be used to operate on the **p** address, but only a single location’s back-up copy is retained. However, this provides a most useful debugging facility.

There is no single step facility but a way in which it can be achieved is described, requiring only a 74LS74, BC107 and two resistors forming a circuit to “stretch” the SYNC signal. A NMI (Non Maskable Interrupt) is generated every opcode not fetched in the monitor, and using the recommended method the monitor routine at FFB3 will display the processor status after each instruction. The next instruction is executed by pressing **r**.

RAM I/O

There are two 40-pin I/O device sockets on the Acorn MPU board. One of these has an occupant which interfaces to the keyboard and display p.c.b., and the other can be filled for around £8 with a second 8154 RAM I/O device for external interfacing to, for example, a VDU.

The 8154 is TTL compatible, with 128 bytes of RAM, and two 8-bit peripheral ports, of which one can be programmed to operate in various strobed modes with handshaking. The device is covered in a cursory manner only in the Acorn manual, and so it would be advisable to obtain a data sheet to fully realise its potential.



REGULATOR

The supply requirement is stated as being 7–35V unregulated, but minimal emphasis is placed on the need to put a “surplus power” dissipating resistor in the line if the supply source is greater than 9V. Even running the Acorn at 10V produced excessive heat at the regulator chip, which has no heatsink. Alternatively a heatsink could be added.

Although this point is made in the technical manual, it might easily be overlooked in a hasty attempt to “get things going”, resulting in heat damage.

FOR THOSE WITH “L” PLATES

The User’s manual contains an assortment of printing errors ranging from the immediately obvious to those which, for the owner struggling along with minimal background knowledge, might cause confusion. An outbreak of mistakes occur in Chapter 6.2 where an unspecified program example is said to produce the answer 03, but should produce 30. Just above this program a set of brackets indicate the way to enter the diagnostic routine start address FFB3; here the second 001E should read 001F. However, anyone fooled by these simple errors should revert to reading a basic primer on the subject—*therein lies the yard-stick!*

If a lasting relationship with the 6502 is anticipated, then a

worthwhile investment would be the MOS Technology manual set, namely 6502 Hardware, and 6502 Programming manuals, available from Commodore of Euston Road, London.

CONCLUSION

The Acorn is designed to be an attractive proposition in all fields of the microprocessor technology. It could form the heart of a sophisticated home or small business computer, with all the trappings, such as extra memory and BASIC interpreter, VDU, printer, and floppy disk. In fact, at the time of writing this article, a fast 4K BASIC was already at an advanced state of development by Acorn Computers, and a TV interface plus slightly modified ROMS. Both of these may be available by now. Naturally, to put the Acorn computer into the high level language class of machine, it would need to be coupled to a full ASCII keyboard, also coming soon. Alternatively, the Acorn could be employed as a machine code computer and used, for example, to develop software for dedicated 6502 based automated systems. BASIC might even be considered for control applications if easily changed routines are desirable.

As the name *Acorn* implies, upwards expandability is genetically built in, but while you’re waiting for it to grow, the minimum configuration serves as an ideal training tool for hex code programming.

News Briefs

COUNTDOWN

Harrogate International Festival of Sound—August 18–19 (public), August 20–21 (trade) 1979. The Exhibition Centre + hotels. Details: Exhibition and Conference Services Ltd. Tel: 0423 62677.

IBM Small Systems (conference)—September 4, 5 1979. Skyline Hotel, London Airport. Details: Online Conferences Ltd. Uxbridge (0895) 39262.

Laboratory ’79—September 11–13. Grosvenor House, London. Details: 0799 22612.

Telecom ’79—September 20–26. Palais des Expositions, Geneve. Details: Secretariat Telecom ’79, Orgexpo, 18 Quai Ernest Ansermet, Case Postale 65, CH-1211, Geneve 4 (Suisse).

Euro IFIP ’79—September 25–28. Wembley Conference Centre, London. “Europe’s most comprehensive computer conference.” Details: Uxbridge (0895) 31118.

Eltro Hobby ’79—October 3–7, Killesberg Exhibition Grounds, Stuttgart. Details: 01-236 0911.

Retailing in the 80’s—Automation for Profit—October 23, 24 1979. International Press Centre, London. Conference taking a broad view of the relationship between the retail manager and computer. Details: Online Conferences Ltd., Uxbridge (0895) 39262.

Satellite Communications (conference)—October 30, 31. London Press Centre. Will “tele-conferencing” replace business travel? Who will finance this expanding technology, and how should outer space be shared between the nations? Details Online Conferences Ltd, Uxbridge (0895) 39262.

Personal Computer World Show—November 1–3. West Centre Hotel, London. The *computer* versus *computer* Chess Championship will again take place, and this year the prize money has been increased to £1,500. Further details to be announced.

Compec—November 6–8, 1979. Grand Hall, Olympia, London. Details: Iliffe Promotions Ltd. Tel: 01-261 8437/8.

Professional Viewdata Exhibition ’79—November 7 & 8. West Centre Hotel, London.

Electronics 79—November 20–23. Olympia, London. Details: 021-705 6707.

Breadboard 79—December 4–8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. Tel: 0822 4671.

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

Viewdata ’80—March 26–28. Wembley Conference Centre, London. Conference and exhibition. Details: Online Conferences Ltd. Uxbridge (0895) 39262.

Communications ’80—April 14–18. National Exhibition Centre, Birmingham. Details: ITF Exhibitions. Tel: 021-705 6707.

All-electronics Show (1980)—April 29–May 1, Grosvenor House, London. Details: 0799-22612.

International Conference On The Electronic Office—April 22–25, 1980. London Penta Hotel. Organised principally by the Institute of Electronic and Radio Engineers, 99 Gower St., London WC1E 6AZ.

The Mersey Micro Show—April 30, May 1, 2, 1980. Adelphi Hotel, Liverpool. Exhibition and seminars, with the cooperation of Liverpool University. Details: Online Conferences Ltd. Uxbridge (0895) 39262.

IBC 80—September 20–24. Metropole Centre, Brighton, UK. Details: Secretariat, IEE, Savoy Place, London WC2R 0BL.

MOVE

Z ILOG (UK) Ltd. have moved to a new address: Babbage House, Z King Street, Maidenhead, Berkshire SL6 1DU.

COLOUR WITHOUT MASK

A HIGH-resolution, three-colour, electrostatic display has been developed by Hewlett-Packard to help solve the problem of presenting complex, real-time data.

Conventional colour displays use some form of shadow mask to present colour information. Red, green and yellow colour hues are generated in the new seven-inch display (HP1338A) by varying the c.r.t. post accelerator voltage, which changes the energy with which the electron beam strikes the phosphor. This allows the coloured data forming the image to be placed anywhere on the screen and greatly enhances resolution: spot size is 0.012in.

Colour switching is also much faster with the beam penetration phosphor technique. As an indication of speed, some 600 colour blocks of data can be colour switched in 100µ. Bandwidth of the X and Y amplifiers is in excess of 3MHz, and the rise time of the Z amplifier is better than 30ns.

As well as being able to handle conventional analogue inputs, an associated graphics translator (HP1350A) provides interfacing to the international IEEE-488 standard digital interface bus. TTL level colour switching, colour busy and colour valid signals allow control of the colour of each vector of character.



FRANK W. HYDE

FINDING A CLEAR WINDOW

The frontiers of space are continually expanding but not to the same extent on all fronts at the same time. Thus, a situation had arisen with regard to optical facilities in the Northern Hemisphere, which restricted the useful hours of operation and observation, a dirty window. Now after several years of slow progress in finding and obtaining a satisfactory site, free to the heavens, free from vagaries of politics; having the prospect of a collective and democratic site is now resolved. An agreement between the Spanish Government and a group of astronomers from Britain, Denmark and Sweden—has now been signed so that at last, work to catch up with necessary research, will be possible, in the Canary Islands on La Palma.

Radio Astronomy is not affected (except at certain narrow bands) by weather or clouds. In consequence a great deal of recorded data relevant to optical astronomy awaits the attention of the optical astronomers. So much of the northern sky has been mapped by radio that the time needed for direct observation in the electromagnetic spectrum is at a premium. The new facilities will have two and a half times as many hours of excellent "seeing" as is available at the present time.

Many sites were investigated over several years and some of these were also very suitable. One in Hawaii had all the conditions required except the extremely costly transport of personnel to and from the site and Britain. It was at this point of decision that the political situation in Spain changed. Also Spain would benefit in her scientific programme by the collaboration, to the extent of 20 per cent of the observing time at her disposal.

Three national research councils were involved in the new proposition. These were the Science Research Council for the United Kingdom, the Royal Academy of Sciences for Sweden, and the Research Administration of Denmark, who negotiated through the Higher Council for Scientific Research for Spain. The

direct contribution from Spain will be the site facilities; the access road to the site at the Roque do los Machachos (what a beautiful choice of name), power supplies, water supply, houses, a hostel and workshop. Though these services are not at the moment available, work will begin in earnest. The project team at Herstmonceux expect that the 2.5m Isaac Newton telescope and the one metre telescope will be ready for operation in late 1981 or early 1982.

The special advantages of La Palma are that the population has a total of only 50,000. There are only roads near the coast except that which crosses the Island from Los Llanos to Santa Cruz de la Palma. There is very little pollution of the atmosphere and the prevailing wind at the site level flows smoothly round the island. The major attraction of the choice of La Palma is common to the Canary Islands. That is that it is a region of high atmospheric pressure. For 75 per cent of the year there is a sort of cover (or perhaps better, a lid) which results from a temperature inversion layer. The dust and moisture is kept below this layer at a level around 1500m. The observing site is at a level of 2400m giving clear blue sky. Even the island lower levels were beneath a cloud so that the site for much of the time during testing over several months was between a cloud a kilometre below and a clear blue sky above. In fact an astronomer's dream.

RADIO AND OPTICAL STUDIES

It may be thought that the facilities of space orbiting telescopes, which have so rewarded science in the past few years, would render the need for Earth based instruments somewhat less than in the past. The facts are quite the opposite. While it is true that Radio Astronomy, X-ray Astronomy and Gamma-ray Astronomy opened up an unknown universe there is an even greater need for the Earth based observatories. The reason is an important one. Firstly much of the work done, and the data accumulated by the non-optical systems, raise questions of vital importance and the answers lie with the direct observations using special techniques. In some respects the Radio observations are "finders" for the other disciplines. It might also be said, where is the link with electronics? The answer to that is, that probably the modern optical telescope has more sophisticated electronics than most people realise. The 4.2m telescope which is in the process of getting its final specification for manufacture is a case in point. It is to be mounted as an altazimuth instrument since this offers certain advantages from the point of control thanks to electronics. There are advantages in altazimuth over the equatorial system. One of these is that the base is parallel to the Earth so that both axes have to be compensated, the equatorial mounting avoids having to compensate for the Earth's rotation. However, the computer takes care of both axes and therefore allows the engineering to be more solid at less cost. The fact that compensation is required on both axes provides a difference component which could be recorded. That is the difference in not only the second to second rotation of the Earth but short period changes in both axes. This may not be regarded at this time as being important

though it could further the knowledge on this matter which has to be dealt with in satellites and probes.

The distance of the objects to be studied will require a standard of pointing perfection not required before. This telescope then will be the most sophisticated, though not the largest in the world. The title for the largest telescope goes to the Soviet 6m telescope in the Caucasus at Zelenchukskaya. This has great potential but there have been difficulties partly due to its siting and partly due to some technical difficulties that have arisen.

Time available for observations has always been at a premium in all parts of the world and many hopeful projects have been put up by astronomers from time to time. Time is, however, of the essence and it is not possible to accommodate all that individual astronomers would like to do. Doubtless some discoveries will be late in having publication. That is a sad thought but is the result of fiscal parameters under which scientific discovery labours at the present time. The capital cost of the present United Kingdom programme over the period of five years to bring the project to full working, the Science Research Council has estimated at between 15 and £20M. The cost of running and operation is not known at present but this will also come from the funds allocated by the Government to the Council. There is never enough for the projects the Council would like to undertake.

RED SHIFT KEY TO QUASARS

Some of the particular problems that will be tackled will be the problem of the quasars, whether they are near with great energy but of small size. According to the red shift techniques they should be far away. The key would appear to be the red shift. The 4.2m telescope will examine the spectra of these faint objects. Galaxies which are recorded by radio as having enormous energies are not easily given accurate distance figures. If there is an optical counterpart then the large telescope will be able to measure it. There will also be the opportunity to add to data as to whether the Universe is continually expanding or whether it will slow up eventually and repeat a cycle.

It is believed that the 4.2m telescope will prove to be the most effective one in the Northern Hemisphere.

This is an exciting prospect but though it may be the most glamorous part of the undertaking there are other important areas of study. The galaxy in which the solar system has its place has many clues waiting for the space detective. These will show how galaxies are formed and grow by the ratio of the chemical elements in the stars of different ages and types. The very accurate spectrographs that the Isaac Newton telescope can produce may provide the answers. The problem of the size of the organic molecules in the interstellar gas may also be solved by such spectra.

The 1m telescope will enable astronomers to assess the brightness and position of stars with their relative movements. Particular targets for observation will be the globular clusters, immense groups apparently nearly spherical conglomerations of elderly stars containing up to 500,000 stars.

The other countries participating will have their own specialities. The Danish astronomers will be installing a transit circle. This is a telescope set on a north south meridian which can check the exact time of the passing of a star as the Earth rotates. The Swedish astronomers will be setting up a solar station on the site. Their site at Capri has not been as successful as hoped. Their equipment has already arrived in the Canaries. Germany and France are also invited to set up a solar station.

The Director of Herstmonceux, Professor Graham-Smith has said that there will not be a permanent Royal Greenwich Observatory staff at La Palma. He prefers that each project should have an individual budget. In planning this way he hopes to avoid the unfortunate position of that of the United Kingdom physics unit at CERN.

SOLAR POWER SATELLITES

There is a rising concern about solar power satellites. The conversion by large arrays of

solar collectors to microwaves with orders between 5 and 10GW would cause serious interference to radio communication. A spokesman of the Electrical Research Association says that the harmonic radiation would be difficult to predict in direction or magnitude and that the scheme should be abandoned. A Home Office spokesman from the Directorate of Radio Technology said that there would be interference problems from the scattering of the microwave beam by plasma in the upper atmosphere and by raindrops.

Motorola Microcomputer Forum

6800.....

6801.....

6805.....

6809.....

68000

DELEGATES attending the Forum in London on 4th June heard about Motorola's latest products from their top men in Texas and England.

A lot has happened since their 6800 was released in 1974; its price has dropped by about two orders of magnitude, and the technology has advanced to the stage where about eight times as many transistors can be put onto one mass-produced chip.

One of the problems facing Motorola, and indeed the other microprocessor manufacturers, is how best to make use of this technological progress.

6801

The first answer, illustrated by the 6801 microcomputer chip, is to keep the processing power about the same, but to put more of the support devices on the same chip alongside the CPU.

In this lunchtime address Colin Crook, the chairman of the seminar, referred to this as the 'Silicon VLSI Black Hole'. In his words, "Every year significant portions of the subsystem, and ultimately system, pass over the silicon Black Hole 'event horizon' and fall irreversibly onto the silicon".

The 6801 puts the functions of seven parts from a typical system onto one chip: CPU, clock, RAM, ROM, serial I/O, parallel I/O, and timer. The CPU is a slightly enhanced version of the old 6800, perked up by a few instructions such as PUSH X and PULL X, an 8-bit multiply, and operations using the A and B accumulators as one 16-bit D register.

The first 6801s will be made with mask-programmed ROMs, and a version with a MIKBUG-type monitor on board is planned. One of the modes of operation allows the 6801 to address external memory, so it could replace a 6800 in a system. Planned for next year is an EPROM version, the 68701, incorporating 2K of UV-erasable memory.

6805

The second use of advancing technology is to bring down the cost of microprocessors to encourage their incorporation into low-end applications such as toys and home appliances. This is achieved by designing the instruction set to produce compact code, incorporating as much as possible on the same chip, and keeping the pin count down by not bringing out the address and data buses.

The most popular 1-chip controller on the market at the moment is the Texas TMS1000, but Motorola are hoping to get a share of the market with their new 6805 family. These 8-bit computers, in NMOS or low-power CMOS, have pared-down 6800-type instruction sets with some extra instructions added with a view to saving program bytes. The 6800's B accumulator has been scrapped, and the index register has been reduced to 8 bits. Like the 6801 there is a clock, RAM, ROM, parallel I/O, and a timer on the chip with the CPU. However, because the address and data lines are not brought out to pins, the 6805 is limited to addressing what is on the chip.

One problem arises: how do you access the CPU to test it? The answer is to provide a self-test input. A voltage at this input initiates a program in part of the ROM which checks the chip functions. As micros get more and more complex this may become a general feature.

6809

The advance of silicon technology has been called the 'irresistible force' by the microprocessor manufacturers, and software is the 'immovable object' which stands in its way. The major cost in developing an application using micros is invariably the software, which tends to cost about £2 per line of debugged code, and the manufacturers see this as limiting exploitation of their latest products.

One way of reducing this software cost is to write in a high-level language so that each line of the program solves a greater proportion of the problem.

The third alternative as to what to do with more silicon power is to make a more powerful processor which is designed with compilation by high-level languages in mind. The 6809 is Motorola's next-generation member of the 6800 family. It carries on the tradition for a simple architecture started with the 6800, but the performance is said to be about 2.5 to 5 times that of its predecessor. By increasing the generality of the instructions the number of mnemonics has been reduced from the 6800's 72 to only 59 while increasing the number of operations and addressing modes.

There are four 16-bit index registers, two of which double as stack pointers, and all of which can be used for indexed and indexed-indirect addressing with optional auto-increment or decrement. The saving due to the more versatile addressing modes is illustrated by the high-level language statement $a(i)=b(j)$. This compiles into 20 bytes of 6809 code; the 6800 would require 52 bytes.

There are also program-counter relative addressing modes which make it possible to write position-independent code. The importance of this is that it enables manufacturers to supply firmware routines in ROM which the user can link in anywhere in memory.

First samples of the 6809 are around now so we should see 6809-based microcomputers available by the end of the year.

... 68000

Looking further into the future, the 68000 is a 16-bit microprocessor currently being developed by Motorola which looks more like a minicomputer than a micro. It has 16 32-bit registers, two operating modes (supervisor and user), 7 prioritized interrupts, a 16 megabyte address space, and a claimed throughput of 10 to 25 times that of the 6800. All this will come in a 64-pin package, and despite its power it will be possible to build a minimum system around the 68000 with only 7 LSI packages.

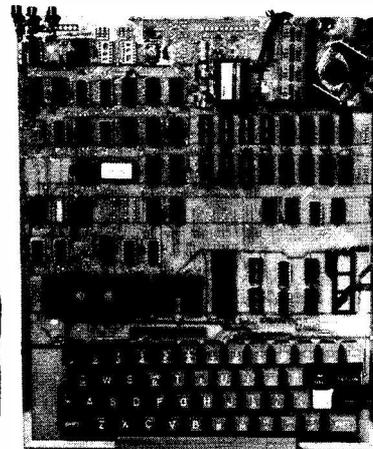
Tom Gunter, head of the Advanced Computer Systems group in Austin, Texas, revealed that he had just received the first wafers from processing, and that they had been 95 per cent operational when tested. Even so, it seems doubtful whether the 68000 will appear before 1981. Can enough products be thought of that could use the computing power of the 68000 to make it worth manufacturing it? Motorola's hope is that the very promise of such computing power at a low cost will make applications appear that are not even imagined today. One thing is certain, whoever dreams up the applications will be making his fortune if this power does become available.

DJD

COMPUKIT UK 101

SINGLE BOARD COMPUTER

PART 2 **A.A. BERK** B.Sc. Ph.D.



A CERTAIN amount of the following will be considered unnecessary by the experienced, although some points are very important. The constructor is advised to read through this section at least once!

You will need a good pair of wire cutters, a small screwdriver and a soldering iron of around 15-20 Watts with a narrow bit. The bit should ideally be new—make sure you coat the end with solder *as it first warms up* or a patina of corrosion will immediately form making soldering impossible. Also, iron-clad bits must not be filed for cleaning them or the anti-corrosion property is lost. The thinnest resin-cored solder should be used.

Never try to drill any of the p.c.b. holes out, as this will destroy the plating-through. All solder connections are made to the bottom of the board and no i.c. pins must remain unsoldered even if they *appear* to go nowhere. The board should be protected at all times from excessive abrasion, flexion, and contamination.

ASSEMBLY

Following the component legend very carefully, the best sequence of construction is to start with the i.c. sockets. Locate and push their pins carefully through the holes, taking extreme care to prevent pins from being bent *under* the socket. The socket must be pressed very firmly against the p.c.b. while two pins are soldered down to keep it in place.

Sockets may not be supplied for the following positions: IC67, IC68.

All i.c.s are fitted with pin 1 towards the keyboard except for IC41 (Character Generator) whose pin 1 is towards the RAM block. Socket polarity is normally identified and even though i.c.s will fit either way around, put the sockets in correctly as a reminder for the future. Do not insert the i.c.s yet.

Insert the discrete components, except for the voltage regulator, UHF modulator and large capacitor. The 100n bypass capacitors should be soldered in last, to prevent a mix up. Most of the resistors stand on end. *None* of the components will tolerate overheating, *especially the crystal*. Remember, once a device is soldered in place its removal is *very difficult* because of the plating-through. A solder sucker is very useful for this eventuality, but sockets are particularly troublesome and are usually destroyed by the operation.

KEY SWITCHES

Next insert and solder the keypad switches from top right to bottom left. Each switch is labelled on the p.c.b. and the switch, and with correct key-top, may be inserted carefully

in place. Do not use undue force or heat, as the switch is quite delicate until held in place. Operation will be impaired if the switch pins are pushed into the thermo-plastic body.

The pins must be soldered with the switch *pressed firmly against the p.c.b.* All switches except SHIFT LOCK are return sprung, so do not make the mistake of fitting this switch elsewhere, which will stay down when pressed once and return on the second press. The SPACE bar and switch is fitted last. The bar should be placed over the switch and the white plastic locators into their holes. Carefully heat-form the projections beneath the board to hold the bar in place. *Use the back of your soldering bit.*

Before continuing, check for shorts across the key-switch terminals and between Data and Address Bus lines at IC8.

The regulator (with heat-sink), UHF modulator and large electrolytic, may now be soldered in place. Solder flux should be removed with methylated spirit, using an old tooth-brush. Fully inspect the board for solder bridges or broken tracks (a watch-maker's glass is invaluable for this task).

The power supply can be checked at this point to ensure it delivers five volts to each of the i.c. sockets.

Insertion of the i.c.s is a delicate process *and pins are very easily bent between the chip and the socket* (often undetectable), causing hours of fruitless searching for a bug. Pins should be bent straight from their normal splayed out condition and pushed bit by bit, inspecting continually, into their sockets.

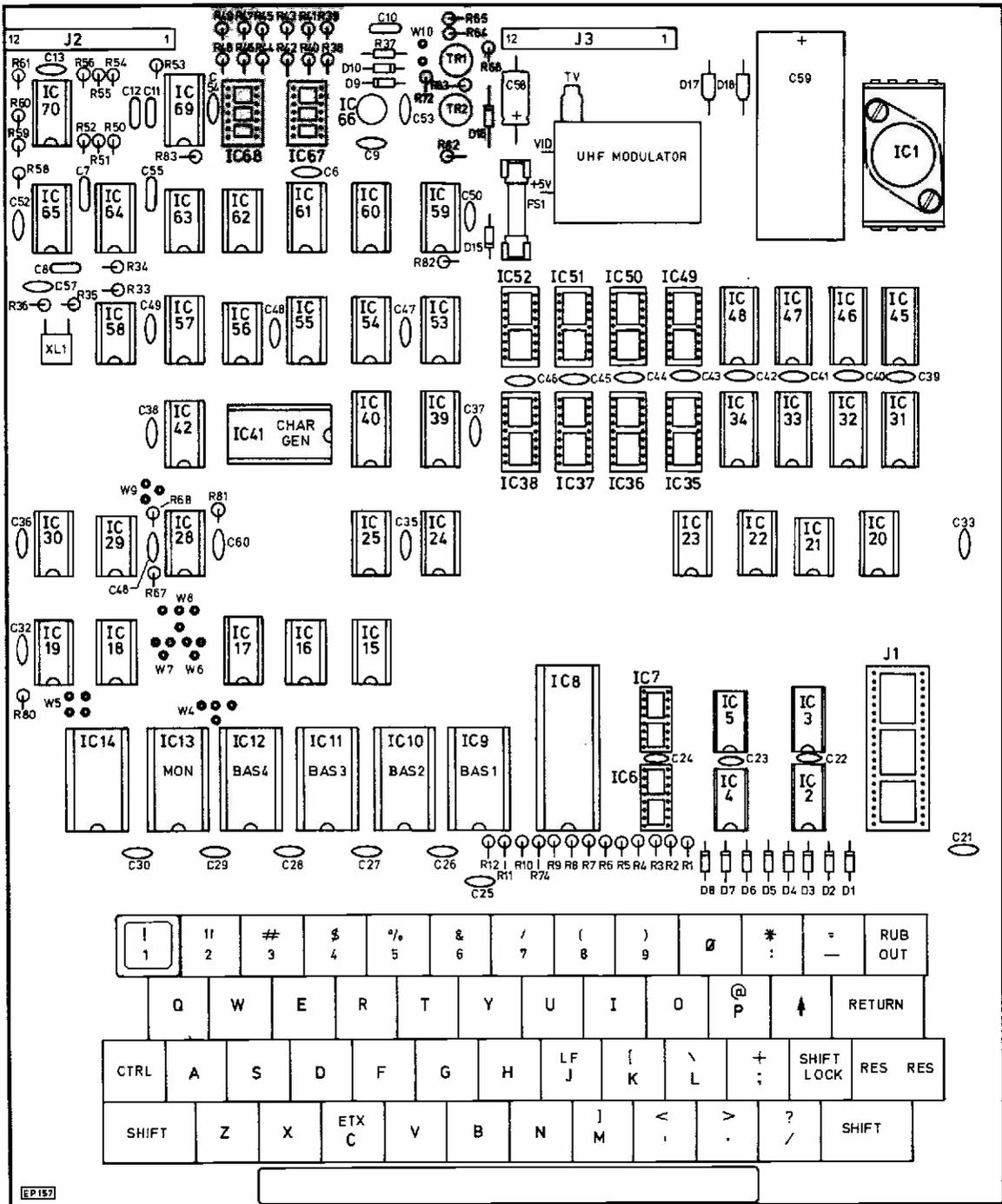
A final check of i.c. orientation should be made. If you are not using the full complement of memory, the right-most RAM sockets (IC31 and IC45) must be populated first in "vertical" pairs.

If all seems correct, connect up and switch on. Tune the TV to the computer somewhere around channel 36, and press *both* RESET keys *simultaneously*. **D/C/W/M?** should appear. Check that SHIFT LOCK is in the down position and press C.

If this causes **MEMORY SIZE?** to appear, and pressing RETURN a couple of times gives the start up message on the screen, then you have a working model of what is probably one of the most advanced computers for its price.

TROUBLESHOOTING

The troubleshooting process is best assimilated while the reader's mind is fresh from the hardware description. There are several categories of malfunction which may arise, and only one or two of a very definite nature can be mentioned here. The tools necessary for troubleshooting are an oscilloscope and a continuity tester. The latter may be all that is necessary but a 'scope considerably speeds the process.



UK101 COMPUTER

Fig. 2.1. Component layout of Compukit single board computer. The p.c.b. supplied by Comp Components has all component positions clearly printed on it. Most resistors are mounted on end. The kit includes TR1, R72, R63-65 serial interface components for a printer, but the remaining shaded components are not supplied. The small signal p.n.p. transistors can be of any type, and are not shown in last month's component list. Copyright of this p.c.b. belongs to Comp Components, and is too complex to show here. Please note: R83 should read as R62, and R82 as R83

BASIC REFERENCE AND DEFINITIONS

NUMERIC VARIABLES

Numeric variables may be one or two alphanumeric characters in length, but the first must be alphabetic. Longer variable names are identified by the first two characters only, e.g. HELLO, HE, HE123XY are all indistinguishable to the machine. Basic words (such as NEW, SIN etc.) may not be used as variable names, nor may non-alphanumeric characters.

LEGAL

A
B1
B 175
TQ
EGG
MONDAY TUESDAY

ILLEGAL

(Think about these . . . embedded BASIC words etc.)

1B
B*
TOP
COSQR3
18Z
AND2
TELETYPE3

Spaces are irrelevant, so that the second and third members of the "LEGAL" column are indistinguishable. If you are worried about the validity of a variable, try giving it a value in immediate mode. For instance, type the "assignment":

B1 = 3

This will be accepted whereas:

B1* = 3

will not. If a variable *is accepted*, try printing it out. For instance:

1B* = 7

appears to be accepted, but follow it with **PRINT 1B** and the answer is far from 7.

The above applies to STRING variables too, except that each such variable must end with a \$ sign. **A1** is a numeric variable with a floating-point value. **A1\$** is a STRING variable and its "value" is a string of characters of any type including graphic characters, and these are described later.

Any computer language is used to formalise a logical set of steps into a form suitable for execution on a machine, whose understanding is limited to a grammar composed of a few statements and variables.

The function must be broken down into *input* steps *calculation* steps and *output* steps.

RANGE AND ACCURACY

Numeric variables are allowed values between 10^{-38} and 10^{+38} (approximately) and have $6\frac{1}{2}$ figures of accuracy (i.e. 6 figures displayed, and one extra "guarding"). Strings may be from 0 to 255 characters in length.

ARRAYS

Arrays are available for both types of variable to any dimension which does not cause an overflow. This depends upon the range of each dimension's subscript, and a little experimentation is worthwhile if arrays are to be used extensively.

STATEMENTS

The language BASIC may have several statements on the same program line (maximum of 71 characters). Statements on the same line are separated by : (colon), and spaces may be omitted.

10 X = 13*14.6

20PRINT X

may be written as:

10X = 13*14.6:PRINTX

This format has the advantage of saving memory, space and time but produces program code which is harder to modify and edit.

BASIC OPERATORS

- (a) - This is the usual minus sign and may be used for subtraction or negation, e.g. **A = B - C** or **D = - E**
- (b) + Addition
- (c) * Multiplication
- (d) / Division
- (e) ↑ Raise to a power (exponentiation), e.g. X^3 is written as **X↑3** or $\sqrt[3]{X}$ is written as **X↑(1/3)**
- (f) = May be used in assignments, **A = 3**, **B = K + 1**, etc. (or optionally, **LET A = 3**). It can also be used in Boolean relationships and as follows: **IF A = 3 THEN GOTO 30**. This last use of = can apply to the next five relations:
 - (g) > Greater than
 - (h) < less than
 - (i) <> or < not equal to
 - (j) <= or < less than or equal
 - (k) >= or > greater than or equal
 - (l) AND This Boolean operator combines logical statements, and with the next two may be used to form complex logic expressions with the value true or false.
- (m) OR
- (n) NOT

PULL-OUT

BOOLEAN EXPRESSIONS

Boolean (or logical) expressions using the above are given a numerical value by the BASIC, as follows: A true statement is given the value **-1**, a false statement has value **0**. Thus:

K = (A=3 AND A=4)

gives **K** a zero value since the expression (in brackets), set equal to **K**, is false. Similarly:

K = (A = (A + A)/2)

will give the value **-1** or "TRUE". This is a numerical value and may be used as such.

For instance:

PRINT (A = (A + A)/2)*6

will print the number **-6** on the VDU.

In addition **:AND, OR, NOT** may be used in BIT manipulation mode for Boolean operations of 16-bit two's-complement numbers from **-32768** to **+32767**.

e.g.	63 AND 16	=16
	-1 AND 8	=8
	4 OR 2	=6
	10 OR 10	=10
	NOT 0	=-1
	NOT 1	=-2 etc.

OPERATOR EVALUATION ORDER

Expressions are evaluated in this order: **Brackets** first, then:

- (1) ↑
- (2) negation
- (3) */ from left to right
- (4) + - from left to right
- (5) < > = from left to right
- (6) NOT
- (7) AND
- (8) OR

Two separate numbers or variables may not stand next to each other, similarly two operators, unless the *second* is + or -

e.g. (i) **A+ -6** is equivalent to **A-6** likewise **A-+6**
(ii) **A*-5 = -5*A** but **A*-5** is *illegal*
(iii) **3↑2 * 7 + 5/10 * 2** will be calculated as follows: **3↑2 = 9** first, then **9*7 = 63**, **5/10 = 0.5**, **0.5*2 = 1** in that order; and, finally **63 + 1**, giving **64** as a result. To change this order, brackets must be used.

DEFINITIONS OF BASIC STATEMENTS

In the following:

V and **W** are numeric variables,

X, **Y** and **Z** are numeric expressions which may contain numeric and Boolean operators or functions.

B is a Boolean expression.

I and **J** are truncated integers,

\$ denotes a string variable.

READ DATA DATA statements contain lists of data for READ instructions in strict order of use.

100 READ V,W\$

200 DATA 1, "HELLO", 2, "BYE"

Each time the READ statement is executed, a pair of data is read into the variables **V** and **W\$**, in order, until the data is exhausted. The data types must match up with the READ variables.

RESTORE Restores the data pointer to the start of the data list for re-use by a READ statement.

DEF FN This is a user-defined function of one argument used as follows:

DEF FN (V) = 3*V↑2 defines a function **FNA (V)**

e.g. **W = FNA (3)** gives **W** the value 27. The argument may also be a numeric-valued expression.

DIM is used to allocate space for arrays and set all array variables to zero.

e.g. **DIM V (12,12, 2)** allocates a 3-dimensional numeric array with first two subscripts from 0 to 12, and third from 0 to 2 similarly, **DIM V\$(12,12, 2)** allocates a string array of the same size. Not dimensioning, causes a default to 10 for one and two dimensional arrays. The same array name may not be used for arrays of different dimensions.

END Terminates program (optional). Useful in statements such as

IF A=3 THEN END

FOR NEXT, STEP Example: **FOR**

V = X TO Y STEP Z NEXT V This "FOR-loop" executes all program statements contained between **STEP Z** and **NEXT V**, for all values of **V** from **X** to **Y** incrementing **V**'s value by **Z** each time. The program statements may include further "nested" FOR-loops. **NEXT V** may be abbreviated to **NEXT**. If two FOR-loops are nested and each terminates at the same **NEXT**, this may be written **NEXT V,W**. Example:

```
10 FOR I = 1 TO 10 STEP 2
20 FOR J = 2 TO -3 STEP -0.1
30 PRINT I*J
40 NEXT J,I
```

Note that **NEXT** recalls the variables on a "last-in-first-out" basis. Line 40 may be written: **40 NEXT: NEXT**

Note also that *omitting* **STEP** defaults the step value to 1.

The **FOR** statement uses those values of the expressions **X**, **Y**, and **Z** which are encountered on first entering the **FOR** loop. Thus **X**, **Y**, and **Z** may be used and changed within the FOR loop without affecting its operation.

GOTO I Forces execution to jump to line **I**, which may only be a positive number. Non integers are truncated towards zero.

GOSUB I RETURN This causes execution of a subroutine starting at line **I**, terminating in a **RETURN** statement which forces execution back to the line following **GOSUB I**. Subroutines may be nested.

IF THEN Example: **IF B THEN P**. **P** is a statement or set of program statements separated by colons which will be executed if the expression **B** has a TRUE value. Strictly speaking **B** is a Boolean expression such as

A = 3 AND C = 5.8 OR T >= Q↑2.

This **B** may be any numeric expression. If its value is 0 it will be taken as FALSE. Although **-1** is normally taken to be TRUE, here any non zero value for **B** will have this affect.

IF A↑2 THEN PRINT "NON ZERO" will print **NON ZERO** whenever **A↑2** is non zero.

Similarly for:
IF B GOTO (line number)

ON I GOTO L, M, N etc. The technical term for this statement is the "Computed GOTO". The line No. **L**, **M**, or **N** etc., chosen by the GOTO statement, depends upon the value of the expression **I**. If **I = 1** (after truncation) **GOTO L** is executed, if **I = 2** then **M** is chosen etc. Negative values of **I** give an error message, and larger unaccommodated values of **I** cause the next line after the computed **GOTO** statement to be executed.

REM All characters after **REM** are disregarded by BASIC and this space is available for comments (REMARKS).

STOP Causes execution to cease at that line and print out the line-number. The program may be restarted by **CONT**.

PRINT Example: **PRINT 3** causes 3 to appear, as with any other number. **PRINT X** will cause X's value or contents to be printed, where X is any numeric, Boolean or string variable expression.

PRINT A = (A + A)/2
will cause -1 to appear
PRINT 3↑2 + 2
will cause 11 to appear.

PRINT X\$

will cause the contents of the string variable X\$ to be printed.

PRINT X\$Y\$ will cause the combined (concatenated) contents of X\$ and Y\$ to be printed.

Try:

X\$ = "WE": Y\$ = "L": PRINT X\$Y\$
(in immediate mode.)

Messages (literals) may be printed verbatim.

PRINT "HELLO"

will cause HELLO to appear. Any combination of these print command types may be included in a **PRINT** list.

Commas cause the members to be printed in columns beginning fourteen spaces apart. Semi-colons cause printing in adjacent positions.

PRINT 3, 4; 7

will give:

```
3      47
```

If a **PRINT** list is terminated with a comma or semi-colon, the next print statement will continue where the last terminated. The cursor (■) always indicates the next print position.

```
10 PRINT 4, 6,  
20 GOTO 30  
30 GOTO 20
```

Causes

```
4      6      ■
```

to be output before the infinite loop is entered.

PRINT with an empty (null) list causes the Cursor to move to a new line.

PRINT: PRINT: PRINT

Causes three new lines.

The cursor position is called the "Print Head", and it is that screen position at which the next **PRINT** statement will begin.

SPC (I) and **TAB (I)** may also be included in a print list where I is a positive truncated integer expression.

SPC (I) prints I spaces, placing the print head I places ahead of its former position.

TAB (I) merely moves the print head I places without overwriting existing material.

POS (I) gives the current line position of the Print Head.

INPUT Allows the user to input data to a program during its execution, and may be started with a prompt message followed by a semi-colon, then the variables awaiting values.

An example of the use of the **INPUT** statement:

Program listing

```
10 INPUT "HELLO, TELL ME YOUR  
NAME AND AGE"; N$, A  
20 PRINT "PLEASED TO MEET  
YOU"; N$, "SO YOU ARE"; "A  
YEARS OLD EH?"
```

Program running

```
HELLO, TELL ME YOUR NAME AND  
AGE ?
```

User types in:

```
NICK, 24 (return)
```

Computer:

```
PLEASED TO MEET YOU NICK, SO  
YOU ARE 24 YEARS OLD EH?
```

The user could type in:

```
NICK (return)
```

```
24 (return)
```

since the computer will keep prompting (with ??) until it has all the required information. Care should be taken to ensure that the data presented is of the correct type for each of the input list members.

If too much data is presented, a message saying **EXTRA IGNORED** will appear.

If RETURN is pressed on an empty piece of data, the program returns to the command mode (a useful way of leaving a program).

If the wrong type of data is presented, the machine will ask the user to

REDO

the INPUT from the start.

NUMERIC FUNCTIONS

(X is any numeric or Boolean expression)

ABS(X) For $X \geq 0$ **ABS(X)** = X
For $X < 0$ **ABS(X)** = -X

INT(X) Rounds X down to the nearest integer

INT(8.1) = 8
INT(-3.3) = -4

RND(X) gives a random number between 0 and 1. Each time **RND** is executed with a non-zero argument, the random number generator advances to the next number.

RND(0) will give the same number each time unless interspersed with a **RND** execution with non-zero argument.

The expression **(B-A)*RND(1)+A** gives a random number between A and B.

SGN(X) If $X > 0$ **SGN(X)** = 1 if $X \leq 0$
SGN(X) = 0

SIN(X), **COS(X)**, **TAN(X)**, **ATN(X)** are the usual trig. functions with all angles in radians.

SQR(X) = square root of X

EXP(X) e^X where $e = 2.71828$

LOG(X) = log of X to base e

FRE(X) For any X gives the number of unused RAM bytes. Can use **PRINT FRE(X)**.

TAB(I), **SPC(I)** and **POS(I)** described in section on **PRINT**.

PEEK(I) Returns contents of the memory location I (decimal).

POKE I, J loads memory location I with J (both decimal).

Limits:

I ≤ 65535

J ≤ 255

STRING FUNCTIONS:

X\$ is any STRING EXPRESSION or VARIABLE.

ASC(X\$) This returns the ASCII value (decimal) of the first character in the string.
ASC("AB") = 65.

CHR\$(I) Equals the string character having ASCII value I.

PRINT CHR\$(65) gives A

LEFT\$(X\$, I) and **RIGHT\$(X\$, I)** Gives a string composed of the left-most and right most I characters of X\$ respectively.

MID\$(X\$, I, J) Gives J characters of X\$, starting at the Ith character. If J is omitted, all characters from Ith to end of string are given.

LEN(X\$) Gives length of string in characters.

STR\$(X) Converts a numeric expression into the string of characters representing its value.

STR\$(-6.8) = "-6.8"
and

STR\$(1.3E + 29) = "1.3E + 29".

VAL(X\$) Gives numeric value corresponding to string of digits (inverse of STR\$). e.g. If **X\$ = "4"** and **Y = 4**, you cannot say that **X\$ + Y = 8**; but can say **VAL(X\$) + Y = 8** in BASIC.

STRING EXPRESSIONS AND OPERATIONS

Any of the previous functions may act on an **X\$** composed of those functions and the operator +

X\$="HE" + "LLO"

gives **X\$** the value "HELLO".

+ performs CONCATENATION.

Thus **LEFT\$("HE" + "LLO", 3)** = "HEL" etc.

Strings may be compared to produce Boolean functions—the ASCII values of their characters are used from left to right for the comparison.

"HELLO" is greater than "ABC" because **ASC("H") > ASC("A")**. In this way, a file of string records can be sorted alphabetically.

Using the **VAL(X\$)** and **STR\$(X)** functions, numeric strings can be converted into numbers, acted upon by the normal rules of algebra and converted back into strings.

INPUT OUTPUT

WAIT I, J, K Sends computer into a wait-state until memory location **I** (decimal) takes on a certain value dependent upon **J** and **K**. **WAIT** takes the contents of location **I**, exclusive **OR**'s it with **K** **AND**'s with **J** and waits until the result is non-zero (omitting **K** defaults it to zero). Thus any bit of location **I** can be considered as providing a flag. This could be used, for instance, with a medium speed printer and allows fast servicing from BASIC of I/O devices connected into the system at specific memory locations. Other examples would be for the control of industrial equipment directly via BASIC.

CALLING MACHINE CODE ROUTINES

USR (I) Calls machine code routines which may be useful due to their greater speed, or ability to service I/O devices directly, occupying specific memory locations.

The **USR** function is called in BASIC by a statement such as: **X=USR(X)** which causes a jump to a machine code routine either in ROM or RAM. To access **USR**, the start of the routine must be poked into the addresses 11 and 12. Executing **X=USR(X)** will automatically cause the machine code routine, which must be terminated with an **RTS**, to be executed. If the machine code program is to be started in RAM, a block must be protected against overwriting by BASIC. This is done by pressing the **BREAK** keys and answering **MEMORY SIZE?** with a number less than the total RAM available. This restricts BASIC to that number of bytes and leaves the remainder (top) of memory, protected.

Note that 770 is the minimum number allowed for memory size, and does not allow space for any BASIC programs. Even though only one **USR** function is provided, use of **POKE** on address 11 and 12, before each **USR** call, enables any number of routines to be executed, one at a time, during the running of a BASIC program. In addition, values stored in RAM locations may be passed back and forth between BASIC and the machine code programs by using **PEEK** and **POKE**.

The following provides an example of the application of **USR** to clear the screen and print up a message. Reference must be made to the Machine Code Monitor section (later). The example will work on the 4K machine.

Break should be pressed and the answer 1024 given to the question **MEMORY SIZE?** This restricts the RAM space as follows (see memory map of machine). All addresses below are in HEX.

0000		
to		BASIC workspace
03FF		etc.
(1023 in decimal)		
0400		
(1024 in decimal)		Protected for
to		machine code etc.
END of RAM		

This quantity of protected RAM is not necessary for the following example, but it illustrates the point that the user is able to control this aspect.

The Machine Code Monitor may now be used to load the following three blocks of hexadecimal number pairs starting at the address shown.

START ADDRESS	DATA	COMMENTS
Hex: 0500 (1280 dec)	A2 00 BD 00 06 C9 5F F0 07 9D E5 D1 E8 18 90 F2 60	This program stores a message in the VDU RAM (resident at D000-D3FF)
Hex: 0600 (1536 dec)	43 4F 4D 50 55 4B 49 54 5F	Any set of ASCII character or graphic character codes

may be placed here by the user for display: ending in 5F

Hex: 0700 (1792 dec)	A9 00 85 E1 A8 A9 D0 85 E2 A9 20 91 E1 C8 C0 00 D0 F9 A6 E2 E0 D3 F0 06 E8 86 E2 18 90 ED 60	This routine clears the VDU screen.
-------------------------	---	-------------------------------------

To return to BASIC, **BREAK** must be pressed. The message **D/C/W/M?** should be answered with **W** to conserve the above program. The following program gives an example using the above.

```

10 PRINT "TO CLEAR SCREEN TYPE
C"
20 PRINT
30 PRINT " TO DISPLAY MESSAGE
TYPE M"
40 INPUT A$
50 IF A$="C" THEN 100
60 IF A$="M" THEN 200
70 GOTO 40
100 POKE 11,0: POKE 12,7: X=USR(X)
110 GOTO 40
200 POKE 11,0: POKE 12,5: X=USR(X)
210 GOTO 40
    
```

To leave the program press **RETURN** without **C** or **M**.

Note that in **POKE**ing the address of the machine code routine into 11 and 12 the Hex address is split into low and high bytes and then separately converted into decimal and loaded into 11 and 12 respectively. If the routine were to start at EA32 (Hex) for example, the following holds:
low part: 32 (Hex)=50 (decimal)
high part: EA (Hex)=234 (decimal)
thus **POKE 11,50** and **POKE 12,234** are used.

To write messages other than that shown above, stored at 0600, the user may either use the machine code monitor to write in the Hex codes of the symbols to be displayed, ending in 5F; or a BASIC program may be written to **POKE** the ASCII values of any characters typed on the keyboard into that area of memory using the **ASC** function. Data blocks or machine code programs may also be written directly into the protected RAM space using the **POKE**, **READ** and **DATA** statements. Remember that to **POKE** a machine code routine into RAM from BASIC, the 6502 operation codes must be converted to decimal notation, unless you include a routine in your program to perform the conversion automatically.

Once the chain is oscillating, failure may then be due to the area of the 74123 monostables IC65, IC71, IC69—again check through from the counting chains. \overline{HS} should be negative-going pulses at 64 μ s separation (Horizontal sync), and \overline{VS} at 20mS (Vertical sync). Pin 9 of IC42 should be pure video information in short closely packed spikes.

(c) VDU OK—No Reset

If the two break keys, pressed simultaneously, do not produce **D/C/W/M?** on the screen it is possible that the 6502 (IC8), is not receiving its clock (pin 37 at 1MHz) or its RESET (pin 40). Check both with scope.

The most likely cause, however, is almost always a simple bridge connecting a couple of Data Bus lines or Address Bus lines together. Check for any shorts between the pins of IC8.

All the Data and Address lines should be oscillating and should all be affected by pressing the two break keys. If not, check the relevant lines through from start to finish for shorts and lack of continuity.

If **D/C/W/M?** appears but pressing C has no effect, you have almost certainly failed to lock the SHIFT LOCK in the "down" position; *this must be checked every time a fault condition arises*. If this is not the answer, check that none of the keyboard switches are permanently shorted and check that the C key is working electrically. R0–R7 on the keyboard should be receiving a square-wave signal.

(d) Cassette Interface Not Receiving

The scope may be used to ensure that a sine-wave is present at the capacitor C10 and a square wave at pin 10 of IC69. The waveforms described for the cassette interface may then be checked through. The ACIA should be checked for clock information.

(e) Transmitting

Checking this side is confined to looking for a signal at the MIC and AUX outputs and then working back through the system.

(f) Adjustments To The VDU

A certain amount of adjustment of picture density is possible on R58 if required for contrast. Adjustment of the time-constant of IC71 by capacitor C48 and resistor R67 will move the picture up or down.

INITIAL USE OF THE MACHINE

Check that the SHIFT LOCK key is in the "down" position. *This should always form the first check if the computer seems inoperative at any time.*

The two RESET keys should be pressed simultaneously so that the following will appear in the lower left hand corner of the screen:

D/C/W/M?

This is a question requiring the user to reply via the keyboard with one of the four letters requested.

D is for disc operation and is not covered here. Now press M. This is for the machine code monitor, and six characters will appear near the middle of the screen—four for address and two for data (both in HEX).

This is explained in a later section and the user should now press the two RESET keys again to restore **D/C/W/M?**

Keys C and W are for COLD START and WARM START respectively and have the following meanings. If a program has been written and stored and is, say, in the operation of being executed, the user may RESET at any time. **D/C/W/M?** appears and pressing W (warm start) will revert the machine to its BASIC function without clearing its memory. Key C

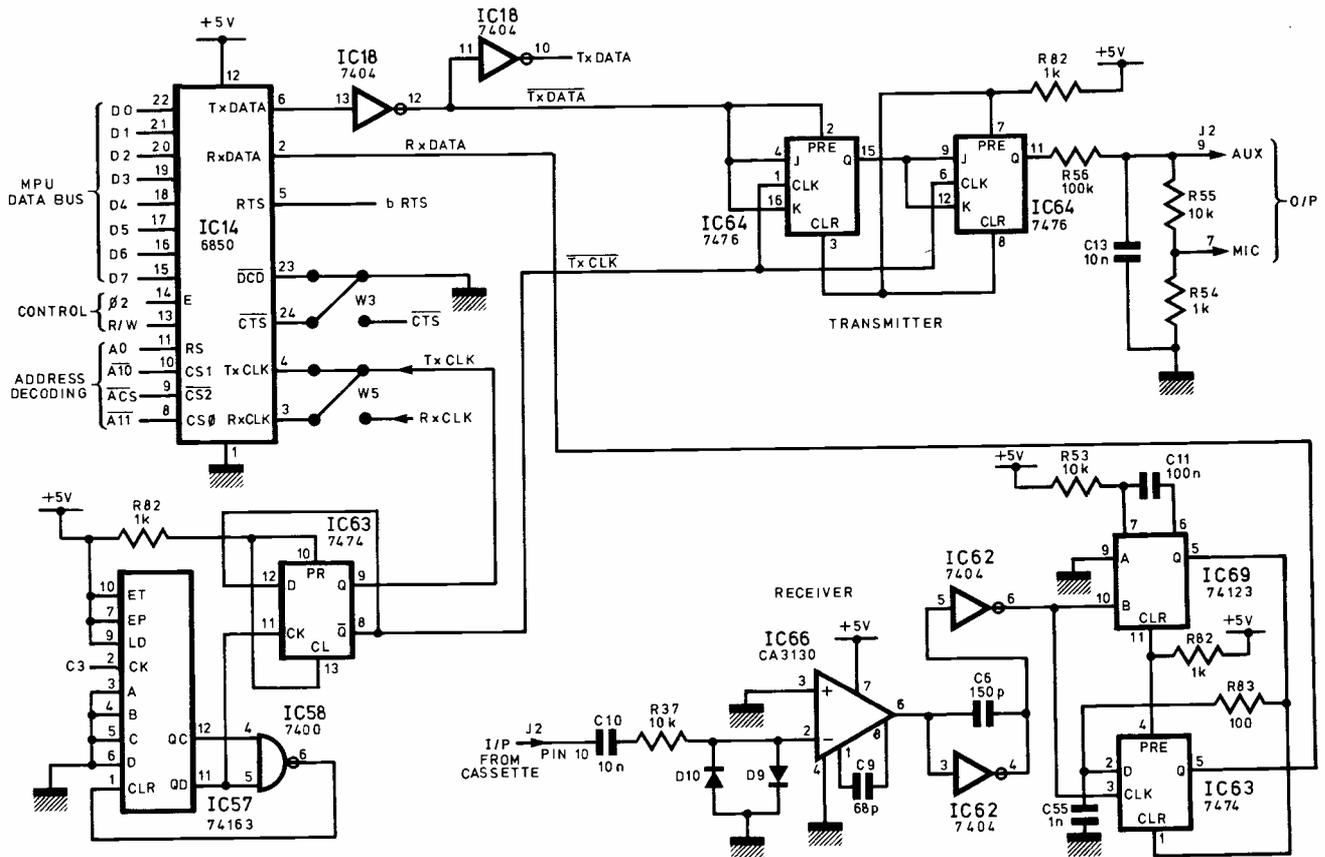


Fig. 2.3. Cassette Interface. 7400 series devices are LS types. Printed circuit "patch-panels" have W numbers. The ACIA signals $\phi 2$ and R/W go to expansion socket pins 31 and 32 respectively

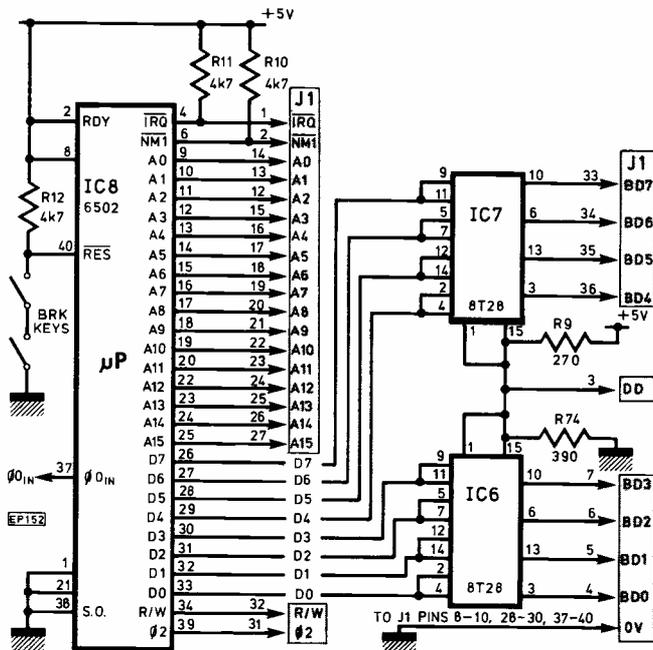


Fig. 2.4. The 6502 microprocessor and expansion socket J1. When pressed simultaneously, the BREAK keys reset the processor

restarts the computer "from the top" and should now be pressed—by the reader following this text. The words:

MEMORY SIZE?

should have appeared. If not, check shift lock. If there is no success, switch off and check the p.c.b. very thoroughly, especially around the ROMS. Typing any number after **MEMORY SIZE?** defines the number of bytes which may be used by BASIC from the start of RAM. The rest of the RAM is thus protected from being overwritten, and may be used to store data and machine-code blocks—accessible by PEEK, POKE, and the USR function defined later. Pressing RETURN, "defaults" to the full memory for BASIC—this is jargon for saying that the computer automatically assumes you would have typed a number of bytes equal to the total memory available. From now on, the computer will not look at any information until you press RETURN. This gives you time to change your mind about things and delete unwanted entries before the computer acts on them. The words:

TERMINAL WIDTH?

should have appeared now, and you are being asked to supply the number of characters across the screen to be printed before each new line starts.

Pressing RETURN defaults to 48, but not all of these characters would appear on a normal T.V. screen. Try typing 46 followed by return, this will fit comfortably on most T.V.s. At this point, the COMPUKIT does a complete scan of its RANDOM ACCESS MEMORY to determine how many bytes are free for writing in BASIC. This inbuilt memory test can be used to determine whether the memory chips are working correctly, i.e. 3324 bytes should be free in the 4K system and 7423 in the 8K system. The latter is given by the message:

7423 BYTES FREE

followed by:

**COMPUKIT UK101
Personal Computer
8K BASIC Copyright 1979
OK**

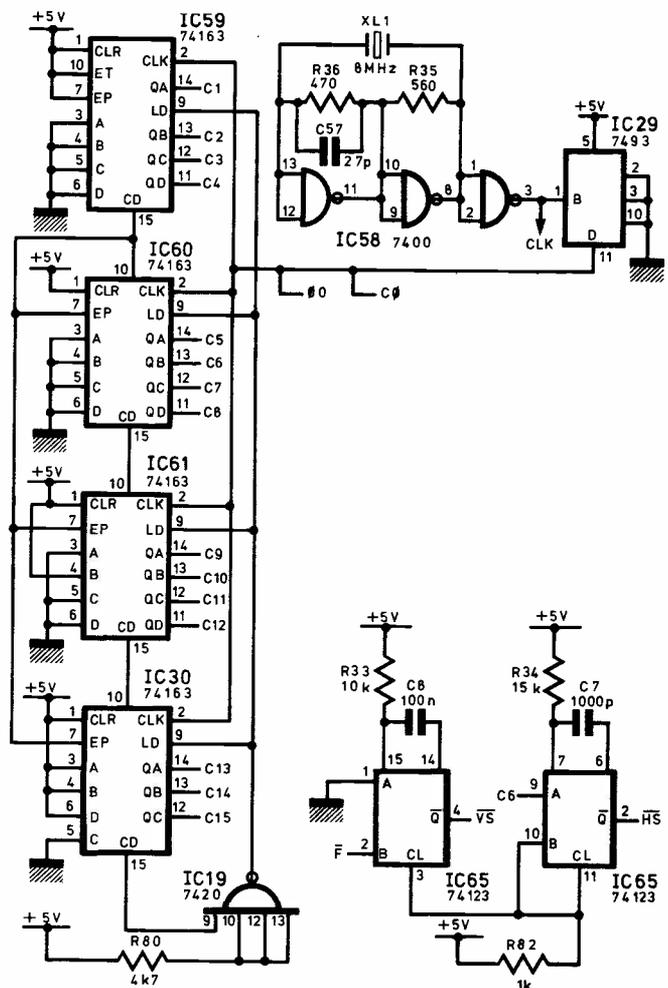


Fig. 2.5. System Clocks

Well done!—you are now ready to start programming a powerful and versatile personal computer. With a little study of BASIC you will be able to persuade it to perform almost any activity for which you are able to write down a logical set of steps.

The "█" character is a CURSOR which tells you where on the screen your next keyboard entry will appear—try it! The program:

```
10 PRINT "HELLO"
20 X=3*6*4*8
30 PRINT "X=";X
```

contains three program lines and three program statements. The first (labelled 10) commands the VDU to display the word **HELLO**. The second to calculate a value for X, and the third to print it.

The program may be run by pressing RUN (followed by RETURN as always). Try it!

The central point about File Mode is that the program is retained after execution, plus all the variable values—try typing:

PRINT X (RETURN)

in immediate mode, and then RUN again.

NEXT MONTH: Error codes, program recording/playback, and using the machine in BASIC, plus remaining circuit diagrams.

**QUARTZ LCD
5 Function**

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

£6.65

Guaranteed same day despatch. Very slim, only 6mm thick.



M1

**SOLAR QUARTZ
LCD 5 Function**

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

£8.65

Guaranteed same day despatch.



M2

**QUARTZ LCD
11 Function** SLIM CHRONO

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

£10.65 Thousands sold! Guaranteed same day despatch.



M3

**QUARTZ LCD
ALARM 7 Function**

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

£12.65

Guaranteed same day despatch.



M4

**MULTI ALARM
6 Digits 10
Functions**

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

£18.65

M5



**FRONT-BUTTON
Alarm Chrono
Dual Time**

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

£22.65

M6



**SOLAR QUARTZ LCD
Chronograph with
Alarm** Dual Time Zone Facility

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

£27.95

M7



**ALARM CHRONO
with 9 world
time zones**

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

£29.65

M8



**SOLAR QUARTZ LCD
Chronograph**

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

£12.65

Guaranteed same day despatch.

M9



SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass. List Price £130.00 METAC PRICE

£105.00

M10



**SEIKO MEMORY
BANK**

Calendar watch M354 Hours, mins., secs. Month, day, date in 12 or 24 hour format all indicated continuously. Monthly calendar display month, year and all dates for any selected month over 80 year period. Memory bank function. Any desired dates up to 11 can be stored in advanced. 2 year battery life. Water resistant. List Price £130 Metac Price

£105

M11



**SEIKO-STYLE
Dual time-alarm
Chronograph**

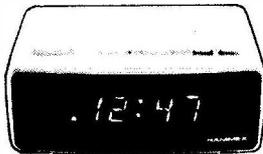
Mineral glass face. Battery hatch for DIY battery replacement. Top quality finish with fully adjustable bracelet.

£35.00

M12



**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 3/8" x 2 3/8" (141mm x 111mm x 60mm) Weight: 1.43 lbs (0.65 kg) AC power 220V.

£9.65 Thousands sold! Mains operated.

Guaranteed same day despatch.

M13

**HANIMEX portable
LCD clock radio**



- Time set & alarm controls.
- Snooze & sleep controls.
- Wake to music or alarm.
- AM/PM indicator.
- Battery operated. No plug required.
- Receives all standard AM radio broadcasts.
- Drawstring carrying case included.
- Back-light.
- Batteries supplied free. **£17.95**
- Quartz crystal controlled. **M14**

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and the order details clearly, enclose 30p for post and packing or the amount stated. We do not wait to clear your cheque before sending the goods so this will not delay delivery. All products carry 1 year guarantee and full money back 10 day reassurance. Battery fitting service is available at our shops. All prices include VAT.

Trade enquiries: Send for a complete list of trade prices - minimum order value £100. Telephone Orders: Credit card customers can telephone orders direct to Daventry or Edgware Rd., 24 hour phone service at both shops: 01-723 4753 03272-76545.



CALLERS WELCOME Shops open 9.30 - 6.00.

**QUARTZ LCD
Ladies 5 Function**

Only 25 x 20mm and 6mm thick. 5 function. Hours, mins., secs., day, date and back light and auto calendar. Elegant metal bracelet in silver or gold. State preference. **£9.95** Guaranteed same day despatch.

M15



**Price breakthrough
only
£18.95**



OUTSTANDING FEATURES

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

Guaranteed same day despatch. **M16**

Metac

**ELECTRONICS
& TIME CENTRES**

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

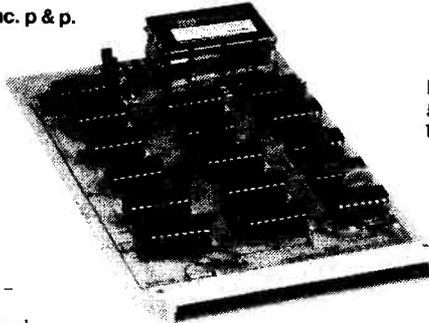
South of England
327 Edgware Road
LONDON W.2
Telephone: (01) 723 4753

Now, the complete MK 14 micro-computer system from Science of Cambridge

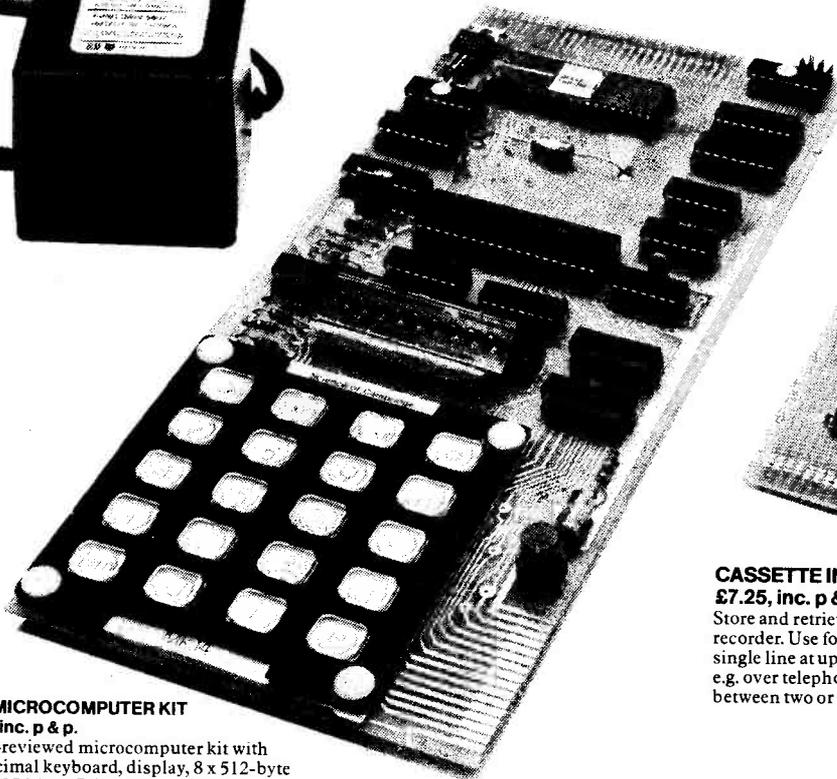
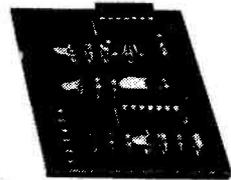
VDU MODULE. £33.75
 (£26.85 without character generator) inc. p & p.

Display up to ½K memory (16 lines x 32 chars. with character generator; or 4096 spot positions in graphics mode) on UHF domestic TV. Eurocard-sized module includes UHF modulator, runs on single 5 V supply. Complete ascii upper-case character set can be mixed with graphics.

POWER SUPPLY. £6.10 inc. p & p.
 Delivers 8 V at 600 mA from 220/240 V mains – sufficient to drive all modules shown here simultaneously. Sealed plastic case, BS-approved.



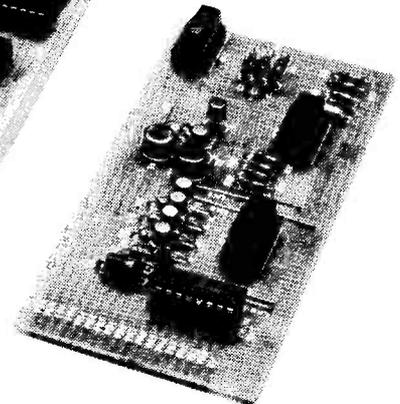
PROM PROGRAMMER. £11.85 inc. p & p.
 Use to transfer your own program developed and debugged on the MK 14 RAM to PROM (74S571) to replace SC10S monitor for special applications, e.g. model railway control. Software allows editing and verifying.



MK 14 MICROCOMPUTER KIT
 £46.55 inc. p & p.
 Widely-reviewed microcomputer kit with hexadecimal keyboard, display, 8 x 512-byte PROM, 256-byte RAM, and optional 16-lines I/O plus further 128 bytes of RAM.

Supplied with free manual to cover operations of all types – from games to basic maths to electronics design. Manual contains programs plus instructions for creating valuable personal programs. Also a superb education and training aid – an ideal introduction to computer technology. Designed for fast, easy assembly; supplied with step-by-step instructions.

CASSETTE INTERFACE MODULE. £7.25, inc. p & p.
 Store and retrieve programs on any cassette recorder. Use for serial transmission down single line at up to 110 baud (teletype speed), e.g. over telephone line, and to communicate between two or more MK 14s.



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

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

PE9

Please send me:

- MK 14 standard kit @ £46.55.
 - Extra RAM @ £4.14 per pair.
 - RAM I/O device @ £8.97.
 - VDU module including character generator @ £33.75.
 - VDU module without character generator @ £26.85.
 - Cassette interface module @ £7.25.
 - PROM programmer @ £11.85.
 - Power supply @ £6.10.
 - Full technical details of the MK 14 System, with order form.
- All prices include p and p.

I enclose cheque/MO/PO for £ _____ (total).

Name _____

Address (please print) _____

Delivery within 14 days.

Science of Cambridge Ltd

6 Kings Parade, Cambridge, CAMBS., CB2 1SN.
 Tel: 0223 311488.

Strictly Synthesised

by K. Lenton-Smith

The external input module has been a synthesiser feature for some time, its original purpose being to process electric guitar signals. The external input is converted into two output signals—amplified voltage and a pulse to trigger voltage controlled filters and amplifiers. Indeed, synthesiser techniques are now used in electronic musical instruments to the extent that it is becoming difficult to know whether the instrument is piano, organ or synthesiser; practically any audio signal can be processed.

SYNTH DRUMS

Pick-ups have long been used to amplify acoustic instruments, including the sideman's kit. By today's standards, a 'bug' could be used to feed drum signals into a synthesiser it would seem; but synthesised drums do not operate on this principle totally.

Drummers have used practice pads for years, allowing them to perfect their flam paradiddles relatively quietly! The pad consists of a disc of rubber mounted on a wooden base: using sticks, the bounce obtained is similar to that from a plastic or skin drum head. Synthesised drums (Synare 3, for example) use a sponge rubber head, while others use plastic heads. The actual sound produced by beating the head is immaterial as a trigger pulse is the sole end product. Underneath the head is some form of pick-up which provides the pulse, after which the drum sound is produced entirely by electronic means. Most of these drums are of fairly small diameter, perhaps 8in or so, and the drummer finds them similar in feel to his old practice pad.

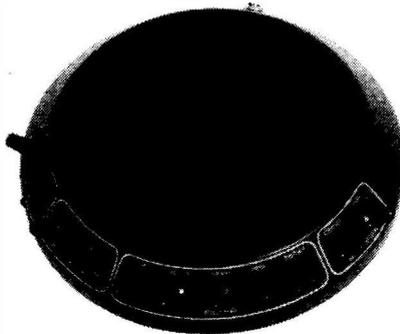
The synth controls have the usual familiar functions—Oscillator Tune, White Noise, Filter, etc. The latter may have facilities for resonance, decay and sweep. Some synth drums are touch sensitive with pitch rising the harder the head is struck. Sweep is an effect that allows a pitch alteration for the duration of the drum sound.

Synare 3 (shown) is a self contained drum shaped rather like a flying saucer with control knobs round its periphery. The Syn-drum is a considerably more expensive kit (priced at over £1,000, though few are available in the U.K. as yet). The kit comprises four drums, synthesiser control panel and dual function foot pedal, and the stands are not included in the basic price. The pedal allows pitch-bending in both directions and also control over sustain. The synthesiser has four channels and so can

be used for stereo panning. The drummer can select volume, sustain, noise, vibrato and choose his waveform.

Certain units cater for microphone triggering, so that a tape recording of the unit can be used to double up sound effects. Headphone facilities are usual and are of course vital as this new synthesiser field demands even greater attention to levels. No doubt these drum units will be used in recording studios for the most part and only by those groups wealthy enough to afford them as yet.

One wonders if the drummer will become so immersed in setting the faders that good rhythmic drumming will suffer? There could be a serious application for synthesised drums as anyone who has tried to retune a set of timpani during a concert ready for a key change will appreciate.



VOCODER

Another synthesiser has appeared, based on the external input module: the Vocoder is designed to process the most variable sound of all—the human voice. Years ago we had 'Sparkie' and ring modulators but the Korg Vocoder allows the voice to be altered in pitch, tone, vibrato and even choral effects are obtainable.

Herbie Hancock has been one of the first musicians to complete albums with the Vocoder in use. He is a keyboard musician and, by his own admission, not really a vocalist. It appears that Stevie Wonder managed to interest him in the choral facility, so he started to work with a Sennheiser Vocoder. After a great deal of effort on the ancillary equipment to get exactly what he wanted, 'Sunlight' and 'Feets Dont Fail Me Now' were recorded.

Now that the synthesiser seems to have taken over drums and voice, what next? I expect there are plenty of other ideas in the pipeline and yet to emerge.

RHYTHM UNIT

A reader with a *Practical Electronics* Rhythm Unit (Jan./Feb. '78) recently asked for help because his Leslie 145 controls seemed to be upsetting the rhythm patterns. Switching from 'Fast' to 'Chorale' was inserting a spike in the a.c. supply which reset the downbeat.

In this design, the system earth is isolated from mains earth and casework. The fault was cured by connecting a 0.22 μ polyradial between casework and system earth. He had also found that certain of the sinusoidal oscillators (which produce Bass Drum, Bongos and Claves) produced sounds nearer to clicks than tuned pitches. Although this could depend on the condition of the CD4011 used, correct operation can be achieved by an extra capacitor; an 0.033 μ should be connected between the input of each inverter and system earth, the 470k preset being trimmed as described in the text.

Some rhythm units feature touch switches, but they do not appear to me to be very useful anyway as you need both hands for the keyboards. Similarly, an auto-start system can only be used when the melody starts on the downbeat. So, reverting to the *P.E.* design, it is best to use the 'Remote Start' connected to a switch on the side of the swell pedal. I would also suggest calibration of the speed control as an essential towards professional-sounding results. This saves unnecessary trials between pieces being played—the height of musical bad manners in company!

CHIPS

The microprocessor is being found new applications every day and I believe it will be used increasingly in the electronic music field in future. It can already be used to play tunes, or as a sequencer, but I hope it will never replace the live musician. Its probable future role is to control the systems of the instruments we know today. Even though we have reached the point where a small i.c. can achieve what a dozen 12AU7 valves—backed up by a hefty power supply—were doing some three decades ago, there is still the possibility of compacting circuitry further.

The combination, coupler and stop controls of a large organ is a field open to the microprocessor. Stored waveform systems are in use already (in the Allen Computer Organs) and can be read at any speed. Tone generators could veer away from the conventional bistable or free phase oscillator to use the chip's facilities in this respect.

Polyphonic synthesisers are complex and costly instruments at present. Each keyboard note either has its own chain of oscillator, filter and VCA, or groups of notes are provided with this chain of modules and the keyboard is scanned to select the appropriate connections. The synthesiser's popularity is ever-increasing and, because every player aspires to a polyphonic instrument, this role for the microprocessor looks most likely to capture the imagination of the development engineer. Indeed, a fortune awaits the company that can come up with a reasonably priced polyphonic synthesiser.



V.L.F. Signals and the MAGNETOSPHERE

C.R.FRANCIS B.Sc.

An insight into the structure of the magnetosphere, including magnetic storms, and the various types of naturally occurring v.l.f. signals originating from it which can be received.

Next month we will publish a project describing a receiver for the reception of v.l.f. signals.

THE EARTH behaves as if it has a bar magnet at its core. Many of us were taught this at school, and probably had visions of magnetic field lines disappearing off to infinity. In the last few decades, however, our understanding of the geometry of the geomagnetic field has undergone a profound change. It will probably be more illuminating to present the current view as the outcome of the historical progression of ideas on the subject.

EARLY WORK

The earliest reliable reference to the Earth's magnetic field is by the eleventh century Chinese encyclopaedist Shon-Kua, who described the directional properties of a magnet. Chinese mythology, however, puts the discovery 4,500 years ago, in about 2600 BC. It was not until the late sixteenth century though that the properties of magnets were compared to the magnetism of the Earth. In 1600 William Gilbert, who was a physician at the court of Elizabeth I, published a book called *De magnete, magneticisque corporibus, et de magno magnete tellure physiologia nova*, in which he described experiments he had performed, modelling the Earth and its magnetic field by the use of a sphere of lodestone.

There the matter rested until 1722, when the instrument-maker George Graham discovered that the angle between true north and magnetic north (the **declination**), which was known to change in a uniform way, showed irregular, non-uniform varia-

tions. Then in 1741 Celsius and Hiorter noticed that these variations coincided with the appearance of the aurora borealis, or Northern Lights. By the second half of the nineteenth century it was widely accepted that these fluctuations, which have become known as magnetic storms, were related to the solar cycle which had been discovered by Schwabe and reported in 1843. This solar cycle was an 11-year periodicity in the number of sunspots visible on the face of the sun; there is also a progression during the cycle of the mean latitude of the spots on the sun's globe.

With a link established between magnetic storms and solar activity it was not long before Balfour Stewart, in 1882, suggested that the magnetic variations were due to currents flowing externally to the Earth, in an electrified layer of the atmosphere. He proposed that the air could be rendered conducting by solar action. This suggestion seems to have been forgotten until 1901, when Marconi made his famous transatlantic transmission.

In order to explain the reception of the signals around the curve of the Earth, an electrified layer of the atmosphere was again proposed, independently, by Kennelly writing in *Electrical World and Engineer*, and Heaviside in an article on Telegraphy in *Encyclopaedia Britannica*, both in 1902. Doubts were still expressed about the existence of such a layer however; it was thought that diffraction might work differently at radio frequencies.

IONOSPHERE

In 1925 however, Appleton and Barnett demonstrated conclusively that signals could be bounced from a layer in the atmosphere, by sending and receiving signals in a vertical direction. Appleton went on to introduce the present nomenclature for the several layers that go together to make up the **ionosphere**: the D-, E- and F- layers. The term ionosphere itself, however, was introduced later by Watson-Watt as a collective name for all the layers.

Another of the founders of the modern school of thought on the ionosphere was Sydney Chapman, who was able, in 1931, to show how the ionised layers came to be formed by the action of solar radiation on the atmosphere. In the same year Chapman published a paper with his research student, Vincent Ferraro, which made the first move away from the traditional view of the dipole nature of the Earth's magnetic field. They proposed that during periods of high solar activity streams of ions would leave the sun and impinge on the geomagnetic field, causing distortions in the field, to the extent of confining it to a cavity in the ion stream. These distortions would be perceived on the ground as the magnetic storm.

MORE RECENTLY

The modern view of the configuration of the geomagnetic field really began to emerge, however, with E. N. Parker's realisation, in 1957, that a stream of matter was constantly flowing out from the sun in all directions, in the form of a "wind" of **plasma**. Now a plasma is a homogeneous mixture of neutral gas molecules, free electrons and ions, and is sometimes regarded as a fourth state of matter since it has properties quite different from the other three. In the case of the solar wind the plasma is virtually all ionised, and this is also true for the plasma trapped around the Earth which we shall come to later, with the exception of the ionosphere which has a large proportion of neutral gas molecules.

The difference between a plasma and a gas is particularly marked in its interaction with a magnetic field. Hannés Alfvén had shown, in 1950, that magnetic field lines will behave as if they are "frozen-into" the plasma, when the kinetic energy density of the plasma is much greater than the magnetic energy density of the field. Where the plasma moves, the magnetic field is dragged along too. The condition is satisfied in the solar wind, and it thus carries the sun's magnetic field with it.

A plasma is a good conductor of electrical currents along the direction of the magnetic field; electrons move freely along field lines by spiralling around them, but they have difficulty in moving across the lines. When the highly conducting solar wind encounters the geomagnetic field, currents are induced in the plasma, modifying the geomagnetic field, which then interacts with these currents to cause a change of direction of the wind.

The result of this rather complex set of interactions is that the solar wind is made to flow around a region surrounding the Earth which has become known as the **magnetosphere**. The distorted geomagnetic field is confined to this region, within a sharp boundary called the **magnetopause** (where the kinetic pressure of the solar wind is equal to the magnetic pressure of the modified geomagnetic field inside).

This sounds fairly complicated, but the process can be visualised as a fluid flowing against a flexible bag into which it cannot penetrate. The bag will take up much the same shape as the magnetopause; this shape can be seen in Fig. 1, which shows a cross-section of the magnetosphere as a whole. The region near the Earth is shown in more detail in Fig. 2.

The presence, in Fig. 1, of the feature labelled as the bow-shock can be explained using our bag analogy; when the relative speed between the fluid and the bag is supersonic just such a detached shock-wave is set up. The solar wind is supersonic in rather a special sense; its density is too low to support normal sound waves and the waves concerned here are called magnetosonic, or Alfvén waves. They may be conveniently pictured as a vibration of the magnetic field lines, as if they had been plucked.

RADIATION BELTS

The space within the magnetopause may be divided into a number of regions according to the properties of the magnetic field, energetic particles and plasma within them; they are shown in Figs. 1 and 2. Among the first discoveries of the satellite era was a belt of trapped energetic particles extending from just above the ionosphere to a distance of about ten Earth-radii in the equatorial plane; the radiation belts discovered by van Allen and his colleagues in 1958.

To understand how charged particles can be trapped we must look at the way they move in a magnetic field. They spiral around the field lines, but where the magnetic field gets stronger so that the field lines move closer together, the pitch of the spiral

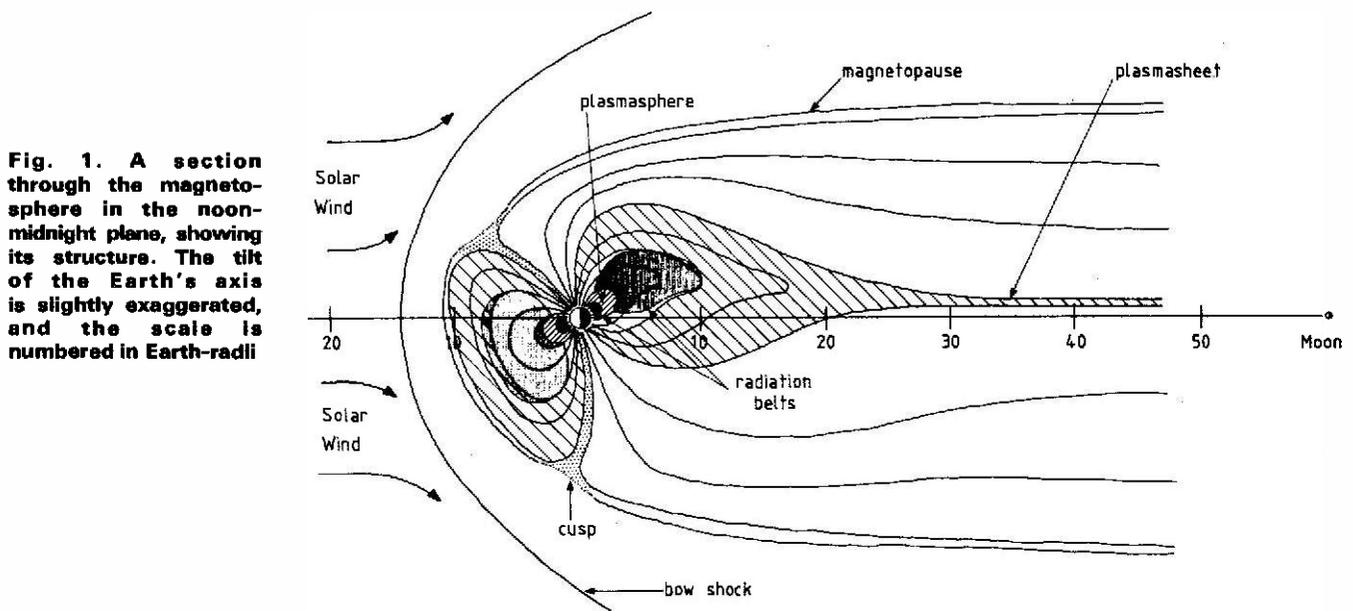


Fig. 1. A section through the magnetosphere in the noon-midnight plane, showing its structure. The tilt of the Earth's axis is slightly exaggerated, and the scale is numbered in Earth-radii

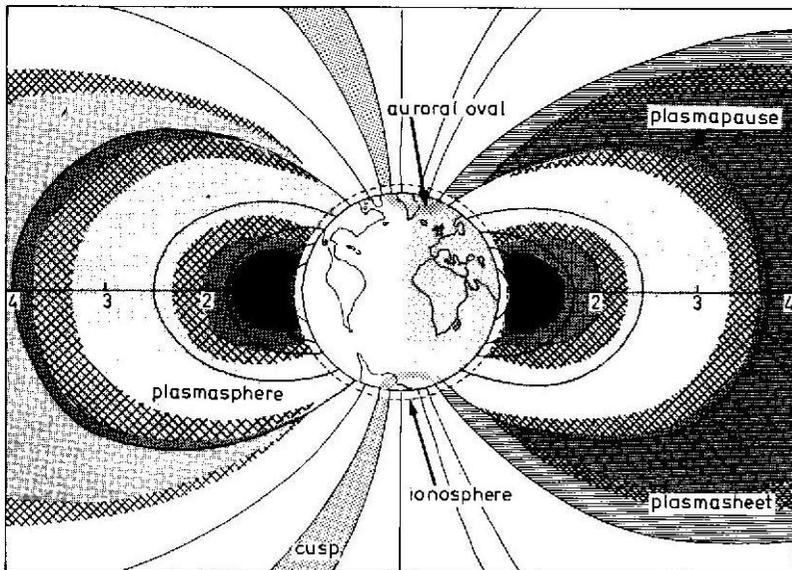


Fig. 2. The region around the Earth, showing the structure in the radiation belts. Also notice the auroral oval; this is the zone around the poles where the aurorae are seen

decreases. This is shown in Fig. 3. When the particle reaches the point where the pitch has decreased to zero, it begins to spiral out again to weaker parts of the field. This may be extended to the case of the Earth's magnetic field, as shown in Fig. 4.

Electrons bounce from one hemisphere to the other in about a second or so. The energetic protons and electrons constitute a hazard to space flight in the regions they occupy, though not such a serious one as it was at first imagined. The electrons are more of a problem than the protons, since although they have lower energies (extending to a few MeV, while the proton energies extend to hundreds of MeV) the flux intensities are far higher.

Manned orbital flights tend to be at altitudes less than about 500km; within the upper ionosphere really, and well below the radiation belts. The danger is more severe for unmanned spacecraft which are often in higher orbits and are normally in space for much longer periods. The effects of radiation are cumulative and for long endurance spacecraft consideration has to be given to protecting sensitive electronic components (particularly CMOS devices).

PLASMA REGIMES

The radiation belts lie partially within a region of plasma, known as the **plasmasphere**, which is really an extension of the outer atmosphere. Whilst the trapped radiation of the van Allen belts may be considered "hot", in the sense that the particle energies are high, the plasma within the plasmasphere is "cold"; typical energies are fractions of an eV. The plasma density in the plasmasphere is considerably higher than elsewhere in the magnetosphere, being of the order of 100–1,000 particles/cm³ at the outer edge.

The edge, known as the **plasmopause**, is quite well defined; the density drops off by a factor of 10–100 within a few hundred km. This plasma co-rotates with the Earth, and this is the reason for the discontinuity in density, since beyond the plasmopause the plasma tries to co-rotate, but when it approaches the dusk sector high above the sunset terminator on the Earth, it is convected away by electric fields. It cannot therefore attain the density of the plasma in the co-rotation region. The plasmopause was first detected by means of ion-traps aboard the Russian Lunik probes, and later confirmed by Carpenter, in 1963, by means of observations carried out from the surface of the Earth. He did this by analysing natural electromagnetic signals in the v.l.f. band, known as **whistlers**, which we will come to later.

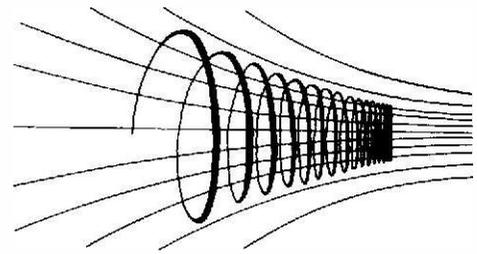


Fig. 3. The spiral path of a charged particle in a non-uniform magnetic field, showing how it may be reflected by a strong field

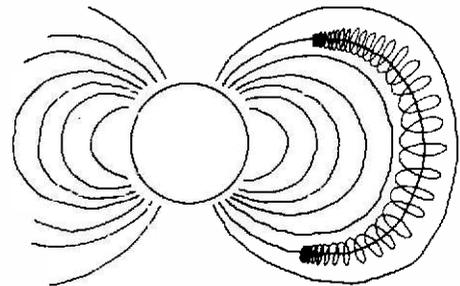


Fig. 4. The motion of charged particles trapped in the radiation belts

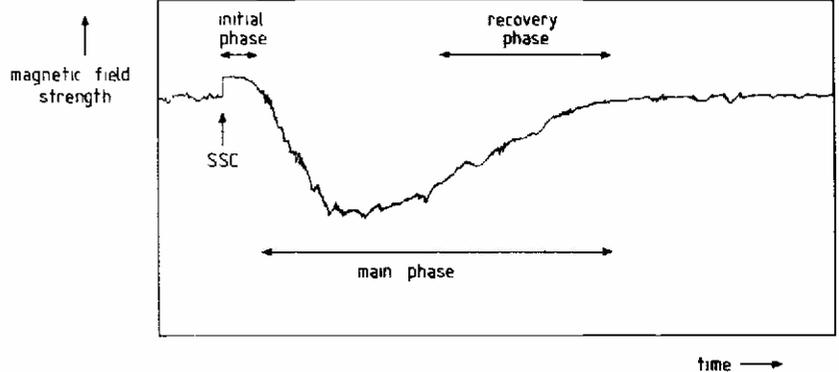
The third plasma regime is the "warm" plasma located in the **plasmashet**; this does not co-rotate but remains fixed with respect to the sun in the **magnetotail**. It is, at present, unknown what happens at the far end of the magnetotail: we do not know whether the magnetosphere is open or closed. The closed case can be visualised easily as a tapering-off of the magnetotail, so that all the field lines leaving the Earth eventually return. Such a closed end to the magnetosphere would have to be at a great distance; it is known to extend beyond the orbit of the moon, at about 60 Earth-radii, and may stretch out to a distance of up to 1,000 Earth-radii. If the magnetosphere is open, then the geomagnetic field will be linked to the interplanetary magnetic field, carried by the solar wind.

MAGNETIC STORMS AND SUBSTORMS

We have already seen how magnetic storms were discovered by George Graham in 1722. Since that time, particularly in recent years with the availability of observations made by satellite, our understanding of these events has increased enormously. A magnetic storm is noticed on the ground as a change in the Earth's magnetic field, which can be recorded by means of an instrument called a **magnetometer**. This measures three quantities of the geomagnetic field; the field strength in both vertical and horizontal directions, and the declination. The magnitude of the changes depend on the location of the magnetometer; in the auroral regions the variations may be as much as one part in 100, while nearer the equator the fluctuations become smaller.

There are many geophysical observatories equipped with magnetometers situated all over the Earth, often arranged into chains of stations, say along a north-south meridian. An example of the variation in the horizontal component during a typical magnetic disturbance is shown in Fig. 5.

Fig. 5. The change in the Earth's magnetic field during a magnetic storm. The time scale is a few days, and the variations are up to about one part in 100



The field is initially steady, and the first sign of activity is the **sudden storm commencement**, labelled SSC. This is a sudden increase in field strength, and is caused directly by disturbances on the sun. Solar disturbances cause local increases in the solar wind density and velocity; it becomes gusty, and compresses the geomagnetic field. The resulting increased, but fairly steady, field strength at the ground is called the **initial phase** of the storm.

During the quiet intervals between storms energy is stored in the magnetosphere. It is not known exactly how this is done, but the energy source must be the solar wind. The release of this energy constitutes the **main phase** of the storm; a current builds up in the radiation belt in the form of a ring around the equator. This is called the **equatorial ring current** and its magnetic field, which is in the opposite sense to the geomagnetic field, causes the decreases in field strength of the main phase. The ring current then decays over a period of one or two days, and the magnetic field slowly returns to its pre-storm level; this is called the **recovery phase**.

It is thus clear that the source of the magnetic fluctuations lies in currents flowing externally to the Earth, as Balfour Stewart had suggested. In addition to the ring current there is another current system called the **auroral electrojet**, which flows in the ionosphere at auroral latitudes. The development of these current systems can be traced in detail from a study of magnetometer records.

The charged particles which form the ring current appear to come from the magnetotail; the plasmasheet becomes thinner, and plasmasheet particles are accelerated up the tail towards the Earth. Some of these particles, following the field lines, enter the upper atmosphere at high latitudes, causing the aurorae. The aurorae are principally located on the side of the Earth facing down the tail; local midnight on the surface, but they do extend

around the nightside of the Earth, particularly the evening side rather than the morning side.

It should be emphasised that our knowledge of some aspects of the magnetic storm is rather speculative at present. This is a consequence of the difficulties involved in making systematic observations in the vast volume of the magnetosphere simultaneously; one can never tell whether measurements made from a satellite moving along its orbit represent spatial or temporal variations.

Large magnetic storms can have a significant effect on everyday life. The changing magnetic field leads to voltages being developed in conductors. During construction of the trans-Alaskan oil pipeline attention had to be paid to this point, since it runs approximately north-south through the auroral zone, and large electrical currents could have been induced in it. The major magnetic storm of recent years, in August 1972, led to many electrical power failures in the United States, due to overloading of the distribution system.

V.L.F. EMISSIONS

The interaction between the plasma surrounding the Earth and radio signals in the e.l.f. and v.l.f. bands (300Hz–3kHz and 3kHz–30kHz respectively) leads to a very interesting set of phenomena.

The v.l.f. band is used for navigational and communication purposes: its low frequencies are able to penetrate sea-water to considerable depths, so the band has mainly been exploited for submarine applications, though aircraft are now starting to use v.l.f. navigation systems. The advantage here is that v.l.f. signals have a very long range, so that relatively few transmitters are required. At the frequencies and wavelengths involved propagation is really in a waveguide mode in the cavity between the Earth and the ionosphere, rather than as conventional radio-waves.

Much more interesting than the man-made transmitters however are naturally-occurring signals. A major source of these is lightning; the electrical discharge during a lightning stroke gives rise to a broadband emission which we see as a flash of light, may hear as a crackle on the radio and which is also strong in the v.l.f. band. A particularly intense lightning discharge may propagate enormous distances in the Earth-ionosphere waveguide, easily travelling halfway around the world.

Now this waveguide is a dispersive medium (so that higher frequency components travel faster than the lower frequency ones) and what started out as a sharp pulse will eventually be transformed into a rapidly falling tone. The duration of one of these tones is typically about a tenth of a second, most of this being a fairly low frequency "tail" at about 2–3kHz, just above the Earth-ionosphere waveguide cutoff frequency. Such a signal is known as a **tweek**; a name by which they are easily recognised when they are amplified and fed to a loudspeaker.

WHISTLERS

Lightning is also responsible for a longer duration and much better known type of signal called the whistler, and again dispersion of the pulse is important. A whistler occurs when energy from a lightning stroke leaks through the ionosphere into the magnetosphere. In this frequency band, interactions with the plasma cause electromagnetic waves to be weakly guided along the magnetic field lines. Under certain conditions, however, concentrations (or depletions) of electrons may exist along a field line; this is known as a **duct**, and electromagnetic waves in the v.l.f. band may propagate along a duct in much the same way as light along an optical fibre. The pulse due to the lightning is thus strongly guided along the field line to the opposite hemisphere, where some of the energy leaks back through the ionosphere, some is absorbed and some is reflected to repeat the journey.

The plasma in the magnetosphere is more strongly dispersive than the Earth-ionosphere waveguide, and the whistler's path is long, so that the pulse becomes transformed to a falling tone lasting about a second. The phenomenon is illustrated in Fig. 6, which also shows the frequency-time profile which would be observed at each end of the field line. Note that on each journey the whistler suffers more dispersion.

Often energy travels in more than one duct simultaneously, so that a family of whistlers is received. Such a group is illustrated in Fig. 7, about which a few words of explanation may be required. This diagram is in the same form as the frequency-time profiles in Fig. 6 and is called a **dynamic spectrum**. The intensity of shading represents signal intensity in the frequency-as-a-function-of-time presentation. Plots of this kind can be produced by a spectrum analyser; the particular machine on which the illustrations in this article were made was originally designed for making voice-prints.

SFERICS

The vertical lines in Fig. 7 are lightning strokes, received from an enormous area, and known collectively as **sferics** (a contraction of "atmospherics"). The whistlers do not quite conform to the shape shown in Fig. 6; they curl over at the top displaying what is known as a **nose**. This is due to peculiarities in the dispersion equation, and the frequency of the nose is related to the latitude of the whistler's path. The variation in nose frequency in the whistler group of Fig. 7 reflects the variation in latitude of the multiple paths.

Noses are only really noticeable in high latitude whistlers; this particular whistler group was recorded at Halley Bay in

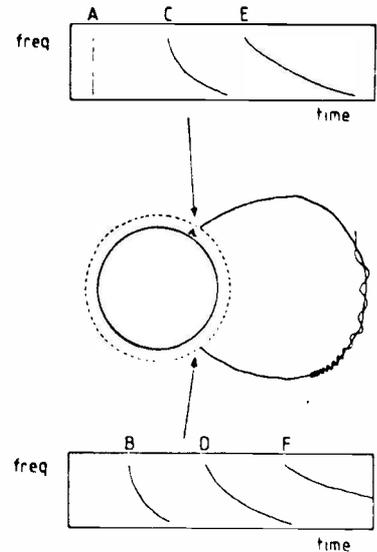


Fig. 6. The path of a whistler in travelling from one hemisphere to the other. The signals received at each end of the field line are shown as frequency-time diagrams. The lightning pulse is shown at A, the one-hop whistler at B, and the whistler after subsequent hops at C, D, E and F

Antarctica, where the British Antarctic Survey have for many years operated v.l.f. receivers as part of their programme of geophysical observations. Halley Bay is ideally suited to receive whistlers, and probably has one of the highest whistler-rates in the world, reaching about one per second during active times in the winter. This is due partially to the long Antarctic night, when the ionosphere becomes relatively transparent, and partially to the conjugacy, at the opposite end of the field lines, of the eastern seaboard of the United States, a region of high thunderstorm activity at this time of year.

There are also naturally-occurring signals in the v.l.f. band which are not due to lightning, but are generated within the magnetosphere. Probably the most common of these is **chorus**, which, when replayed through a loudspeaker, sounds remarkably like the dawn chorus of birds, and which is actually

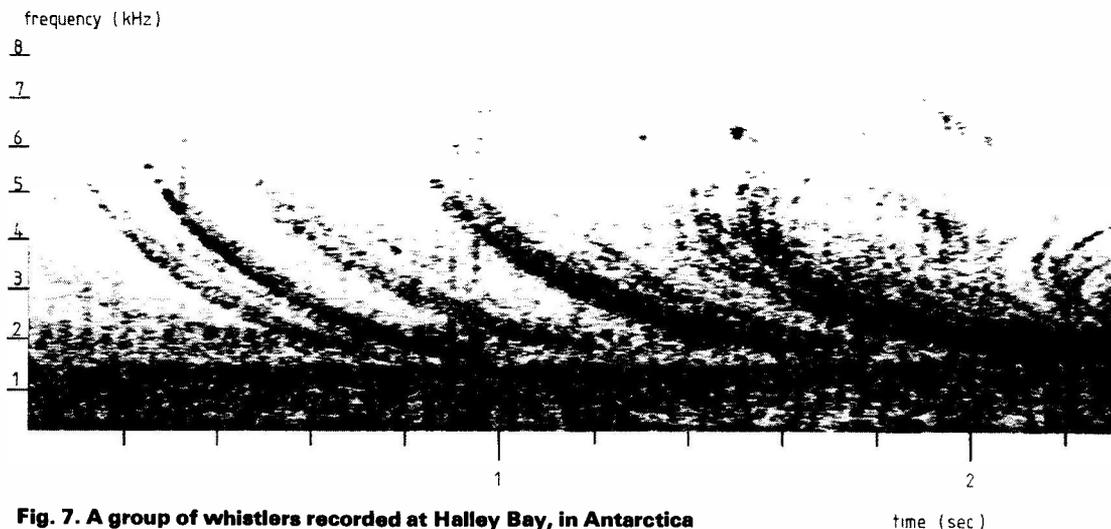


Fig. 7. A group of whistlers recorded at Halley Bay, in Antarctica

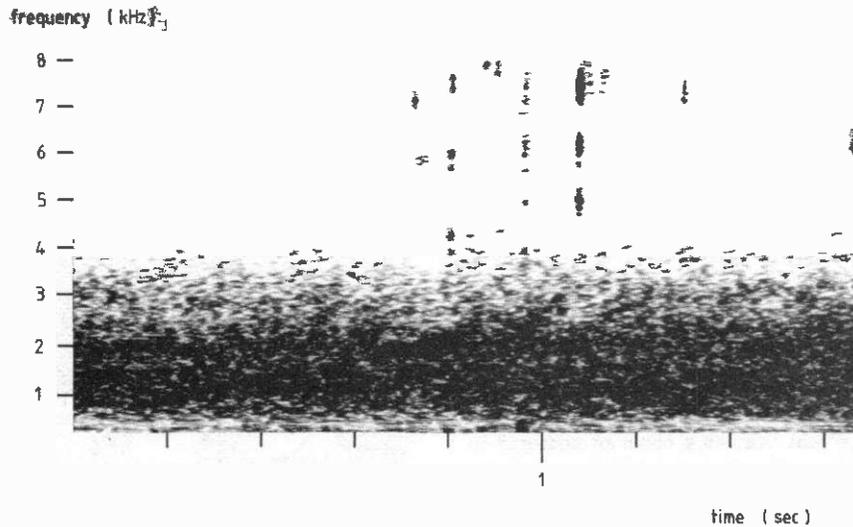


Fig. 8. Chorus at Halley Bay

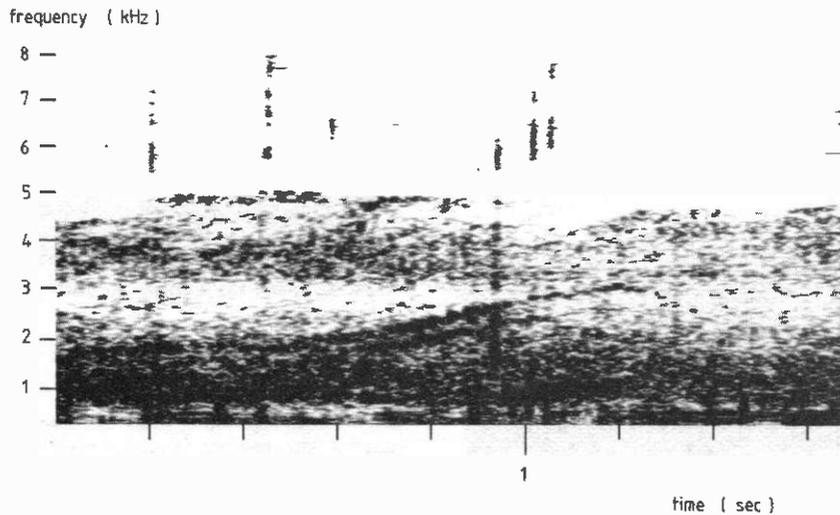


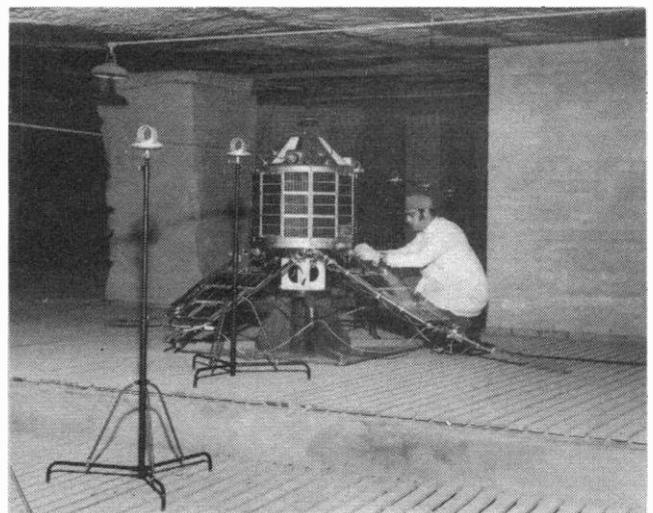
Fig. 9. Risers recorded at Halley Bay

mainly observed around dawn. Fig. 8 shows the dynamic spectrum of chorus; it can be seen to consist of many overlapping rising tones. These are due to electrons radiating v.l.f. waves as they spiral around the field line; there is a mutual interaction so that many electrons spiral in unison, reinforcing the wave. The rising tones may also occur separately, when they are called **risers**; an example is shown in Fig. 9.

V.L.F. HISS

Another common signal, though mainly confined to high latitudes, is v.l.f. hiss. This hiss is often quite intense, and sometimes band-limited with fairly sharp boundaries. It has been observed from a few hundred hertz up to 500kHz, though this upper limit is of course well out of the v.l.f. band. V.L.F. hiss is often observed in conjunction with the aurorae, and in recent years satellite observations have shown a definite link between hiss and precipitating electrons, which spiral down the field lines at high latitudes and enter the atmosphere causing the aurorae.

One such satellite is Ariel 4, one of the very successful British series of scientific satellites. An illustration of Ariel 4 is shown and the aerial loop of an e.l.f./v.l.f. receiver can be seen at the ends of the "paddles" carrying solar cells. This receiver was part of an experiment designed at Sheffield University, and has been



The Ariel 4 satellite being tested prior to launch. The receiving aeriels of some of the experiments are visible. (By courtesy of British Aerospace)

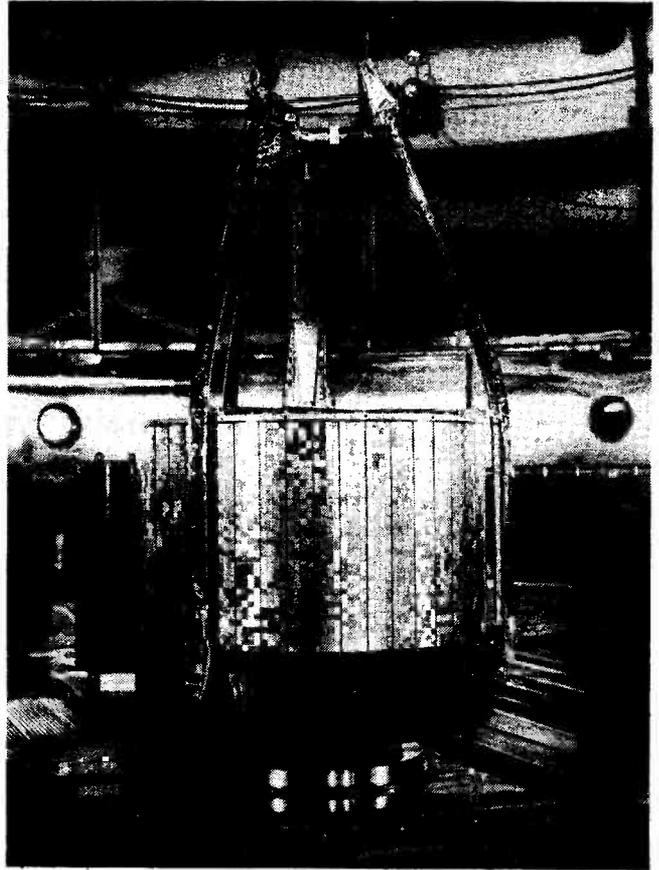
used to observe v.l.f. hiss (amongst other emissions) simultaneously with the detection of low-energy precipitating electrons by an experiment from the University of Iowa, which formed a contribution from the United States.

There are many other types of emission known, though these are often variations on those described already, and with the added ingredient of echoing. This is due to the reflection of v.l.f. waves at the ionosphere, causing them to echo backwards and forwards along the field line. These emissions generally have descriptive names; examples are **hooks**, **hisslers**, **surf** and **quasi-constant tones**. These names were given by early workers, who had to rely on their hearing for the classification of signals.

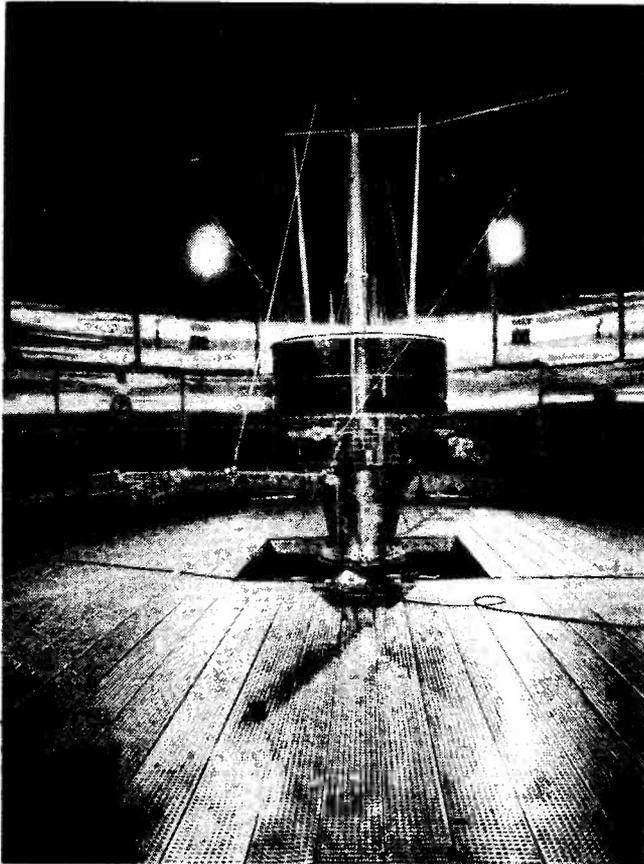
Natural v.l.f. signals were in fact detected at the end of the nineteenth century by workers at the British Post Office, who reported hearing strange noises in telephone circuits; the long telephone lines were acting as aerials. Natural signals were also detected during the first World War as a result of attempts to eavesdrop on enemy telephone conversations by the use of sensitive amplifiers connected to sensors in the ground. The cause of the signals was not really understood however until the 1950's.

CURRENT RESEARCH

There is much interest in the propagation of e.l.f./v.l.f. waves at present due to the increasing use of these bands for communication and navigation systems, while on the scientific side the activity has changed from the exploration phase to a consolidation of our new observations and knowledge. There are of course still many questions to be answered, such as how the



ISEE-B, with its booms folded. (By courtesy of European Space Agency)



Geos undergoing spin tests. The booms are supported from a pillar which is not part of the satellite. (By courtesy of European Space Agency)

sun's magnetic field links to that of the Earth, i.e. is the magnetosphere open or closed; this was mentioned earlier.

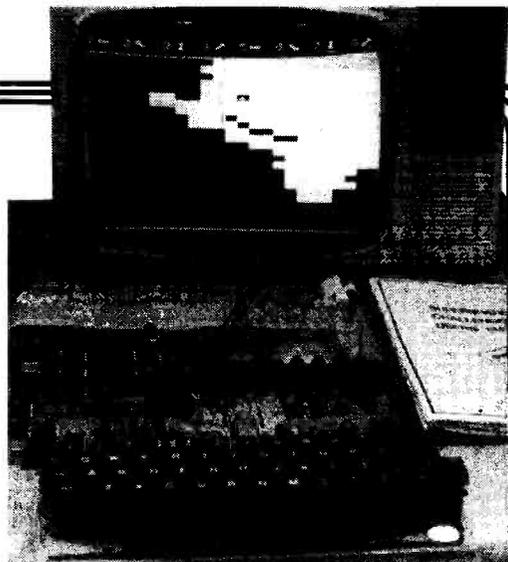
One question which receives a great deal of attention is that of electric fields along magnetic field lines; being conductors magnetic field lines should be at the same potential along their length, yet there seem to be many observations of parallel electric fields. Many workers are therefore trying to explain what has become known as **anomalous resistivity** along field lines.

It is hoped that the answers to many of these questions will be gained during the International Magnetospheric Study of 1976-1979. This is an international effort to gather observations in a co-ordinated worldwide fashion, including observations from satellites. Important components of the IMS are the European satellite Geos, shown left, and another major satellite programme, the dual spacecraft International Sun Earth Explorer mission, ISEE-A and ISEE-B, of which ISEE-B is also European (see above).

There will be a further satellite in this series, ISEE-C launched in 1978, whilst a second Geos satellite (in fact one of the engineering prototypes brought up to flight standard) was launched in mid-1978 because the original satellite was placed in the wrong orbit as the result of a launch vehicle failure. Many other satellites will also be involved, including those primarily designed for other uses and those already in orbit, some of which are being kept active specially. In all, measurements from nearly fifty satellites will be available, some of these being in heliocentric orbits, from where they can study the solar wind.

The IMS involves a very large degree of international collaboration, and we may hope that the results which will be obtained will be able to shed light on many current problems. ★

Why wait for a kit computer when you can buy a fully built & tested Superboard III off the shelf?



Ohio Scientifics

SUPERBOARD III

Now only **£229** + VAT

Full 8K basic and 4K user RAM
Power supply and R.F. Converter P.O.A.

Built and tested

(Delivery within 7 days)

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many of the tasks via the broadest lines of expansion accessories in the microcomputer industry. This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily

instruct it or program it to do whatever you want, but you don't have to. You don't because it comes with a complete software library on cassette including programmes for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on read-to-run cassettes. Program it yourself or just enjoy it, the choice is yours.

Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
- Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper-lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features uppercase, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters, without overscan up to 30 x 30 characters.

Extras

- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands

CONT	LIST	NEW	NULL	RUN	
Statements					
CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions

Operators

-, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =
RANGE 10⁻³² to 10⁺³²

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

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

Plus variables, arrays and editing facilities.

Fully built and tested. Requires only +5V at 3 amps and a videomonitor or TV and RF converter to be up and running.

What the magazines say

"Certainly one of the most exciting (computers) on the present market"
Practical Electronics June '79

"A useful machine.....represents value for money"
Computing Today June '79

"The Superboard represents good value with plenty of potential"
Practical Computing June '79

Dealer Enquiries welcome at Morgan St. address

Watford Electronics
33/35, Cardiff Road,
Watford, Herts.
Tel: Watford 40588/9

Videotime Products
56, Queens Road,
Basingstoke, Hants RG21 1REA
Tel: 0256 56417

Lotus Sound
4, Morgan Street,
London E3 3AB
Tel: 01-981 3993

NEXT MONTH...

Another
FREE
Gift!



I.C. REMOVAL TOOL

Our May cover mounted gift—an I.C. Insertion Tool—created a fantastic response from readers. In addition to their praise many of them said, "Now it's easy to get them in but how do we get them out?"

In reply to this request we have designed and produced another exclusive tool—yes it's an I.C. Removal Tool.

*... together with these exciting
constructionals*

SOLID STATE CAR INSTRUMENTS

Put i.c. technology in your car with our series of automobile projects using the LM3914. Engine RPM, Battery Charging, Battery Condition, Engine Temperature, each using bar displays. Start with the Battery Condition Indicator. Find out how it works, and how to build it.

DIGITAL TEMPERATURE CONTROLLER

Fine temperature control over the range 0–99°C with digital readout. Ideal for photography, home brewing, aquarium or just simple room heating.

PRACTICAL

ELECTRONICS

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY 14 SEPTEMBER 1979

SMOOTH

D.S. GIBBS & I.M. SHAW
C. Eng., M. I. E. E.

The refined effect for the discerning musician

Of all the effects units for electric guitars, fuzz is undoubtedly the most popular and numerous designs have appeared in *Practical Electronics* and other magazines over the years. So why yet another fuzz unit?

In principle fuzz is easy to produce; all one has to do is distort the signal. But in practice it is very difficult to obtain just the right amount and the right character of distortion, and most designs end up producing a sound which is unpleasantly harsh and rasping. We know because we have tried many of them. Some designs use a Schmitt trigger circuit to 'square up' the input waveform and these tend to give very poor results as the output remains absolutely constant up to a certain point and then suddenly stops. Also a guitar produces a large transient at the start of a note and in some designs this causes momentary blocking due to coupling capacitors charging up. This produces a disconcerting 'hiccup' in the output.

What the professional musician usually wants is a more refined sound—a fuzz unit which gives the guitar tone which is 'different' rather than obviously distorted and gives a limited sustain without completely destroying the dynamics of the input signal. The unit described here will do just this and that is why we have called it 'smooth fuzz'.

CIRCUIT

The circuit uses a dual low noise f.e.t. operational amplifier as these devices now offer excellent performance for a very reasonable price.

The first part of the circuit, around IC1a performs two functions—it provides a voltage gain of about 60 to raise the input signal to a suitable level to operate IC1b, and it acts as a low pass filter with a cut-off at about 1kHz and a slope of 18dB per octave. This removes the higher harmonics of the strings and so reduces the number of intermodulation products produced by the following stage.

IC1b is the distortion generator. Very small signals are passed without distortion, but as the output voltage rises above about ± 0.5 volts diodes D1 and D2 conduct, providing gradual limiting of the signal. The output waveform produced by this stage varies as shown in Fig. 3 as the input signal is increased.

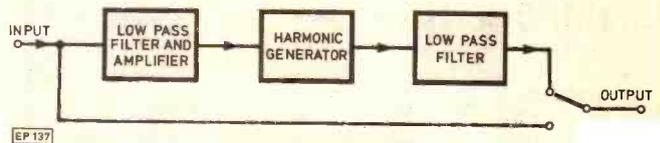
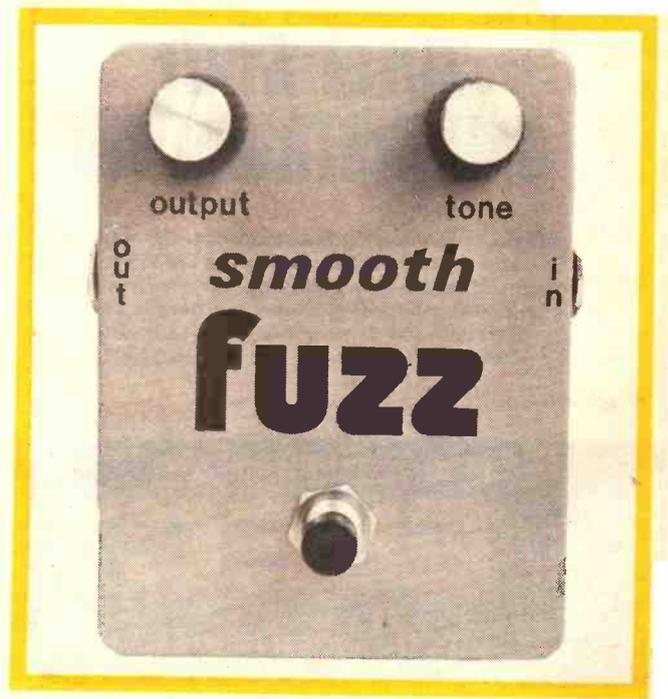


Fig. 1. Block diagram

Although the waveform distortion produced by this stage is not excessive the direct output would still be a little too harsh for most peoples tastes, so two stages of additional filtering are provided by R9 and C8 and VR1 and C9. VR1 is the tone control and as it is varied from the C9 end to the C8 end the tone becomes progressively sharper.



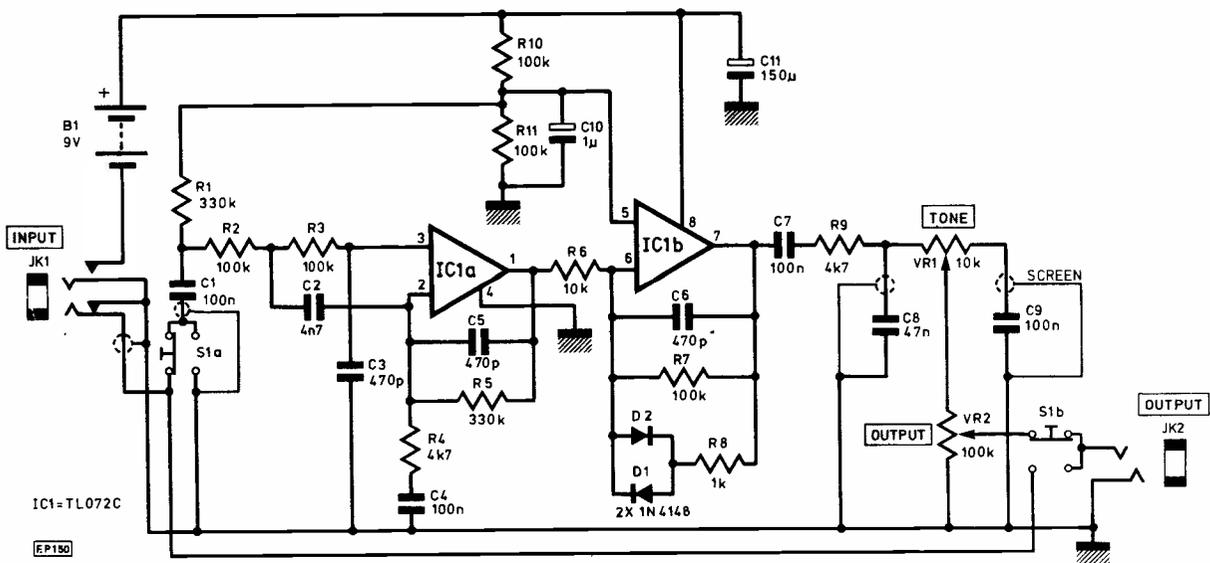


Fig. 2 Circuit diagram

COMPONENTS . . .

Resistors:

R1	330k	R5	330k	R9	4k7
R2	100k	R6	10k	R10	100k
R3	100k	R7	100k	R11	100k
R4	4k7	R8	1k		

All resistors are 0.25W or 0.33W miniature carbon film, 5%

Potentiometers

- VR1 10k single gang linear law
- VR2 100k single gang log law

Capacitors

- C1 100n 250V polyester film
- C2 4n7 100V 10% plate ceramic
- C3 470p 100V 10% plate ceramic
- C4 100n 250V polyester film
- C5 470p 100V 10% plate ceramic
- C6 470p 100V 10% plate ceramic
- C7 100n 250V polyester film
- C8 47n 250V polyester film
- C9 100n 250V polyester film
- C10 1μ 35V tantalum bead
- C11 150μ 16V electrolytic

Semiconductors

- IC1 TL072CP Texas instruments
- D1 1N4148 or 1N914
- D2 1N4148 or 1N914

Miscellaneous

- S1 d.p.d.t. footswitch (latching type)
- JK1 Switched jack socket with front contact normally open and rear contact normally closed (Davian Electronics)
- JK2 Normal, non-switched jack socket
- Box I.T.T. diecast box type 46R CS00 043 A00
- PP3 type battery and battery clip
- Two control knobs
- Two rubber self adhesive feet
- Screened lead and connecting wire

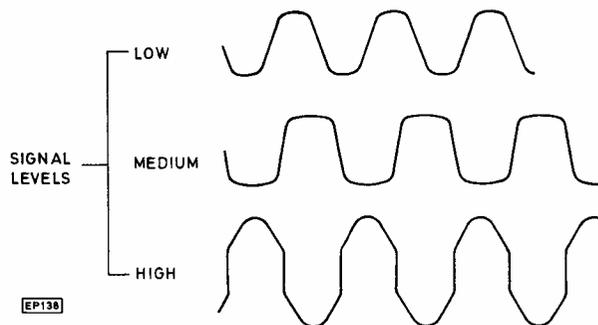


Fig. 3. Waveforms

CONSTRUCTION

Most of the components are mounted on a small printed circuit board which fits into the slots in the side of the box. This is a convenient method of assembly as no screws are required. The component layout and copper pattern for the printed circuit board are shown in Fig. 4.

A low profile type of 8 lead d.i.l. socket can be used for the i.c. if desired.

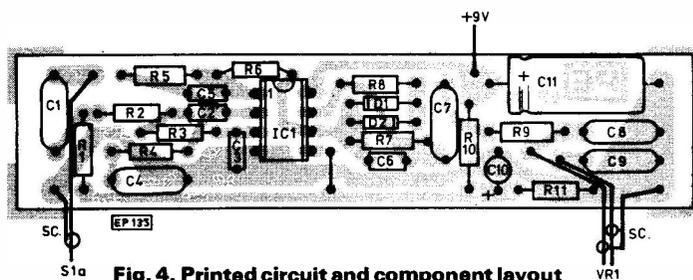
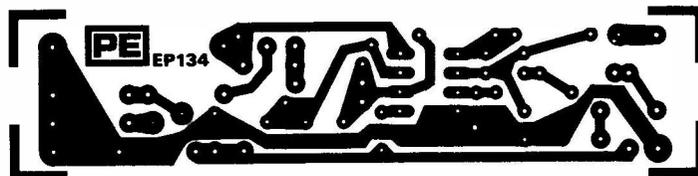


Fig. 4. Printed circuit and component layout

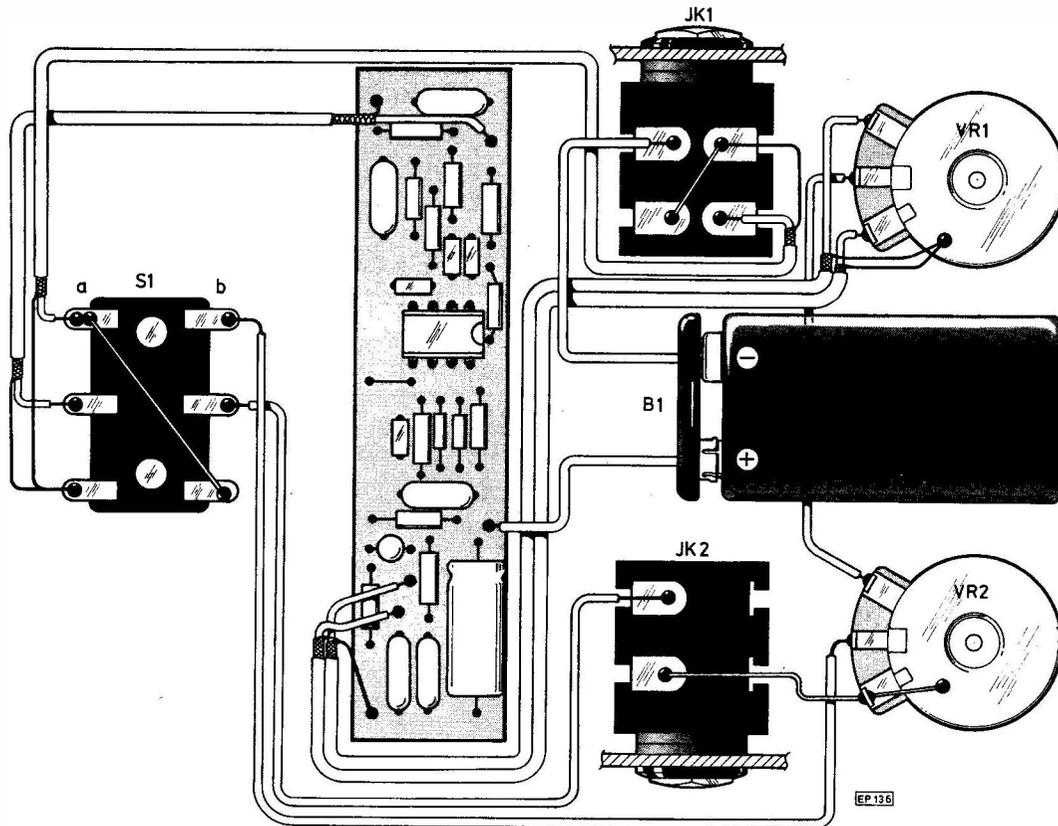
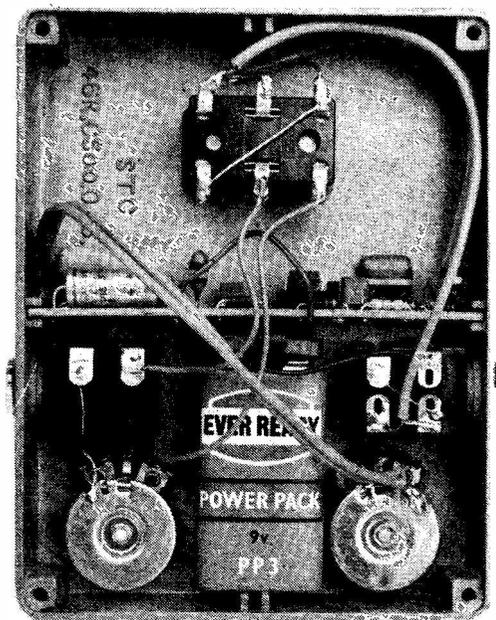


Fig. 5. External assembly to board



Box assembled

The battery should be held in place with a piece of foam rubber glued inside the lid, and the unit is finished off with two self adhesive rubber feet fixed to the rear end of the lid. These stop the box from sliding around and tilt it forward at a convenient angle for foot operation.

A wiring diagram for the unit is given in Fig. 5. Note that miniature screened lead should be used between the input jack and the footswitch, the printed circuit input and the footswitch, and between the printed circuit and the tone control. Note that earth connections are made to the box by soldering to the case of the potentiometers, although a screw and solder tag can be used if preferred.

The input jack socket is a special type which has a front contact (nearest the nut) which is normally open and a rear contact which is normally closed. The battery negative is connected to the normally open contact so that when the input jack plug is inserted this contact 'makes' and automatically switches the unit on. At the same time the rear contact opens and allows the input signal to reach the circuit.

USING IT

Connect the battery, screw on the lid of the box and insert the input and output jack plugs. Then play a note through the unit, adjusting VR1 for a pleasing tone and VR2 for an output signal of similar loudness to the input. The output level from the guitar should be set high to give the best sustain.

If for some reason the unit does not work, check the output voltages at pins 1 and 7 and IC1. Pin 1 should be at exactly half the battery voltage and pin 7 should be within ± 0.7 volts of this.

The current taken by the unit is only about 4 milliamps giving a long life from the PP3 battery used, but don't forget to remove the input jack plug when you have finished playing. ★

SAXON ENTERTAINMENTS

P.A. & DISCOTHEQUE
EQUIPMENT AT
INCOMPARABLE PRICES

STANDARD CENTAUR 100W

£309 incl. of carr. & VAT Deposit £62.00
12 months @ £24.47 or 24 months @ £14.19

SUPER CENTAUR 200W

£366 incl. of carr. & VAT Deposit £74.00
12 months @ £28.94 or 24 months @ £16.78

GXL 200W

£470 incl. of carr. & VAT Deposit £94.00
12 months @ £37.27 or 24 months @ £21.60

GXL WITH PDF BINS

£502 incl. of carr. & VAT Deposit £102.00
12 months @ £39.66 or 24 months @ £23.00

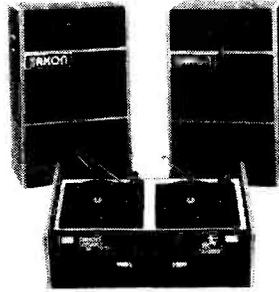
CUSTOM CENTAUR 400/600W WITH FOUR PDF 100A BINS

£833 incl. of carr. & VAT Deposit £167.00
12 months @ £66.03 or 24 months @ £38.28

CENTAUR STEREO DISCOS

C/W LIGHT SHOW & DISPLAY
TWIN LOUDSPEAKERS & LEADS
100W-600W

20%
DEPOSIT
CREDIT
TERMS



GXL + PDF BINS

- ★ 2 Year warranty
- ★ Full Mixing + Crossfade + Mic/Tape Inputs
- ★ Headphone & Cue Light Monitoring
- ★ Full Range Bass/Treble Controls + Mic Tone
- ★ 4 Channel Soundlight + Display

JUST PLUG IN AND GO!!
SEND TODAY FOR YOUR FREE BROCHURE

MINI DISCO 100 WATT

MONO SYSTEM WITH LOUDSPEAKERS

£229.00 incl. of carr. & VAT Deposit £46.00
12 months @ £18.13 or 24 months @ £10.52

P.A. SYSTEMS

2 YEAR GUARANTEE

100 WATT incl. of carr. & VAT Deposit £207.00
12 months @ £16.35 or 24 months @ £9.49 £42.00

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

200 WATT incl. of carr. & VAT Deposit £309.00
12 months @ £24.47 or 24 months @ £14.19 £62.00

AMPLIFIER UNITS ONLY

AP100 AMPLIFIER

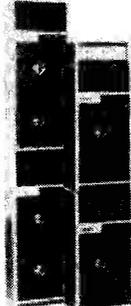
£56.92 + Carr. £1.50 incl. of VAT

- ★ 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 stan-
dard 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

Powersupply 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 £5.46 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
Netlon 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

ABOVE PRICES INCL. OF CARR. & VAT

All prices are inclusive of 15% VAT. Shop premises open Tues to Sat 9 am - 5 pm, Lunch 12.30 - 1.30 pm. Mail order dept open Mon to Fri 10 am - 4 pm. Ring 01-684 6385

TO ORDER

By Post Send your requirements with cheque crossed P.O. or 60p COD charge to address below or just send your Access or Barclaycard Number NOT THE CARD

By Phone You may order COD. Access or Barclaycard. Post & Packing 50p on all orders except where stated

SAXON ENTERTAINMENTS

327 Whitehorse Road, Croydon, Surrey.

All Enquiries Large SAE Please Brochures on request

MANCHESTER DISCO CENTRE, 237 DEANS GATE, MANCHESTER CALLERS ONLY - (061) 832 8772 - COMPLETE UNITS ONLY

Cambridge Learning Enterprises

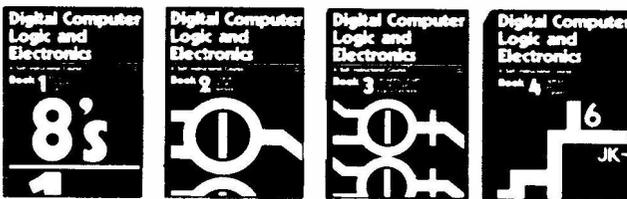
SELF-INSTRUCTION COURSES

UNDERSTANDING DIGITAL ELECTRONICS

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and fuel consumption; you could be 'phoning people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes - each A4 size - and serves as an introduction to the subject of digital electronics. Everyone can learn from it - designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems, AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

FLOW CHARTS & ALGORITHMS help you present: safety procedures, government legislation, office procedures, teaching materials and computer programs by means of YES and NO answers to questions.

The Algorithm Writer's Guide

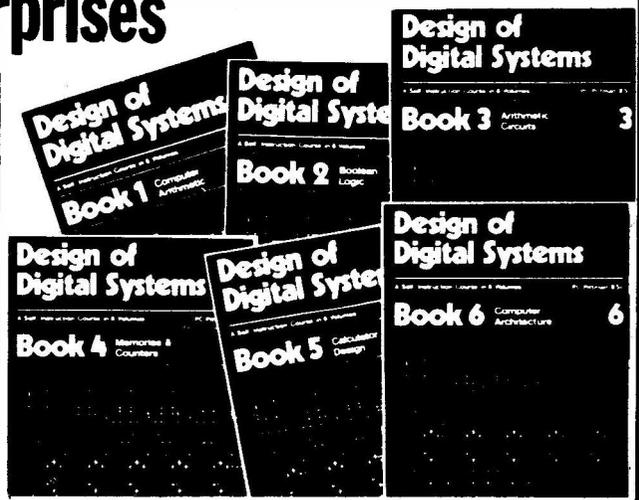
explains how to: define the questions, put them in the best order and draw the flow chart, with numerous examples shown. All that students require is an aptitude for logical thought. Size: A5, 130 pages. This book is a MUST for those with things to say.

NEW from Cambridge Learning Enterprises

O - LEVEL ENGLISH LANGUAGE

More and more jobs require a C-GRADE PASS, and over 250,000 people fail to get this every year. Will one of them be in your family? This new course, written by experts in a style that's serious yet fun to read, shows you how to mark your own work and compare it with the work of other people in their exam year. Set your own pace and assess your results immediately with no postal delays: watch your speed and standards improve. In Book 1 learn how you will be marked on COMPREHENSION, Book 2 covers SUMMARY, PUNCTUATION & SPELLING, and Book 3 coaches you in the principles of COMPOSITION. Size: 3 A4 volumes totalling 250 pages.

CAMBRIDGE LEARNING ENTERPRISES, UNIT 22 RIVERMILL SITE, FREEPOST, ST. IVES, HUNTINGDON, CAMBS. PE17 4BR, ENGLAND
 TELEPHONE: ST. IVES (0480) 67446.
 PROPRIETORS: DAYRIDGE LTD. REG. OFFICE: RIVERMILL LODGE, ST. IVES
 REGD. IN ENGLAND No. 1328762



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes - each A4 size are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers. Contents include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.

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

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

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.

Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

Four volumes Digital Computer Logic & Electronics at £6.50 inc
 Six volumes Design of Digital Systems at £10.50 inc p & p
 Three volumes O-Level English Language at £6.50 inc p & p
 The Algorithm Writer's Guide at £3.40 inc p & p
 If your order exceeds £14 deduct £2 from your payment
 Price includes surface mail anywhere in the world, airmail extra
GUARANTEE If you are not entirely satisfied your money will be refunded
 Please allow 21 days for delivery

Cambridge Learning Enterprises, Unit 22 Rivermill Site,
 FREEPOST, St. Ives, Huntingdon, Cambs. PE17 4BR,
 England.

Please send me the following books:

- sets Digital Computer Logic & Electronics at £6.50, p & p
- sets Design of Digital Systems at £10.50, p & p included
- O-Level English Language at £6.50 p & p included
- The Algorithm Writer's guide at £3.40, p & p included

Name

Address

I enclose a *cheque/PO payable to Cambridge Learning Enterprises for £.....

Please charge my *Access/Barclaycard/Visa/Eurocard/Mastercharge/Interbank account number.....

Signature..... *delete as appropriate.

Telephone orders from credit card holders accepted on 0480-67446 (Ansafone). Overseas customers should send a bank draft in sterling drawn on a London Bank, or quote credit card number.

PE22

FREE ENTRY COMPETITION!

OVER £300 WORTH OF Lektrokit BREADBOARDING TO BE WON

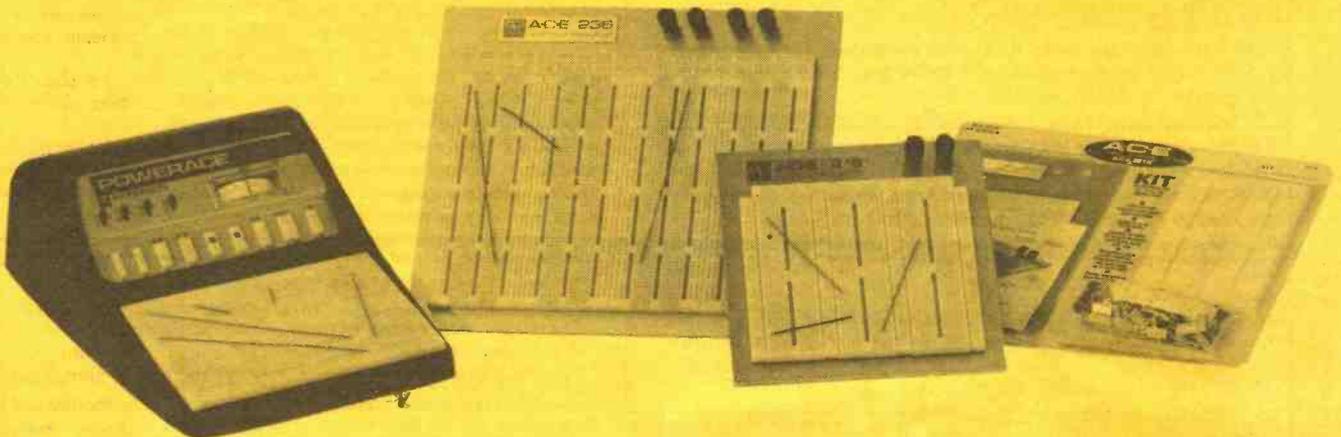
THIS competition is open to nearly everyone (see rules overleaf) and carries the following **31 PRIZES**.

- 1st** LEKTROKIT POWERACE 102 or 103 (winner's choice), a Jumper Wire Kit and 16 Pin Test Clip value approx. £120.
- 2nd** LEKTROKIT ACE 236, a Jumper Wire Kit and 16 Pin Test Clip value approx. £65.
- 3rd** ACE 218, a Jumper Wire Kit and 16 Pin Test Clip value approx. £43. 4th/6th Three ACE 201-K's (in kit form) value each approx. £16. 7th/11th Five SUPER-STRIPS value each approx. £11. 12th/31st Twenty 217L BREADBOARDS value each approx. £3.

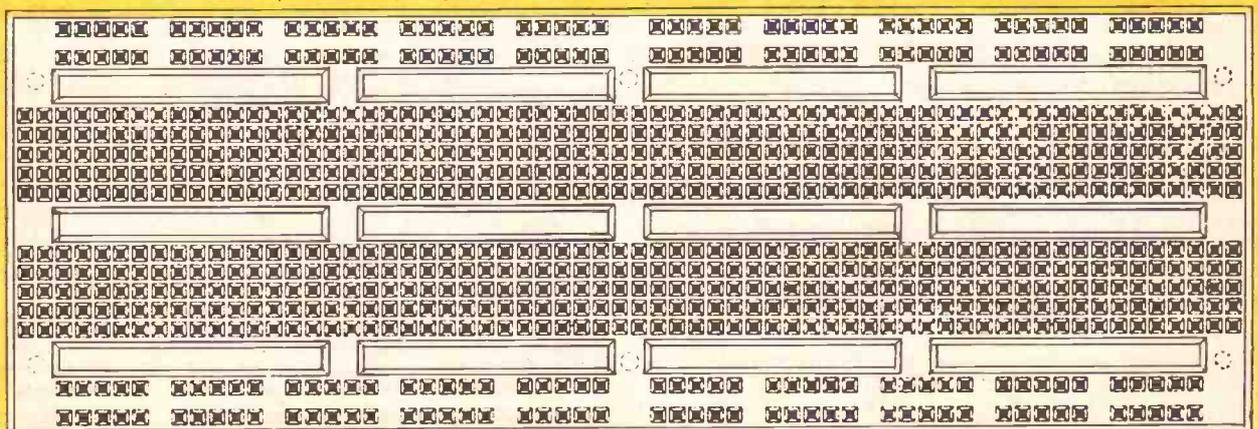
Results will be announced in the February 1980 issue of P.E. and, providing the first prize winner lives in the U.K. he/she will be presented with the prize at Breadboard '79 (Dec. 4-8th 1979).

To enter, simply design a useful circuit that will fit on the Super-Strip layout shown below. You should then draw out the circuit neatly and append a brief description of its operation and capabilities. This should be sent, together with a properly completed entry coupon and component layout drawn on the Super-Strip diagram below, to:

PRACTICAL ELECTRONICS/LEKTROKIT COMPETITION,
55 Ewer St., London SE99 6YP.



Model SS-2 Super-Strip comprising 8 buses of 25 connected terminals and 128 groups of 5 connected terminals.



News Briefs

JOINT MEMORIES

AN AGREEMENT, in principle, has been reached between Zilog and National Semiconductor Corp., on the standardisation and alternate-source manufacturing of a family of quasi-static, eight-bit wide memories. Three functionally and electrically compatible RAMs configured 2k x 8, 4k x 8, and 8k x 8, have specifications jointly agreed on, and which conform to the proposed JEDEC 28-pin configuration.

The memories involved are: Z6132 4k, and the 2k version which will be a "subset" of the former. The 8k design (National NMC 4864 and Zilog 6164) will be compatible with Zilog's micro' family, and National's 16000 processor, and will go into full production in the second quarter of 1980.

TWO NEW MICRO'S

NEW to the S6800 family of microprocessors are the 6802 and 6808, both of which incorporate clock circuitry. The 6802 houses 128 bytes of RAM of which 32 bytes are retainable on stand-by power after power down.

Both of these depletion load n-channel devices only require the addition of a 4MHz crystal, being 1MHz operated from a divider circuit. This allows them to be used with a low cost 3.58MHz colour burst crystal.

CARROT GROWS BIGGER

THE 1979 TDC Innovator Award has the highest yet prize money; a record £35,000, of which £20,000 will go to the winner, and £5,000 each to the three runners-up.

The competition is run by Technical Development Capital (TDC), a subsidiary of Finance for Industry, and the award is presented annually for the best business plan based on technological innovation. Information about the award can be obtained from Technical Development Capital Ltd., 91 Waterloo Road, London SE1 8XP.

BABES IN HEADPHONES

SINCE a child with an unidentified hearing impairment might be labelled ESN (educationally subnormal) due to lack of progress at school, more emphasis is now being placed on first establishing the hearing capability of children at an early age.

But the quest of providing readily available hearing tests for infants has two inherent problems. The first is a technical one, in that a baby cannot be instructed to respond to a programme of audible stimulation. The solution to this limitation has in the past been the BER test (Brainstem Evoked Response), requiring bulky and expensive equipment to produce an electroencephalogram type output, using electrodes taped to the baby's head, and headphones producing the sound.

From this stems the second problem, that such equipment is never likely to become sufficiently widespread to enable screening of all infants. Now the microprocessor has come to the rescue with a new portable system which can test the hearing of a day-old baby. It's called SYNAP I, and is a highly sophisticated, and yet relatively inexpensive miniaturised unit, named after the synapse—the point at which a nerve impulse passes between neurons.

This breakthrough came from the voluntary efforts of the "Telephone Pioneers of America", a community service organisation of long-time Bell System employees. The scientific consultant to the programme, whose concept the portable system was, is Dr. Philip Peltzman, Research Associate at the University of California's San Francisco Medical Centre.

It is fitting that a device made by the inventors of the "Computer-on-a-chip", Intel, is used. The 8085A-2 microprocessor based system evaluates the changes in the brain's electrical activity in response to audible clicks, by accumulating the analogue signals, converting them into digital information and averaging them into a single wave for recording on magnetic tape. This data is then transcribed to paper tape, from which a trained person can determine the degree to which the infant heard the clicks.

IN DEPTH DEFENCE

AUSTRALIA and the UK are being equipped with "the world's most advanced airborne anti-submarine defence system".

As part of the RAF Nimrod maritime reconnaissance fleet's avionics update programme, aircraft will be fitted with the Marconi Avionics Ltd. AQS901 acoustic processing and display system to complement Australia's contribution, the BARRA passive directional sonobuoy. BARRA gives a better capability for the detection and location of submarines than any buoys in current service, and with AQS901 the system will be capable of locating even the quietest, fastest types of nuclear submarine operating at great depth.

FREE ENTRY COUPON

PRACTICAL ELECTRONICS LEKTROKIT COMPETITION

(Block letters please)

NAME (Mr/Mrs/Miss)

ADDRESS

TELEPHONE NUMBER if any

I certify that

(a) This entry is my own original idea and has not been copied from any other source;

(b) This idea has not been published or offered for publication elsewhere.

(c) I agree to abide by the rules and conditions.

SIGNED

Write a slogan using no more than 15 words on the merits of solderless breadboarding:

.....

.....

.....

RULES AND CONDITIONS

There is no entry fee nor limit to the number of entries a reader may submit but each entry must be made on a proper entry coupon, cut from PRACTICAL ELECTRONICS.

All accepted entries will be examined by a panel of expert judges including the Editor of Practical Electronics, and assessed on (a) originality of the idea, (b) technical merit, (c) usefulness (not necessarily in that order). The prizes will be awarded for the best entries in order of merit. In the event of the same idea being submitted by two or more entrants, the slogan submitted will decide such winner(s) or winning order.

In the event that the judges consider there are not enough entries of a sufficiently high standard, the Editor reserves the right not to award any prize(s) at his discretion.

Entries arriving after closing date will not be considered, nor will any received that are illegible, not wholly understandable, are not on a properly completed entry coupon or in any other way do not comply exactly with the instructions and rules. No responsibility can be accepted for entries lost or delayed in the post or otherwise; proof of posting will not be accepted as proof of receipt. No entries can be returned.

The competition sponsors reserve the right to adapt or amend any entry—after judging has been completed—for purposes of publication. Practical Electronics will pay the usual reproduction fee for any entries published. Decisions of the judges, and of the Editor in all other matters affecting the competition, will be final and legally binding. No correspondence will be entered into nor interviews granted.

Winners will be notified by post and brief details of winning entries published later in Practical Electronics.

The contest is open to all readers, but those outside the U.K. may be requested to provide a British address to which any prize may be sent. Employees and the families of employees of IPC Magazines Ltd., the printers of Practical Electronics and Lektrokit Ltd., and anyone directly connected with the competition are not eligible to enter.

Closing date September 28th 1979.

Semiconductor UPDATE...

FEATURING 74AS/74ALS 82S106/7 ICL7600/5

R. W. Coles

TTL-ALIVE AND KICKING

In the beginning there was TTL; 74 series Transistor Transistor Logic that is, the first really successful integrated circuit logic family, which has been with us since the mid sixties. For such an "antiquated" technology, TTL seems to be remarkably durable and is still the most popular logic family for general use and for state-of-the-art applications in microprocessor systems. This longevity is not due solely to the foresight of the original chip designers, it is also due to an intensive program of development which has turned today's TTL into a very different animal to the 74 series of yesteryear.

The first major improvement was Shottky TTL (74S series). Using the low voltage drop of Shottky diodes to prevent the gate transistors from entering saturation, the speed of the standard gate was increased from 10ns to 3ns. Low power TTL was around more or less from the start, but low current versions of TTL were slow—30ns for a standard gate. By combining low power circuitry with the new Shottky technology another improved TTL family, 74LS, was introduced, with the speed of standard TTL but at only 2mW per gate dissipation. Today, 74LS is the "standard" family, replacing the old 74 devices in nearly all new applications.

Even those technology enhancements do not tell the full story. Throughout the long life of TTL there has been a continuous stream of new logic function and sub-system introductions which have provided the potential TTL user with a very wide choice indeed. Add to this the wide range of TRI-STATE devices now in the family, and you can get a clearer idea of why there aren't going to be any overnight challengers for the "standard logic" crown.

But TTL isn't resting on its laurels. Already manufacturers are unveiling their 1980 models, with still higher speeds and yet lower fuel consumption. Take Texas Instruments for example. They will be introducing two new families called "Advanced Shottky" 74AS, and "Advanced Low Power Shottky" 74ALS, in the near future.

The 74AS family will be twice as fast as "ordinary" Shottky TTL, but will have the same 20mW dissipation. The 74ALS devices will be almost as fast as "ordinary" Shottky at 4ns per gate, with a power dissipation as low as the old low power

family at an incredible 1mW per gate! To go with the new families there will be some interesting new logic functions and even a new 0.3 in wide 24 pin package for even greater packing density.

There will be other new TTL families from manufacturers such as Fairchild, so if your data book is more than a few years old, I would say that 1980 will be a very good year to replace it!

ROM PUNCTURE OUTFIT

If your bike tyre is flat, you can fix it with a puncture patch. If you have some wrong data in your ROM you can fix it with a ROM patch—but you won't need any sticky cement or French chalk!

The problem the ROM patch has been designed to solve is that of the expensive masked ROM which turns out to contain some bugs. If a manufacturer doesn't want to throw away perhaps a thousand ROMs costing say £10 apiece, because of a few erroneous program instructions, the ROM patch is the only way he can make the best of a bad job.

The principle is simple. The addresses of the bad locations are detected and the main ROM outputs inhibited. A small ROM containing the appropriate corrections has its output gated on to the bus instead. To the system everything is now O.K. Unfortunately, a problem the ROM patch faces is the fact that corrections may be needed anywhere in the address range of the main ROM, and so all address bits need to be decoded. On the other hand a ROM patch can be economical only if a small number of corrections need to be stored in the new ROM.

Signetics have solved this problem with their **82S106** and **82S107** ROM patch chips by making not only the ROM patch data itself programmable, but also the address decoding. Each patch has 48 programmable 8 bit locations for the substitute data, and these are addressed by means of a 16 bit programmable address comparator, which means that the 48 individual words can be distributed anywhere in a full 65,536 word range. The appropriate comparator and ROM data can be entered by means of standard PROM programming equipment or it may even be possible to get the system to program its own patch since only low programming voltages are required.

For most microprocessor systems only one ROM patch would be needed to cover the full address range so that "fixes" could be implemented for several ROMs. The 28 pin 82S106/7 package could be designed into a micro board from the start—if it turns out to be unnecessary, all that has been wasted is a socket!

These interesting devices can be used for other jobs too, applications listed on the data sheet include digital filters, interrupt vector generators and code generators. Every saddle bag should have one!

THE CAZ AMPS COMETH

Those CMOS whizz kids at Intersil have come up with yet another innovation which looks like a winner—the CAZ AMP. CAZ AMP stands for Commutating Auto Zero Amplifier, a cunning device which manages to overcome the traditional problems of MOS operational amplifiers—large input offset voltages and poor temperature drift performance—retaining the very low power attributes for which CMOS is famous.

The way Intersil have tackled the messy MOS input problem is simple, they have just let it happen and then cancelled it by letting the amplifier continuously re-zero itself. Inside the CAZ AMP package there are actually *two* amplifiers together with some analogue switch logic. Each amplifier spends half of its time connected as the "on-line" amplifier, with the rest of its time devoted to an auto-zero function while its twin takes over!

The auto zero operation is breathtakingly simple. A capacitor is switched *between* the inputs of the amplifier so that it gets charged up to the offset voltage. When the amplifier is put back "on-line" the capacitor is switched in *series* with the inputs to cancel the offset it has just measured. Meanwhile the other amplifier is charging its own capacitor, and so on. Simple eh? Using this technique Intersil have produced an amplifier with a 2 micro volt initial offset voltage (A 741 would be about 2 *milli* volts) and with a 0.005 microvolt per degree C drift temperature coefficient. These specs. rival those of the far more expensive precision modular and chopper amplifiers and could bring about a revolution in low cost, high accuracy, instrumentation systems.

The devices to watch for are the **ICL 7600** and the **ICL 7605**—don't miss them!

PATENTS REVIEW...

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

AUTO-FOCUS

One of the first pending British patent applications of electronic interest to be published under the new laws is GB 2 001 501 A in the name of Bell and Howell, Japan Ltd. The patent concerns automatic focus devices of optical type as used for still cameras (e.g. the Konica Autofocus) and home movie cameras (e.g. from Sanyo).

Whereas Polaroid has developed an ultrasonic autofocus system, which senses distance by evaluating the return echo time of an ultrasound signal beamed out from the camera, the Bell and Howell system relies on an opto-electromechanical equivalent of human eye vision.

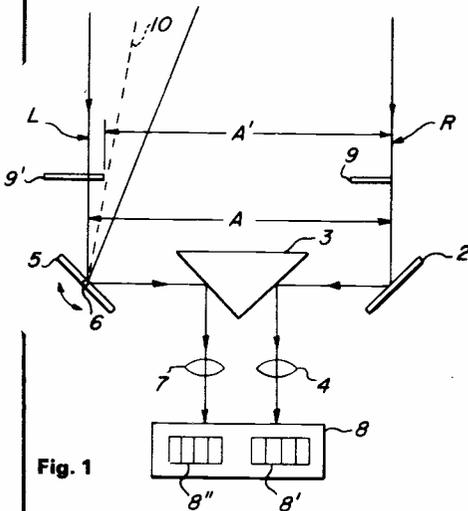


Fig. 1

As shown in Fig. 1, two mirrors 5,2 are spaced apart on the camera front and thereby "see" slightly different images of the scene to be photographed.

The images L,R seen by the two mirrors 5,2 are beamed onto a central prism 3 which, together with lenses 7,4, forms separate images of the scene alongside each other on photoconductive arrays 8'', 8' of an optical sensor 8. The mirror 2 is fixed but the mirror 5 can be pivoted about an axis 6.

A servo system controls scan pivoting of the mirror 5 and the sensor 8 generates a focus signal when the separate images formed on the arrays move into exact coin-

cidence. The angular movement of the mirror 5 is thus representative of the image distance from the camera and the focus signal can thus be used to servo control the lens focus setting.

The patent document admits in honest terms what will already be well known by anyone who has used a camera incorporating such an auto-focus system. This is that the servo control works well when the scene to be photographed, and thus the images on the sensor 8, are of high contrast. In such a case a small change in the angle of the mirror 5 will produce a substantial change in the output of the sensor 8. But when the scene to be photographed has a low contrast, the sensor 8 is unable to differentiate small changes in the mirror angle. Large distance measuring errors and substantial misfocusing of the camera lens can therefore result. The latest Bell and Howell development is a simple embellishment of the basic system intended to minimise focusing errors under conditions of low contrast.

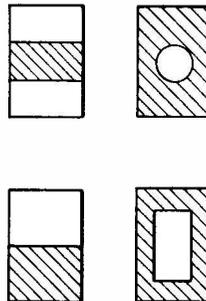


Fig. 2

As shown in Fig. 1 a pair of light filters 9',9 are provided in the optical paths L,R of the mirrors 5,2. These filters are partially optically screened as shown in Fig. 2, and produce artificial contrast differences.

When the camera optics are pointed at a low contrast scene such as the sky, and no useful image coincident output can be obtained from the sensor 8, the artificial contrast created by the filter screens enables the servo system to latch at a pre-set compromise focus. This pre-set compromise will generally be a medium distance similar to the pre-set of a fixed focus lens.

Whenever the scene to be photographed is of sufficient inherent contrast to produce a significant coincident signal from the sensor 8, the artificial contrast effect introduced by the filter screens is over-ridden.

Test results have shown that a light reduction of between 5 and 10 per cent in the screening parts of the filters is ideal for providing compromise focusing when the photographed scene has inadequate contrast for auto-focus control, while enabling the auto-focus control to function unhampered when natural scene contrast is adequate.

STEREO VIA CABLE TV

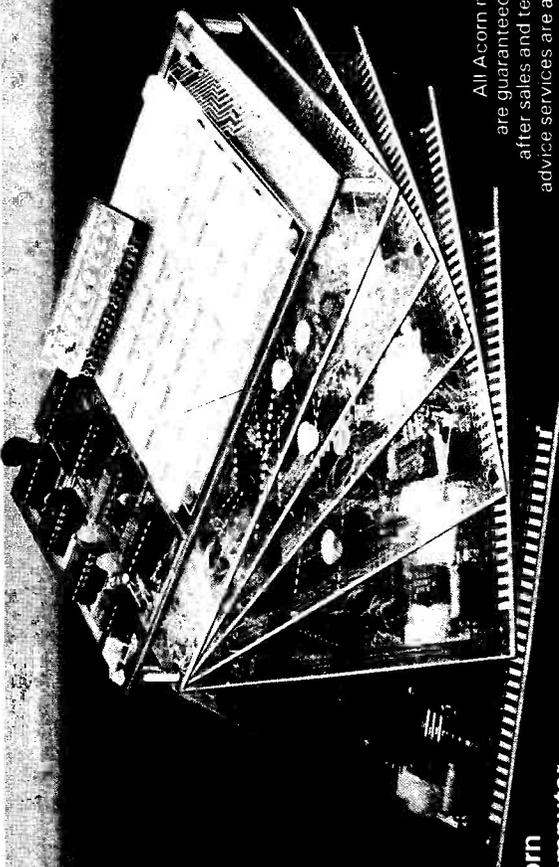
In BP 1 529 985 Communications Patents Ltd. of London SW1 claim novelty in a system for broadcasting stereo sound programmes over a cable TV system. The patent was applied for in 1976 and is granted under the old laws.

As the patent points out, it is clearly impractical to transmit stereo sound on a cable system by providing two separate audio channels. Apart from all other considerations such a system is not mono compatible. An alternative idea is to use FM transmission in a band above that adopted for TV transmission, the stereo sound signal having a format corresponding to that used for stereo radio transmission. But, according to the inventors, the repeaters available on existing cable networks are not suitable for handling such high band FM signals and unacceptable interference between the TV and audio programmes results.

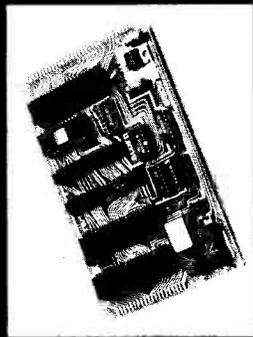
The patent claims that the answer lies in multiplexing a number of stereo sound programmes in a single network channel. Each sound programme is on a frequency modulated HF carrier and the frequency of each carrier is an integral multiple of the stereo sub carrier frequency. In practice, the sub carrier will be at 38kHz and the HF carrier frequencies will be in the band, 4 to 10MHz or 16 to 22MHz.

The carrier frequencies are selected so that the sum of any two carriers is different from any one of the carrier frequencies and so that no carrier frequency is twice any other carrier. This can be achieved by arranging for the frequency difference between any two adjacent carriers to differ from the frequency difference between any other two adjacent carriers. In one practical application of the idea, one of six available TV channels is dedicated to stereo sound. Tables are given which show the arrangement of carriers to be used in the case of 3, 5 and 12 different stereo programmes on the single channel.

Three Trumps from Acorn

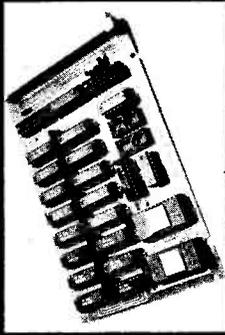


All Acorn modules are guaranteed and full after sales and technical advice services are available.



Acorn Controller

Designed as an industrial controller module, it is based on the 6502 CPU with 2K Eprom, 1.25K ram and 32 I/O lines. In eurocard format it is provided with an onboard monitor (2 x 74S571) giving comprehensive development and debugging facilities. Also available in minimum configuration for low cost OEM applications.



Acorn Memory

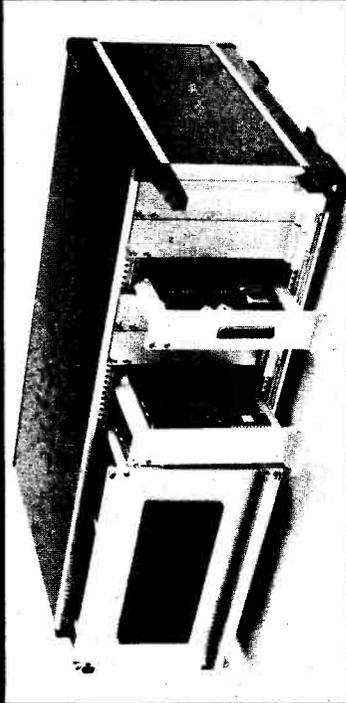
The first in our series of expansion cards is the Acorn 8K + 8K "state of the art" memory module. On a matching eurocard it provides 8K of ram (2114) and 8K of Eprom (2732) or 4K of Eprom (2716). It requires a single 5V rail, is designed for direct connection via a 32 way edge connector to the Acorn bus and is fully buffered for wiring into any system. Two onboard sockets provide independent positioning of Eprom and ram.

The Acorn Microcomputer

The Acorn controller module mounted beneath a matching eurocard with hex keyboard, 8 digit seven segment display and CUTS tape interface requires only a single unswitched power supply to form the powerful Acorn microcomputer.

Although designed for expandability the Acorn Microcomputer is a complete development system for the Acorn controller and together with the Acorn Users Manual provides the perfect introduction to hex programming; the carefully optimised monitor has the following functions:

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



Software available soon includes 4K-Editor-Assembler Disassembler, 4K Proprietary Fast Basic, Disc operating system with full file handling. Although a standard strip of

veroboard is all that is required for a full backplane, a racking system can be made available by Acorn Computers. The rack shown includes the VDU interface, two memory cards and dual floppy disc interface.



ACORN COMPUTERS LTD

4A Market Hill, Cambridge, Cambs.

Order form

Send to: Acorn Computers Ltd, 4A Market Hill, Cambridge, Cambs.

- (qty) Acorn Microcomputer(s) in kit form at £65.00 plus £9.75 VAT
 - (qty) Acorn Microcomputer(s) assembled and tested at £75.00 plus £11.25 VAT
 - (qty) Acorn controller(s) (minimum configuration) at £35.00 plus £5.25 VAT
 - (qty) Acorn Memory(s) assembled and tested at £95.00 plus £14.25 VAT
- N.B. Price shown is for full 8K of ram, prices for smaller memory options and Eprom additions available on request.
- I enclose a cheque for £..... made out to Acorn Computers Ltd.

Name _____ Regd No 1403810

Address _____



PE9



BUY A microcomputer for less than some TV games

only
£79.95
+ VAT

ADD-ONS

- POWER SUPPLY (6.3V AC) for ELF 11 5.00
 - ELF 11 DE LUXE STEEL CABINET (IBM Blue) 23.01
 - GIANT BOARD KIT System/Monitor, Interface to cassette - RS232, TTY etc 35.00
 - 4K STATIC RAM board kits (requires expansion power supply) 69.44
 - Expansion power supply (required when adding 4K Rams) 19.00
 - ASC11 Keyboard Kits 96 printable characters etc 50.58
 - ASC11 d/lux steel cab. (IBM Blue) 15.02
 - KLUGE prototype board (build your own circuits) 12.83
 - 86 pin Gold plated connectors (EA) 4.00
 - ELF Light pen writes/draws on TV screens 6.50
 - Video graphics board 32/64 characters by 16 lines on TV/monitor screens 69.95
 - ELF 11 Tiny basic on cassette 13.50
 - ELF 11 Bug/monitor powerful systems monitor/editor 13.50
 - T. PITMANS short course in programming manual (Nil VAT) 4.00
 - T. PITMAN short course on tiny basic manual (Nil VAT) 4.00
 - RCA 1802 users manual (Nil VAT) 4.00
 - † On cassette test editor: assembler, disassembler (EA) 16.95
- SAVE 10% AND BUY ALL THREE TOGETHER**
All units can be supplied wired and tested
Send S.A.E. for comprehensive brochure

ELF 11 BOARD WITH VIDEO OUTPUT

STOP reading about computers and get your "hands on" an ELF 11 and Tom Pitman's short course. ELF 11 demonstrates all the 91 commands which an RCA 1802 can execute, and the short course speedily instructs you how to use them.

ELF 11's VIDEO OUTPUT makes it unique among computers selling at such a modest price. The expanded ELF 11 is perfect for engineers, business, industry, scientific and educational purposes.

SPECIFICATION

- RCA 1802 8 bit microprocessor with 256 byte RAM expandable to 64K bytes
- RCA 1861 video IC to display program on TV screen via the RF Modulator
- Single Board with professional hex keyboard fully decoded to eliminate the waste of memory for keyboard decoding circuits
- Load, run and memory project switches
- 18 registers
- Interrupt, DMA and ALU
- Stable crystal clock
- Built in power regulator
- 5 slot plug in expansion bus (less connectors)

Name.....

Address.....

Barclaycard/Access.....

**To Newtronics 138 Kingsland Road
London E2 8BY
Tel: 01-739 1582**

LIGHTING & AMPLIFIER MODULES FROM L&B

JUST LOOK AT THESE PRICES!

Superior high quality lighting control modules. No additional power supply, just ready to go!

— LB31000SL —

Sound-light, 3 channel x 1000W. Zero mains voltage switching, high sensitivity, high input impedance, excellent separation.

£18.90

— LB41000LS —

Light sequencer, 4 chan. x 1000W. Suedo-random, zero switching.

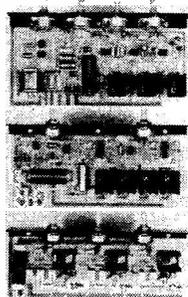
£14.90

Two-speed controls, excellent for stage lighting.

— LB31000LD —

Light dimmer, 3 chan. x 1000W. Stage lighting from full off to full on.

£12.90



Massive audio power at your fingertips! For use in many applications.

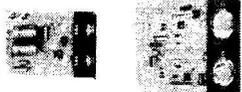
— LB25 —
25W, RMS 4Ω
10Hz-50kHz
T.H.D. 0.1% 90dB S/N

£8.20



— LB250 —
250W R.M.S. 4Ω
10Hz-20kHz
T.H.D. 0.3% 110dB S/N

£29.50



— LB100 —
100W R.M.S. 4Ω
10Hz-25kHz
T.H.D. 0.4% 80dB S/N

£15.70

- PREAMPLIFIERS**
- LBPA1 Stereo disc/tape **£14.50**
 - LBPA2. 4 channel gen. purpose mixer **£13.50**
 - LBPA3. Stereo disco with mic. **£22.00**

- POWER SUPPLIES**
- LB25PS **£10.00**
 - LB100PS **£12.20**
 - LB250PS **£21.20**

- COMPONENTS SEMICONDUCTORS
RES/CAPS TRANSFORMERS**

Send for list

All above prices include VAT. Please add 50p p/packing. Quantity/trade discounts, up to 33% available. Export enquiries welcome. SAE for further info.

L&B ELECTRONICS 45 WORTLEY ROAD, W. CROYDON SURREY CR0 3EB. TEL: 01-689 4138

AURA SOUNDS

THE WERSI SPECIALISTS

Announce the opening of their
NEW SHOWROOM
at Purley Oaks Centre
01-668 9733
for Do-It-Yourself Kits and Ready-Assembled
Organs, Accessories and Pianos

SEE the **OWERSI** KITS

TALK to the **OWERSI** SPECIALISTS

HEAR the **OWERSI** SOUNDS

SEND £1 FOR OUR 104 PAGE FULL COLOUR CATALOGUE AND PRICE LIST TO: -

AURA SOUNDS
14/15 Royal Oak Centre,
Brighton Rd.,
Purley, Surrey.

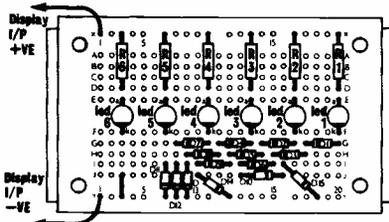
Also at 17 Upper Charter Arcade, Barnsley

THREE FOR FREE FROM CSC

ELECTRONICS BY NUMBERS
FREE PROJECTS
 No 1, No 2,
 & No 3.

ELECTRONICS BY NUMBERS LED BAR GRAPH UNIVERSAL INDICATOR

Now using **EXPERIMENTOR BREADBOARDS** and following the instructions in "Electronics by numbers" ANYBODY can build electronic projects. Look at the diagram and select R1, this is a resistor with a value between 120 to 270 ohm. Plug it into holes X20 and D20, now take LED 1 and plug it into holes E20 and F20. Do the same with the Diodes e.g. plug D7 into holes G7 and G10.



YOU WILL NEED

- EXP- ANY EXPERIMENTOR BREADBOARD**
- D1 to D15** - Silicon Diodes (such as 1N914)
- R1 to R6** - From 120-270 ohm resistors ¼ watt.
- LED1 to LED6** - Light emitting diodes.

LED BAR GRAPHS are replacing analogue meters as voltage-level indicators in many instances. This circuit uses the forward voltage drop of diodes to determine how many LEDs light up. Any type of diode can be used but you must use all the same type. For full working details of this circuit fill in the coupon. If you have already built the Two-transistor Radio and the Fish'n'cliks projects you will find that you can reuse the components from these projects to build other projects in the series.

FILL IN THE COUPON AND WE WILL SEND YOU FREE OF CHARGE FULL COPIES OF "ELECTRONICS BY NUMBERS" PROJECTS No 1, No 2 and No 3.

PROTO-CLIP TEST CLIPS.

Brings IC leads up from crowded PC boards. Available plain or with cable with clips at one or both ends.



- PC - 16 pin. £2.75.
- PC - 16 pin with cable. £6.00.
- PC - 16 with cable and 16 pin clips at both ends. £10.25.



Europe, Africa, Mid-East, Australasia:
 CSC UK LTD. DEPT. 5T
 Unit 1, Shire Hill Industrial Estate,
 Saffron Walden, Essex CB11 3AQ.
 Telephone: SAFFRON WALDEN 21682.
 Telex: 817477.

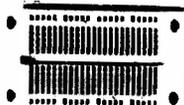
EXPERIMENTOR BREADBOARDS.

No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build breadboard of any size. All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP.4B.

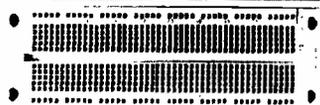
EXP.325. The ideal breadboard for 1 chip circuits. Accepts 8,14,16 and up to 22 pin IC's. **ONLY £1.60.**



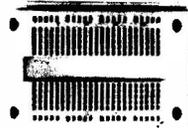
EXP.350. £3.15. 270 contact points with two 20-point bus-bars.



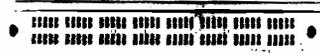
EXP. 300. 550 contacts with two 40-point bus-bars. **£5.75.**



EXP. 650 for Micro-processors. **£3.60.**



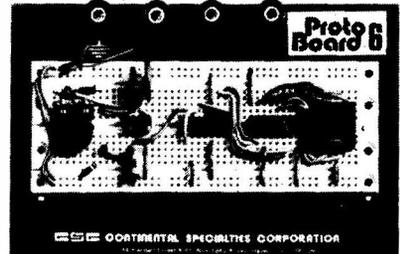
EXP 4B. More bus-bars. **£2.30.**



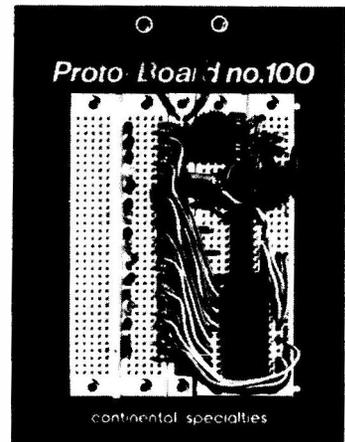
ALL EXP.300 Breadboards mix and match with 600 series.

PROTO-BOARDS.

THE ULTIMATE IN BREADBOARDS FOR THE MINIMUM COST. TWO EASILY ASSEMBLED KITS.



PB.6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips. **PROTO-BOARD 6 KIT. £9.20.**



PB.100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy. **PROTO-BOARD 100 KIT £11.80.**

HOW TO ORDER AND RECEIVE FREE COPY OF TWO-TRANSISTOR RADIO PROJECT, FISH'N'CLIKS AND LED BAR GRAPH.

CSC UK LTD. DEPT. 5T Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

It's easy. Give us your name and full postal address, in block capitals. Enclose cheque, postal order or credit card number and expiry date. OR telephone 0799 21682 and give us your Access, American Express or Barclaycard number and your order will be in the post that night.

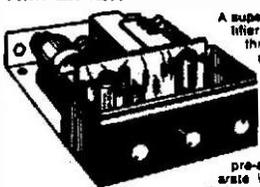
EXPERIMENTOR BREADBOARDS.	CONTACT HOLES.	IC CAPACITY 14 PIN,DIP.	UNIT PRICE INCLUDING POSTAGE AND V.A.T.15%
EXP. 325	130	1	£ 2.70
EXP. 350	270	3	£ 4.48
EXP. 300	550	6	£ 7.76
EXP. 650	270	use with 0.6 pitch Dip's Bus-Bar Strip	£ 4.99
EXP. 4B.	Four 40 Point Bus-Bars		£ 3.51
TEST CLIPS			
PC. 16.			£ 4.03
PC. 16-18.			£ 8.05
PC. 16-18 Dual Clip.			£12.94
PROTO-BOARDS.			
PB. 6.	630	6	£11.73
PB. 100.	760	10	£14.72

NAME

ADDRESS

FILL IN COUPON & RECEIVE FREE COPY OF ELECTRONICS BY NUMBERS PROJECTS Nos 1, 2 AND 3

SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx 13 watts r.m.s. into 8 ohms. Frequency response 12Hz-30kHz. 3db fully integrated pre-amplifier with separate Volume, Bass Boost and Treble cut controls. Suitable for 8-16 ohm speakers input for ceramic or crystal cartridge. Sensitivity approx 40mV for full output. Supplied ready built and tested, with knobs, enclosure panel, input and output plugs. Overall size 3in high x 8in wide x 7 1/2in deep AC 230/250V.

PRICE £18.40 P. & P. £1.20.

HARVERSONIC MODEL P.A. TWO ZERO

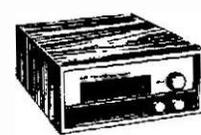


An advanced solid state general purpose mono amplifier suitable for Public Address System, Disco, Guitar, Gram etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp.). Input 1, 15mV into 47k. Input 2, 15mV into 47k (suitable for use with mic. or guitar etc.). Input 3, 300mV into 1 meg. suitable for gram, tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plus into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 30 watts music power. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front enclosure. For AC mains operation 200/240 volts. Size approx 12 1/2in wide x 6in high x 7 1/2in deep.

Special introductory price £29.00 + £2.50 carriage and packing.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 1 1/2in x 1 1/2in deep. Weight 19oz. Power handling 20W R.M.S. 140W peak. Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S.A.E. for full details. Only £28.80 each + P. & P. (one 90p, two £1.10). Now available in 8in round version, 10 watts R.M.S. £21.00. £6.50 + P. & P. (one 80p, two 70p.).

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State F.M. A.M. Stereo Tuner Covering MW AM 540-1605kHz VHF FM 86-108MHz. Built-in Ferrite rod aerial for M.W. Full AF and AGC on A.M. and F.M. Stereo Beacon Lamp indicator Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max. output 600mV R.M.S. into 20k Simulated Test finish cabinet. Will match almost any amplifier. Size 8 1/2in wide x 4in high x 3 1/2in deep approx.

Limited number only at £29.00 + £1.50 P. & P.

10/14 WATT HI-FI AMPLIFIER KIT
A stylish finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram and records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-16Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good low and cut. Valve line-up: 2 EL84s, ECC83, EF85 and 250 rectifier. Simple instruction booklet 50p + S.A.E. (Free with parts). All parts sold separately. ONLY £18.40 P. & P. £1.40. Also available ready built and tested £22.80 P. & P. £1.40.

STEREO MAGNETIC PRE-AMP Sens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. +1dB from 20Hz to 20kHz. Input impedance 47k. Size 1 1/2in x 2 1/2in x 5 1/2in £3.20 + 20p. P. & P.

Multi-rod LP115B RF-IF module 470 kHz £2.80 + P. & P. 20p. Full specification and connection details supplied.

Pyra VHF FM Tuner Head covering 88-108 MHz 10.7 MHz I.F. output. 7.5V + earth. Supplied pre-aligned, with full circuit diagram with precision-gear F.M. gong and 323PF + 323PF A.M. Tuning gong only £3.40 + P. & P. 30p.

SPECIAL OFFER
Sightly shop soiled radio by well-known manufacturer for AC Mains or battery use. MW and FM bands. Dynamic M/cool speakers, telescopic aerial and internal ferrite core. Entice socket for personal listening. Finished in attractive simulated leatherette. Size 7 1/2in x 9 1/2in x 4 1/2in. Fully guaranteed. Bargain price of only £10.25 + £1.30 P. & P.

SPECIAL OFFER LIMITED NUMBER ONLY
GODDMANS speakers, 6 1/2in 8 ohm, long throw, ceramic magnet, full range rated 10 watts R.M.S. (when fitted in enclosure). £4.15 each + 80p. P. & P. (P. & P. are two £1.20)

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 16 transistors including Silicon Transistors in the first five stages of each channel, resulting in even lower noise level with improved sensitivity. Integral pre-amp. with Bass, Treble and two Volume controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 16 ohms. Compact design, all parts supplied including drilled metalwork, high quality ready drilled printed circuit-board with component identification clearly marked smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output, 14 watts R.M.S. per channel into 8 ohms. Frequency response: 3-30 12-30 000Hz. Main feedback network from 60mV into 1 MΩ. Full power bandwidth ±3dB 12-15,000Hz. Bass boost approx to ±20dB. Treble cut approx to -16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1A.

Overall size 12in wide x 8in deep x 2 1/2in high.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT £14.85 P. & P. 80p
(Magnetic input components 30p extra)
POWER PACK KIT £6.20 P. & P. 95p
CABINET £28.20 P. & P. 95p

SPECIAL OFFER—only £28.80 if all 3 items ordered at one time plus £1.25 P. & P.

Full after sales service
Also available ready built and tested £32.20 P. & P. £1.50

HARVERSONIC STEREO 44
A solid state stereo amplifier chassis with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape reel play socket are mounted on the printed circuit panel. Size approx. 9 1/2in x 2 1/2in x 1 1/2in max depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way enclosure (to allow the amplifier to be mounted horizontally or vertically) at only £19.40 + 50p P. & P. Mains transformer with an output of 17V A.C. at 500mA can be supplied at £2.18 + 40p P. & P. if required. Full construction details supplied.

STEREO DECODER
SIZE 2" x 3" x 1" ready built. Pre-aligned and tested for 9-18V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of tests and tips) supplied. £8.20 plus 20p P. & P. Stereo beacon light if required 40p extra.

Open 9.30-5.30 Monday to Friday, 9.30-5 Saturday Closed Wednesday.
Prices and specifications correct at time of press. Subject to alteration without notice.

HARVERSON SURPLUS CO. LTD.

(Dept. P.E.) 170 MERTON HIGH ST., MERTON, LONDON, S.W.19 Tel: 01-540 3885

A few minutes from South Wimbledon Tube Station

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

ZENER DIODES (400 watt) 2-7V to 320V	OPTO/DISPLAY ORP12 70p OR704 110p DL707 110p -12V & -2V LEDs: Red 18p Blue 14p Green 14p Yellow 14p	TTL 7400/1 11p 7402/2 11p 7404/5 11p 7410 13p 7411 13p 7412 13p 7413 27p 7414 40p 7417 25p 7418 25p 7420 13p 7421 21p 7422 22p 7423 25p 7424 25p 7425 25p 7426 25p 7427 13p 7428 13p 7429 13p 7430 13p 7431 13p 7432 13p 7433 13p 7434 13p 7435 13p 7436 13p 7437 13p 7438 13p 7439 13p 7440 13p 7441 13p 7442 13p 7443 13p 7444 13p 7445 13p 7446 13p 7447 13p 7448 13p 7449 13p 7450 13p 7451 13p 7452 13p 7453 13p 7454 13p 7455 13p 7456 13p 7457 13p 7458 13p 7459 13p 7460 13p 7461 13p 7462 13p 7463 13p 7464 13p 7465 13p 7466 13p 7467 13p 7468 13p 7469 13p 7470 13p 7471 13p 7472 13p 7473 13p 7474 13p 7475 13p 7476 13p 7477 13p 7478 13p 7479 13p 7480 13p 7481 13p 7482 13p 7483 13p 7484 13p 7485 13p 7486 13p 7487 13p 7488 13p 7489 13p 7490 13p 7491 13p 7492 13p 7493 13p 7494 13p 7495 13p 7496 13p 7497 13p 7498 13p 7499 13p 7500 13p	74132 40p 74141 40p 74142 19p 74145 40p 74151 40p 74154 80p 74155 40p 74156 40p 74157 40p 74158 40p 74159 40p 74160 40p 74161 40p 74162 40p 74163 40p 74164 40p 74165 40p 74166 40p 74167 40p 74168 40p 74169 40p 74170 40p 74171 40p 74172 40p 74173 40p 74174 40p 74175 40p 74176 40p 74177 40p 74178 40p 74179 40p 74180 40p 74181 40p 74182 40p 74183 40p 74184 40p 74185 40p 74186 40p 74187 40p 74188 40p 74189 40p 74190 40p 74191 40p 74192 40p 74193 40p 74194 40p 74195 40p 74196 40p 74197 40p 74198 40p 74199 40p 74200 40p 74201 40p 74202 40p 74203 40p 74204 40p 74205 40p 74206 40p 74207 40p 74208 40p 74209 40p 74210 40p 74211 40p 74212 40p 74213 40p 74214 40p 74215 40p 74216 40p 74217 40p 74218 40p 74219 40p 74220 40p 74221 40p 74222 40p 74223 40p 74224 40p 74225 40p 74226 40p 74227 40p 74228 40p 74229 40p 74230 40p 74231 40p 74232 40p 74233 40p 74234 40p 74235 40p 74236 40p 74237 40p 74238 40p 74239 40p 74240 40p 74241 40p 74242 40p 74243 40p 74244 40p 74245 40p 74246 40p 74247 40p 74248 40p 74249 40p 74250 40p	4027 32p 4028 40p 4029 50p 4030 32p 4035 107p 4041 78p 4042 58p 4043 40p 4044 72p 4047 85p 4048 60p 4049 27p 4050 27p 4051 13p 4052 13p 4053 13p 4054 13p 4055 13p 4056 13p 4057 13p 4058 13p 4059 13p 4060 13p 4061 13p 4062 13p 4063 13p 4064 13p 4065 13p 4066 13p 4067 13p 4068 13p 4069 13p 4070 13p 4071 14p 4072 14p 4073 17p 4074 14p 4075 14p 4076 14p 4077 14p 4078 14p 4079 14p 4080 14p 4081 14p 4082 14p 4083 14p 4084 14p 4085 14p 4086 14p 4087 14p 4088 14p 4089 14p 4090 14p 4091 14p 4092 14p 4093 14p 4094 14p 4095 14p 4096 14p 4097 14p 4098 14p 4099 14p 4100 14p 4101 14p 4102 14p 4103 14p 4104 14p 4105 14p 4106 14p 4107 14p 4108 14p 4109 14p 4110 14p 4111 14p 4112 14p 4113 14p 4114 14p 4115 14p 4116 14p 4117 14p 4118 14p 4119 14p 4120 14p 4121 14p 4122 14p 4123 14p 4124 14p 4125 14p 4126 14p 4127 14p 4128 14p 4129 14p 4130 14p 4131 14p 4132 14p 4133 14p 4134 14p 4135 14p 4136 14p 4137 14p 4138 14p 4139 14p 4140 14p 4141 14p 4142 14p 4143 14p 4144 14p 4145 14p 4146 14p 4147 14p 4148 14p 4149 14p 4150 14p 4151 14p 4152 14p 4153 14p 4154 14p 4155 14p 4156 14p 4157 14p 4158 14p 4159 14p 4160 14p 4161 14p 4162 14p 4163 14p 4164 14p 4165 14p 4166 14p 4167 14p 4168 14p 4169 14p 4170 14p 4171 14p 4172 14p 4173 14p 4174 14p 4175 14p 4176 14p 4177 14p 4178 14p 4179 14p 4180 14p 4181 14p 4182 14p 4183 14p 4184 14p 4185 14p 4186 14p 4187 14p 4188 14p 4189 14p 4190 14p 4191 14p 4192 14p 4193 14p 4194 14p 4195 14p 4196 14p 4197 14p 4198 14p 4199 14p 4200 14p	BC123 11p BC124 14p BC127 11p BC101 11p BC107 11p BC108 11p BC109 11p BC110 11p BC111 11p BC112 11p BC113 11p BC114 11p BC115 11p BC116 11p BC117 11p BC118 11p BC119 11p BC120 11p BC121 11p BC122 11p BC123 11p BC124 11p BC125 11p BC126 11p BC127 11p BC128 11p BC129 11p BC130 11p BC131 11p BC132 11p BC133 11p BC134 11p BC135 11p BC136 11p BC137 11p BC138 11p BC139 11p BC140 11p BC141 11p BC142 11p BC143 11p BC144 11p BC145 11p BC146 11p BC147 11p BC148 11p BC149 11p BC150 11p BC151 11p BC152 11p BC153 11p BC154 11p BC155 11p BC156 11p BC157 11p BC158 11p BC159 11p BC160 11p BC161 11p BC162 11p BC163 11p BC164 11p BC165 11p BC166 11p BC167 11p BC168 11p BC169 11p BC170 11p BC171 11p BC172 11p BC173 11p BC174 11p BC175 11p BC176 11p BC177 11p BC178 11p BC179 11p BC180 11p BC181 11p BC182 11p BC183 11p BC184 11p BC185 11p BC186 11p BC187 11p BC188 11p BC189 11p BC190 11p BC191 11p BC192 11p BC193 11p BC194 11p BC195 11p BC196 11p BC197 11p BC198 11p BC199 11p BC200 11p	OC25 70p OC28 80p OC35 80p OC71 34p OC84 30p OC89 30p OC92 30p OC93 30p OC94 30p OC95 30p OC96 30p OC97 30p OC98 30p OC99 30p OC100 30p OC101 30p OC102 30p OC103 30p OC104 30p OC105 30p OC106 30p OC107 30p OC108 30p OC109 30p OC110 30p OC111 30p OC112 30p OC113 30p OC114 30p OC115 30p OC116 30p OC117 30p OC118 30p OC119 30p OC120 30p OC121 30p OC122 30p OC123 30p OC124 30p OC125 30p OC126 30p OC127 30p OC128 30p OC129 30p OC130 30p OC131 30p OC132 30p OC133 30p OC134 30p OC135 30p OC136 30p OC137 30p OC138 30p OC139 30p OC140 30p OC141 30p OC142 30p OC143 30p OC144 30p OC145 30p OC146 30p OC147 30p OC148 30p OC149 30p OC150 30p OC151 30p OC152 30p OC153 30p OC154 30p OC155 30p OC156 30p OC157 30p OC158 30p OC159 30p OC160 30p OC161 30p OC162 30p OC163 30p OC164 30p OC165 30p OC166 30p OC167 30p OC168 30p OC169 30p OC170 30p OC171 30p OC172 30p OC173 30p OC174 30p OC175 30p OC176 30p OC177 30p OC178 30p OC179 30p OC180 30p OC181 30p OC182 30p OC183 30p OC184 30p OC185 30p OC186 30p OC187 30p OC188 30p OC189 30p OC190 30p OC191 30p OC192 30p OC193 30p OC194 30p OC195 30p OC196 30p OC197 30p OC198 30p OC199 30p OC200 30p
---	---	--	--	--	--	--

SINCLAIR PRODUCTS New 10MHz scope probe. PFM200 £49.48, case £3.19, adaptor £2.14, £2.28, £2.40, £2.52, £2.64, £2.76, £2.88, £3.00, £3.12, £3.24, £3.36, £3.48, £3.60, £3.72, £3.84, £3.96, £4.08, £4.20, £4.32, £4.44, £4.56, £4.68, £4.80, £4.92, £5.04, £5.16, £5.28, £5.40, £5.52, £5.64, £5.76, £5.88, £6.00, £6.12, £6.24, £6.36, £6.48, £6.60, £6.72, £6.84, £6.96, £7.08, £7.20, £7.32, £7.44, £7.56, £7.68, £7.80, £7.92, £8.04, £8.16, £8.28, £8.40, £8.52, £8.64, £8.76, £8.88, £9.00, £9.12, £9.24, £9.36, £9.48, £9.60, £9.72, £9.84, £9.96, £10.08, £10.20, £10.32, £10.44, £10.56, £10.68, £10.80, £10.92, £11.04, £11.16, £11.28, £11.40, £11.52, £11.64, £11.76, £11.88, £12.00, £12.12, £12.24, £12.36

STEVENSON

Electronic Components

REGULATORS

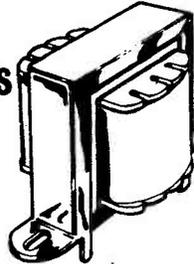
78L05 30p	7805 60p	79L05 70p	7912 80p
78L12 30p	7812 60p	79L12 70p	7915 80p
78L15 30p	7815 60p	7905 80p	LM723 35p

HARDWARE

MINIATURE TRANSFORMERS

240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6-0-6, 9-0-9 and
12-0-12. 92p. each.



LOUDSPEAKERS

56mm dia. 8 ohms	70p
64mm dia. 8 ohms	75p
64mm dia. 64 ohms	75p
70mm dia. 8 ohms	100p
70mm dia. 80 ohms	110p

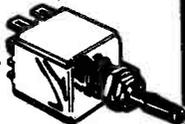


TERMINALS

Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES

Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p



Standard toggle

SPST 34p DPDT 48p

Wavechange switches.

1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)

Push to make 15p Push to break 20p



Slide switches (DPDT)

Miniature 14p Standard 15p

CONTROL KNOBS

Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

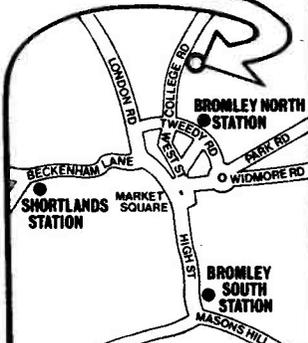


WHY NOT VISIT OUR

NEW SHOP

We welcome callers at our new premises at the address below (5 mins. from High St.) We are open Mon - Sat, 9am - 6pm. Special offers available.

Express telephone order service. Orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Tel: 01-464 2951/5770.



**ORDERS
DESPATCHED
BY RETURN
POST**

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 100+ 10% 1000+ 15%. Prices VAT inclusive. Please add 30p for carriage. All prices valid to April 1980. Official orders welcome.

BARCLAYCARD
& ACCESS WELCOME



Mail orders to: STEVENSON (Dept PE)

TRANSISTORS

AC127 17p	BCY71 14p	ZTX109 14p
AC128 16p	BCY72 14p	ZTX300 16p
AC176 18p	BD131 35p	2N697 12p
AD161 38p	BD132 35p	3N1302 38p
AD162 38p	BD135 38p	2N2905 22p
BC107 8p	BD139 35p	2N2907 22p
BC108 8p	BD140 35p	2N3053 18p
BC109 8p	BF244B 36p	2N3055 50p
BC147 7p	BFY50 15p	2N3442 135p
BC148 7p	BFY51 15p	2N3702 8p
BC149 8p	BFY52 15p	2N3704 8p
BC148 9p	MJ2955 98p	2N3705 9p
BC177 14p	MPSA06 20p	2N3706 9p
BC178 14p	MPSA56 20p	2N3707 9p
BC179 14p	TIP29C 60p	2N3708 8p
BC182 10p	TIP30C 70p	2N3819 22p
BC182L 10p	TIP31C 65p	2N3904 8p
BC184 10p	TIP32C 80p	2N3905 8p
BC184L 10p	ZTX107 14p	2N3908 8p
BC212 10p	ZTX108 14p	2N4058 12p
BC214 10p		2N5457 32p
BC214L 10p		2N5458 30p
BC477 19p		2N5459 32p
BC478 19p		2N5777 50p
BC479 19p		
BC548 10p		
BCY70 14p		

DIODES

1N914 3p	1N5401 13p
1N4001 4p	BZY88ser. 8p
Full spec. product.	
1N4148. £1.40/100. £11/1000	

LINEAR

THIS IS ONLY A SELECTION!	CA3140 38p	NE555 21p
	LM301AN 26p	NE566 50p
	LM318N 85p	NE565 85p
	LM324 45p	NE567 170p
709 28p	LM339 45p	SN76003 200p
741 16p	LM380 75p	SN76013 140p
747 40p	LM382 120p	SN76023 140p
748 30p	LM1830 150p	SN76033 200p
CA3046 55p	LM3909 65p	SN76477 220p
CA3080 70p	MC1496 60p	TDA800 70p
CA3130 90p	MC1458 32p	TDA1022 850p
		ZN414 75p

CAPACITORS

TANTALUM BEAD	each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V	8p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p

MYLAR FILM	3p
0.001, 0.01, 0.022, 0.033, 0.047, 0.068, 0.1	4p

POLYESTER	
Multilard C280 series	
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1	5p
0.15, 0.22	7p
0.33, 0.47	10p
0.68	14p
1.0uF	17p

CERAMIC	
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF 0.047uF	2p

RADIAL LEAD ELECTROLYTIC	
63V 0.47 1.0 2.2 4.7 10	5p
	7p
100	13p
	20p
25V 10 22 33 47	5p
100	8p
	10p
220	15p
1000	23p

CONNECTORS

JACK PLUGS AND SOCKETS		
screened	unscreened	socket
2.5mm 9p	13p	7p
3.5mm 9p	14p	8p
Standard 16p	30p	15p
Stereo 23p	36p	18p

DIN PLUGS AND SOCKETS		
plug	chassis socket	line socket
2pin 7p	7p	7p
3pin 11p	9p	14p
5pin 180° 11p	10p	14p
5pin 240° 13p	10p	16p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits, Red & black.
Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each

PHONO PLUGS AND SOCKETS	
Insulated plug in red or black	9p
Screened plug	13p
Single socket	10p

THERE WILL BE
**NO PRICE
RISES
DUE TO VAT**

WE HAVE DECIDED NOT TO
PASS ON THE INCREASES
DUE TO NEW VAT RATES

TTL	7454 12p	74132 45p
	7473 20p	74141 55p
	7474 22p	74148 90p
	7475 25p	74150 55p
7400 10p	7476 20p	74151 40p
7401 10p	7485 55p	74156 40p
7402 10p	7489 135p	74157 40p
7404 12p	7490 25p	74164 55p
7408 12p	7492 30p	74165 55p
7410 10p	7493 25p	74170 100p
7413 22p	7494 45p	74174 50p
7414 39p	7495 35p	74177 50p
7420 10p	7496 45p	74190 50p
7427 20p	74121 25p	74191 50p
7430 10p	74122 38p	74192 50p
7442 38p	74123 38p	74193 50p
7447 45p	74125 35p	74196 50p
7448 50p	74126 35p	74197 50p

CMOS	4018 55p	4050 25p
	4023 12p	4066 35p
	4024 40p	4068 18p
4001 12p	4026 90p	4069 12p
4002 12p	4027 30p	4071 12p
4007 12p	4028 48p	4081 13p
4011 12p	4029 50p	4093 45p
4013 28p	4040 60p	4510 65p
4015 50p	4042 50p	4511 65p
4016 30p	4046 90p	4518 65p
4017 48p	4049 25p	4520 60p

FULL DETAILS IN CATALOGUE!

SKTS	
Low profile by Texas	
8 pin 8p	16 pin 11p
14 pin 10p	24 pin 18p
	40 pin 32p
Soldercon pins: 100:50p. 1000:370p	

OPTO	
LED's 0.125in. 0.2in	each 100+
Red TIL209 TIL220	9p 8p
Green TIL211 TIL221	13p 12p
Yellow TIL213 TIL223	13p 12p
Clips 3p	3p
DISPLAYS	
DL704 0.3 in CC	130p 120p
DL707 0.3 in CA	130p 120p
FND500 0.5 in CC	100p 80p

RESISTORS	Carbon film resistors. High stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix:	
0.25W each	100+ 1000+
0.5W 1p	0.9p 0.8p
0.5W 1.5p	1.2p 1p
Special development packs consisting of 10 of each value from 4.7 ohms to 1 Meg-ohm (650 res) 0.5W £7.50. 0.25W £5.70.	
METAL FILM RESISTORS	
Very high stability, low noise rated at 1/2W 1%. Available from 51ohms to 330k in E24 series. Any mix:	
0.25W each	100+ 1000+
0.25W 4p	3.5p 3.2p

PLEASE WRITE FOR YOUR FREE COPY OF OUR NEW 80 PAGE CATALOGUE OF COMPONENTS. CONTAINS OVER OVER 2500 STOCK ITEMS.



76 College Road, Bromley, Kent, England

AITKEN BROS

35, High Bridge, Newcastle upon Tyne

Tel: 0632 26729



EXP300



PB6 Kit

EXP300
550 contacts with two 50-point BUS bars, Size 182x53mm. **£8-95.**
PROTO-BOARD 6 KIT
830 contacts, four 5 way binding posts, accepts up to 6 14 pin DIPs. **£10-95.**

CSC LOGIC PROBES

LP-2 ECONOMY PROBE
Min. pulse width 300 nanoseconds, 300 K Ω input impedance, tests circuits up to 1.5MHz. Detecting pulse trains or single-shot event in TTL, DTL, HTL, and CMOS circuits. **£20-85.**

LP-1 Memory Probe **£35-85**
LP-3 High Speed Memory Probe **£54-75**

CSC catalogue available. Please send S.A.E.

CALSCOPE SUPER 6 £188-30

A portable single beam 8MHz bandwidth oscilloscope with easy to use controls. High gain to 10 mv/cm and wide time base range from 1 μ s to 100 ms/cm. Full specification to request. Please send S.A.E. Professional scopes you can afford.

CALSCOPE SUPER 10 £251-85

A dual trace 10MHz instrument of the very highest performance and quality. It has an accuracy of 3% which is achieved by the use of built-in stabilised power supplies which keep the trace rock steady over a wide range of mains fluctuations. Full specification on request. Please send S.A.E.

TE20D TECH R.F. SIGNAL GENERATOR

Accurately covers 120 KCS to 500 MCS in 6 bands. Directly calibrated. Variable RF attenuator 240 VAC. Size 140x215x170mm.

Price **£52-50 (£50-58 to callers).**

TE22D TECH AUDIO GENERATOR

Sine & square wave audio generator. Sine wave range -20 cps to 20K cps in four bands
Square wave range 20 cps to 15K cps in four bands 240V A.C. Size 140x215x170mm.

Price **£83-31 (£81-31 to callers).**

TMK 500 MULTIMETER 30,000 o.p.v. AC volts 2.5, 10, 25, 100, 250, 500, 1000. DC volts. 0.25, 1, 2.5, 10, 25, 100, 250, 1000 DC current 50 μ a, 5MA, 50MA, 12 amp Resistance 0-6K, 60K, 6MEG, 60MEG. Decibels. -20 to + 56 db. Buzzer continuity test size, 160 x 110 x 55MM. Batteries & leads included.
PRICE £25-95.

CSC EXPERIMENTOR BREADBOARDS

No soldering modular breadboards, simply plug components in and out of letter/number identified nickel-silver contact holes. Start small and simply snap lock boards together to build breadboards of any size.



SINCLAIR DM350 **£79-95**
SINCLAIR DM450 **£114-95**

Size 255x148x40mm.
DM350 3 $\frac{1}{2}$ digit display DM450 4 $\frac{1}{2}$ digit display. Both provide six functions in 34 ranges. D.C. voltage 10 μ V to 1200V (100 μ V on DM350) A.C. voltage 100 μ V to 750V. D.C. current 1nA to 10A, A.C. current 1nA to 10A resistance 10m Ω to 20M Ω (100m Ω on DM350). Accessories for DM350 & 450 as for DM235 below. Full spec. on request. Please send S.A.E.

Sinclair PMM200 frequency meter

Size 157x76x32mm.
Range 20Hz to 200MHz. Accessories and illustration as for PDM35 above. **£87-85.**

SINCLAIR PDM35 DIGITAL POCKET MULTIMETER

DC volts (4 ranges) 1MV to 1000V AC volts 1V to 500V DC current (6 ranges) 1nA to 200MA, Resistance (5 ranges) 1 Ω to 20 MEG Ω . **PRICE £34-95.** AC Adaptor **£3-95** de luxe padded carrying case **£3-50** MN 1604 Battery **£1-14.** Size 157x76x32mm.

SINCLAIR DM235 BENCH-PORTABLE DIGITAL MULTIMETER.

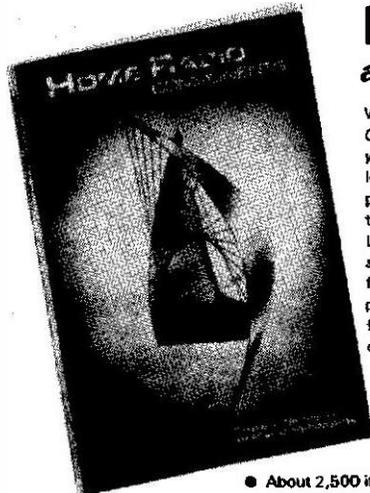
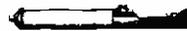
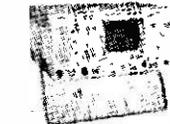
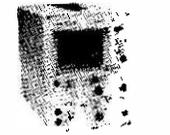
DC volts (4 ranges) 1MV to 1000V AC volts (4 ranges) 1MV to 750V AC & DC current 1 μ a to 1000MA Resistance (5 ranges) 1 Ω to 20 MEG Ω . **PRICE £57-95.** Carrying case **£9-85.** AC adaptor/charger. **£4-50.** Rechargeable Battery Pack. **£9-70.** Size 255 x 148x40mm.

PANEL METERS

DIMS 60MM x 45MM 50 μ amp, 100 μ amp 1MA, 5MA, 10MA, 50MA, 100MA, 500MA, 1 amp, 2 amp. 2.5V dc. 30V dc, 50V AC, 300V ac. "S", "VU" 50-0-50 μ a, 100-0-100 μ a, 500-0-500 μ a. **PRICE £5-95.**

DESOLDERING TOOL **£6-45**
SUCTION PUMP.

Education Establishment Orders Accepted.
PHONE OR SEND YOUR ACCESS OR
BARCLAYCARD NUMBER FOR SALES OVER £10.
ALL PRICES INCLUDE POSTAGE AND VAT.



FIRST and STILL BEST!

We've been producing our Electronics Components Catalogue for over 20 years. During that time we've learned a lot, not only in the art of catalogue production but in building a business that serves the needs of constructors. Little wonder that we have a reputation *second to none* for our catalogue - and for the service that backs it up. Experience both for yourself. Just send £1.25 with the coupon and a catalogue will come by return of post.

- About 2,500 items clearly listed and indexed.
- Profusely illustrated throughout.
- 128 A-4 size pages, bound in full-colour cover.
- Bargain list of unrepeatable offers included free.
- Catalogue contains details of simple Credit Scheme.

HOME RADIO (Components) LTD.,
Dept. PE., 234-240 London Road, Mitcham, Surrey CR4 3HD

Please write your Name and Address in block capitals

NAME.....

ADDRESS.....

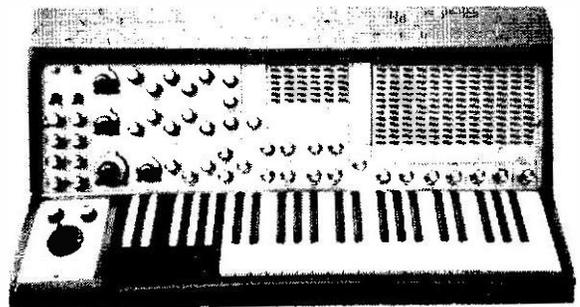


HOME RADIO (Components) LTD., Dept. PE
234-240 London Road, Mitcham, Surrey, CR4 3HD (Regn. No
London 912966

POST THIS COUPON with cheque or P.O. for £1.25

BUILD A SYNTHESIZER!

NO SPECIAL SKILLS REQUIRED
SPECIAL EQUIPMENT REQUIRED



Using **Dewtron** (Reg'd)
PROFESSIONAL MODULES

Over 20 different electronic modules to select what YOU want to build a synthesiser; simple or complex. Start simple and add to it as you can afford. New attractive prices for the long-popular, well-tried range of Dewtron synthesiser and other effects modules.

Send 25p for Musical Miracles Catalogue NOW!

D.E.W. LTD.

254 RINGWOOD ROAD, FERNDOWN, DORSET BH22 9AR

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC126	£0.21	BC148	£0.08	BC549	£0.12	BU105	£1.84	ZTX108	£0.11
AC127	£0.21	BC149	£0.08	BC550	£0.16	BU105/02	£2.24	ZTX109	£0.11
AC128	£0.18	BC157	£0.12	BC556	£0.16	BU204	£1.61	ZTX300	£0.13
AC128BK	£0.30	BC158	£0.12	BC557	£0.15	BU205	£1.61	ZTX500	£0.13
AC132	£0.23	BC159	£0.12	BC558	£0.14	BU208/02	£2.58	2N1613	£0.24
AC134	£0.23	BC167	£0.14	BC559	£0.15	MJE2955	£1.04	2N1711	£0.23
AC137	£0.23	BC168	£0.14	BD115	£0.58	MJE3055	£0.69	2N1889	£0.51
AC141	£0.25	BC169	£0.10	BD116	£0.58	MJE3440	£0.60	2N1890	£0.51
AC141K	£0.35	BC169C	£0.12	BD121	£0.75	MPP102	£0.40	2N1893	£0.35
AC142	£0.23	BC170	£0.10	BD124	£0.40	MPP104	£0.40	2N2147	£0.86
AC176	£0.20	BC171	£0.10	BD131	£0.40	MPP105	£0.40	2N2148	£0.81
AC176BK	£0.30	BC172	£0.10	BD132	£0.40	MPSA05	£0.23	2N2160	£1.15
AC178	£0.29	BC173	£0.10	BD133	£0.40	MPSA06	£0.23	2N2192	£0.44
AC179	£0.29	BC174	£0.18	BD135	£0.44	MPSA55	£0.23	2N2193	£0.44
AC180	£0.23	BC178	£0.18	BD136	£0.40	MPSA56	£0.23	2N2194	£0.44
AC180K	£0.32	BC179	£0.18	BD137	£0.40	OC22	£1.73	2N2217	£0.25
AC181	£0.23	BC180	£0.29	BD138	£0.41	OC23	£1.73	2N2218	£0.23
AC181K	£0.32	BC181	£0.10	BD139	£0.41	OC24	£1.55	2N2219A	£0.23
AC182	£0.21	BC182L	£0.10	BD140	£0.40	OC25	£1.15	2N2219A	£0.23
AC187K	£0.32	BC183	£0.10	BD155	£0.92	OC26	£1.15	2N2904	£0.23
AC188	£0.21	BC183L	£0.10	BD175	£0.69	OC28	£0.52	2N2904A	£0.23
AC188K	£0.32	BC184	£0.10	BD176	£0.69	OC29	£0.52	2N2905	£0.20
AD140	£0.69	BC207	£0.13	BD177	£0.78	OC35	£1.03	2N2905A	£0.23
AD142	£0.69	BC208	£0.10	BD178	£0.78	OC36	£1.03	2N2906	£0.18
AD143	£0.86	BC209	£0.14	BD179	£0.86	OC37	£0.27	2N2906A	£0.21
AD149	£0.69	BC212	£0.10	BD203	£0.92	OC71	£0.17	2N2907	£0.23
AD161	£0.40	BC212L	£0.10	BD204	£0.92	TIC44	£0.33	2N2907A	£0.25
AD162	£0.40	BC213	£0.10	BD204	£0.92	TIC45	£0.40	2N2908	£0.18
AD162MP	£0.81	BC213L	£0.10	BF457	£0.43	TIP29B	£0.48	2N2926Y	£0.09
AF124	£0.35	BC214L	£0.10	BF459	£0.44	TIP29C	£0.51	2N2926Y	£0.09
AF125	£0.35	BC227	£0.18	BF594	£0.35	TIP30A	£0.46	2N2926Y	£0.09
AF126	£0.35	BC238	£0.18	BF596	£0.32	TIP30B	£0.48	2N3055	£0.09
AF127	£0.37	BC251	£0.17	BFR39	£0.26	TIP30C	£0.50	2N3055A	£0.11
AF139	£0.40	BC181A	£0.18	BFR40	£0.29	TIP31A	£0.46	2N3056	£0.09
AF186	£0.58	BC301	£0.32	BFR79	£0.32	TIP31B	£0.46	2N3056	£0.09
AF239	£0.47	BC302	£0.33	BFR80	£0.32	TIP31C	£0.50	2N3614	£1.15
AL102	£1.38	BC303	£0.32	BFX29	£0.25	TIP31D	£0.50	2N3615	£1.21
AL103	£1.36	BC304	£0.44	BFX30	£0.35	TIP32A	£0.46	2N3616	£1.21
AU104	£1.61	BC324	£0.18	BFX64	£0.28	TIP32B	£0.48	2N3702	£0.09
AU110	£1.61	BC325	£0.17	BFX85	£0.28	TIP32C	£0.50	2N3703	£0.09
AU113	£1.61	BC337	£0.17	BFX86	£0.29	TIP41A	£0.50	2N3704	£0.08
BC107A	£0.09	BC338	£0.17	BFX87	£0.25	TIP41B	£0.52	2N3705	£0.08
BC107B	£0.10	BC440	£0.35	BFX88	£0.25	TIP41C	£0.55	2N3705	£0.08
BC107C	£0.12	BC441	£0.35	BFX90	£0.18	TIP42A	£0.50	2N3706	£0.09
BC108A	£0.09	BC480	£0.44	BFY50	£0.28	TIP42B	£0.52	2N3707	£0.09
BC108B	£0.09	BC481	£0.44	BFY52	£0.18	TIP42C	£0.55	2N3708	£0.08
BC108C	£0.12	BC477	£0.23	BP19	£0.44	TIP2955	£0.69	2N3709	£0.08
BC109A	£0.09	BC478	£0.23	BP20	£0.44	TIS43	£0.25	2N3710	£0.08
BC109B	£0.10	BC479	£0.23	BP19P	£0.44	TIS90	£0.20	2N3711	£0.08
BC109C	£0.12	BC547	£0.12	2OMP	£0.92	UT46	£0.23	2N3820	£0.40
BC147	£0.08	BC548	£0.12	BR39	£0.51	ZTX107	£0.11		

74 SERIES TTL ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7427	£0.27	7472	£0.23	74105	£0.43	74163	£0.71
7401	£0.12	7428	£0.29	7473	£0.28	74107	£0.47	74164	£0.78
7402	£0.12	7430	£0.12	7474	£0.28	74110	£0.41	74165	£0.78
7403	£0.12	7432	£0.25	7475	£0.28	74111	£0.66	74166	£0.89
7404	£0.12	7433	£0.25	7476	£0.28	74118	£0.92	74174	£0.74
7405	£0.12	7437	£0.25	7480	£0.50	74119	£1.35	74175	£0.71
7406	£0.25	7438	£0.24	7481	£0.97	74121	£0.27	74176	£0.66
7407	£0.25	7440	£0.13	7482	£0.78	74122	£0.44	74177	£0.66
7408	£0.14	7441	£0.57	7483	£0.66	74123	£0.46	74190	£1.72
7409	£0.14	7442	£0.46	7484	£1.01	74136	£0.59	74181	£0.66
7410	£0.12	7443	£0.80	7485	£0.78	74141	£0.63	74182	£0.80
7411	£0.19	7444	£0.80	7486	£0.25	74145	£0.63	74184	£0.80
7412	£0.17	7445	£0.74	7489	£1.95	74150	£0.78	74190	£0.78
7413	£0.27	7446	£0.69	7490	£0.36	74151	£0.55	74191	£0.71
7414	£0.57	7447	£0.55	7491	£1.01	74152	£0.69	74192	£0.69
7416	£0.26	7448	£0.64	7492	£0.40	74154	£0.94	74193	£0.66
7417	£0.26	7450	£0.12	7493	£0.34	74155	£0.57	74194	£0.71
7420	£0.12	7451	£0.12	7494	£0.86	74156	£0.57	74195	£0.69
7421	£0.23	7453	£0.12	7495	£0.56	74157	£0.57	74196	£1.20
7422	£0.18	7454	£0.12	7496	£0.57	74158	£0.66	74197	£1.20
7423	£0.24	7455	£0.32	74100	£0.97	74160	£0.71	74198	£1.12
7425	£0.21	7470	£0.28	74104	£0.44	74162	£0.71	74199	£2.12
7426	£0.26								

CMOS ICs

Type	Price								
CD4000	£0.16	CD4015	£0.87	CD4026	£1.38	CD4043	£1.01	CD4070	£0.19
CD4001	£0.17	CD4016	£0.48	CD4027	£0.57	CD4044	£0.94	CD4071	£0.19
CD4002	£0.18	CD4017	£0.86	CD4028	£0.78	CD4045	£1.61	CD4072	£0.19
CD4006	£1.05	CD4018	£0.97	CD4029	£0.97	CD4046	£1.49	CD4081	£0.19
CD4007	£0.19	CD4019	£0.48	CD4030	£0.55	CD4047	£1.00	CD4082	£0.20
CD4008	£1.05	CD4020	£1.03	CD4031	£2.30	CD4049	£0.48	CD4510	£1.13
CD4009	£0.51	CD4021	£0.94	CD4035	£1.15	CD4050	£0.48	CD4511	£1.09
CD4010	£0.55	CD4022	£0.94	CD4037	£1.01	CD4054	£1.26	CD4516	£1.15
CD4011	£0.17	CD4023	£0.17	CD4040	£1.01	CD4055	£1.15	CD4518	£1.15
CD4012	£0.80	CD4024	£0.74	CD4041	£0.87	CD4056	£1.55	CD4520	£1.15
CD4013	£0.48	CD4025	£0.17	CD4042	£0.82	CD4059	£0.19	CD4014	£0.92

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.92	CA3130	£1.09	MC1350	£1.39	UA710C	£0.48	SN76115	£2.18
CA3014	£1.55	CA3140	£0.80	MC1352	£1.81	72710	£0.34	SN76660	£0.86
CA3018	£0.74	LM301	£0.33	MC1468	£3.39	UA711C	£0.36	SL414A	£2.24
CA3020	£1.85	LM302	£1.84	MC1469	£1.03	72723	£0.36	TAAS508	£0.40
CA3028	£0.92	LM303	£1.15	NE536	£3.05	UA723C	£0.52	TA621A	£2.30
CA3035	£1.61	LM309	£1.72	NE550	£1.09	72723	£0.52	TA6621B	£2.87
CA3036	£1.15	LM320-5V	£1.72	NE555	£0.27	UA741C	£0.27	TA6661	£1.72
CA3042	£1.72	LM320-12V	£1.72	NE556	£0.89	72741	£0.27	TA670	£1.49
CA3043	£2.12	LM320-15V	£1.72	NE558	£1.38	74193	£0.55	TA6540	£2.41
CA3046	£0.80	LM320-24V	£1.72	NE568	£1.38	UA7447C	£0.69	TBA810S	£0.86
CA3052	£1.84	LM380	£0.97	NE567	£1.95	72747	£0.69	TBA810	£1.12
CA3054	£1.26	LM381	£1.66	UA702C	£0.52	UA748	£0.40	TBA820	£0.80
CA3075	£1.72	LM3900	£0.86	72702	£0.52	72748	£0.40	TBA9200	£2.87
CA3081	£1.72	MC1303L	£0.97	UA703	£0.28	749P	£0.40	IC2470S	£2.30
CA3089	£2.30	MC1361	£2.18	UA709	£0.28	SM76013N	£2.01	TBA800	£0.92
CA3090	£2.41	MC1310	£1.09	72709	£0.52	SM76023	£2.01		
CA3123	£2.18	MC1312	£2.18	709P	£0.28	SN76110	£1.72		

THYRISTORS

1 amp	TO 5 Case	Price
Volts No:		
50 THY1A/500		£0.29
100 THY1A/100		£0.32
200 THY1A/200		£0.36
400 THY1A/400		£0.43
600 THY1A/600		£0.51
800 THY1A/800		£0.66
3 amp	TO 66 Case	Price
Volts No:		
50 THY3A/50		£0.32
100 THY3A/100		£0.34
200 THY3A/200		£0.37
400 THY3A/400		£0.48
600 THY3A/600		£0.57
800 THY3A/800		£0.74
5 amp	TO 66 Case	Price
Volts No:		
50 THY5A/50		£0.41
100 THY5A/100		£0.51
200 THY5A/200		£0.57
400 THY5A/400		£0.65
600 THY5A/600		£0.79
800 THY5A/800		£0.93
7 amp	TO 48 Case	Price
Volts No:		
50 THY7A/50		£0.55
100 THY7A/100		£0.58
200 THY7A/200		£0.65
400 THY7A/400		£0.71
600 THY7A/600		£0.89
800 THY7A/800		£1.05
10 amp	TO 48 Case	Price
Volts No:		
50 THY10A/50		

TRAIN FOR SUCCESS

in Radio, Television & Electronics

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

Personal Tuition and Guaranteed Success

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

City and Guilds Certificates

Excellent job prospects await those who hold one of these recognised certificates. ICS can coach you for:

- Telecommunications Technicians
- Radio, T.V. Electronics Technicians
- Technical Communications
- Radio Servicing Theory
- Radio Amateurs
- Electrical Installation Work
- Also MPT Radio Communications Certificate

Diploma Courses

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

Other Career Courses

A wide range of other technical and professional courses are available including GCE.

FREE BOOK

Post this coupon or 'phone today for free ICS careers guide.

Name _____

Address _____

Age _____

ICS

To ICS, Dept. L273, Intertext House, London SW8 4UJ or telephone 01-622 9911 (all hours)

ASTRA-PAK

92 GODSTONE ROAD
WHYTELEAF SURREY CR3 0EB

VAT must be added at 15% to all prices shown. P&P 25p + VAT. Send SAE for full catalogue including books, resistors, capacitors, vero, etc.

7400	0.18	7483	0.58	74186	0.78	4021	0.80	4180	1.05	LINEAR	18 pin	0.12	
7400D	0.23	7484	0.88	74187	2.00	4022	0.80	4181	1.05	CA3045-14	0.48	18 pin	0.16
7401	0.11	7485	0.88	74170	1.50	4023	0.15	4182	1.05	CA3048-14	0.50	20 pin	0.18
7402	0.11	7486	0.22	74172	0.30	4024	0.58	4183	1.05	LM3809-14	0.85	22 pin	0.22
7403	0.11	7488	0.42	74173	1.15	4025	0.85	4184	1.05	LM3818-14	1.48	24 pin	0.24
7404	0.11	7489	1.85	74174	0.85	4026	1.15	4174	1.05	LM710-14	0.38	28 pin	0.28
7404D	0.23	7490	0.32	74175	0.80	4027	0.42	4175	0.80	LM711N-14	0.30	40 pin	0.37
7405	0.12	7491	0.84	745175	1.00	4028	0.65	4194	1.05	MC1310P-14	0.88	81LS95	1.25
7405D	0.23	7492	0.38	74176	0.59	4029	0.78	4404	0.48	NE555-8	0.20	81LS97	1.26
7408	0.22	7493A	0.80	74173	0.58	4030	0.48	4428	0.38	LM388-14	0.50	81LS97	1.25
7407	0.22	7494	0.72	74178	1.50	4031	0.95	4449	0.19	NE5501B-14	1.40	MICROPROCESSOR	9.25
7408	0.13	7495	0.50	74179	1.50	4032	0.80	4445	0.98	SN75110N	0.40	CRYSTALS	1.60
7409	0.13	7496	0.48	74180	0.85	4033	1.25	4449	0.19	SN78003N	1.80	FREQUENCY	1.25
7410	0.11	7497	1.90	74181	0.58	4034	1.15	4501	0.18	SN78013N	1.25	MHz.	3.50
7410D	0.23	74100	0.85	74182	0.70	4035	1.00	4502	0.80	SN78023N	1.25	0.100	2.00
7411	0.17	74194	0.38	74182	1.50	4036	2.78	4503	0.80	SN78033N	1.60	0.282	3.50
7411D	0.23	74105	0.38	74183	0.75	4037	0.65	4508	0.62	SN78477N	2.50	0.300	3.50
7412	0.15	74107	0.24	74184	1.38	4038	0.95	4507	0.52	TAA5508	0.32	0.300	3.50
7413	0.24	74109	0.32	74185A	1.30	4039	2.75	4508	2.56	TAA8618	0.88	1.000	3.25
7414	0.58	74110	0.36	74188	5.00	4040	1.85	4510	0.82	TBA1208	0.88	1.008	3.25
7415	0.23	74111	0.38	74189	0.88	4041	0.75	4511	0.82	TBA631A	1.50	1.8432	3.50
7416	0.23	74113	0.38	74190	0.88	4042	0.82	4512	1.28	TBA801	0.78	2.000	3.25
7417	0.23	74114	1.50	74191	0.88	4043	0.88	4513	1.85	TBA8105	0.75	2.087	3.25
7420	0.11	74118	0.80	74192	0.82	4044	0.80	4514	2.30	TBA8205	0.88	2.457	3.25
7421	0.20	74119	1.50	74193	0.82	4045	1.25	4515	2.60	TCA2705D	1.00	3.276	2.80
7422	0.18	74121	0.25	74195	0.88	4047	0.85	4517	3.75	TDA2020	3.00	3.579	2.80
7423	0.21	74122	0.38	74196	0.72	4048	0.48	4518	0.88	TDA14	0.80	3.932	2.80
7425	0.23	74120	0.38	74196	0.72	4048	0.48	4518	0.88	VOLTAGES	4.000	4.000	2.80
7426	0.23	74123	0.38	74197	0.58	4049	0.33	4519	0.95	REGULATORS	4.433	2.80	2.80
7427	0.24	74125	0.32	74198	1.00	4050	0.40	4520	0.80	LM300H-T098	0.75	4.915	2.80
7428	0.28	74128	0.35	74199	1.20	4051	0.72	4521	2.20	LM309K-T03	1.30	5.000	2.80
7429	0.28	74128	0.35	74201	1.30	4052	0.72	4522	1.25	uA723-14	0.32	5.088	2.80
7430	0.23	74130	0.82	74202	1.00	4053	0.72	4528	1.28	7805-T020	0.78	8.000	2.80
7432	0.22	74132	0.55	74278	1.85	4054	1.00	4527	1.40	7812-T0220	0.70	8.575	2.80
7433	0.30	74134	0.38	74279	1.10	4055	1.05	4528	0.82	7815-T0220	0.70	8.000	2.80
7437	0.21	74135	0.78	74283	1.85	4080	1.08	4529	1.38	7824-T0220	0.70	8.144	2.80
7438	0.21	74136	0.52	74284	3.40	4088	0.48	4530	0.78	7905-T0220	0.78	6.555	2.80
7440	0.12	74137	0.58	74188	1.30	4087	3.25	4531	0.98	7912-T0220	0.78	8.000	2.80
7441	0.50	74141	0.55	74298	1.80	4088	0.20	4532	1.20	7915-T0220	0.78	8.867	2.80
7442	0.40	74142	1.95	74390	1.75	4089	0.17	4534	5.20	LOW PROFILE	10.000	2.80	2.80
7443	0.70	74143	2.50	74393	1.25	4070	0.17	4536	3.80	DIL SOCKETS	12.000	2.80	2.80
7444	0.70	74144	2.50	CMOS	4071	0.17	4538	1.25	8 pin	0.09	13.518	2.80	
7445	0.52	74145	0.88	4001	0.13	4042	0.17	4539	0.88	14 pin	0.11	18.000	3.20
7446	0.80	74147	1.40	4001	0.15	4075	0.17	4543	1.88	LED's	0.25"	0.2"	2.80
7447	0.48	74148	1.25	4002	0.15	4075	0.17	4543	1.88	RED	0.85	0.89	2.80
7448	0.56	74150	0.88	4006	0.85	4076	0.84	4549	3.82	YELLOW	0.14	0.14	2.80
7450	0.11	74151	0.48	4007	0.16	4077	0.21	4553	3.80	GREEN	0.14	0.14	2.80
7451	0.11	74153	0.48	4008	0.78	4078	0.18	4554	1.25	Light clip	0.25	0.35	2.80
7452	0.23	74155	0.40	4009	0.80	4081	0.18	4556	1.88	TMS 4030 4098-BIT DYNAMIC RANDOM ACCESS (2107A) MEMORY 22 PIN DIL	2.78	2.80	2.80
7453	0.11	74155	0.50	4010	0.40	4082	0.18	4558	1.88	300ms max. access time. 470ns max. read or write cycle time. TTL compatibility on all inputs. No pull up resistors needed. Low power dissipation. 350mW operating @ 0.3mW standby. Single low capacitance clock. Data sheet available	2.40 each	4-10%	8-20%
7454	0.11	74156	0.50	4011	0.15	4085	0.83	4557	3.25				
7460	0.11	74157	0.50	4012	0.15	4088	0.83	4558	1.25				
7470	0.25	74158	0.88	4013	0.40	4089	1.35	4559	3.85				
7472	0.22	74159	1.80	4014	0.78	4093	0.80	4580	1.98				
7473	0.25	74160	0.80	1015	0.80	4094	1.88	4581	1.88				
7474	0.25	74161	0.58	4016	0.40	4095	0.80	4582	5.50				
7474	0.42	74162	0.82	4017	0.72	4098	0.80	4588	1.42				
7475	0.30	74163	0.82	4018	0.75	4097	3.30	4588	2.50				
7476	0.25	74164	0.88	4019	0.42	4098	0.95	4589	1.80				
7480	0.43	74165	0.88	4020	0.88	4099	1.40	4580	4.88				

TOUCH CONTROLLED LIGHTING KITS (300W)

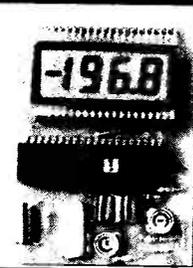
A Lightdimmer with NO knob. Dimming and on/off functions are controlled by touch. Features include:

- ★ No mains rewiring.
- ★ Easy to build - uses one MOS IC.
- ★ Switches on to preset brightness.
- ★ Can be switched and dimmed from many locations using TDE/K kit making 2-way switching easy.
- ★★ PRICE TD300K £6.50 TDE/K £1.50



TSD300K TOUCH-SWITCH & DIMMER combined. One touchplate for on/off. Small knob controls brightness. **£5.50***
TS300K TOUCHSWITCH. Two touchplates. ON/OFF **£4.30***
TS4300K AUTOMATIC. One touchplate. Preset time delay of variable 2 secs to 3½ mins. **£4.30***
LD300K LIGHTDIMMER. **£2.90***
***SPECIAL OFFER**
 10% Discount on any 2 of these kits.

DIGITAL VOLT/METER THERMOMETER KIT



Based on the 7106 single IC 3½ digit D.V.M. the Kit contains a PCB, resistors, capacitors, pre-sets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor. Requires a 2mA 9V supply (PP3 battery). **ONLY £20.75**

24HR CLOCK/APPLIANCE TIMER KIT



Switches any appliance of up to 1KW on and off at preset times once a day. KIT contains: AY-5-1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. **£14.90**
 White box (56 x 131 x 71mm) - drilled **£2.50**
 - undrilled **£2.80**
 Ready built

TRIACS

400V Plastic Case	
3A 48p	18A 90p
8A 62p	25A 180p
12A 70p	
6A with trigger	80p
8A isolated	82p
SCR (C106D) 5A/400V	38p
Disc	18p

LEDs DISPLAYS
 0.2" Red 5p (50p/10p)
 Green or Yellow 12p
 DL727 ½ CA **1.20**
 (two for £2.70)
 LCD 3½ digit 0.5" di. **£8.10**

SUPER SAVERS

741 18p	555 27p
LM3911 Thermometer IC	£1.80
ZN1034E Timer IC	£1.80
10 x BC108 Transistors	£0.80

RESISTORS

½W (CR25 size) E12 series
 Values 22 ohm to 10 Mohm
 Pack 10 (one value) 10p
 10 packs (mixed values) 80p

TRANSFORMERS

Standard 240V mains primary
 100mA secondary (miniature)
 6-0-6V 80p 9-0-9V 88p
 12-0-12V 80p

TEMPERATURE CONTROL KIT

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

Enjoy your favourite Radio and T.V. on holiday...

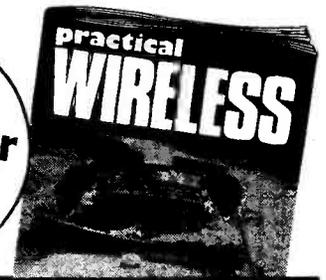


The trouble with holidays is that you're likely to miss your favourite listening and viewing.

Thanks to our pull-out "Holiday Radio and TV Guide" all that is now a thing of the past. Get the September issue, out now, and take this handy guide with you on holiday. See how to pick up the programmes you would get at home as well as the local stations. Including local traffic bulletins and weather forecasts. Detailed maps show you the location of local transmitters so you can align your aerial for the best reception.

For better listening and viewing on holiday, tune in to

In the
September
issue
50p



Now, complete your system!



Citronic MM313 Mixer

Ideal for the DIY enthusiast building up a complete disco system 4/6 ch mono-inc. LED indicators, connections via phono sockets at rear. Bargain price, including PSU £89.70.

The ultimate range of speakers

We carry a good selection of high quality chassis for the DIY speaker constructor. 12" or 15" Bass speakers and Dual Concentrics Exponential horns from £13.80, or our fabulous P-220 Horns which handle a 5K-20K frequency range in any PA system up to 100W (No X over required) and cost only £6.32 each.



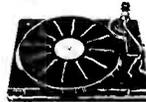
Projectors

Come and see our specially selected projectors from £50.60 (Squire Multi-fact 150) to £83.37 (Tutor HE DDU) plus the widest array of projector attachment and effects that you'll ever see on continuous demonstration.



Turntables

Our unsurpassed Disco experience has enabled us to select the best turntables for your requirements. For example the new BSR P200 belt drive. ONLY £28.75



Many disco accessories

All Roger Squire's shops have a service department which carries large stocks of DISCO SPARES & ACCESSORIES

Ropelights

Great effect at discos. 7 metres long. Multiway connectors. 4 channel £46.00 (inc. pack of spare bulbs)

Bulgin Octal plugs and sockets

There's always hundreds of Bulgin Octal multiway plugs and sockets in stock at Roger Squire's. Each pin rated 6A. Perfect for your Sound to Light System P552 SOCKET £0.69 P561 PLUG £1.72.



Multiway Cables
4 core (6A) 63p/metre
5 core (6A) 78p/metre
6 core (6A) 92p/metre

PERSONAL CALLERS ONLY

Roger Squire's
DISCO CENTRES

LONDON 176 Junction Road, N19, 50yds Turnmill Park Tube Station. 1 mile from end of M32
BRISTOL 125 Church Road, Redfield (Near St. George) 15 mins from City Centre
MANCHESTER Tel: 0272 550650
GLASGOW Tel: 061 831 7676
1 Queen Margaret Road, off Queen Margaret Drive, Kelvinside 20. just behind the BBC. Tel: 041 946 3303

ALL SHOPS OPEN TUE-SAT LATE NIGHT WED (UP TO 8 PM)

Codespeed Electronics ELECTRONIC MAIL ORDER SPECIALISTS

PO BOX 23, 34 SEAFIELD ROAD, COPNOR, PORTSMOUTH, P03 5BJ

New, Full Spec. Devices

WRISTWATCH LCD'S A high contrast 3 1/2 digit wristwatch LCD with centre colon. Supplied with polarizers and data. Only £1.00 Cat. No. 202

MM5314 CLOCK CHIP A super value digital clock chip for only £1.99. With data. Cat. No. 207

4 DIGIT LCD A high contrast, easy to solder display with four 0.5" high non-multiplexed digits. £6.95 each with data. Cat. No. 206

DIGITAL ALARM CLOCK MODULE Complete with giant 0.84" LED display. Add transformer and switches for complete clock. With data only £8.50 Cat. No. 205

SLIDE SWITCHES A miniature slide switch with two pole change-over contacts. All brand new. 16p each. Cat. No. 702

MOMENTARY SWITCHES Miniature spring loaded push button switches with one normally open contact. Super value 15p each. Cat. No. 703

POLARIZING FILTER MATERIAL 0.008" thick plastic film. Any size cut - even 1 sq. inch. Max. width 19", any length. Only 2p per sq. inch. Cat. No. 701

PROGRAMMABLE UNIJUNCTIONS Four MEU21 PUTS (similar to 2N6027). Makes long delay timers, oscillators etc. With data and applications sheet. 4 for 50p. Cat. No. 402

MINI 6 DIGIT LED DISPLAY 6 digit 7 segment display from Texas. Common cathode, multiplexed, with 0.1" digits. £1.00. Cat. No. 306

DMM CHIP MM5330 dvm chip. Builds into high accuracy dvm or panel meter. Requires additional circuitry. Supplied with data and circuit. Only £3.95. Cat. No. 404

GIANT LED DISPLAY Common cathode, non-multiplexed super 4 digit LED clock display. Lots of other uses too. Only £3.95 each. Cat. No. 204

MINIATURE DIODES 25 mini 1N3470 germanium diodes (35v, 600mA). Excellent value, 25 for 50p. Cat. No. 401

20 KEY KEYBOARDS Calculator keyboards, excellent key action. 20 keys per board. 2 keyboards for £1.00. Cat. No. 101

1 1/2 DIGIT DISPLAY Bright orange gas discharge display. 1 1/2 digits 0.25" high. With data only 50p. Cat. No. 304

MATRIXED SWITCHING DIODES 23 diodes on each 14 pin chip. Supplied with data sheet. 5 chips for 50p. Cat. No. 504

HIGH SPEED DIODES 1N4151 high speed switching diodes. Similar to 1N4148. 10 diodes for 35p. Cat. No. 403

10 HYBRID CIRCUITS 8 resistors and 8 capacitors built into each hybrid circuit. Ideal values for semiconductor circuits. Excellent for minimizing PCB component space. 10 Hybrids for 50p. Cat. No. 801

Untested Items

LED DISPLAYS (Untested - no guarantees) 10 seven segment LED displays. 0.127" digits common cathode. 10 for £1.00. Cat. No. 311

30 MIXED IC'S (Untested - no guarantees) Could include anything Linear or Digital. You test. Good value for £1.00. Cat. No. 503

REJECT CALCULATORS Production line rejects. Yields lots of goodies when stripped down (not much wrong with some we tested) Only £2.50 each. Cat. No. 104

A full refund guarantee on all items. Post and Packing please add 35p (Overseas orders add 90p). Lots more goodies in our catalogue. Send medium sized SAE for your free copy.

OUR 1979 CATALOGUE

including the first edition of

STOP PRESS

(Send S.A.E. for copy)

- ★ Latest low prices
- ★ Fascinating new items
- ★ Special offers — a bargain on their own
- ★ Lowest prices ever for TTL
- ★ Free 45p worth of vouchers

RAM
2102A 2
1024 x 1 250ns
£1.33
16 for £18.95

RAM 4116
16K x 250ns
£10.36
8 for £75.36

C.P.U.
8080
£5.84

CATALOGUE
40p

E PROM
2708
£8.38

E PROM
1702
£5.93

CHROMASONIC electronics

DEPT. 16, 56 FORTRIS GREEN ROAD
MUSWELL HILL, LONDON N10 3HN
TELEPHONE: 01-883 3705/2289



USE OUR "ORDER RING" LINES



VAT INCLUSIVE PRICES P&P 25p

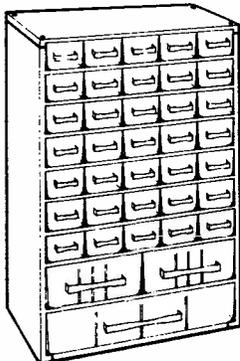
FOR YOUR GUIDANCE

VALUE ADDED TAX

In view of changes affecting V.A.T. at the time of going to press, readers should ensure that they have added the correct amount of V.A.T. before ordering.

Export orders are not subject to the addition of Value Added Tax.

STORAGE CABINETS



Metal Cabinets 12" wide x 5 3/4" deep, finished blue with transparent plastic drawers.

Type	H (ins)	No. of Drawers	Price
1118	11	15 2 1	£9.85
1633	16	30 2 1	£12.75
1838	18	35 2 1	£14.95
2236	22	30 4 2	£16.85
2260	22	60 - -	£16.95

Prices include VAT and Post. Cheque/P.O. to:

Millhill Supplies (Tools),
35 Preston Crowmarsh, Benson,
Oxon OX9 6SL.

RST VALVE MAIL ORDER CO.

Climax House
Fallsbrook Road, London SW16 6ED

SPECIAL EXPRESS MAIL ORDER SERVICE

AA119	0-12	BCY70	0-17	MPSU01	0-21	1N914	0-06	7405	0-18
AAV30	0-31	BCY71	0-20	MPSU06	0-53	1N916	0-08	7406	0-46
AAV32	0-48	BCY72	0-15	MPSU56	0-56	1N4001	0-07	7407	0-46
AAZ13	0-21	BCZ11	1-72	NE555	0-52	1N4002	0-07	7408	0-23
AAZ15	0-39	BD115	0-52	NKT401	2-30	1N4003	0-08	7409	0-23
AAZ17	0-31	BD121	1-38	NKT403	1-99	1N4004	0-08	7410	0-18
AC107	0-69	8D123	1-38	NKT404	1-99	1N4005	0-09	7411	0-30
AC125	0-23	BD124	1-30	OA5	1-04	1N4006	0-09	7412	0-37
AC126	0-23	BF121	1-40	OA7	0-73	1N4007	0-10	7413	0-37
AC127	0-23	BD132	0-44	OA10	0-64	1N4009	0-17	7417	0-37
AC128	0-23	BD135	0-39	OA47	0-16	1N4148	0-07	7420	0-20
AC141	0-29	BD136	0-39	OA70	0-35	1N5400	0-15	7422	0-23
AC141K	0-40	BD137	0-40	OA79	0-35	1N5401	0-15	7423	0-37
AC142	0-35	BD138	0-46	OA81	0-35	1S44	0-05	7425	0-35
AC142K	0-35	BD139	0-49	OA85	0-35	1S920	0-08	7427	0-35
AC176	0-23	BD140	0-51	OA90	0-09	1S921	0-08	7428	0-49
AC187	0-23	BD144	2-30	OA91	0-09	2G301	1-15	7430	0-20
AC188	0-23	BD181	1-26	OA95	0-09	2G302	1-15	7432	0-35
ACV17	0-98	BD182	1-36	OA200	0-10	2G306	1-27	7433	0-41
ACV18	0-32	BD237	0-46	OA202	0-10	2N2218	0-15	7437	0-37
ACV18	0-86	BD238	0-63	OA211	1-15	2N696	0-29	7438	0-37
ACV20	0-80	BDX10	1-05	OA2200	1-15	2N697	0-29	7440	0-21
ACV21	0-86	BDX32	2-30	OA2201	1-15	2N698	0-35	7441AN	0-97
ACV39	1-72	BDY20	1-44	OA2206	1-15	2N705	1-38	7442	0-83
AD149	0-89	BDY60	0-29	OA2207	0-30	2N706	0-16	7447AN	1-04
AD168	1-72	BF115	0-29	OC16	2-88	2N708	0-23	7459	0-21
AD162	0-52	BF152	0-21	OC20	2-30	2N930	0-23	7451	0-21
AF106	0-52	BF153	0-23	OC22	2-88	2N1131	0-30	7453	0-21
AF114	0-86	BF154	0-20	OC23	3-16	2N1132	0-30	7454	0-21
AF115	0-86	BF159	0-35	OC24	3-45	2N1302	0-40	7460	0-21
AF116	0-86	BF160	0-18	OC27	1-38	2N1303	0-40	7470	0-40
AF117	0-86	BF167	0-23	OC28	1-04	2N1304	0-52	7472	0-38
AF139	0-46	BF173	0-23	OC28	2-30	2N1305	0-52	7473	0-41
AF186	1-38	BF177	0-28	OC29	2-30	2N1306	0-58	7474	0-46
AF239	0-52	BF178	0-28	OC35	1-73	2N1307	0-58	7475	0-62
AFZ11	3-16	BF179	0-29	OC36	1-73	2N1308	0-58	7476	0-46
AS212	0-46	BF181	0-35	OC41	0-82	2N1309	0-63	7480	0-63
ASV26	0-46	BF181	0-35	OC42	0-86	2N1613	0-29	7482	0-86
ASV27	0-46	BF182	0-35	OC43	2-59	2N1671	1-73	7483	1-04
ASZ15	1-44	BF183	0-29	OC44	0-69	2N1893	0-29	7484	1-15
ASZ16	1-44	BF184	0-29	OC45	0-63	2N2147	2-02	7486	0-40
ASZ17	1-44	BF185	0-29	OC71	0-63	2N2148	1-89	7490	0-60
ASZ10	1-72	BF194	0-10	OC72	0-83	2N2223	0-29	7491AN	0-69
ASZ21	2-30	BF195	0-10	OC73	1-15	2N2219	0-28	7492	0-69
AU110	1-96	BF196	0-12	OC74	0-74	2N2220	0-21	7493	0-69
AU113	1-96	BF197	0-14	OC75	0-74	2N2221	0-21	7494	0-92
AU110	1-96	BF200	0-31	OC76	0-63	2N2222	0-21	7495	0-83
BA145	0-86	BF201	0-29	OC77	1-38	2N2223	0-29	7496	0-92
BA148	0-15	BF244	0-22	OC81	0-74	2N2568	0-20	7494	0-45
BA154	0-10	BF257	0-28	OC81Z	1-38	2N2369A	0-24	74100	1-73
BA155	0-10	BF258	0-28	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	0-06	OC84	0-74	2N2904	0-29	74110	0-58
BAW62	0-07	BF337	0-35	OC122	1-73	2N2905	0-29	74111	0-81
BAX16	0-10	BF338	0-36	OC123	2-02	2N2906	0-24	74116	2-02
BC107	0-14	BF521	4-55	OC139	2-59	2N2907	0-24	74118	1-15
BC108	0-14	BF528	2-56	OC140	3-16	2N2924	0-24	74119	1-73
BC109	0-15	BF561	0-23	OC141	3-74	2N2925	0-25	74120	0-95
BC113	0-16	BF598	0-23	OC142	0-74	2N2925	0-25	74121	0-46
BC114	0-16	BFW10	0-74	OC171	1-15	2N3053	0-29	74122	0-69
BC115	0-16	BFW11	0-74	OC200	1-73	2N3054	0-58	74123	1-15
BC116	0-17	BFX84	0-25	OC201	2-02	2N3055	0-81	74125	0-63
BC117	0-20	BFX85	0-26	OC202	2-02	2N3440	0-69	74126	0-83
BC118	0-12	BFX87	0-24	OC203	2-02	2N3441	0-69	74128	0-69
BC125	0-16	BFX88	0-24	OC204	0-29	2N3442	1-26	74129	0-83
BC126	0-23	BFY50	0-30	OC205	2-88	2N3525	0-92	74136	0-63
BC135	0-16	BFY51	0-30	OC206	2-88	2N3614	1-73	74141	0-92
BC136	0-17	BFY52	0-30	OC207	2-02	2N3702	0-13	74142	2-65
BC137	0-17	BFY64	0-30	OC207	2-02	2N3702	0-13	74142	2-65
BC147	0-10	BFY90	1-44	OC207	2-02	2N3702	0-13	74142	2-65
BC148	0-10	BSX18	0-23	OC207	2-02	2N3702	0-13	74142	2-65
BC149	0-10	BSX20	0-23	OC207	2-02	2N3702	0-13	74142	2-65
BC157	0-10	BSX21	0-23	OC207	2-02	2N3702	0-13	74142	2-65
BC158	0-09	BT106	1-44	OC207	2-02	2N3702	0-13	74142	2-65
BC159	0-12	BTY79/4	3-67	OC207	2-02	2N3702	0-13	74142	2-65
BC167	0-16	BU205	2-02	OC207	2-02	2N3702	0-13	74142	2-65
BC170	0-13	BU206	2-30	OC207	2-02	2N3702	0-13	74142	2-65
BC171	0-12	BU208	2-30	OC207	2-02	2N3702	0-13	74142	2-65
BC172	0-12	BY100	0-52	OC207	2-02	2N3702	0-13	74142	2-65
BC173	0-14	BY126	0-16	OC207	2-02	2N3702	0-13	74142	2-65
BC177	0-17	BY127	0-19	OC207	2-02	2N3702	0-13	74142	2-65
BC178	0-16	SZV61	0-21	OC207	2-02	2N3702	0-13	74142	2-65
BC179	0-10	Series	0-71	OC207	2-02	2N3702	0-13	74142	2-65
BC182	0-13	BZY88	0-15	OC207	2-02	2N3702	0-13	74142	2-65
BC183	0-12	Series	0-77	OC207	2-02	2N3702	0-13	74142	2-65
BC184	0-13	CRS1/05	0-52	OC207	2-02	2N3702	0-13	74142	2-65
BC212	0-15	CRS1/40	0-89	OC207	2-02	2N3702	0-13	74142	2-65
BC213	0-16	CRS3/40	0-86	OC207	2-02	2N3702	0-13	74142	2-65
BC214	0-17	CRS3/60	1-04	OC207	2-02	2N3702	0-13	74142	2-65
BC237	0-10	GEX66	1-73	OC207	2-02	2N3702	0-13	74142	2-65
BC238	0-14	GEX541	2-02	OC207	2-02	2N3702	0-13	74142	2-65
BC301	0-29	GJ3M	0-86	OC207	2-02	2N3702	0-13	74142	2-65
BC303	0-28	GJ5M	0-86	OC207	2-02	2N3702	0-13	74142	2-65
BC307	0-12	GL7M	0-86	OC207	2-02	2N3702	0-13	74142	2-65
BC308	0-12	GM0378A	2-02	OC207	2-02	2N3702	0-13	74142	2-65
BC327	0-23	KS100A	0-52	OC207	2-02	2N3702	0-13	74142	2-65
BC328	0-21	MJE340	0-92	OC207	2-02	2N3702	0-13	74142	2-65
BC337	0-21	MJE370	1-35	OC207	2-02	2N3702	0-13	74142	2-65
BC338	0-15	MJE371	0-73	OC207	2-02	2N3702	0-13	74142	2-65
BCY30	0-20	MJE520	0-60	OC207	2-02	2N3702	0-13	74142	2-65
BCY31	1-15	MJE521	0-63	OC207	2-02	2N3702	0-13	74142	2-65
BCY32	1-15	MJE2955	1-44	OC207	2-02	2N3702	0-13	74142	2-65
BCY33	1-04	MJE3055	0-86	OC207	2-02	2N3702	0-13	74142	2-65
BCY34	1-04	MFF102	0-35	OC207	2-02	2N3702	0-13	74142	2-65
BCY39	3-16	MFF103	0-35	OC207	2-02	2N3702	0-13	74142	2-65
BCY40	1-15	MFF104	0-35	OC207	2-02	2N3702	0-13	74142	2-65
BCY42	0-29	MFF105	0-35	OC207	2-02	2N3702	0-13	74142	2-65
BCY43	0-29	MPSA06	0-28	OC207	2-02	2N3702	0-13	74142	2-65
BCY58	0-18	MPSA56	0-30	OC207	2-02</				



RECEIVERS AND COMPONENTS

TURN YOUR SURPLUS capacitors, transistors, etc., into cash. Contact COLES-HARDING CO., 103 South Brink, Wisbech, Cambs, 0945-4188. Immediate settlement.

ANY AVAILABLE COMPONENT YOU WANT

Having Trouble?
Ask us to quote you
System 696 Ltd.
01-609 3402

COMPONENTS AT SILLY PRICES! Mixed Resistors: 250 £1.20, 1000 £3.00. Capacitors: 100 £1.00, 500 £3.20. Transistors: BC108, BC214-10 70p, 100 £5.80. Mixed Components, Hardware, Boards 10lbs £3.50. S.A.E. Lists. W.V.E.3, Craigo Farm, Tintern, Gwent.

TUNBRIDGE WELLS COMPONENTS, Ballards, 108 Camden Road, Tunbridge Wells. Phone 31803. No Lists. Enquires S.A.E.

BRAND NEW COMPONENTS BY RETURN

Electrolytic Capacitors 15V, 25V, 50V.
0.47, 1.0, 2.2, 4.7 & 10 Mfd. — 5p.
22 & 47 — 5p. (50V — 6p), 100 — 7p. (50V — 8p).
220 — 8p. (50V — 10p), 470 — 11p. (40V — 10p).
1000/15V — 15p. 1000/25V — 18p. 1000/40V — 35p.
Subminiature bead Tantulum electrolytics.
0.1, 0.22, 0.47, 1.0 & 35V, 4.7 & 6.3V — 10p.
2/235V, 4/725V — 11p. 10/25V, 15/18V — 14p.
22/18V, 33/10V, 47/6V, 68/3V & 100/3V — 18p.
15/25V, 22/25V, 47/10V — 24p. 47/16V — 32p.
Subminiature Ceramic Caps. E12 Series 100V.
2% 10 pf. to 47 pf. — 3p. 56 pf. to 330 pf. — 4p.
10% 390 pf. to 4700 pf. — 4p.
Vertical Mounting Ceramic Plate Caps. 50V.
E12 22 pf. to 1000 pf. 5p. 1500 pf. to 47000 pf. — 2p.
Polystyrene E12 Series 63V. Horizontal Mounting.
10 pf. to 820 pf. — 3p. 1000 pf. to 10,000 pf. — 4p.
Miniature Polyester 250V Vert. Mtg. E6 Series.
01 to 068 — 4p. 1 — 5p. 15, 22 — 6p. 33, 47 — 10p.
.68 — 12p. 1.0 — 18p. 1.5 — 22p. 2.2 — 24p.
Mylar (Polyester) Film 100V Vertical Mounting.
.001, .002, .005 — 3p. .01, .02 — 4p. .04, .05 — 5p.
Miniature Film Resistors Highstab. E12 Ser. 5%.
0.125W mixed carbon/metal 100 to 1MΩ — 1p.
0.25W Carbon 10 to 10MΩ (10% over 1MΩ) — 1p.
(E24 Series by in. 1W C. Film 10 to 5MΩ) — 1p.
0.25W, 0.5W & 1.0W Metal Film 100 to 2MΩ — 2p.
1N4148 — 2p. 1N4002 — 4p. 1N4006 — 6p. 1N4007 — 7p.
BC107/8/9, BC147/8/9, BC157/8/9, BF194 & 7 — 10p.
8 Pin I.C.'s. 741 Op. amp — 18p. 555 Timer — 24p.
Dil. Holders 8 pin — 3p. 14 pin — 4p. 16 pin — 4p.
LED's. 3 & 5mm. Red — 10p. Green & Yellow — 14p.
Grommets for 3mm. — 1 1/2p. 2 pce. holders 5mm. — 2 1/2p.
20mm. Q.B. Fuses .15, .25, .5, 1, 2, 3 & 5A — 3p.
20mm. Anti Surge 100mA. to 5.0A — 8p.
20mm. Fuseholders P.C. or Chassis Mtg. — 8p.
Solid A1. knots 15mm. — 25p. 25mm. — 35p. 30mm. — 50p.
400mW Zener diodes E24 series 2V7 to 33V — 8p.
Prices VAT Inclusive Post 10p. (Free over £4).

THE C. R. SUPPLY CO.

127, Chesterfield Rd., Sheffield S8 0RN.

P.C.B.s Paxolin 10 1/2" x 4 1/2" 4-£1.30. 12" x 9 1/2" 85p. 16" x 11 1/2" £1.40. D.S. 10" x 8 1/2" 85p. Fibre Glass 12" x 7 1/2" £1.60. D.S. 10 1/2" x 7" £1.35. 8" x 7" £1.15. Unit with 8 silicon diodes 600V 20 amp, 8 SCR's 400V 16 amp, 6 Vinkors, W.W. resistors etc. £6.75. 300 small components, trans. diodes £1.55. 7 lbs. assorted components £3.75. List 15p refundable. Post 20p. Insurance add 15p.

J.W.B. RADIO

2 Barnfield Crescent, Sale, Cheshire M33 1NL

SURPLUS stocks of Electronic Components at less than wholesale prices. SAE brings free lists. Bardwell Ltd., 212 Stubby Lane, Dronfield-Woodhouse, Sheffield, S18 5YP.

SMALL ADS

The prepaid rate for classified advertisements is 20 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £6.60 per single column centimetre (minimum 2.5 cms). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Practical Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

100 MIXED COMPONENTS £2.75, 10 LEDS 90p Lists 15p. Sole, 37 Stanley Street, Ormskirk, Lancs. L39 2DH.

MINIATURE PANEL METERS approx. 1" cube. Left pointer rest position. Scale calibrated 1-10. 600 ohm resistance. Sensitivity 400µA £1.25 each inc. P&P. Wilkinsons Ltd., Industrial Estate, Pocklington, York.

ELECTRONIC COMPONENTS. Send S.A.E. for List. Special Offers monthly. Radnor Supplies, 23 Arbury Road, Nuneaton, Warwick.

AERIALS

AERIAL BOOSTERS

Improves weak VHF Radio and Television reception.

B45-UHF TV, B11-VHF Radio, B11A-2 metre radio. For next to the set fitting.

Price £5. S.A.E. for leaflets.

ELECTRONIC MAILORDER LTD.
62 Bridge Street,
Ramsbottom, Bury, Lancs, BLO 9AG.

EDUCATIONAL

TELEVISION & VIDEO SYSTEMS SERVICING

15 MONTHS full-time Diploma course to include a high percentage of practical work.

- ELECTRONIC PRINCIPLES
- MONO & COLOUR TELEVISION
- CLOSED CIRCUIT TELEVISION
- VIDEO CASSETTE RECORDING
- DIGITAL TECHNIQUES
- TELETEXT & TV GAMES

Shortened courses for applicants with suitable electronics background.

Next session starts September 17th.

(Also available 2 1/2 year course in Marine Electronics & Radar for employment as ships Radio Officer.)

Prospectus from:

LONDON ELECTRONICS COLLEGE

Dept. PE9, 20 Pennywern Road,
London SW5 9SU. Tel. 01-373 8721.

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.
2. The publishers reserve the right to refuse or withdraw any advertisement.
3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

TECHNICAL TRAINING

Get the training you need to move up into a higher paid job. Take the first step now—write or phone ICS for details of ICS specialist homestudy courses on Radio, TV, Audio Eng. and Servicing, Electronics, Computers: also self-build radio kits. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. L272 Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

CITY & GUILDS EXAMS

Study for success with ICS. An ICS homestudy course will ensure that you pass your C. & G. exams. Special courses for: Telecoms. Technicians, Electrical Installations, Radio, TV & Electronics Technicians, Radio Amateurs. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. L272 Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

COLOUR TV SERVICING

Learn the techniques of servicing Colour TV sets through new homestudy course approved by leading manufacturers. Covers principles, practice and alignment with numerous illustrations and diagrams. Other courses for radio and audio servicing. Full details from:

ICS SCHOOL OF ELECTRONICS
Dept. L272 Intertext House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

RECORD ACCESSORIES

STYL Cartridges for MUSIC CENTRES, &c. FREE List No.29 for S.A.E. includes Leads, Mikes, Phones &c. **FELSTEAD ELECTRONICS (PE)**, Longley Lane, Gatley, Cheadle, Ches. SK8 4EE.

SITUATIONS VACANT

UNIVERSITY OF LONDON GOLDSMITHS' COLLEGE
New Cross, London, SE14 6NW
Psychology Department

The Psychology Department has two senior vacancies for technical staff to start as soon as possible.

1) TECHNICIAN (Grade 6)

to work in the Department's extensive range of electronic and video equipment. Normal qualifications for this post will be HNC/HND.

Salary on the following scale:
£3,984-£4,104-£4,236-£4,365-£4,497-£4,626-£4,758 plus £525 London Weighting Allowance.

2) TECHNICIAN (Grade 5)

to work in the field of computer and microprocessor applications/psychological research. Normally technical qualifications/experience would be required for this post but applications for graduates in relevant fields will be welcome.

Salary on the following scale:
£3,474-£3,582-£3,699-£3,816-£3,933-£4,056 plus £525 London Weighting Allowance.

Write for further details to the Personnel Officer to whom applications should be sent by 31st August, 1979.

'O' or 'F' grades at 'A' level?

We are looking for school leavers aged 17-19 who have obtained O or F grades in Mathematics and Physics, at G.C.E. 'A' Level, and wish to take up a career in Telecommunications.

The Company

GEC Telecommunications Limited, Coventry, design develop and manufacture a wide range of telecommunications equipment.

The Job

Together with the Coventry Technical College we are offering a

Three year sandwich course for Technician Engineers

specialising in telecommunications and electronic engineering. This course of sponsored full-time education and industrial training leads to a final qualification as a **TECHNICIAN ENGINEER**.

Applicants

School leavers aged 17-19 who have recently taken G.C.E. 'A' Levels in Physics and Maths but are unable or do not wish to study at Degree level. A weekly salary is paid so no L.E.A. grant is necessary.

Apply

With full personal details, including academic qualifications and address of school to:
Mr. C.J. Peterson, Student Training Officer, GEC Telecommunications Limited, Spon Street,
Coventry CV1 3AZ.

Tel: Coventry 452152 ext. 7361. Quoting Ref. No. CP/79/PE

GEC
Telecommunications

ASSISTANT FILM RECORDISTS & TRAINEES

WOULD YOU LIKE TO SPECIALISE IN SOUND WITH THE BBC TV'S FILM DEPARTMENT? THERE ARE VACANCIES IN WEST LONDON.

ASSISTANT FILM RECORDISTS work initially in sound transfer and dubbing areas operating sound recording and reproduction equipment for a wide range of programmes. There are prospects of progressing to mobile Film Recording work in due course. If you have professional experience in this field, the starting salary would be £4185 p.a. perhaps higher if exceptionally qualified, rising to £5605 p.a. An additional allowance is paid for shift work (not nights). Normal hearing is essential.

EXCELLENT TRAINING is given if you have ambitions to do this type of work but lack experience. You will need 'O' level standard of education or equivalent, preferably including Physics and/or Maths and a basic knowledge of electronics. You should be able to demonstrate a practical interest in sound and recording. Trainees will start at a salary of £3800 p.a. early in 1980 and should qualify for promotion to Assistant Film Recordists about a year later.

Conditions of Service are good. Telephone or write immediately for an application form and further particulars, enclosing addressed envelope and quoting reference 2383/PW, to **Appointments Department, BBC, London W1A 1AA.** Telephone 01-580 4468. Ext. 4619.

BBC tv

SERVICE SHEETS

SERVICE SHEETS for Radio, Television, Tape Recorders, Stereo etc. With free Fault-finding guide, from 50p and S.A.E. Catalogue 25p and S.A.E. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

BELL'S TELEVISION SERVICES for Service Sheets on Radio, Tv, etc £1.00 plus S.A.E. Colour TV Service Manuals on request. S.A.E. with enquiries to B.T.S. 190 Kings Road, Harrogate, N. Yorkshire, Tel: (0423) 55885.

FOR SALE

NEW BACK ISSUES of "PRACTICAL ELECTRONICS" available 70p each Post Free. Open P.O./Cheque returned if not in stock - Bell's Television Services, 190 Kings Road, Harrogate, N. Yorks. Tel: (0423) 55885.

P.E. JAN: '66 to DEC: '77. P.W. JAN: '77 to JAN: '79. (Some missing) + 36 add PE/PW total 131 Mags. Offers? Sandy 80567.

MK14 - Many extras and improvements £60. PE VDU Built £50. 0204 694265 (Manchester).

SUPERBOARD II CASE, also suitable compukit UK101 £20. Tel: Farnborough (Kent) 51591.

MK14, Working, spare sockets, power unit, improved keyboard, extra manual. £50. Lowestoft 85379.

ITT 9099X Dual JK Flip Flops Brand New 10 for £1. 50 for £4.50. Add 20p Post. Simpson, 2 Neville Street, Norwich, Norfolk.

MK14 MICROCOMPUTER, working with P.S.U., cassette interface, RAM, I/O. £63. Phone 01-560 1015. (Isleworth) evenings.

PRACTICAL ELECTRONICS 1973-1978 inclusive. Sensible Offer. AV08 Mk II - £45. Ely 2371 Ext. 372.

SUPERBOARD 11 complete with manuals unused, obtained from USA £225. Enquiries Box No. 81.

BOOKS AND PUBLICATIONS

ROMANIAN ELECTROGRAPHY, toboscopes, electrokinesis, biogravity, hallucinophography, dermoptics, psychronic generators, Kirlianography. SAE 4" x 9". PARALAB, Downton, Wilts.

WHY NOT START YOUR OWN BUSINESS REWINDING ELECTRIC MOTORS. A genuine opportunity to success. **LARGE PROFITS.** You can't help but make money if you follow the easy, step by step, instructions in our fully illustrated Manual showing how to rewind Electric Motors, Armatures and Field coils as used in Vacuum Cleaners, Electric Drills and Power Tools. **NO PREVIOUS KNOWLEDGE IS REQUIRED**, as the Manual covers in 13 Chapters, where to obtain all the work you need, materials required, all instructions rewind charts and how to take data etc. A gold mine of information. How to set up your home workshop and how to cost each job to your customer, £4.00 plus 30p P. & P. UK CWO. to **INDUSTRIAL SUPPLIES**, 102 Parrswood Rd., Withington, Manchester 20, Dept. PE.

COMPLETE REPAIR information any requested T.V. £5 (With diagrams £5.50). Any requested service sheet for £1. plus SAE. SAE brings newsletter + special offers - service sheets from 50p, bargain vouchers, unique publications.

AUS (PE) 76 Church Street, Larkhall, Lanarkshire

LADDERS

LADDERS. Varnished 25' ext. £40.34. Carr. £3. Leaflet. Callers Welcome. Ladder Centre (PEE5) Halesfield (1). Telford S96644.

MISCELLANEOUS

CABINET FITTINGS

FOR Stage Loudspeakers and Amplifier Cabs
Fretcloths, Coverings, Strap & Recess Handles, Feet, Castors, Jacks & Sockets, Cannons, Bulgin 8 ways, Reverb Trays, Locks & Hinges, Corners, Trim, Speaker Bolts etc.

Send 2 x 9p Stamps for samples and illustrated catalogue

ADAM HALL (P.E. SUPPLIES)

Unit 3, Carlton Court, Grainger Road
Southend-on-Sea, Essex.

THE SCIENTIFIC WIRE COMPANY

PO Box 30, London E.4
Reg. Office 22 Coningsby Gardens.

ENAMELLED COPPER WIRE

SWG	1 lb	8 oz	4 oz	2oz
10 to 19	2.83	1.55	.80	.64
20 to 29	3.03	1.76	1.00	.75
30 to 34	3.25	1.86	1.07	.80
35 to 40	3.60	2.08	1.22	.89
41 to 43	4.84	2.71	2.07	1.38
44 to 46	5.37	3.25	2.29	1.80
47	8.37	5.32	3.19	1.91
48 to 49	15.96	9.58	6.38	3.51

SILVER PLATED COPPER WIRE

14, 16, 18	4.30	2.39	1.53	1.00
20 & 22	5.32	3.03	1.85	1.13
24 & 26	6.06	3.57	2.13	1.30
28 & 30	7.00	4.10	2.50	1.53

Fluxcore 60/40 Solder 22 swg 65 ft 90p
18 swg 22 ft 80p

Tinned Copper Wire. 6 mm 23 swg 1 lb £4.00 10 lbs £20
Wire Wrapping Wire 30 awg 82 ft £1.10
Wire Wrapping Tool & 4 Reels £6.00

CABLES

		Per Meter
2 WAY	13.2 mm	2.5 amp 13p
2 WAY	16.2 mm	2.5 amp 16p
3 WAY	24.2 mm	6 amp 24p
3 WAY	32.2 mm	10 amp 32p
3 WAY	14.2 mm	2.5 amp 16p
4 WAY	14.1 mm	.75 amp 30p
4 WAY	7.2 mm	1.4 amp 30p
6 WAY	14.2 mm	2.5 amp 45p
10 WAY	7.2 mm	1.4 amp 60p
1 CORE	7.2 mm	Screened 12p
2 CORE	7.2 mm	Each Screened 16p
2 CORE	7.2 mm	Screened 14p
4 CORE	7.2 mm	Screened 30p
LO LOSS	Co-Axial	25p

Prices include P & P and VAT Dealer enquiries welcome.
Orders under £2 please add 20p.

HIGH QUALITY
PCB's

From your own artwork master negative or positive
maximum 12" x 12"

Manufactured in glass fibre tinned and drilled
Express service for prototypes and small production runs
Small contract circuit boards assembled
Gold plating for reliability where edge connectors
are used

ANODISED SELF ADHESIVE FASCIA PANELS WITH LEGENDS

Manufactured from your own artwork master
Various colours available brushed and satin finish
Express service and competitive prices

Send artwork or phone for prices
125W 5% C.F. Resistors E12 Series 1p each
IN4148 Diodes 2p each

Ecoscope Instruments Ltd.,
Clyde Workshops, Fullarton Road, Glasgow G32
01-641 7863

MAKE YOUR OWN PRINTED CIRCUITS
 Etch Resist Transfers - Starter pack (5 sheets, lines, pads, I.C. pads) £1.55. Large range of single sheets in stock at 32p per sheet.
 Ferric Chloride - 1 lb bags 80p (P&P 50p)*
 Master Positive Transparencies from P.C. layouts in magazines by simple photographic process. Full instructions supplied. 2 sheets (20 x 25cm) negative paper and 2 sheets (18 x 24cm) positive film £1.30.
 S.A.E. lists and information. P&P 25p/order except*
P.K.G. ELECTRONICS
OAK LODGE, TANSLEY, DERBYSHIRE

NO LICENCE EXAMS NEEDED

To operate this miniature, solid-state Transmitter-Receiver Kit. Only £10.25 plus 25p P. & P. 'Brain-Freeze' 'em with a MINI-STROBE Electronics Kit, pocket-sized 'lightning flashes', varispeed, for discos and parties. A mere £4.50 plus 25p P. & P. Experiment with a psychedelic DREAM LAB, or pick up faint speech/sounds with the BIG EAR sound-catcher; ready-made multi-function modules. £5 each plus 25p P. & P.
 LOTS MORE! Send 25p for lists. Prices include VAT.

BOFFIN PROJECTS
 4 Cunliffe Road, Stoneleigh Ewell, Surrey (P.E.)

SOLAR CELLS, Batteries, Panels, Thermoelectric Generators, heat pipes, books etc., Details; Edencombe Ltd., 34 Nathans Road, N. Wembley, Middx. HA0 3RX.

PRACTICAL ELECTRONICS P.C.B.'s
 Professional quality glass fibre Fry's roller tinned and drilled.
 Dec. 78 RC Motor control 67p. RC Fail safe 39p.
 Apr. 79 Phaser (EG60) 98p.
 May 79 Sound operated switch (ES9) 88p.
 Auto ranging multimeter. Set of 5 pcb's £5.70
 Aug. 79 Door Chime EG140/3 Set of two £1.80
 For full list and current pcb's please send SAE. Pcb's also produced from customers own masters. Trade enquiries welcome. Please write for quote.
 Postage - On orders less than £10 please add 25p postage. CWO please.
PROTO DESIGN
 14 Downham Road, Ramaden Heath, Billericay, Essex CM11 1PU

P.C. BOARDS FOR INDUSTRY 'and' THE AMATEUR

- * One off or production runs
- * Assembly of P.C.Bs or kits
- * Expert hand soldering
- * Design service if required
- * Artwork & Photography

SEAHORSE ELECTRONICS LTD.
 Unit 2 Picow Farm Road
 Service Industry Estate,
 Runcorn, Cheshire.
 (09285) 75950

CLEARING LABORATORY. Scopes, recorders, testmeters, bridges, audio, R.F. generators, turntables, tapeheads, stabilised P.S.U.s, sweep generators, test equipment, etc. Lower Beeding 236.



Readily available Hardware and Accessories for Home Constructors, Dev Engineers, Modelmakers. Selected range of quality components, Drawing materials for p.c. boards, Reliable resist coated epoxy glass laminate, no unusual chemicals. Printed circuit boards, top quality to personal designs, prompt service. Photography for p.c.b. Solid tungsten carbide drills. All immediately available. Catalogue 15p stamps please to:

RAMAR CONSTRUCTOR SERVICES,
 Masons Rd. Stratford on Avon
 Warwks. CV37, 9NF 0789-4879

SUPERB INSTRUMENT CASES BY BAZELLI, manufactured from P.V.C. Faced steel. Hundreds of people and industrial users are choosing the cases they require from our vast range. Competitive prices start at a low 90p. Chassis punching facilities at very competitive prices, 400 models to choose from. Suppliers only to Industry & The Trade. BAZELLI (Dept. No. 23), St. Wilfrids, Foundry Lane, Halton, Lancaster, LA 6LT.

PROFESSIONAL AND DIY BURGLAR ALARM EQUIPMENT
 Send SAE for Pricelist and full details of our top quality items at competitive prices
SONIC INTRUDER ALARM SYSTEMS
 19, Hope Street, Old Glossop, Derbyshire, SK13 9SB. Tel: (04574) 2858

ULTRASONIC TRANSDUCERS. £2.85 per pair + 25p P & P. Dataplus Developments, 81 Cholmesley Road, Reading, Berks.

NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine.

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of Practical Electronics for

insertions. I enclose Cheque/P.O. for £

(Cheques and Postal Orders should be crossed Lloyds Bank Ltd. and made payable to Practical Electronics)

NAME

ADDRESS

.....

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS.

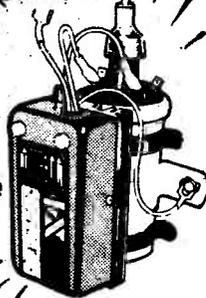
Send to: Classified Advertisement Manager
PRACTICAL ELECTRONICS
 GMG, Classified Advertisements Dept., Room 2337,
 King's Reach Tower, Stamford Street,
 London SE1 9LS. Telephone 01-261 5846
 Rate:
 20p per word, minimum 12 words. Box No. 60p extra.

The latest kit innovation!

from Sparkrite

Sparkrite was featured by Shaw Taylor in 'DRIVE IN'

the quickest fitting
CLIP ON
capacitive discharge
electronic ignition
in KIT FORM



- Smoother running
- Instant all-weather starting
- Continual peak performance
- Longer coil/battery/plug life
- Improved acceleration/top speeds
- Optimum fuel consumption

Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins. Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.

NOTE — Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £4.25 inc. VAT, post & packing UK only.

Electronics Design Associates, Dept. PE 10, 82 Bath Street, Walsall, WS1 3DE. Phone: Walsall 614791

Electronics Design Associates, Dept. PE9
82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

Name

Address

Phone your order with Access or Barclaycard

Inc. V.A.T. and P.P.

QUANTITY REQ'D.

Send SAE if brochure only required.

X4 KIT £17.95

TACHOPULSE SLAVE UNIT £4.25

I enclose cheque/PO's for

£

Cheque No.

Please state polarity pos or neg earth.

Access or Barclaycard No.

MINIATURE MAINS TRANSFORMERS

Top quality. Split bobbin construction

will give 4.5V-0-4.5V at 250 MA.

1 1/2" x 1 1/2" x 1 1/2", all sorts of uses.

ONLY 90p. 3 for £2.20.

1000 uf, 100V, Radial, 1 1/2" x 2". ONLY 70p. 3 for £1.50.

Don't Let Your Environment Dehydrate You!
Buy our Honeywell Humidity Controller.
Membrane actuated, very sensitive. 1/2" shaft. 250V. 3.75A
Contacts. Ideal for greenhouses, centrally heated homes,
offices etc. Build your own humidifiers or alarms. Fraction of
original cost 90p ea. 3 for £2.

SMOKE AND GAS DETECTOR
Uses TGS 105 plug in sensor, housed in neat 3 1/2" dia cast
box, led indicator. 24V. (12V by altering 3 component
values). Will operate lamp or relay, with data and
circuit £0.95
Relays for above £1 ea. with voltage

CASSETTE MOTORS
Self Regulating, will operate 0-12V ideal for models,
mechanical switching etc. 2000 R.P.M. approx. 90p ea.

TRANSISTOR PACKS
100. Full spec, new and marked. Includes BC148, BC184L,
MED412, BF274, BC154 etc. etc. £4.95
298 as above and includes AC128, 2N3055, BFY50,
BD131, BF200 etc. £9.95
Buy bulk and save money, these packs are worth at least
double.

ULTRASONIC TRANSDUCERS
Transmitter and receiver. 40 kHz 14 mm diam. £4.25 pair.

P/B SWITCH BANKS
These cost a fortune! Were made for various music centres.
Includes independent and interdependent latching types multi
pole etc etc. Can be modified. Can't be repeated. 3 Banks for £1

6 x 6 POLE REED RELAYS ON BOARD
12V ideal for burglar alarms, model railways etc. £2.45

100 MINIATURE REED SWITCHES
We are the cheapest! £3.30

BULK BARGAINS, STOCK UP FOR SUMMER
300 mixed 1/2 & 1/4 watt resistors £1.90
150 mixed 1 & 2 watt resistors £1.90
300 mixed capacitors, modern, most types £3.30

EARPIECES
Magnetic with plug and lead 25p ea. 5 for £1
Crystal with lead 40p ea. 3 for £1

100 mixed ceramic and plate caps £1.20
400 mixed 7 1/2m resistors £2.95
100 mixed polystyrene caps £2.20
25 pots and potentiometers £1.80

MAKE CHEAP BATTERY ELIMINATORS
Fully shrouded mini mains transformers. 240V in 0-0-8V at
100 MA out. Complete with mains lead and plug, ex new
equip. 80p

25 presets, slider etc. £1.20
20 VDRs and thermistors £1.20
100 Hi-voltage resistors minimum etc. £2.20
100 electrolytics, nice values £2.20
300 printed circuit resistors £1
300 printed circuit components £1.60

DE LUXE FIBRE GLASS PRINTED CIRCUIT ETCHING KITS
Includes 150 sq. in. copper clad F/G. board, 1 lb ferric
chloride, 1 date etch resist pen, Abrasive cleaner. Each tray
plus instructions. Special Price £4.95

100K miniature thumbwheel slider pots
Very neat, can be banded side by side. Ideal for v. cap
tuning, graphic equalizers etc. 10 for £1

1 lb FE. C1. To mil. spec. £1.25
5 lb FE. C1. To mil. spec. £5.00

100K STEREO SLIDER POTS
Good quality. 25p ea. 5 for £1

150 sq. in. Single sided board £2.00
150 sq. in. Double sided board £3.00

MINIATURE LEVEL/BATT. METERS 200µA
F.S.D. as fitted to many cassette recorders 60p

40p P & P on all above items. Cheque or P.O. with order to:

SENTINEL SUPPLY, DEPT. P.E.
149A BROOKMILL RD., DEPTFORD, LONDON, SE8

AMPLUS ELECTRONICS

12 Home Close, Blatchley MK3 6JE

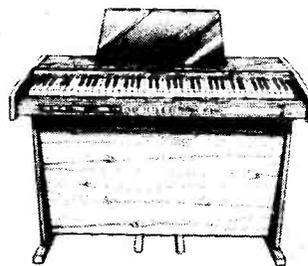
C.W.D. only.	P/Packing 35p								Mail Order Callers by appointment
BC107/9	12p	BFX88	£1.10	2N614	30p	2N3108	35p	2N6125	47p
BC119	32p	BFX81	40p	2N616	30p	2N3205	35p	2N6128	40p
BC140	30p	BFX84	32p	2N619	40p	2N3440	50p		
BC142	33p	BFX85	32p	2N630	20p	2N3724	70p	Linear	
BC143	33p	BFX88	32p	2N1132	20p	2N3726	80p	LOOST1	£2.26
BC180	40p	BFX87	33p	2N1613	25p	2N3886	£1.20	TA0821AX1	
BC177	25p	BFX89	30p	2N1893	31p	2N4037	67p		£2.82
BC441	30p	BFY18	70p	2K2216	37p	2N4236	£1.57	TA0841BX1	
BC481	30p	BFY50	70p	2N2219	22p	2N4698	£1.56		£2.82
BD477	27p	BFY51	70p	2N2221	25p	2N4810	£1.20	TA0851	£2.83
BD142	84p	BFY52	22p	2N2222	22p	2N5190	65p	TA0890	£1.82
BDS38	77p	BFY72	90p	2N2297	40p	2N5191	75p	TA08105	£1.87
BDS76	60p	BFY75	77p	2N2368	22p	2N5192	80p	TA0820	£3.60
BD878	60p	BF167	30p	2N2369	17p	2N5193	75p		
BD877	70p	BF173	30p	2N2443	31p	2N5194	80p	Diodes	
BD878	82p	BF257	30p	2N2484	27p	2N5195	87p	1N814	5p
BFW43	£1.80	BF258	30p	2N2846	£1.82	2N6038	£1.30	1N4148	5p
BFX13	32p	BF259	30p	2N2894	33p	2N6039	£1.17	1N4001	5p
BFX18	40p	2N698	40p	2N2905	20p	2N6099	82p	1N4003	5p
BFY29	34p	2N697	27p	2N2906	20p	2N6121	61p	1N4004	7p
BFY30	34p	2N698	40p	2N2907	20p	2N6122	60p	1N4005	7p
BFY34	60p	2N706	21p	2N3053	22p	2N6123	60p	1N4006	7p
BFY37	40p	2N708	21p	2N3056	80p	2N6124	65p	1N4007	7p

All components Brand New and Top Grade. No Seconds.

Please add 7% to transistors and diodes and 25% VAT to Linear.

Clef Kits -

Designer approved quality kits for Electronic Musical Instrument Construction.



JOANNA 72 & 88 PIANOS
Six and 7 1/2 Octave Electronic Pianos with unique Touch Sensitive Action, as used in the P.E. JOANNA, which electronically simulates piano key inertia - a feature not available in any other design. A new physical layout has been adopted to simplify construction.

P.E. STRING ENSEMBLE
The only kit available to the proven A. J. Boothman Design for this versatile String Machine. Specialists in all sizes of Square Front Keyboards. Send S.A.E. to -

Clef Products (Dept P.E.) 16, Mayfield Road, Bramhall, Cheshire SK7 1JU

Mail Order Protection Scheme

The Publishers of 'Practical Electronics' are members of the Periodical Publishers Association which has given an undertaking to the Director General of Fair Trading to refund monies sent by readers in response to mail order advertisements, placed by mail order traders, who fail to supply goods or refund monies owing to liquidation or bankruptcy. This arrangement does not apply to any failure to supply goods advertised in a catalogue or in a direct mail solicitation.

In the unhappy event of the failure of a mail order trader readers are advised to lodge a claim with 'Practical Electronics' within three months of the date of the appearance of the advertisement, providing proof of payment. Claims lodged after this period will be considered at the Publisher's discretion. Since all refunds are made by the magazine voluntarily and at its own expense, this undertaking enables you to respond to our mail order advertisers with the fullest confidence. For the purpose of this scheme, mail order advertising is defined as:—

'Direct response advertisements, display or postal bargains where cash had to be sent in advance of goods being delivered'. Classified and catalogue mail order advertising are excluded.



Become a radio amateur.

Learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence.

WAA

Brochure, without obligation to:
BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL,
 P.O. Box 156, Jersey, Channel Islands. PEK 9/79

Free! NAME _____

ADDRESS _____

(Block caps please)

INDEX TO ADVERTISERS

Acorn Computers	71	Electronic Mail Order	82	Progressive Radio	74
Adam Hall (P.E. Supplies)	84	Electrovalue	6	Proto Design	85
Aitken Bros.	76	Fladar	14	Radio Component Specialists	14
Amplus Electronics	86	G.E.C. Telecommunications	83	Ramar Constructor Service	85
Astra-Pak	78	George Sales, David	4	R.S.T. Valve Mail Order	81
Aura Sounds	72	Goldsmith College	82	Radio & T.V. Components	7
A.U.S.	84	Gould Advance	59	Saxon Entertainments	65
Barrie Electronics	10	Harversons	74	Science of Cambridge	50
B.B.C. T.V.	84	Home Radio	76	Scientific Wire Co.	84
Bib Hi-Fi Accessories Ltd.	59	I.C.S. Intertext	78, 82	Seahorse Electronics	85
Bi-Pak	77	I.L.P. Electronics	15	Sentinel Supply	86
Birkett J.	79	Jayen Developments	9	Service Trading	Cover III
Boffin Projects	85	J.W.B. Radio	82	Sonic Intruder Alarm Systems	85
British National Radio & Electronics School	11, 87	L & B Electronics	72	Special Products	12
Calscope	6	London Electronics College	82	Squires, Roger	80
Cambridge Learning	66	Maclin-Zand	5	Stevensons Electronic Components	75
Chromasonic	81	Maplin Electronics	Cover IV	Swanley Electronics	74
Clef Products	86	Marshall A. (London) Ltd.	13	Systems 696 Ltd	82
Codespeed	80	Metac	49	Tandy	16
Computer Components (Teleplay)	Cover II	Mill Hill Supplies	81	T.K. Electronics	78
Continental Specialties Corporation U.K. Ltd.	73	Modern Book Co.	79	Technomatic	88
Crimson Elektrik	10	Newtronics	6, 72	Tele Production Tools	9
Crofton Electronics	4	North London Polytechnic	12	Timetron	79
C.R. Supply Co.	82	P.K.G. Electronics	85	T.U.A.C.	3
Davian Electronics	14	Phonosonics	8, 9	Vero Electronics	4
Delta Tech	74	Progressive Radio	74	Watford Electronics	2, 3, 60
D.E.W.	76	Proto Design	85	West London Direct Supplies	79
Dziubas	3	Radio Component Specialists	14	Wilmslow Audio	12
Ecoscope	84	Ramar Constructor Service	85		
E.D.A.	86	R.S.T. Valve Mail Order	81		
		Radio & T.V. Components	7		
		Saxon Entertainments	65		
		Science of Cambridge	50		
		Scientific Wire Co.	84		
		Seahorse Electronics	85		
		Sentinel Supply	86		
		Service Trading	Cover III		
		Sonic Intruder Alarm Systems	85		
		Special Products	12		
		Squires, Roger	80		
		Stevensons Electronic Components	75		
		Swanley Electronics	74		
		Systems 696 Ltd	82		
		Tandy	16		
		T.K. Electronics	78		
		Technomatic	88		
		Tele Production Tools	9		
		Timetron	79		
		T.U.A.C.	3		
		Vero Electronics	4		
		Watford Electronics	2, 3, 60		
		West London Direct Supplies	79		
		Wilmslow Audio	12		

SERVICE TRADING CO

RELAYS SIEMENS, PLESSEY, etc. MINIATURE RELAYS

RELAYS. WIDE RANGE OF A.C. and D.C. RELAYS AVAILABLE from stock phone or write in your enquiries

RODENE UNIST TYPE 71 TIMER

0-60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price £6. P. & P. 60p. (£7.59 inc. VAT & P. & P.)

WHY PAY MORE?

MULTI RANGE METER Type MF15A a.c. d.c. volts 10 - 50, 250, 500, 1000 Ma 0-5, 0-10, 0-100. Sensitivity 2000V, 24 range. diameter 133 by 93 by 46mm including test leads. Price £7.00 plus 50p P. & P. (£8.63 inc. VAT & P.)

METERS (New) - 90 mm DIAMETER

A.C. Amp., Type 62T2, 0-1A, 0-5A, 0-20A. A.C. Volt, 0-150V, 0-300V. D.C. Amp., Type 65C5, 0-2A, 0-10A, 0-50A, 0-100A. D.C. Volt, 0-15V, 0-30V. All types £3.50 ea. + P. & P. 50p (£4.32 inc. VAT), except 0-50A, 0-100A. D.C., price £5.00 + 50p. P. & P. (£6.33 inc. VAT).

HEAVY DUTY SOLENOID, mf. by Magnetic Devices, 240V, A.C. Intermittent operation. Approx. 20 lb. pull at 1 1/2 in. Ex-equip. Tested. Price: £4.75 + 75p. P. & P. (£6.33 inc. VAT & P.)

A.C. SOLENOID pvc ether type 178/2 240 AC. Approx 1lb at 3 inch, intermittent rating. Price £1 p&p 20p (£1.38 inc VAT & P.).

WESTOOL TYPE MMS Model 2, 240V AC. Approx 1 1/2 lb pull at 1/2 inch. Rating 1. Price £1.50 p&p 20p. (£1.84 inc VAT & P.) N.M.S.

18-24V. D.C. 70 ohm Coil Solenoid. Push or Pull. Adjustable travel to 3/16 in. Fitted with mounting brackets and spark suppressor. Size: 100 x 65 x 25 mm. Price: 3 for £2.40 + 30p. P. & P. (min. 3 off.) (£3.11 inc. VAT & P.)

MINIATURE UNISELECTOR 12 volt, 11-way, 4 bank (3 non-bridging 1 homing). £2.50. P. & P. 35p (£3.28 inc. VAT & P.). N.M.S.

240 A.C. SOLENOID OPERATED FLUID VALVE Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring 1/2 in. b.s.p. inlet outlet. Precision made. British mfg. PRICE £3.50 Post 50p (£4.60 inc. VAT & P.). N.M.S.

MICRO SWITCHES Sub min Honeywell roller m/s type 3115m 906t 10 for £2.68 post paid LEVER OPERATED 20 amp C/O. Mfg by Unimax USA 10 for £4. P & P 50p (min order 10) £5-18 inc. VAT D.P. C/O lever m/s/switch mfg by Cherry Co USA Precious metal low resistance contacts 10 for £2.25 P & P 30p Total inc VAT £3.02 (min 10)

MERCURY SWITCH Size 27mm x 5mm, 10 for £5.00 (inc VAT £6.12) min quantity 10 Heavy duty type, size 38 x 16 x 10mm, minimum quantity 10. £7.50 post paid (£8.63 inc. VAT & P.)

A.E.G. CONTACTOR Type LS6/L11. Coil 240V 50 Rs. Contacts - 3 make: 600V: 20 amp. 1 break: 600V: 20 amp. Price £6.50 + 50p P. & P. (£8.05 inc. VAT & P.) Yet another outstanding offer.

IMFD 600V Dubilier wire ended capacitors 10 for £1.50 p&p 50p (£2.30 inc VAT & p&p) (Min 10) N.M.S. Reduction Drive Gear Box. Ratio 72:1. Input spindle 1/2 x 1/2 in. Output spindle 3/8 x 3 in. long. Overall size approx: 120 x 98 x 68 mm. All metal construction. Ex-equip. tested. Price: £2.00 + 50p.

TORIN BLOWER Smith type FFB 16 022 220/240V A.C. Aperture 10 x 4 cm overall size 16 x 14 cm Price £3.75 P. & P. 75p. (inc. VAT £5.18) Other types available. S.A.E. for details

24 volt D.C. BLOWER UNIT Precision 24 volt. D.C. 0.8 amp Blower that works well on 12V 0.4 amp D.C. Producing 30 cu.ft. min at normal air pressure. £4.50 P. & P. 75p (inc. VAT £6.04). N.M.S.

INSULATION TESTERS NEW! Test to I E E Spec Rugged metal construction suitable for bench or field work constant speed clutch Size L 8in W 4in H 6in weight 6lb, 500V, 500 megohms, £49. Post 80p (£57.27 inc. VAT & P.). 1,000V 1,000MΩ, £55. Post 80p (£64.17 inc. VAT & P. SAE for leaflet.

VARIABLE VOLTAGE TRANSFORMERS

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

200 watt (1 amp inc. a.c. voltmeter	£14.50
0.5 KVA (2 1/2 amp (MAX)	£17.00
1 KVA (5 amp MAX)	£22.50
2 KVA (10 amp MAX)	£37.00
3 KVA (15 amp MAX)	£45.50
5 KVA (25 amp MAX)	£74.00
10 KVA (50 amp MAX)	£168.00
15 KVA (75 amp MAX)	£260.00

CARRIAGE PACKING & VAT EXTRA

LT TRANSFORMERS 0-10-15V at 3 amp (ex new equip) £2.50 P. & P. 50p (£3.45 inc. VAT)

13-0-13V at 1 amp £2.63 P. & P. 50p (£3.45 inc. VAT) 25-0-25V at 2 1/2 amp £4.50 P. & P. 75p (£6.04 inc. VAT & P.) 0-4V/6V/24V/32V at 12 amp £18.50 P. & P. £1.90 (£23.46 inc. VAT & P.)

0-6V/12V at 20 amp £14.70 P. & P. £1.50 (£18.63 inc. VAT) 0-12V at 20 amp or 0-24V at 10 amp £12.00 P. & P. £1.50 (£15.53 inc. VAT & P.)

0-6V/12V at 10 amp £8.25 P. & P. £1.25 (£10.93 inc. VAT) 0-6V/12V/17V/18V/20V at 20 amp £19.00 P. & P. £1.50 (£23.58 inc. VAT & P.)

0-10V/17V/18V at 10 amp £10.50 P. & P. £1.50 (£13.80 inc. VAT)

Other types in stock; phone for enquiries or send sae for leaflet

HY-LIGHT STROBE KIT MK IV

Latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/240V a.c. operation. Designed for larger rooms, halls, etc. Speed adjustable 1-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. Price £19.00. Post £1 (£23.00 incl. VAT & P.). Specially designed case and reflector for Hy-Light £8.80. Post £1 (£11.27 inc. VAT & P.)

XENON FLASHGUN TUBES

Range available from stock S A E for details

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES

4ft. 40 watt £8.70 (callers only) 2ft. 20 watt £6.20. Post 75p. (£7.99 inc. VAT & P.) (For use in stan bi-pin fittings) Miri 12 in. 8 watt £2.60. Post 35p. (£3.62 inc. VAT & P.) 9 in. 6 watt £2.25. Post 35p. (£2.81 inc. VAT & P.) 6 in. 4 watt £2.25. Post 35p. (£2.99 inc. VAT & P.)

Complete ballast unit, for either 6", 9" or 12" tube 230V AC op. £3.50. Post 45p. (£4.54 inc. VAT & P.) Also available for 12V DC op. £3.50. Post 45p. (£4.54 inc. VAT & P.)

400 watt UV lamp and ballast complete £31.50. Post £3. (£39.98 inc. VAT & P.) 400 watt UV lamp only £11.25. Post £1. (£14.32 inc. VAT & P.)

SQUAD LIGHT

A new conception in light control. Four channels, each capable of handling 750 watts of spotlights, floodlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. S.A.E. (footsap) for further details. Price £60.00 p&p 70p (£69.81 inc. VAT & P.)

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, embedded winding heavy duty brush assembly, continuously rated. 25 WATT 10/25/50/100/250/500/1kΩ/1.5kΩ £2.40. Post 20p (£2.99 inc. VAT & P.) 50 WATT 250Ω £2.90. Post 25p (£3.62 inc. VAT & P.)

100 WATT 1/5/10/25/50/100/250/500/1kΩ/1.5kΩ/2.5kΩ/3.5kΩ £9.00 P. & P. 35p (£9.70 inc. VAT) Black, Silver, Skirted knob calibrated in Nos 1-9 1 1/2 in dia brass bush. Ideal for above Rheostats 24p each

SPECIAL OFFER

BERCO type L. RHEOSTAT 85 ohm 300 watt 1.86 amp. £7.50 p. & p. 50p (Total. £9.20 incl. V.A.T.). N.M.S.

RELAYS

230/240V A.C. Relays: Arrow 2 c/o. 15 amp £1.50 (£1.96 inc. VAT & P.) T.E.C. open type 3 c/o. 10 amp £1.10 (£1.95 inc. VAT & P.) Omron or Keyswitch 1 c/o 7 amp £1.00 (£1.30 inc. VAT & P.)

D.C. Relays: Open type 9/12V 3 c/o 7 amp £1.00 (£1.38 inc. VAT & P.) Sealed 12V 1 c/o 7 amp octal base. £1.00 (£1.38 inc. VAT & P.) Sealed 12V 2 c/o 7 amp octal base. £1.25 (£1.67 inc. VAT & P.) Sealed 12V 3 c/o 7 amp 11-pin. £1.35 (£1.78 inc. VAT & P.) 24V. Sealed 3 c/o 7 amp 11-pin. £1.35 (£1.78 inc. VAT & P.) (any contact rating). P&P on any Relay 20p. N.M.S.

Other types available — phone for details.

Diamond H heavy duty A.C. relay 230/240V a.c. Two C/O contacts 25 amps res at 250 a.c. £2.50 p&p 50p. (£3.45 inc. VAT & p&p) Special base 50p. N.M.S.

GEARED MOTORS

4 1/2 rpm, 115V, a.c. 50 cycle, mf. SIGMA Inst. Ltd. U.S.A. Price: £7.50 + 75p. P. & P. (£8.91 inc. VAT). supplied with transformer N.M.S.

7 1/2 rpm, 115V, a.c. 50 cycle approx. 25lb. mf. KLAXON

28 rpm, 115V, a.c. 20lb. in. reversible.

Price of either 2 Motors £4.75 each + 75p. P. & P. (£6.33 inc. VAT). N.M.S. Any of above 3, supplied with transformer for 240V. operation: £7.25 x £1.00 P. & P. (£9.49 inc. VAT).

19 rpm FHP 220/240V a.c. reversible, torque 14.5kg. Gear ratio 144-1. Brand new including capacitors. mf. CITENCO. Price £14.25 + £1.25 P. & P. (£17.83 inc. VAT). N.M.S.

30 rpm, 230/240V, a.c. 50lb in mf. PARVALUX. Price: £15.00 + £1.50 P. & P. (£18.98 inc. VAT). N.M.S.

56 rpm, 240V a.c. 50lb in. 50Hz 0.7 amp. Shaft length 35mm. Dia. 16mm. Wt 6kg. 600g. mf. FRACMO. Price £15.00 + £1.50 P. & P. (£18.98 inc. VAT). N.M.S.

100 rpm, 110V a.c. 115lb in. 50Hz 2.8 amp single phase split capacitor. Immense power. Continuously rated. Totally enclosed. Fan-cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle dia. 15.5mm. length 145mm. Tested. Price: £12.00 + £1.50 P. & P. (£15.53 inc. VAT). R. & T. Suitable Transformer for 230/240V. operation. Price £8.00 + 75p. P. & P. (£10.06 inc. VAT)

200 rpm, 35 lbs in 115V 50Hz. Price: £16.00 + £1.50 P. & P. (£18.98 inc. VAT) N.M.S. Suitable Transformer for 230/240V a.c. Price: £8.00 + £1.00 P. & P. (£10.35 inc. VAT). N.M.S.

500 rpm, 230/250V a.c. 3 1/2 lb in. 2 right-angled spindles. mf. PARVALUX. Price: £11.00 + £1.00 P. & P. (£13.80 inc. VAT). N.M.S.

6/9V. D.C. Miniature Geared Motor, precision built, incredibly powerful for size — approx. speed @ 6V - 60 rpm 40 ma. approx. speed @ 9V - 80 rpm 50 ma. 27mm dia., 30mm length, 55gr. weight, drive spindle 5 x 3mm dia.

Price: £2.50 post paid (£2.88 inc. VAT). N.M.S.

12V. D.C. type SD2. Shunt & ph continuously rated 4000 rpm mf. PARVALUX. Price: £10.00 + 75p. P. & P. (£12.35 inc. VAT) N.M.S.

1rpm 230/240V, a.c. Synchronous geared Motor, mf. HAYDON. 2 rpm 230/240V, a.c. Synchronous geared Motor, mf. CROUZET. Either type £2.50 + 30p. P. & P. (£3.68 inc. VAT). N.M.S.

1,400 rpm 115V, a.c. Motor, HP 1/2 continuously rated. Fitted with anti-vibration cradle mounting, mf. FRACMO. Supplied complete with transformer for 230/240V, a.c. operation. Price: £10.00 + £1.00 P. & P. (£12.65 inc. VAT). N.M.S.

1,600 rpm, 230V, a.c. reversible Motor, 0.25 a. complete with anti-vibration mounting bracket and capacitor. O/a size: 110 x 90mm. Spindle 1/4 dia. reversing. Mf. GENERAL ELECTRIC. R. & T. Price: £3.00 + 50p. P. & P. (£4.03 inclusive).

ROTARY VACUUM AIR COMPRESSOR & PUMP

Carbon Vane oil-less, 100/115V A.C. 1/12 h.p. motor 50/60 cyc- 2875/3450 rpm, 20" vacuum

1.25 c.f.m. 10 p.s.i. (approx. figures) mft. by Gast Co. Fraction of maker's price £14.00 p. & p. £1.00 (Total: £17.25 inc. VAT). Suitable Transformer. £3.50 p. & p. 50p. (Total, £4.60 inc. VAT) N.M.S.

BLOWER VACUUM PUMP English Electric 3 phase A.C. motor 220/250V. Or 380/440V, 1.425 r.p.m. 1/2 h.p. continuously rated. Direct coupled to William Allday & Co Alcolca carbon vane blower/vacuum pump 0.9 cm 8.H.G. Price £22 p&p £2 (£27.60 inc VAT + p) N.M.S.

Time Switch Vomer Type ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs at any manually pre-set time 36 hour Spring Reserve and day-emitting device Built to highest Electricity Board specification. Price £9.00. P. & P. 75p (£11.22).

R & T. SANGAMO WESTON TIME SWITCH Type S251 200/250V a.c. 2 on/2 off every 24 hours 20 amps contacts with override switch dia 4 x 3 price £6.50 P. & P. 50p inc. VAT £8.05 Also available with Solar dial R. & T.

REVERSIBLE SPLIT PHASE MOTOR 250 r.p.m., 100 - 115 210 - 240V, A.C. 2" x 1" extremely powerful. Inc. capacitor £2.90 + 30p. P. & P. (£3.68 inc. VAT)

230V a.c. FAN ASSEMBLY. Powerful continuously rated a.c. motor complete with 5 blade 6 1/2 in. or blade 3 in. aluminium fan. Price £3.00. P. & P. 65p (£4.20 inc. VAT & P.).

KEY N.M.S. R & T New Manufacturers Surplus Reconditioned and Tested

SERVICE TRADING CO
57 BRIDGMAN ROAD CHISWICK LONDON W4 5BB 01 995 1560
ACCOUNT CUSTOMERS MIND. ORDER £10.00

Personal callers only Open Saturdays
9 Little Newport Street,
London WC2H 7JJ
Phone 01-437 0576

MAPLIN



This superb organ – build the first working section for just over £100. Full specification in our catalogue.



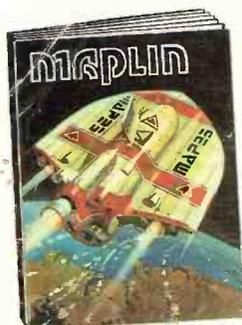
Touch operated rhythm generator, the 'Drumsette'. Construction details 25p. (Leaflet MES49). Specification in our catalogue.



Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 106 and 183 to 188 for details.



61-note touch-sensitive piano to build yourself. Full specification in our catalogue.



A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages – some in full colour – it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data.

Our bi-monthly newsletter contains guaranteed prices, special offers and all the latest news from Maplin.



A range of highly attractive knobs is described in our catalogue. Our prices are very attractive too!



The 3800 synthesiser build it yourself at a fraction of the cost of one ready-made with this specification. Full details in our catalogue.



A pulse width train controller for smooth slow running plus inertial braking and acceleration. Full construction details in our catalogue.



Speakers from 1½ inch to 15 inch; megaphone, PA horns, crossovers etc. They're all in our catalogue. Send the coupon now!

MAPLIN

ELECTRONIC SUPPLIES LTD

Post this coupon now for your copy of our 1979-80 catalogue price 70p.

Please send me a copy of your 280 page catalogue. I enclose 70p (plus 37p p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.35 or ten International Reply Coupons. I enclose £1.07.

NAME _____

ADDRESS _____

PE 979



A wide range of disco accessories at marvellous prices. Our catalogue has all the details.



A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.



A genuine 150W per channel stereo disco to build yourself. Full specification in our catalogue.

All mail to:—
 P.O. Box 3, Rayleigh, Essex SS6 8LR.
 Telephone: Southend (0702) 554155.
 Shop: 284 London Road, Westcliff-on-Sea, Essex.
 (Closed on Monday).
 Telephone: Southend (0702) 554000. P.E. 9/79