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PRACTICAL

ELECTRONICS

SEPTEMBER 1979

50p

6 CHANNEL MIXER

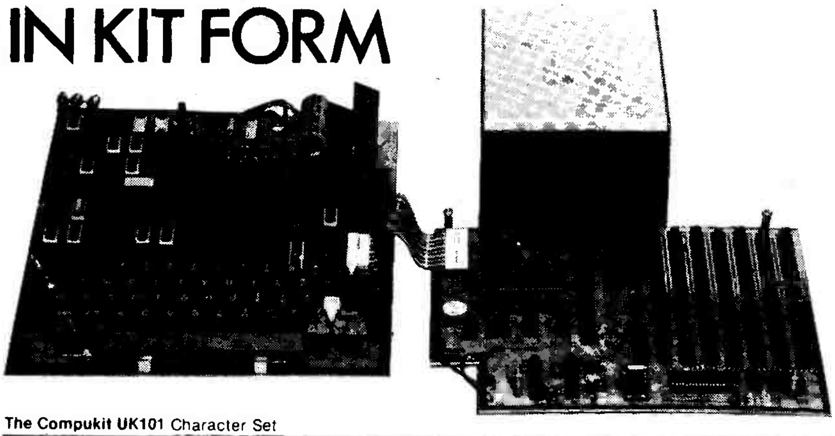
Free Entry Competition

OVER £300 WORTH OF BREADBOARDING FROM Lektrokit TO BE WON!

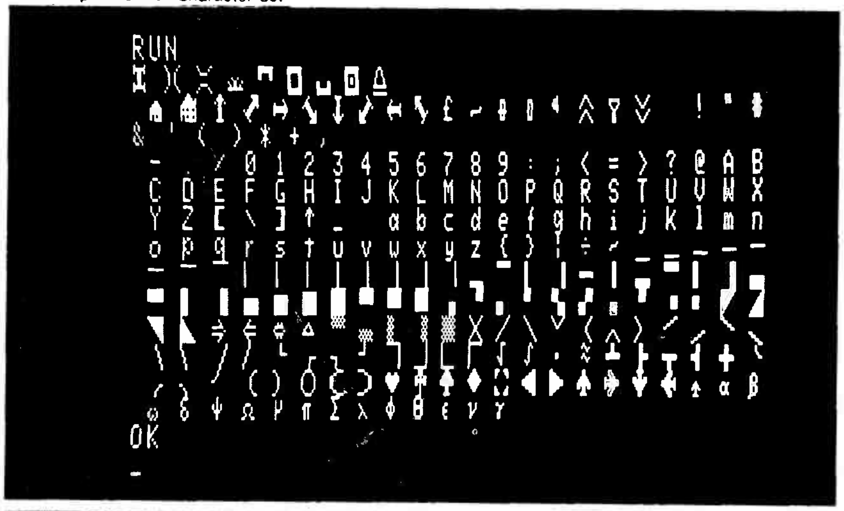
COMPUKIT UK101

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 consise 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		

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$)	CHR$S(I)	FRE(X$)	LEFT$(XS,I)	LEN(X$)	MID$(X$,I,J)
RIGHT$(X$,I)		STR$(X)		VAL(X$)	

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 $,e.g.A$.

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
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PRACTICAL
ELECTRONICS

VOLUME 15 No. 9 SEPTEMBER 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

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

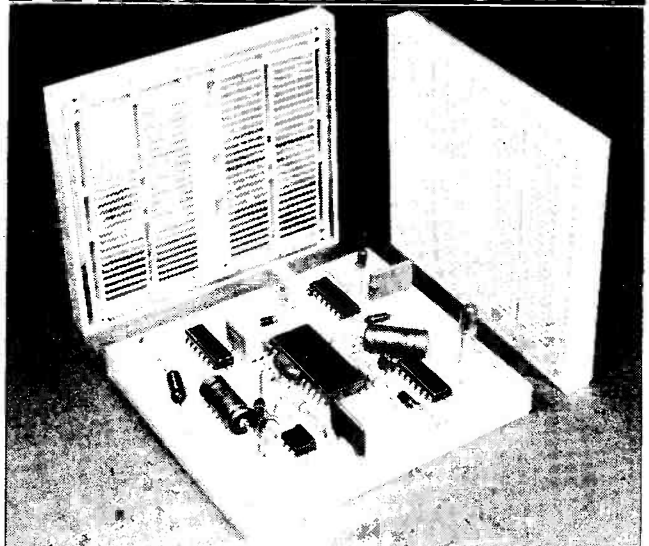
THE NEW

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

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PE9/79

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

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

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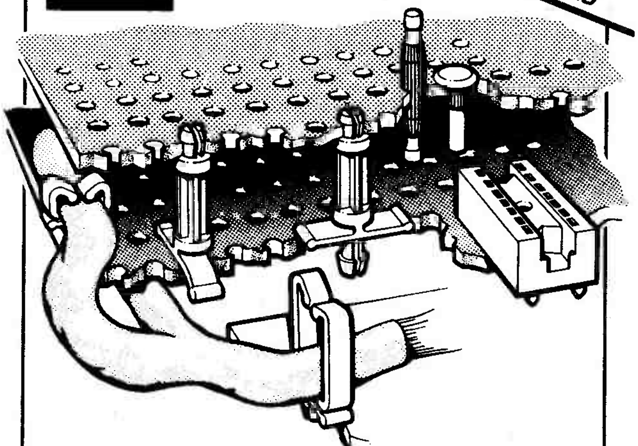

Our new catalogue lists circuit board accessories for all your projects – DIP sockets, pins, stand-offs, cable clips, hand tools. And we've got circuit boards, module systems, cases and boxes – everything you need to give your equipment the quality you demand. Send 25p to cover postage and packing, and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

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10" Metal Cased Industrial Video Monitor

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Ideal for Computer Terminal or General Video Monitor.
Complete With Own Power Supply.
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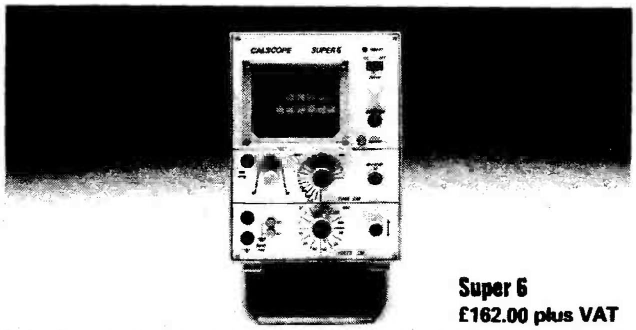

Super 6
£162.00 plus VAT

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

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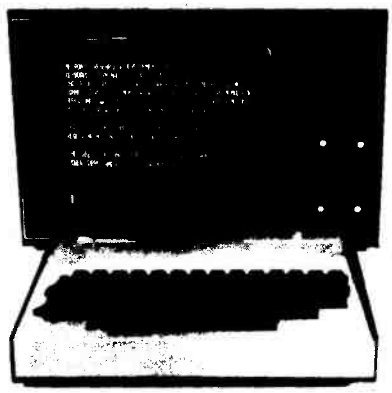
Newtronics



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

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 57p

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) £14·93
- Power supply set (incl. PCB) £6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)

A simple 4-octave frequency comparator for use with synthesisers 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 £24·05*
- Printed circuit board £3·03*

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

TAPE NOISE LIMITER

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

- Standard tolerance set of components £2·96
- Superior tolerance set of components £3·76
- Regulated power supply (will drive 2 sets) £4·69

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 COPYRIGHT 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
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	T05	87p
723	14-pin DIL	51p
728	T05	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	17½p
4011	14-pin DIL	17½p
4024	14-pin DIL	46½p
4089	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16721/6		188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	160p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

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

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

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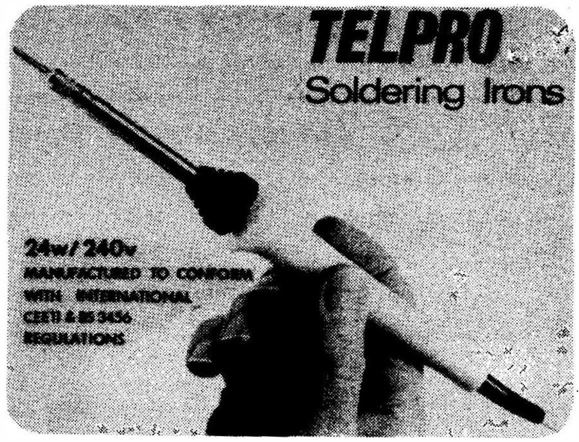

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SEND £5.50 per iron plus 83p V.A.T.

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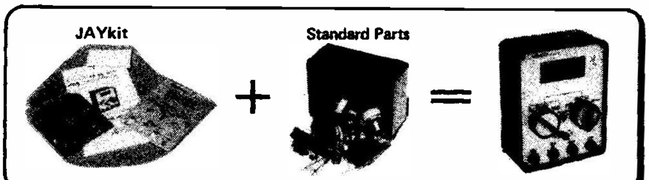
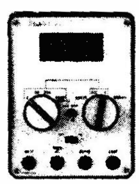


DM-2



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
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- ★ 1% accuracy (DC volts)
- ★ Designed around Intersil 7106 IC
- ★ Total cost around £30 (incl. case)

FG-1a

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- ★ 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.

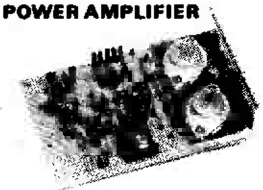
P.E.9

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 slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB, signal to noise ratio is 70dB relative to 3·5mV, distortion < ·005% 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 ration 86db; slew-rate 3V/uS, T.H.D. 20Hz—20kHz < ·008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138 × 80 × 20mm. Supply to be ± 15 volts.

MC 1—PRE-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

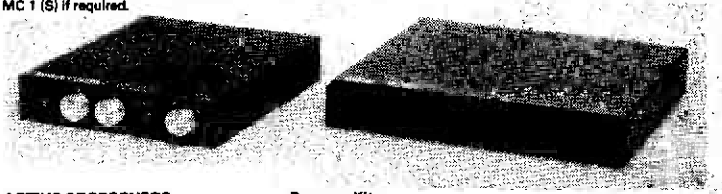
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically ·01% any power 1kHz 8 ohms. T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, —3dB, stability unconditional; protection—drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 × 80 × 25mm.

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 .... £15·16 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
CPS1 for 2 × CE 608 or 1 × CE 1004 £16·56
CPS2 for 2 × CE 1004 or 2/4 × CE 608 .... £18·80
CPS3 for 2 × CE 1008 or 1 × CE 1704 .... £19·75
CPS4 for 1 × CE 1008 .... £17·12
CPS5 for 1 × CE 1708 .... £24·15
CPS6 for 2 × CE 1704 or 2 × CE 1708 .... £25·63

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Light duty, 50mm, 2°C/W ..... £1·44
Medium power, 100mm, 1·4°C/W ..... £2·35
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Fan, 80mm, state 120 or 240v ... £19·70
Fan mounted on two drilled 100mm heatsinks, 2 × ·4°C/W, 65°C max. with two 170W modules. .... £31·05

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
CPRIS .... £40·87
MCI ..... £21·28
MCIS ..... £33·17

POWER SUPPLY
REGI .... £6·90
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Ref	Amps	Price	P & P
112	0·5	2·64	0 78
79	1 0	3·57	0·96
3	2 0	5·77	0 96
20	3 0	6·20	1·14
21	4 0	7·89	1·14
51	5·0	9·87	1·32
117	6 0	11·17	1·45
88	8 0	14·95	1·64
89	10·0	17·25	1·64
90	12·0	19·17	1·95
91	15·0	21·96	2 08
92	20·0	29·45	O.A.

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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
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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 50
107	6 0	15·06	1 64
118	8 0	20·26	2·08
119	10 0	24·98	O.A.
109	12·0	28·90	O.A.

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Ref	VA	Price	P & P
*07	20	4·40	0·79
149	60	6·70	0·96
150	100	7·62	1·14
151	200	11·16	1 14
152	250	13·28	1 50
153	350	16·43	1 84
154	500	20·47	2 15
155	750	29·06	O A.
156	1000	37·20	O A.
157	1500	51·38	O.A.
158	2000	61·81	O.A.
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240V cable in 115V USA flat pin outlet

VA	Price	P & P	Ref
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75	7·73	1·14	64W
150	10·01	1 14	4W
200	10·92	1 45	65W
250	11·58	1·45	69W
500	19·17	1·64	67W
1000	27·88	2 30	84W
1500	26·02	O.A.	93W
2000	49·97	O A.	95W

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Pri 220-240 volts

Ref	Amps 12V	Amps 24V	Price	P&P
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213	1·0	0·5	2·64	0·78
71	2	1	3·51	0·78
18	4	2	4·03	0·96
85	0·5	2 5	6·00	0·96
70	6	3	6·35	0·96
108	8	4	7·42	1·14
72	10	5	8·12	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	O.A.

AUTO TRANSFORMERS

Ref	VA	(Watts)	£	P&P
113	15	0-115-210-240	2·46	0 71
64	75	0-115 210-240	4·41	0·96
4	150	0-115-200-220-240	5·35	0·96
67	500	0-115-200-220-240	[illegible]	1 64
84	1000	0-115-200-220-240	18·76	2 08
93	1500	0-115-200-220-240	23·36	OA
95	2000	0-115-200-220-240	34·82	OA
73	3000	0-115-200-220-240	[illegible]·21	OA
80S	4000	0-10-115-200-220-240	76·[illegible]	OA
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Ref				P+P
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13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1·99	0 38
207	500, 500	0-8-9, 0-8-9	2·77	0 71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·99	0·38
214	300, 300	0-20, 0-20	2·80	0·78
221	700(DC)	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	3·99	0·96
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239	50	12-0-12	2·57	0 38

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W02	1A	200V	0.32	PW04	6A	400V	1.08	S04	2A	400V	0.60
W04	1A	400V	0.40	PW06	6A	600V	1.18	S06	2A	600V	0.70
W06	1A	600V	0.50	PW08	6A	800V	1.25	S08	2A	800V	0.84
W08	1A	800V	0.60	PW10	6A	1000V	1.60	S10	2A	1000V	1.35
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74C04N	0.24	74C85N	1.30	74C162N	1.11	74C374N	1.87	74C914N	1.41
74C08N	0.24	74C86N	0.64	74C163N	1.11	74C901N	0.54	74C915N	1.11
74C10N	0.24	74C89N	4.39	74C164N	1.04	74C902N	0.54	74C918N	1.15
74C14N	0.95	74C90N	0.85	74C165N	1.04	74C903N	0.54	74C922N	3.90
74C20N	0.24	74C93N	0.85	74C173N	0.90	74C904N	0.54	74C923N	3.74
74C30N	0.24	74C95N	1.04	74C174N	0.90	74C905N	7.28	74C925N	5.22
74C32N	0.24	74C107N	1.22	74C175N	0.90	74C906N	0.54	74C926N	5.22
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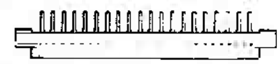

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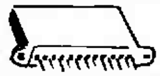

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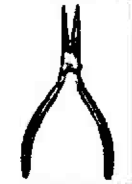

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74LS02N	0.26	74LS132N	0.85	74LS275N	3.20	SN74S300N	5.06
74LS03N	0.26	74LS136N	0.42	74LS279N	0.58	SN74S301N	3.71
74LS04N	0.29	74LS138N	0.65	74LS280N	1.65	SN74S387N	3.05
74LS05N	0.29	74LS139N	0.65	74LS283N	1.20	SN74S470N	5.06
74LS08N	0.26	74LS145N	1.30	74LS289N	3.74	SN74S471N	5.06
74LS09N	0.26	74LS147N	1.65	74LS290N	1.00	SN74S472N	13.48
74LS10N	0.26	74LS148N	1.35	74LS293N	1.00	SN74S473N	13.48
74LS11N	0.26	74LS151N	0.58	74LS295N	1.35	SN74S474N	13.48
74LS12N	0.26	74LS153N	0.58	74LS298N	1.35	SN74S475N	13.48
74LS13N	0.58	74LS154N	1.45	74LS299N	2.95	SN7490AN	0.36
74LS14N	0.75	74LS155N	0.80	74LS323N	3.50	SN7491AN	0.60
74LS15N	0.26	74LS156N	0.80	74LS324N	1.65	SN7492N	0.36
74LS20N	0.26	74LS157N	0.60	74LS325N	2.40	SN7493N	0.36
74LS21N	0.26	74LS158N	0.65	74LS326N	2.70	SN7494N	0.90
74LS22N	0.26	74LS160N	0.80	74LS327N	2.55	SN7495N	0.76
74LS26N	0.32	74LS161N	0.85	74LS348N	1.10	SN7496N	0.54
74LS27N	0.26	74LS162N	0.80	74LS352N	1.07	SN7497N	1.95
74LS28N	0.29	74LS163N	0.85	74LS353N	1.07	SN74100N	1.40
74LS30N	0.26	74LS164N	1.10	74LS365N	0.66	SN74107N	0.24
74LS32N	0.27	74LS165N	1.15	74LS366N	0.55	SN74118N	0.85
74LS33N	0.29	74LS166N	1.65	74LS367N	0.55	SN74119N	1.40
74LS37N	0.32	74LS168N	1.45	74LS368N	0.55	SN74121N	0.28
74LS38N	0.32	74LS169N	1.45	74LS373N	0.85	SN74122N	0.55
74LS40N	0.26	74LS170N	1.90	74LS374N	0.85	SN74123N	0.55
74LS42N	0.80	74LS173N	1.10	74LS375N	0.66	SN74124N	1.20
74LS47N	1.09	74LS174N	0.75	74LS377N	1.30	SN74125N	0.45
74LS48N	1.00	74LS175N	0.75	74LS378N	1.00	SN74141N	0.56
74LS49N	1.09	74LS181N	2.75	74LS379N	1.25	SN74145N	0.85
74LS51N	0.26	74LS183N	2.70	74LS386N	0.44	SN74148N	1.35
74LS54N	0.26	74LS189N	3.74	74LS390N	0.90	SN74150N	0.90
74LS55N	0.26	74LS190N	1.00	74LS393N	0.90	SN74151N	0.76
74LS63N	1.26	74LS191N	1.00	74LS395N	1.50	SN74153N	0.65
74LS73N	0.42	74LS192N	0.95	74LS398N	1.90	SN74154N	1.20
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LM340T-15	0.88	LM1310N	2.10	MC848P	1.10	CA3070	1.90
LM340T-24	0.88	LM1351N	1.30	MC849P	0.70	CA3071	1.90
LM341P-5	0.56	LM1458N	0.45	MC857P	0.85	CA3072	1.90
LM341P-12	0.56	LM1496N	0.97	MC861P	0.85	CA3075	1.70
LM341P-15	0.56	LM1800N	1.94	MC1035P	1.90	CA3076	2.12
LM341P 24	0.56	LM1801N	2.25	CA3000	3.30	CA3080	0.85
LM345K	6.97	LM1808N	2.10	CA3001	4.25	CA3080A	2.10
LM348N	0.95	LM1812N	6.20	CA3002	3.30	CA3086	0.50
LM350K	6.50	LM1820N	1.18	CA3006	4.80	CA3088E	1.87
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LM371H	2.35	LM1848N	1.58	CA3013	1.85	CA3140	1.04
LM373N	3.35	LM1850N	1.90	CA3014	2.20	L005T1	2.25
LM374N	3.35	LM1889N	2.50	CA3018	0.75	LF355N	0.90
LM377N	1.80	LM1890N	P.O.A.	CA3018A	1.10	LF356N	0.90
LM378N	2.40	LM2907N-8	1.80	CA3020	2.20	LF357N	0.90
LM379S	4.25	LM2917N-8	1.80	CA3020A	2.50	LF13201N	3.00
LM380N-8	0.96	LM3301N	0.60	CA3021	2.40	LF13331N	3.06
LM380N-14	1.08	LM3302N	0.55	CA3022	2.20	LF13741H	0.49
LM381AN	2.70	LM3401N	0.55	CA3023	2.20	LF13741N	0.38
LM381N	1.69	LM3900N	0.60	CA3026	0.70	LM114H	2.75
LM382N	1.32	LM3905N	1.15	CA3028A	0.90	LM301AH	0.40
LM384N	1.56	LM3909N	0.70	CA3028B	1.25	LM301-8	0.30
LM386N	0.88	LM3911N	1.10	CA3029	0.75	LM304H	1.50
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LM748-14	0.50	MC799P	2.20	CA3052	1.78	LM338K	P.O.A.
LM900	0.50	MC832P	0.70	CA3053	0.77	*MC1327P	1.70
LM911	0.50	MC833P	0.70	CA3054	1.18	*MC1330P	1.70
LM921	0.50	MC836P	0.82	CA3059	2.18	*MC1352P	1.28
LM923	0.50	MC837P	0.82	CA3060	2.58	*MC1433G	3.65
LM1303N	1.15	MC838P	2.35	CA3062	3.75	*MC1435G	2.20

TRANSISTORS *(see catalogue for full range)*

2N335	3.00	2N708	0.30	2N1420	0.55	2N2219	0.38	40081	1.20	AC188	0.54	BC118	0.22	BCY33A	1.10	BD140	0.43	BF157	0.46
2N388	0.80	2N718	0.30	2N1483	1.86	2N2219A	0.39	40232	0.80	AC188K	0.85	BC119	0.33	BCY34A	1.10	BD142	0.70	BF159	0.37
2N388A	0.77	2N718A	0.54	2N1485	2.20	2N2220	0.39	40233	0.70	AD136	2.79	BC122	0.81	BCY38	2.20	BDX14	1.32	BF160	0.33
2N398	0.80	2N720A	0.85	2N1507	0.35	2N2221	0.25	40235	0.85	AD142	1.45	BC123	0.85	BCY40	1.05	BDX18	1.90	BF161	0.65
2N456	2.20	2N721	1.06	2N1524	0.80	2N2221A	0.25	40237	0.45	AD143	1.46	BC125	0.22	BCY42	0.65	BDX32	2.87	BF166	0.44
2N489	4.90	2N722	0.46	2N1553	1.50	2N2222	0.25	40242	0.66	AD149	2.05	BC132	0.33	BCY43	0.76	BDY11	3.30	BF167	0.37
2N489A	5.40	2N727	0.60	2N1613	0.30	2N2222A	0.25	40251	1.15	AD150	3.10	BC134	0.22	BCY54	2.40	BDY17	3.30	BF170	0.76
2N489B	5.90	2N744	0.36	2N1637	0.72	2N2223	6.78	40254	0.66	AD161	1.00	BC135	0.22	BCY58	0.27	BDY18	3.80	BF173	0.37
2N490	4.99	2N753	0.35	2N1638	0.70	2N2223A	8.90	40264	0.96	AD162	1.00	BC136	0.21	BCY59	0.27	BDY20	1.10	TIP29C	0.65
2N490B	6.50	2N780	0.35	2N1711	0.30	2N2270	0.48	40280	3.70	AF106	0.60	BC137	0.22	BCY66	2.20	BDY23	2.45	TIP30A	0.54
2N490C	6.90	2N869	0.35	2N1889	0.30	2N2303	1.54	40309	0.60	AF109	0.82	BC138	0.44	BCY67	2.70	BDY24	2.85	TIP30C	0.70
2N491A	5.75	2N914	0.38	2N1890	0.30	2N2368	0.27	40310	0.85	AF114	0.70	BC140	0.38	BCY70	0.21	BDY25	2.85	TIP31A	0.54
2N491B	6.25	2N916	0.33	2N1893	0.30	2N2369	0.27	40311	0.55	AF115	0.70	BC141	0.32	BCY71	0.26	BDY38	1.10	TIP31C	0.72
2N491	7.50	2N917	0.38	2N1907	5.95	2N2369A	0.27	40312	0.98	AF116	0.70	BC142	0.32	BCY72	0.18	BDY54	1.55	TIP32A	0.58
2N492	6.75	2N918	0.45	2N1974	0.98	2N2405	0.88	40313	1.38	AF117	0.70	BC143	0.32	BCY77	0.70	BDY55	1.80	TIP32C	0.82
2N492A	6.75	2N929	0.37	2N1990	0.45	3N81	3.60	40315	0.80	AF118	0.70	BC152	0.38	BCY78	0.43	BDY56	2.10	TIP33A	0.86
2N492B	7.75	2N929A	0.37	2N1991	1.10	3N83	2.25	40316	0.86	AF124	0.70	BC153	0.30	BCY79	0.41	BDY57	5.80	TIP33C	1.18
2N492C	10.00	2N930	0.37	2N2060	7.00	3N128	1.35	40317	0.60	AF125	0.70	BC154	0.30	BCY87	5.35	BDY58	6.50	TIP34A	0.97
2N493A	7.99	2N930A	0.94	2N2102	0.50	3N139	1.60	40324	0.95	AF126	0.70	BC160	0.38	BCY88	3.99	BDY60	1.65	TIP34C	1.31
2N493B	8.75	2N1131	0.32	2N2147	1.55	3N140	1.10	40325	1.35	AF139	0.75	BC161	0.38	BCY89	3.80	BDY61	2.75	TIP35A	2.20
2N494	6.90	2N1132	0.36	2N2160	1.56	3N141	0.95	AC126	0.48	AF172	0.70	BC175	0.43	BD115	0.88	BDY62	2.75	TIP36A	3.80
2N494A	7.05	2N1204	1.05	2N2192	0.58	3N142	0.70	AC127	0.48	AF178	1.30	BC204	0.12	BD116	1.36	BDY92	2.75	TIP41A	0.78
2N494B	8.40	2N1302	0.80	2N2193	0.50	3N143	0.88	AC128	0.48	AF186	0.55	BC205	0.17	BD121	2.20	BF115	0.38	TIP41C	0.97
2N494C	9.35	2N1303	0.80	2N2193A	0.52	3N152	1.10	AC151	0.43	AF200	1.30	BC206	0.17	BD124	2.20	BF119	1.10	TIP42A	0.86
2N549	3.25	2N1304	0.80	2N2194	0.42	3N153	1.89	AC152	0.54	AF201	1.30	BC207	0.17	BD131	0.55	BF121	0.80	TIP42C	1.00
2N696	0.39	2N1305	0.80	2N2194A	0.45	3N154	0.99	AC153	0.59	BC113	0.22	BC208	0.17	BD132	0.76	BF123	0.80	TIP50	0.82
2N697	0.31	2N1306	1.00	2N2195	0.49	3N159	1.35	AC153K	0.59	BC114	0.22	BC209	0.17	BD135	0.40	BF134	0.80	TIP54	1.83
2N698	0.49	2N1307	1.00	2N2195A	0.49	3N187	1.80	AC176K	0.70	BC115	0.22	BCY10	1.10	BD136	0.40	BF137	0.80	TIP110	0.77
2N699	0.50	2N1308	1.10	2N2217	0.56	3N200	2.85	AC176	0.54	BC116	0.21	BCY30A	1.10	BD137	0.41	BF152	0.27	TIP112	0.93
2N706	0.30	2N1309	1.10	2N2218	0.35	3N201	1.35	AC187	0.58	BC116A	0.22	BCY31A	1.10	BD138	0.41	BF153	0.27	TIP115	0.83
2N706A	0.30	2N1370	0.55	2N2218A	0.38	40050	1.70	AC187K	0.65	BC117	0.22	BCY32A	1.10	BD139	0.43	BF154	0.27	TIP117	0.90

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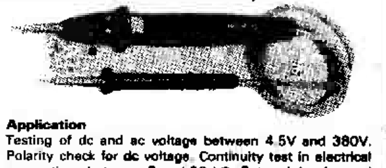
The 2 pole combitester is a universal voltage and continuity tester with incorporated battery. This combitester allows testing of dc and ac voltages from 4.5V to 380V. Continuity tests of electrical connections between 0 to 20 kΩ can be performed by pressing the red button, built into the handle of the tester. Display is by means of LEDs. The Siemens combitester has been tested to VDE standard 0425/1.73 and has the VDE symbol.



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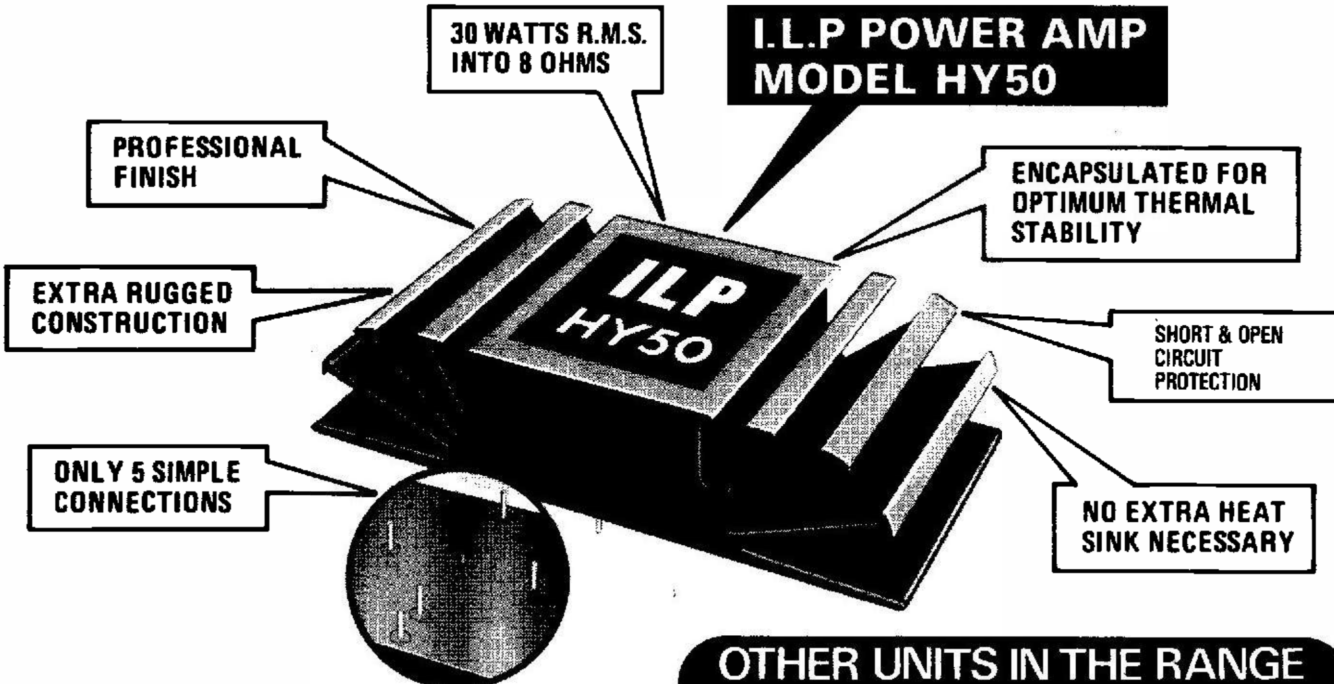

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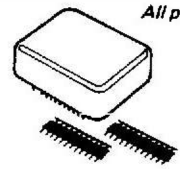

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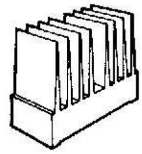

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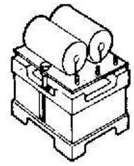

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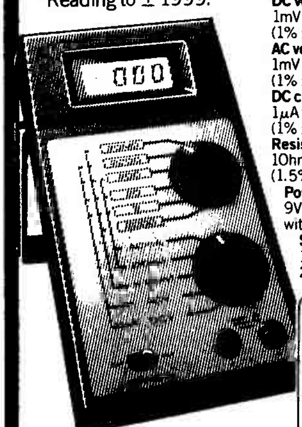

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LOW–COST LCD MULTIMETER

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

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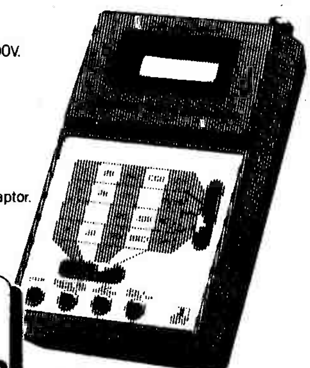
200–500V.
DC current:
2–20–200MA.
Resistance:
2–20–200–2000 KOHM.
Power source:
9V battery or AC adaptor.
Size:
37 x 85 x 130 mm.
22–197



PRICE
39.93

COMPONENTS AND PARTS

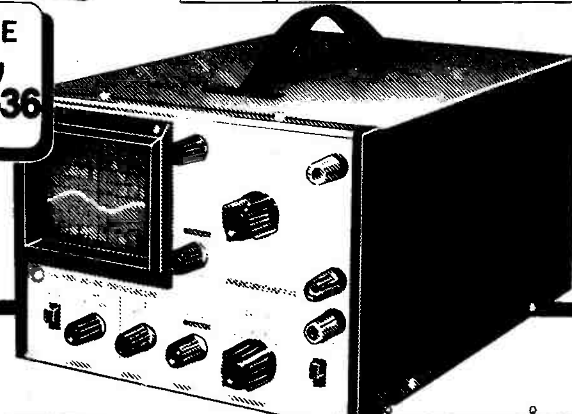
CAT. No.	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
276–9110	6 pin edge connector for 277–1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO–220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

AC/DC 8 MHz OSCILLOSCOPE

PRICE
137.36

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). Synhronization: Internal (–) **Size:** 200 x 155 x 300 mm. Supply: 220/240 V/50Hz. **22–9501.**



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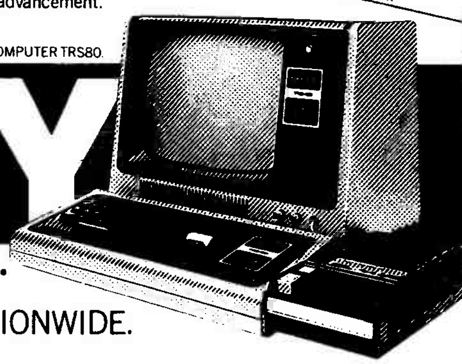

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PE VOLUME 15 No. 9 SEPTEMBER 1979

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*

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Technical Queries

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

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

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

Back Numbers

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6 CHANNEL MIXER

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

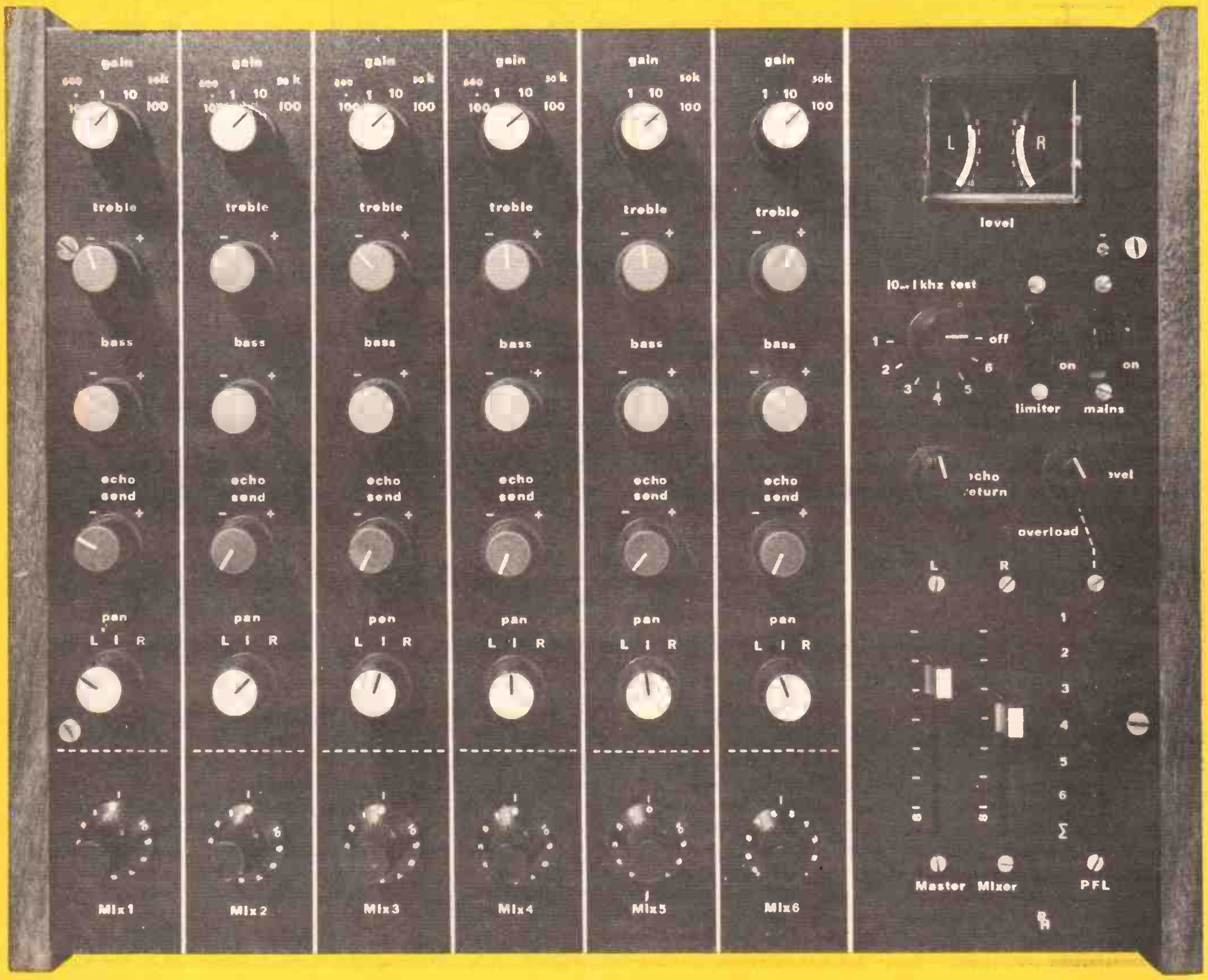
WITH the increase in popularity of home-recording studios and electronic musical instruments there is a demand for a mixer to combine several signal sources and provide a well-balanced sound for recording. Most users do not require mixers which have many input channels (as with some commercial units)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



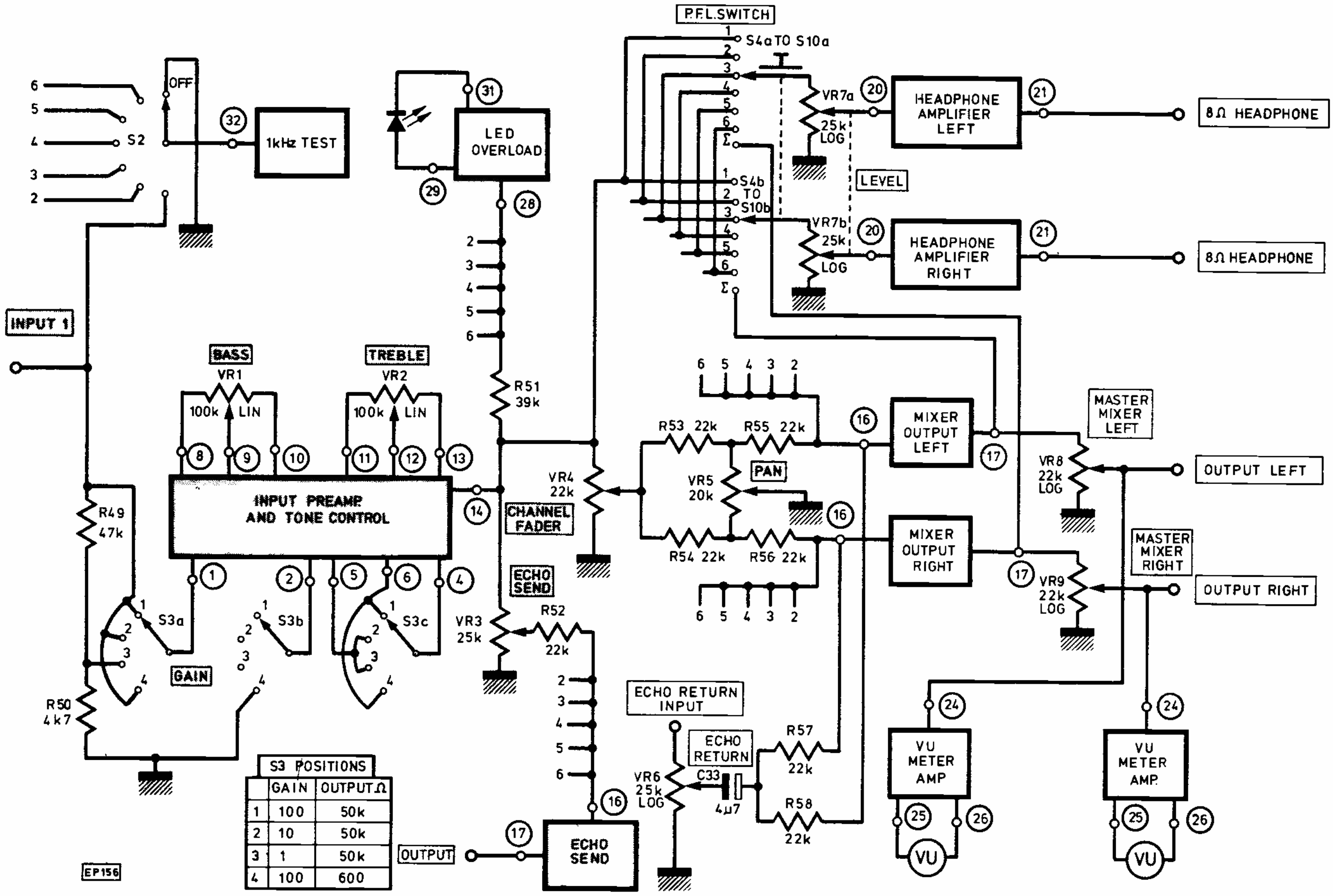


Fig. 1 Block diagram

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 ±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 47kΩ or 600Ω (switchable)
Input sensitivity 10mV or 100mV for 1V output (switchable)
Overload margin 20dB
Frequency response 20Hz–20kHz ± 1dB
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 ±18dB at 50Hz
Treble Control ±18dB 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 8Ω

PFL
Switchable to each channel or summation of all channels

Power Supply
±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

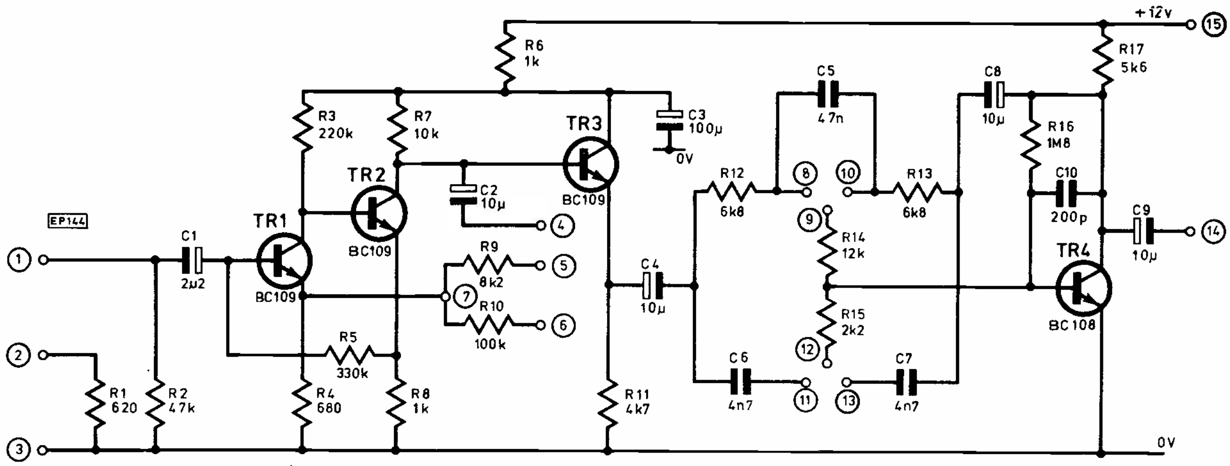


Fig. 2 Preamplifier and tone controls (6 required)

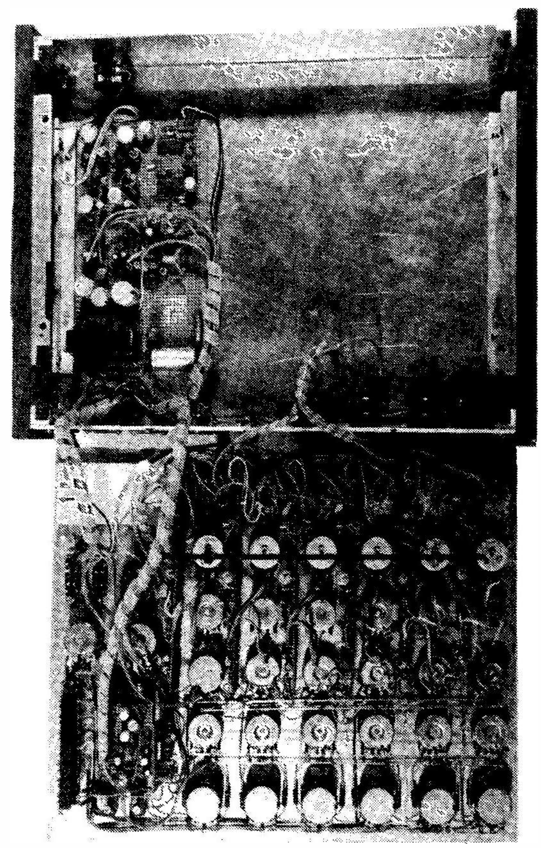
INPUT CHANNEL AMPLIFIERS

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

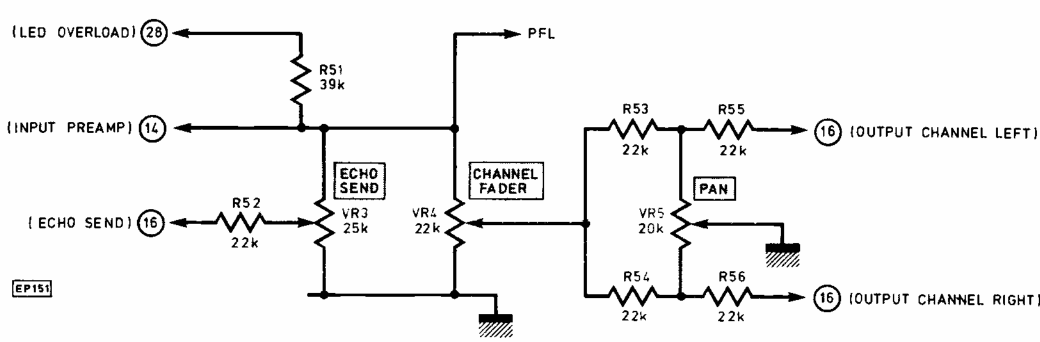


Fig 3 Pan pot and mixing network

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.

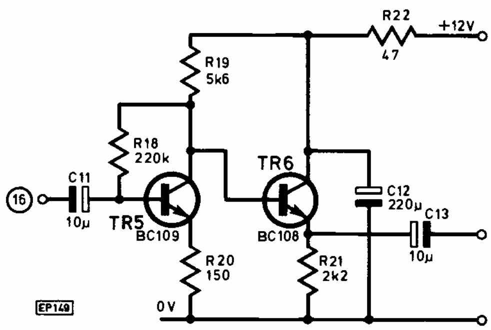


Fig. 4 Output and echo send amplifiers (3 required)

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.

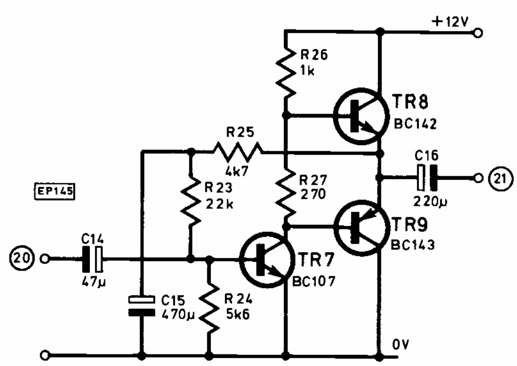


Fig. 5 Headphone amplifier (2 required)

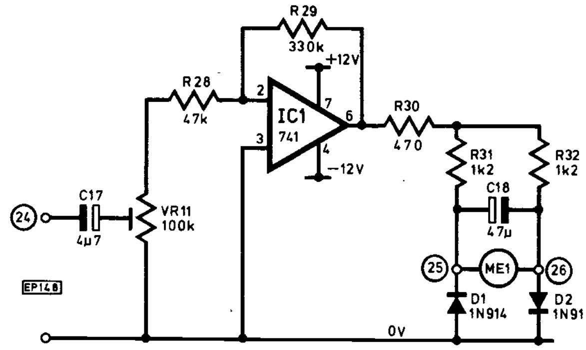


Fig. 6 VU meter amplifier (2 required)

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.

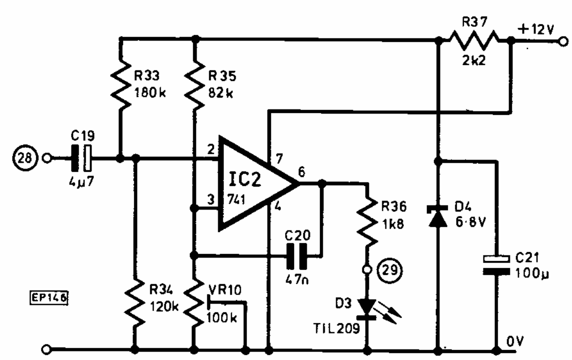


Fig. 7 Overload indicator

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
VR$_x$	100k linear (see text)

Capacitors

C1	2µ2 15V electrolytic
C2, C4, C8, C9	10µ 15V electrolytic (4 off)
C3	100µ 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	10µ 16V electrolytic
C26	4µ7 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	10µ 15V electrolytic (2 off)
C12	220µ 15V electrolytic
C33	4µ7 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	4µ7 electrolytic
C18	47µ 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	1,000µ 25V electrolytic (4 off)
C29, C30	220µ 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	47µ 15V electrolytic
C15	470µ 15V electrolytic
C16	220µ 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	4µ7 16V electrolytic
C20	47n polyester
C21	100µ 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

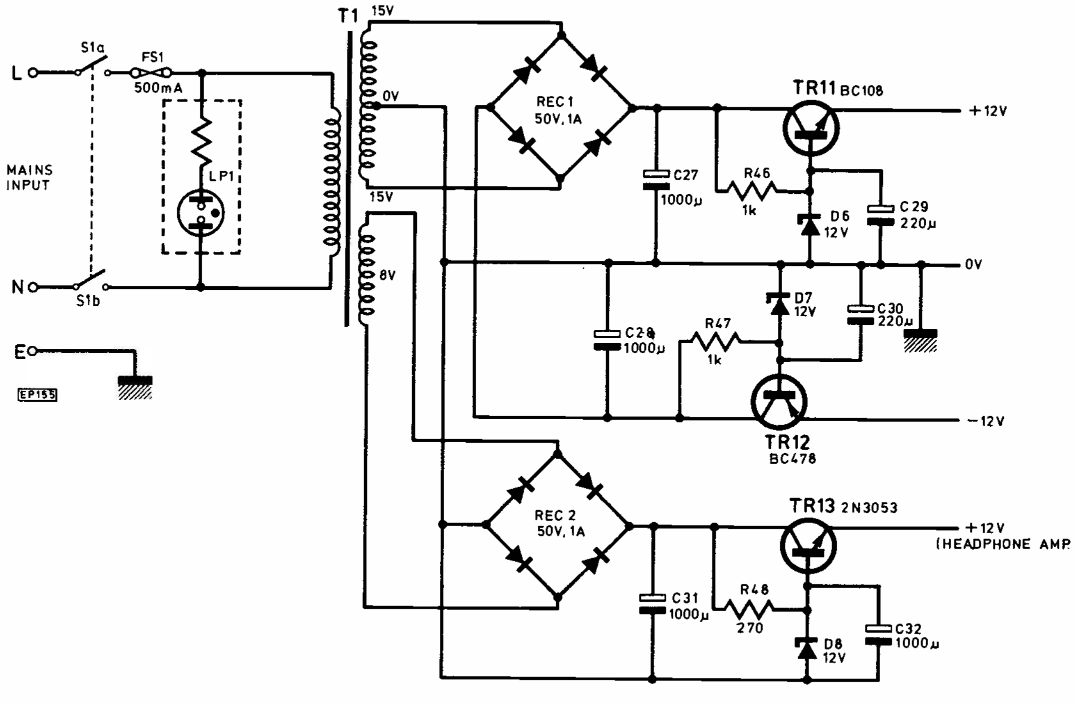
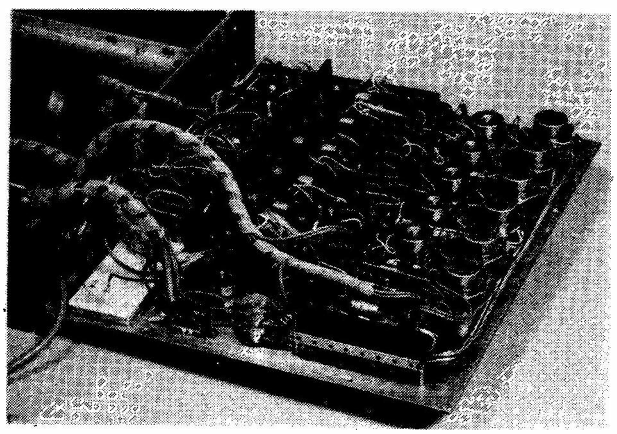


Fig. 9 Power supply



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.

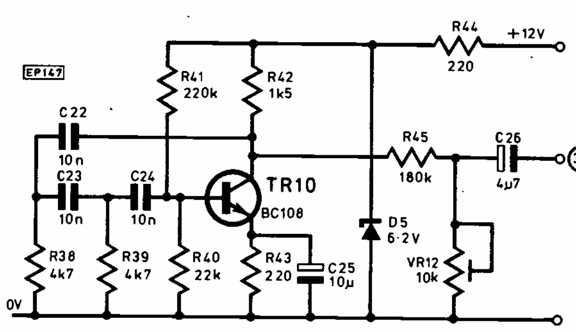


Fig. 8 Test oscillator

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.

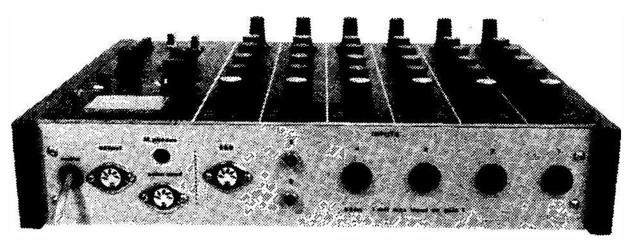
The transformer used on the prototype has secondaries of 15-0-15V at 50mA and 8V at 500mA. The 15-0-15V windings are fed via a diode bridge and smoothing capacitors to series pass transistors TR12 and TR11 which are biased by Zener diodes to give approximately ±12V stabilised output.

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

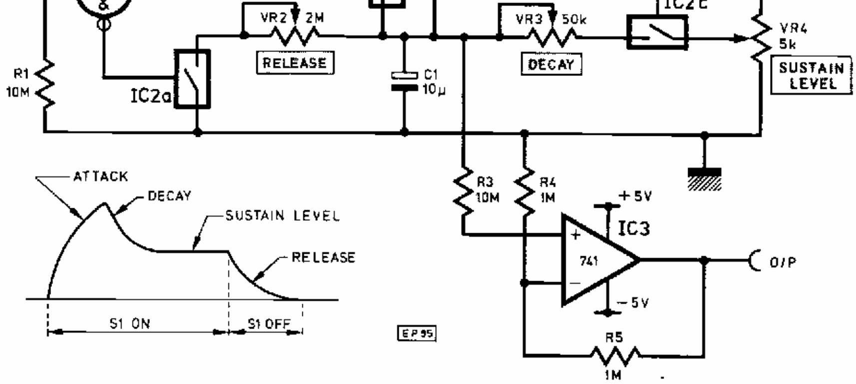
ADSR ENVELOPE SHAPER

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, IC2c switches off and IC2b 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.

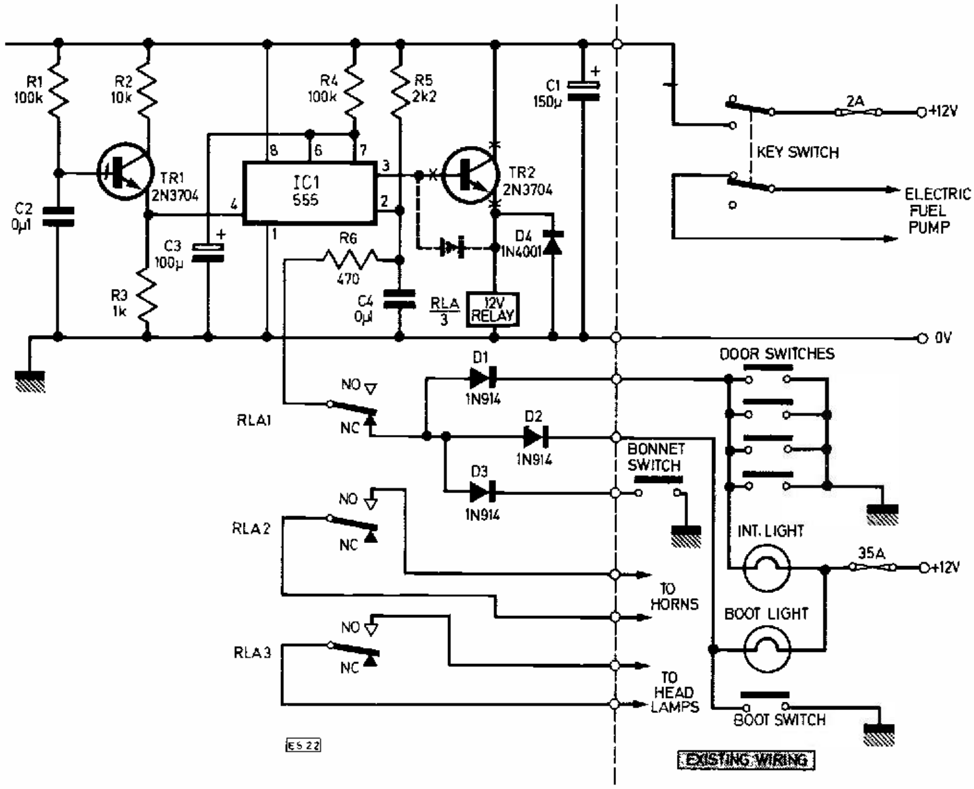
By replacing the inverter by a Schmitt trigger with a hysteresis level of say 4 volts, a higher voltage output can be produced. VR4 should also be changed to give a comparable sustain level.

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.

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.

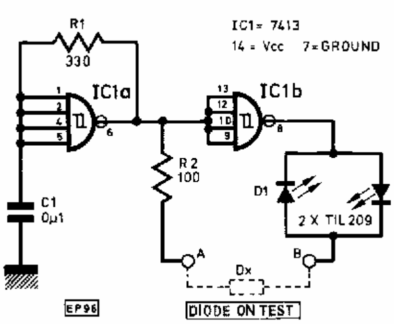
When the circuit is triggered by any of the door, boot, or bonnet switches, the 555 latches for approximately 15S, determined by R4 and C3, during which TR2 conducts, closing RLA which sounds the horns and lights the headlamps. If any of the switches are still closed after that period, IC1 is triggered by RLA1, and latches for a further 15S, this cycle repeating untill 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.

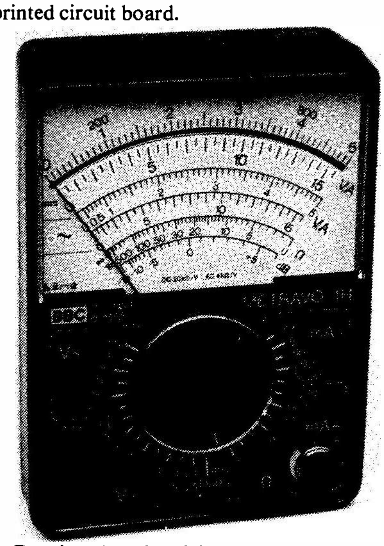
Market Place

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

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 it's 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 1 MΩ

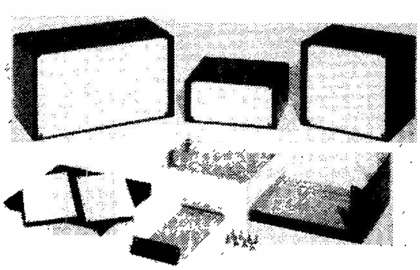
Precision Instrument Laboratories, Instrument House, 212 Ilderton Road, London, SE15 1NT. (01-639 4461). Available UK only.

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).**

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 re-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.**

6500 BASED KEYBOARD

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

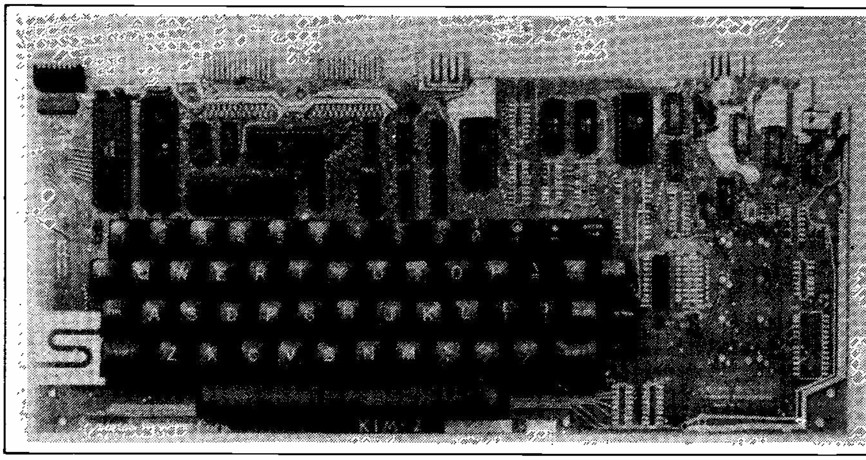
Rastra Electronics Ltd. of Hammersmith present the Synertek Systems KTM-2; a full ASCII keyboard and all the logic to display 24 lines of 40 characters each with full graphics.

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.

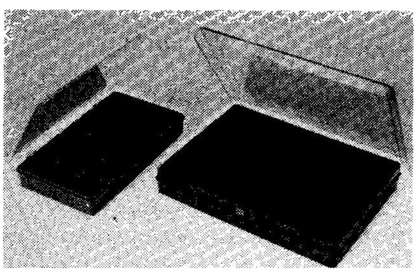
In addition Rastra offer the full range of Synertek Systems with special kit prices for integral systems based on SYM-1.

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.



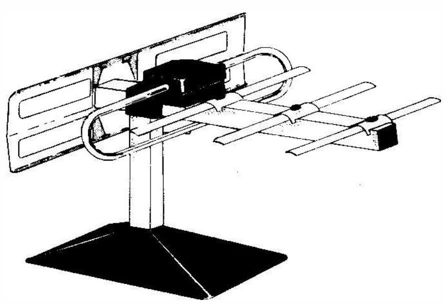
The 18 compartment case (model 18M) measures 274 × 157 × 40mm. The 16 compartment case (model 16M) is 315 × 245 × 45mm. Prices are — (18M) £1·99 plus p&p — (16M) £2·99 plus p&p.

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

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.



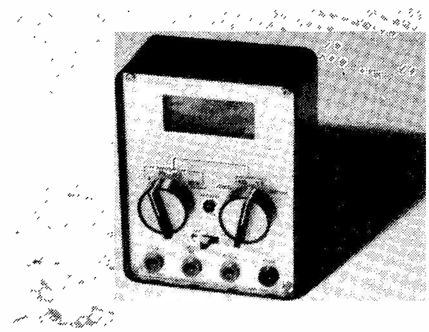
Although called a set-top aerial, it can be mounted outside with perhaps a little weatherproofing around the junction box where the co-ax joins the array.

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.

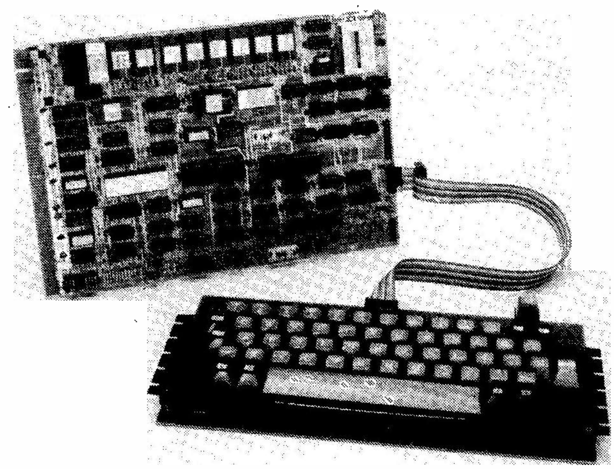
Jayen Developments, 21 Gladeside, Bar Hill, Cambridge, CD3 8DY (0954 80285).

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.



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

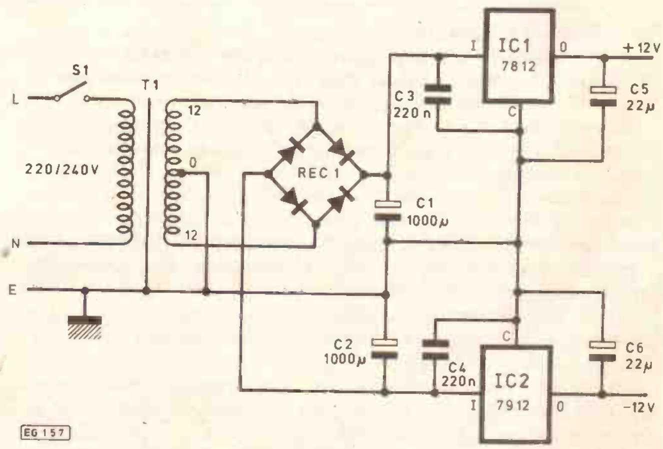


Fig. 1. Circuit diagram of the power supply

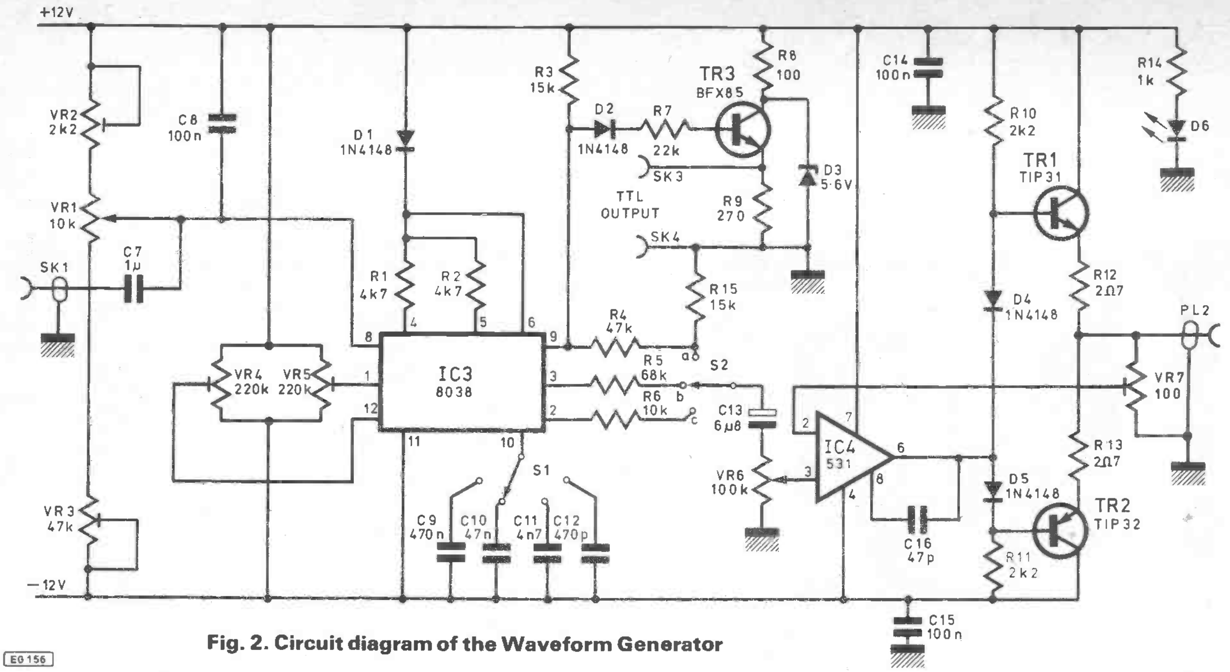


Fig. 2. Circuit diagram of the Waveform Generator

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.

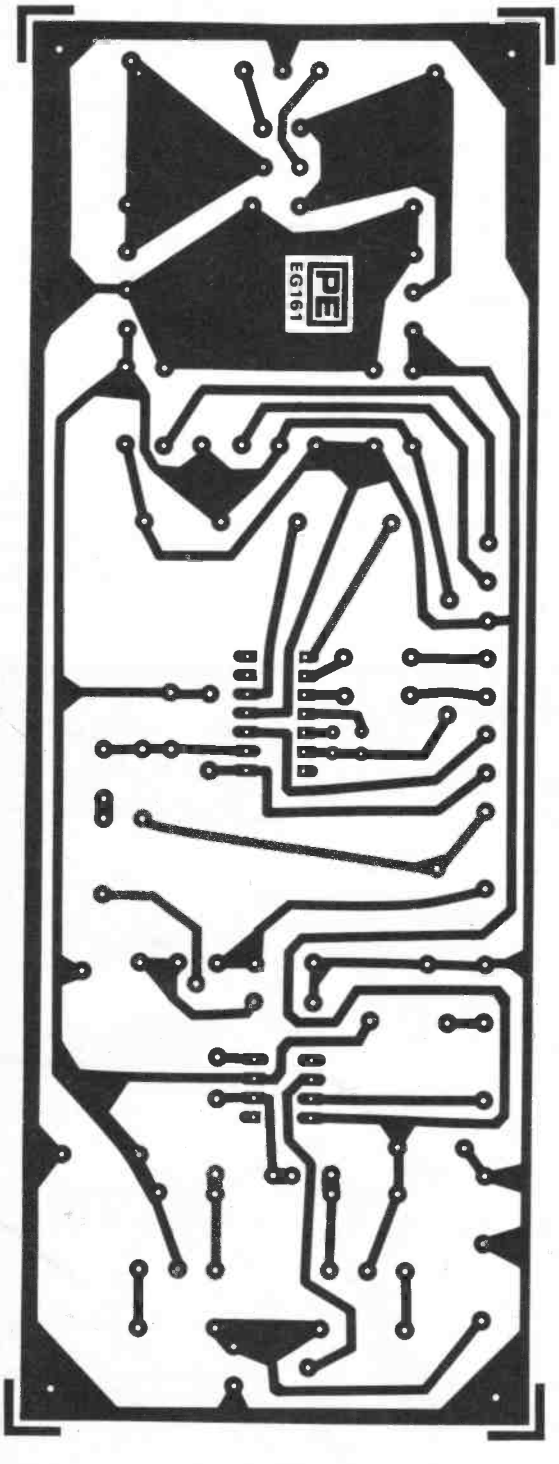
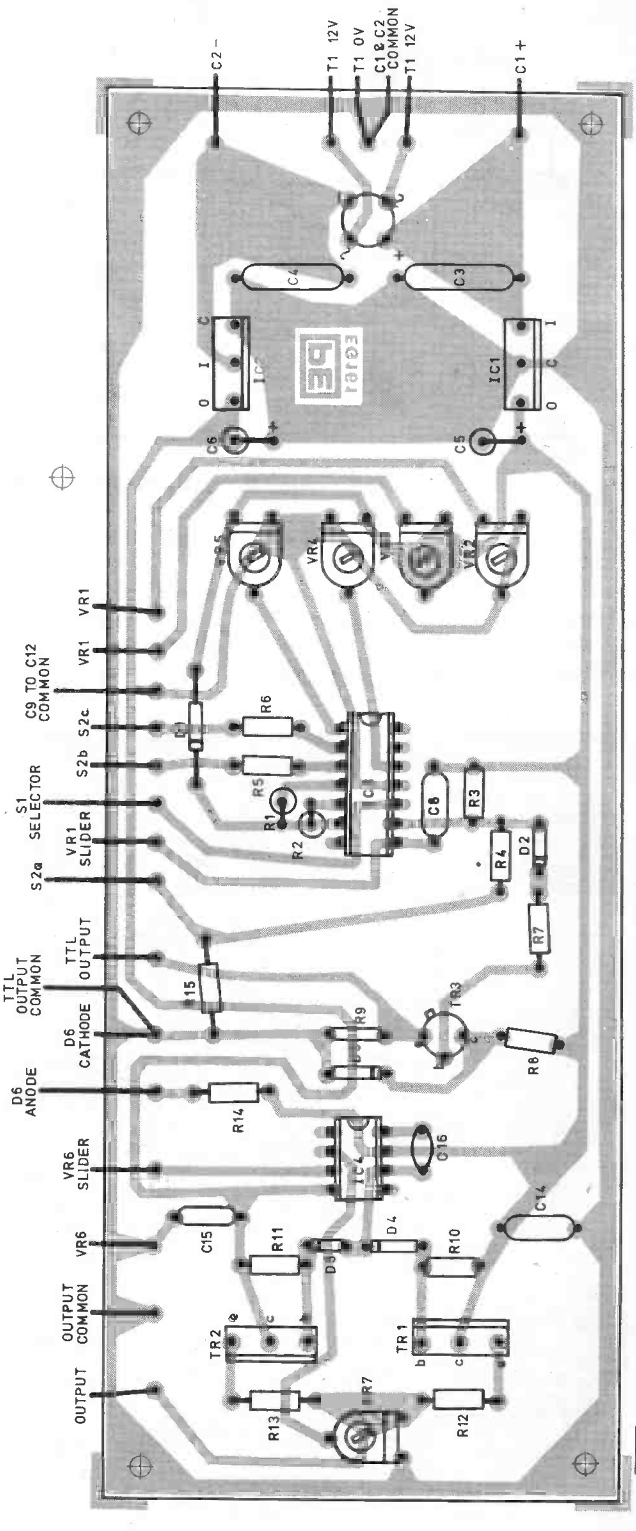


Fig. 3. Printed circuit board design



EG162

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	2Ω7 (2 off)
R14	1k

All resistors ¼W 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	6μ8 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 (WO1)
TR1	TIP 31
TR2	TIP 32
TR3	BFX85
IC1	7812 12V pos. reg.
IC2	7912 12V neg. reg.
IC3	8038
IC4	531

Miscellaneous

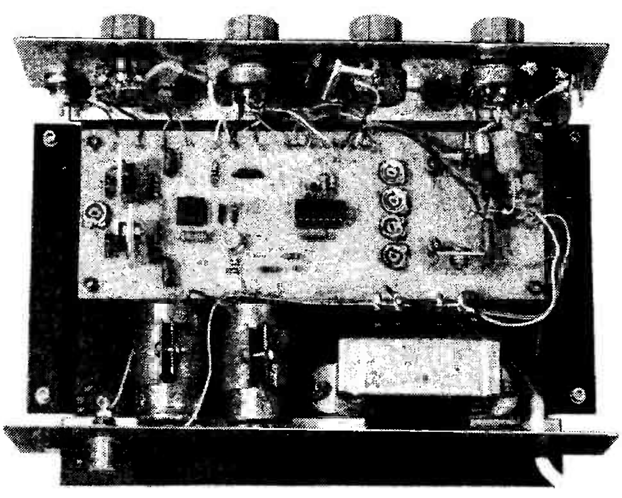
S1 1 pole 4 way rotary switch (3P 4W switch with two poles ignored)

S2 1 pole 3 way rotary switch (4P 3W switch with three poles ignored)

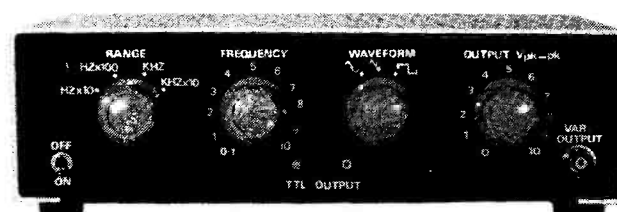
S3 miniature toggle switch s.p.s.t. Heat sinks (4 off) (see text).

T1 12V-0-12V 0·5A mains transformer

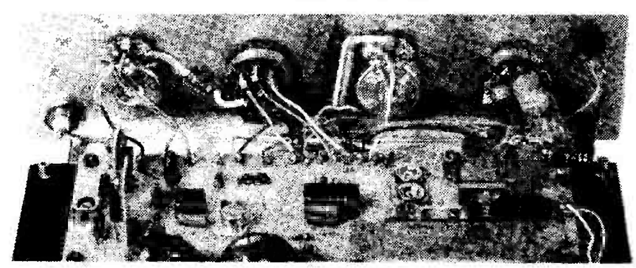
2mm sockets for TTL output (1 red, 1 black), BNC (or similar co-axial sockets) for variable output and FM input (2 off), knobs (4 off), case (Vero G-range G), printed circuit board, capacitor fixing clips (2 off), spacers (4 off).



Internal view of the Waveform Generator



Front panel layout

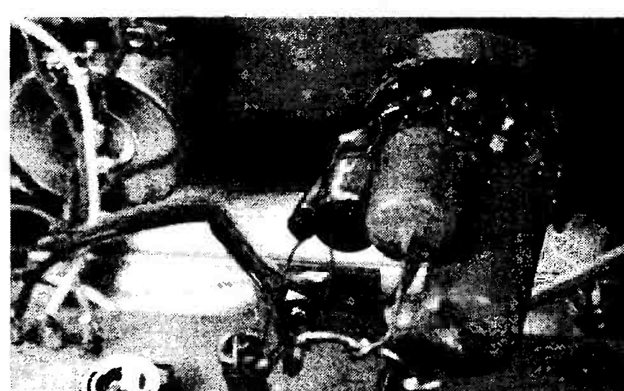


Rear view of front panel

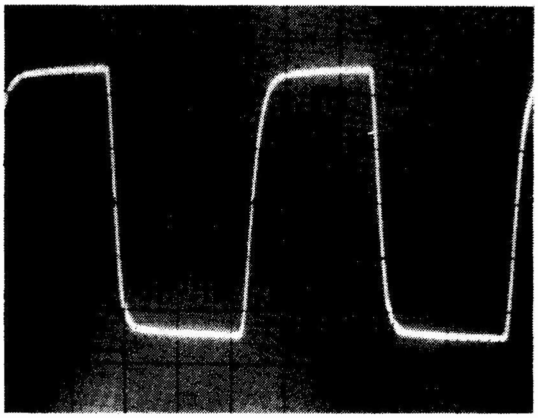
it is important to check the orientation of the transistors and integrated circuits. Four small heat sinks, consisting of around 900mm² 18 s.w.g. aluminium bent into a "U" shape (or proprietary types of between 15°C/W and 20°C/W), should be fitted to IC1, IC2, TR1 and TR2. The use of 14-pin and 8-pin 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.

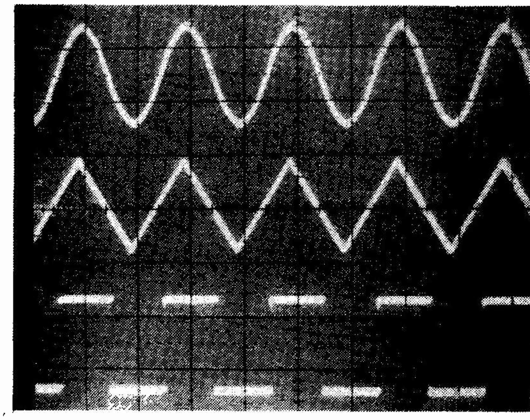
All the wiring leads should then be soldered including the links shown in Table 1.



Capacitor mounting on switch one



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 ±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. ★

TEST VOLTAGES (TABLE 2)

IC1	I	16·1			TR1	c	11·6
	O	11·6				b	0·6
	C	0				e	0
IC2	I	−16·6			TR2	c	−12·3
	O	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			
	5	7·0	12	−3·2			
	6	10·8	13	0			
	7	5·8	14	0			
IC4	1	−11·9	5	−11·9			
	2	0	6	0			
	3	0	7	11·6			
	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.

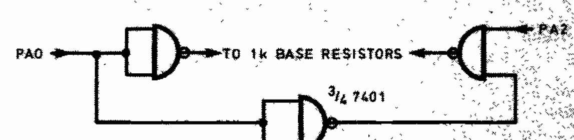
POINTS ARISING

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)*

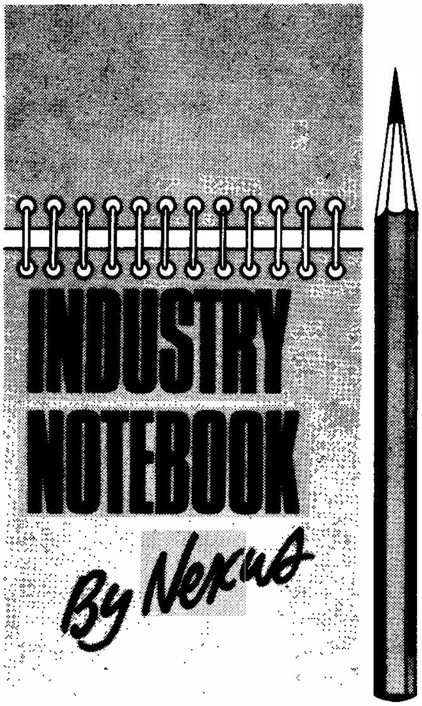
In the motor control circuit, if both inputs PA0 and PA2 are high, all the transistors are turned on and there is a risk of overheating. This state should be prevented using gates as shown:



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.



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 earnings 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 underemployed. 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 Ptarmigan trunk communications network for the British Army and will now be offering Ptarmigan-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 brassiéres? 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.

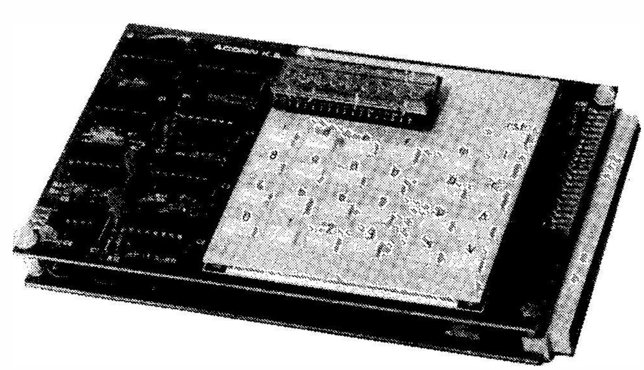
Sufficient description of the resident monitor program is given to show how subroutines contained therein can be jumped to, and from, to save effort and RAM space when writing your own programs. And it is pointed out that user programs should not start at the lowest memory address because the low addresses 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 preceeding description explaining how the memory is divided into 16 blocks and 256 pages, each page consisting of 256 bytes.



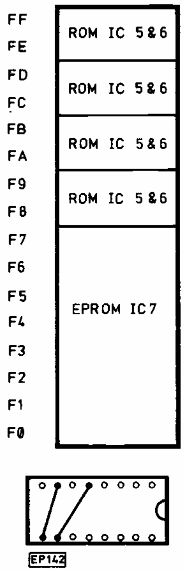


Fig. 1. An example of an address decoding option illustrated in the Acorn manual. Here, a 2048 byte EPROM is fully decoded, but ROM i.c.s 5 and 6 appear four times. The EPROM can be 2704, -08, -16 or -32. With minimal track cuts the triple rail 2704 may also be used.

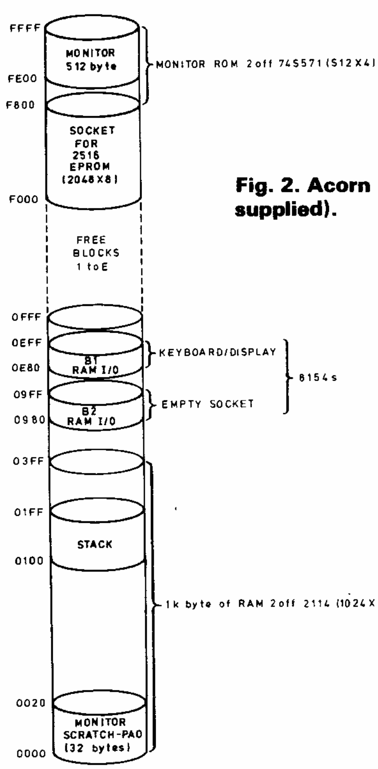


Fig. 2. Acorn memory map (as supplied).

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.

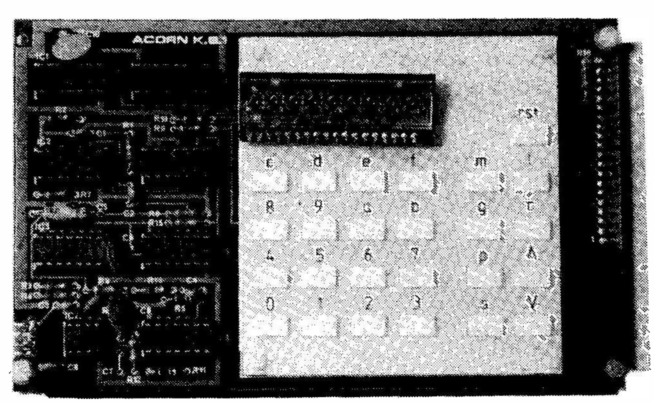
There is no 7-segment decoding as such, since the RAM I/O device simply couples the segment lines **a** through **g** to the data bus lines D0 to D6; thus allowing simple binary data statements of zeros and ones to be remembered in ROM and called up by straightforward memory addressing. These are located 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 ∨ 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.
∨	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
SECOND DISPLAY	PC		SP	

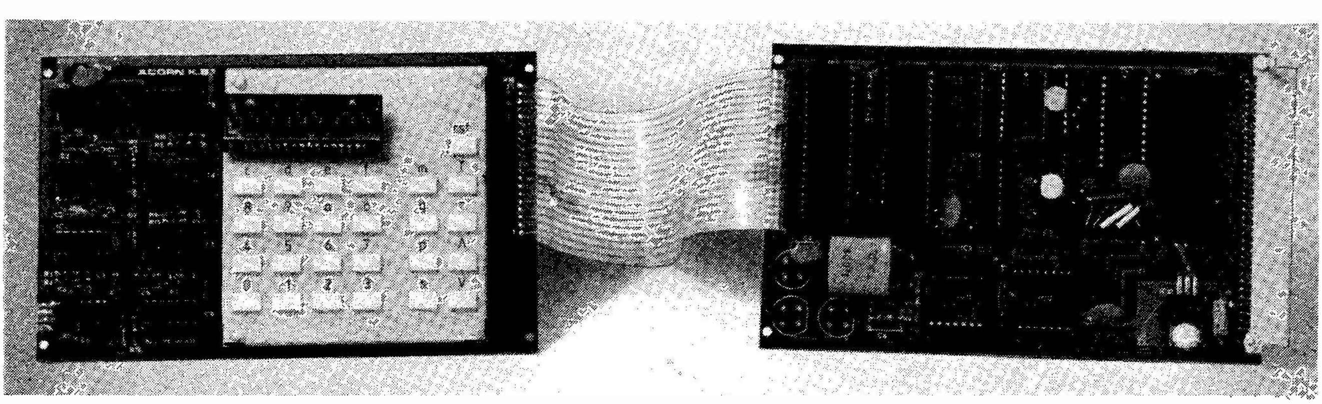
During debugging the ∧ and ∨ keys can be used to operate on the **p** address, but only a single location's back-up copy is retained. However, this provides a most useful debugging facility.

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

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

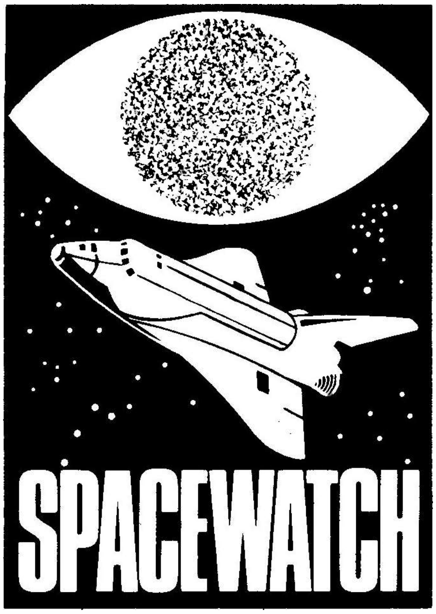
COLOUR WITHOUT MASK

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.

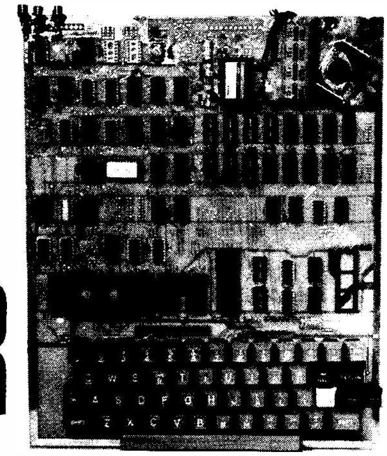
. . . 68000

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 or 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.

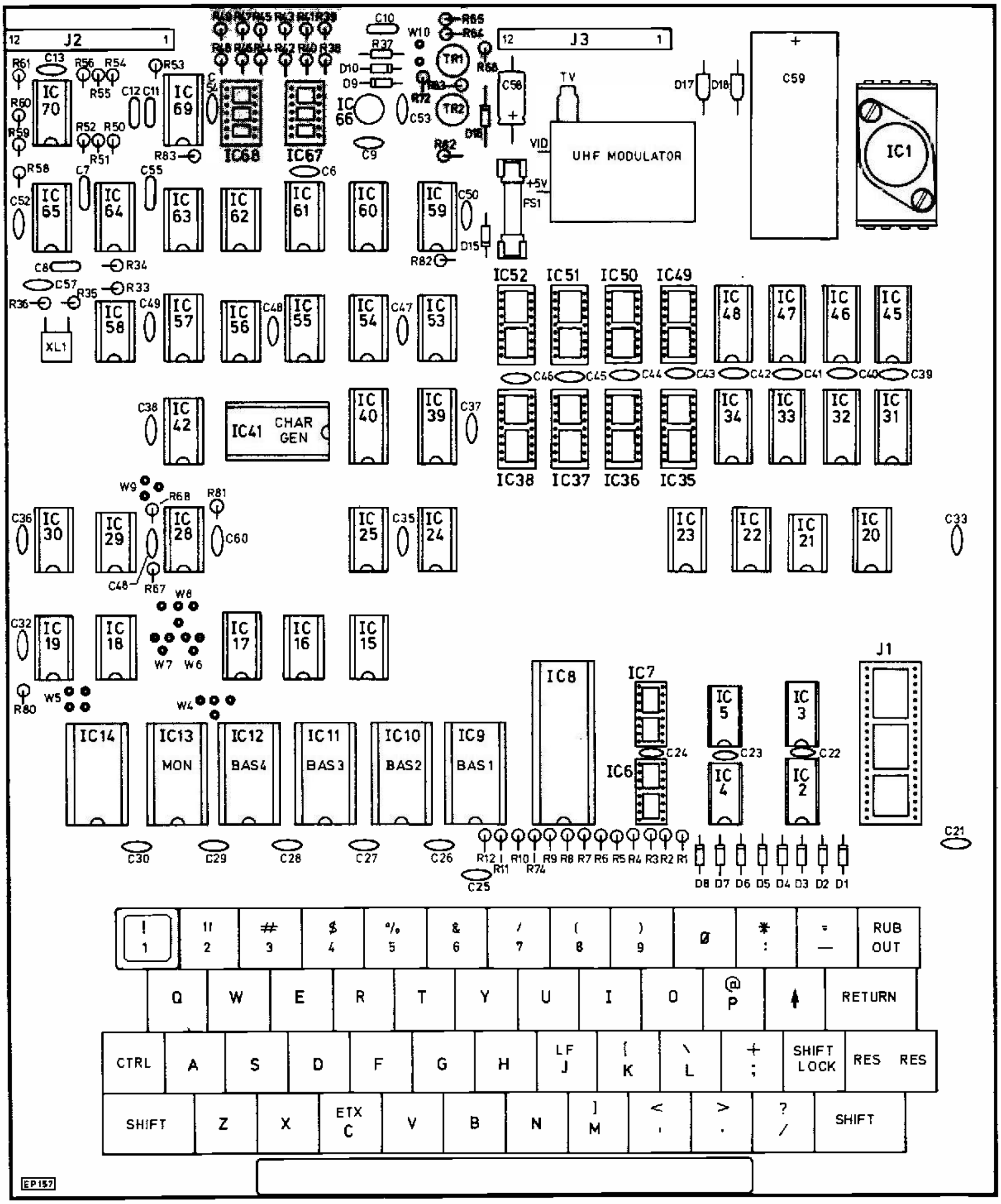
A final check of i.c. orientation should be made. If you are not using the full complement of memory, the right-most RAM sockets (IC31 and IC45) must be populated first in "vertical" pairs.

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 Componets, and is too complex to show here. Please note: R83 should read as R62, and R82 as R83

The following assumes that you have checked the five volt supply and all the external connections and that the SHIFT LOCK key is in the down (locked) position.

If the following procedures are ineffective, the unit should be returned to Comp Components, who have a standard charge of £25 (inc. postage) for repair.

(a) UHF Modulator Failure

This is detected by switching on and tuning the TV through the complete range, particularly near to channel 36, and finding no change throughout the band. (A short band of blank screen *should* be detected near to channel 36.) Check supply at modulator and connections, including ground-to-metal case. "Scope" the video input to the modulator—the waveform should be negative-going pulses 64μs apart, with some fast spikes (positive-going) in between. If this is not present, then either the UHF modulator or its connections are faulty.

(b) No Video Information At Modulator

Scoping through starts at the output of IC58 (pin 3) to detect the 8MHz clock. Work through the counter chain including IC29 to check on oscillation of counters. If this is absent, the sequential nature of the chain will allow you to narrow down the point of failure quite closely. The most common fault is a solder bridge or bent i.c. pin. If this cannot be visually detected, the continuity tester must be used to check that all pins go to the right place *and nowhere else!* A chip must be suspected of failure only as the very last resort. Even then, try a chip from elsewhere on the board in its place if possible.

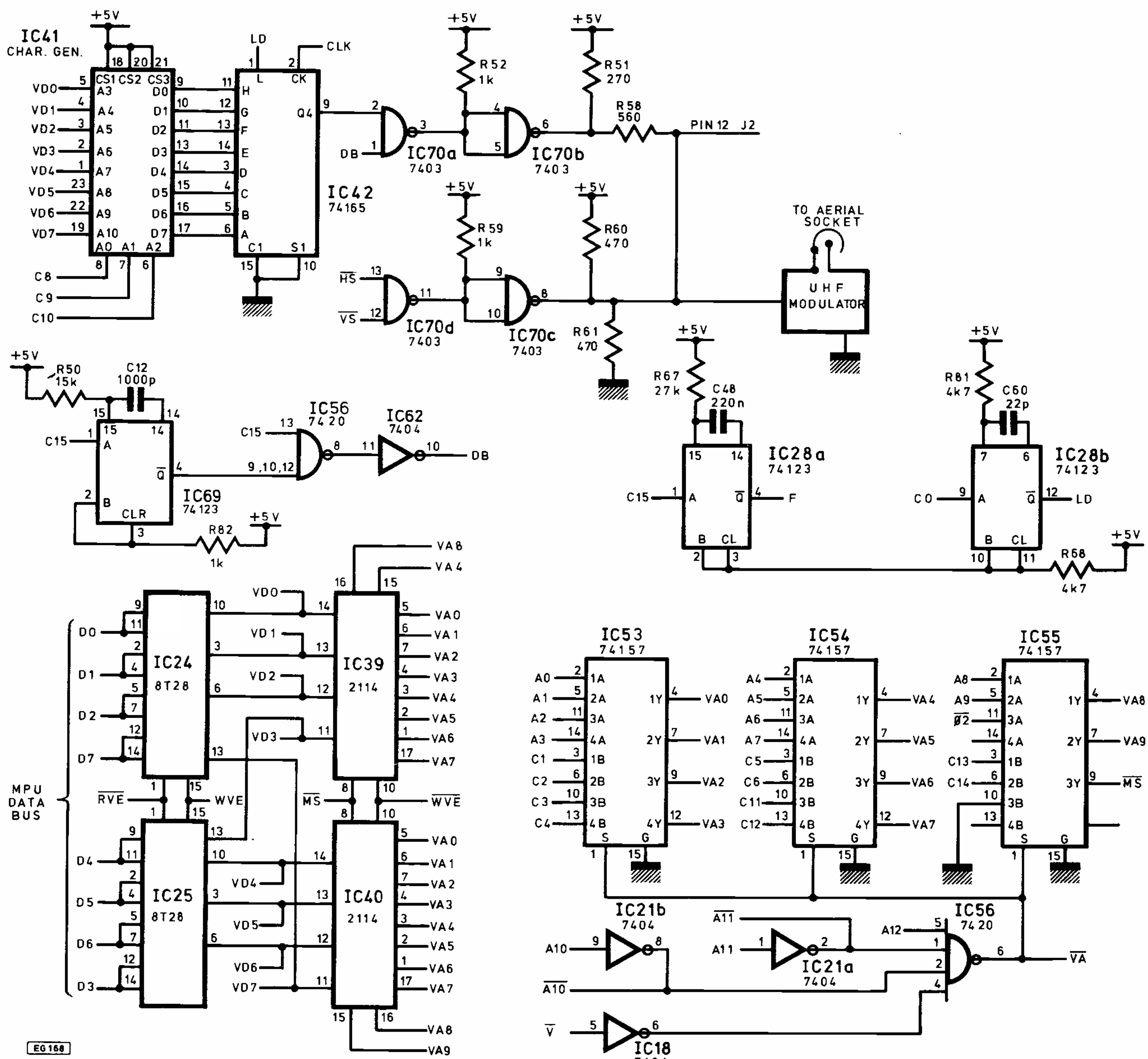


Fig. 2.2. Memory mapped VDU interface. All 7400 series devices are LS types

BASIC REFERENCE AND DEFINITIONS

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.

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	ILLEGAL (Think about these . . . embedded BASIC words etc.)
A	**1B**
B1	**B***
B 175	**TOP**
TQ	**COSQR3**
EGG	**18Z**
MONDAY TUESDAY	**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.

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 seperated by : (colon), and spaces may be omitted.

```
10  X = 13*14.6
20PRINTX
```

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 + I,** 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 **O.** 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:
DEFFNA (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.

Smilarly 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$** to be printed.
PRINT XY will cause the combined (concatenated) contents of **X$** and **Y$** to be printed.
Try:
X$ = "WE": Y$ = "L": PRINT XY
(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
RE DO
the INPUT from the start.

NUMERIC FUNCTIONS

(**X** is any numeric or Boolean expression)

ABS(X) — For **X**>=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<=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 **I**th character. If **J** is omitted, all characters from **I**th 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 addreses below are in HEX.

0000 to 03FF (1023 in decimal)	BASIC workspace etc.
0400 (1024 in decimal) to END of RAM	Protected for machine code etc.

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) The message is stored from 0600 onwards and terminated by 5F
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 POKEing 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 64μs 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

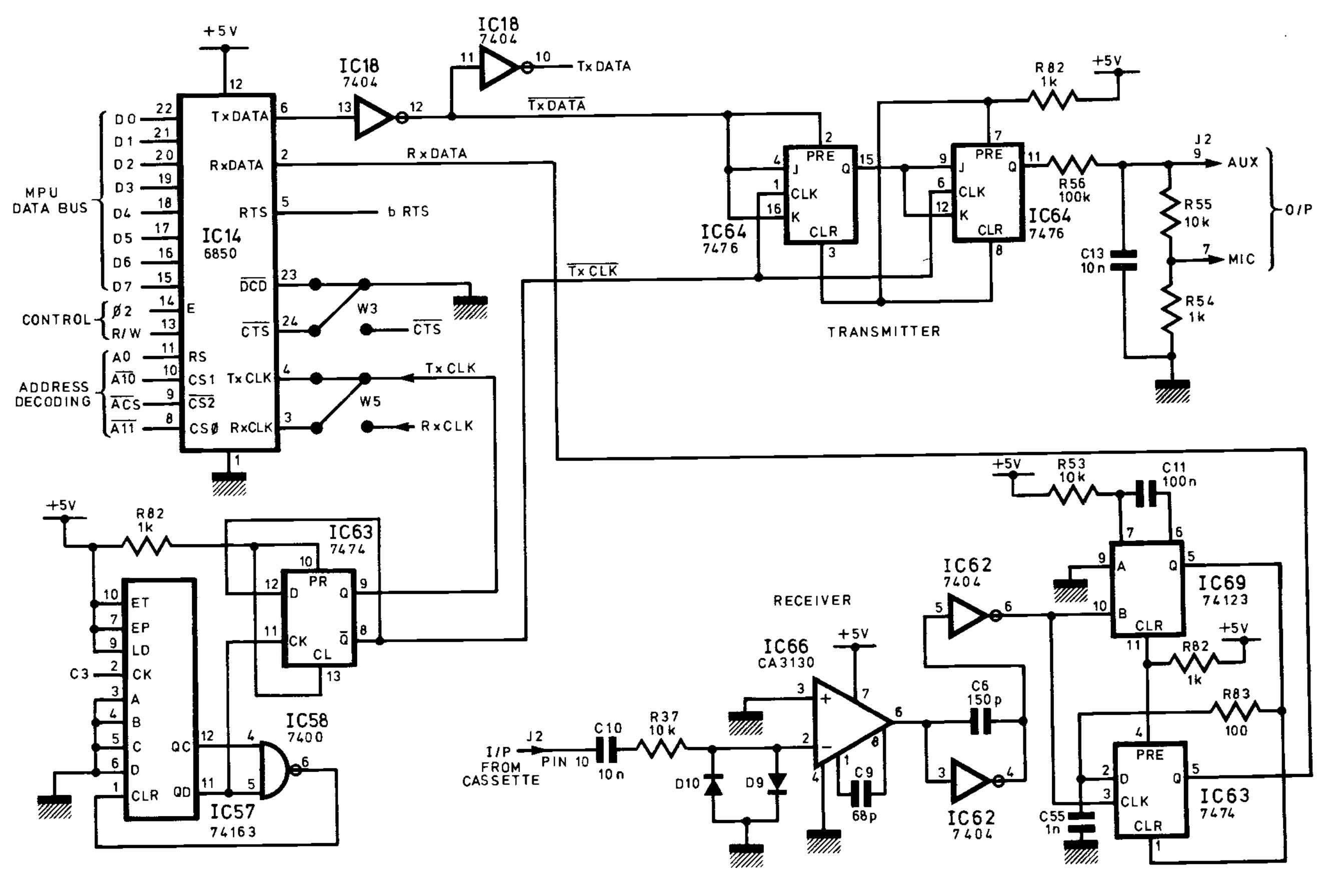


Fig. 2.3. Cassette Interface. 7400 series devices are LS types. Printed circuit "patch-panels" have W numbers. The ACIA signals ϕ2 and R/$\overline{W}$ go to expansion socket pins 31 and 32 respectively

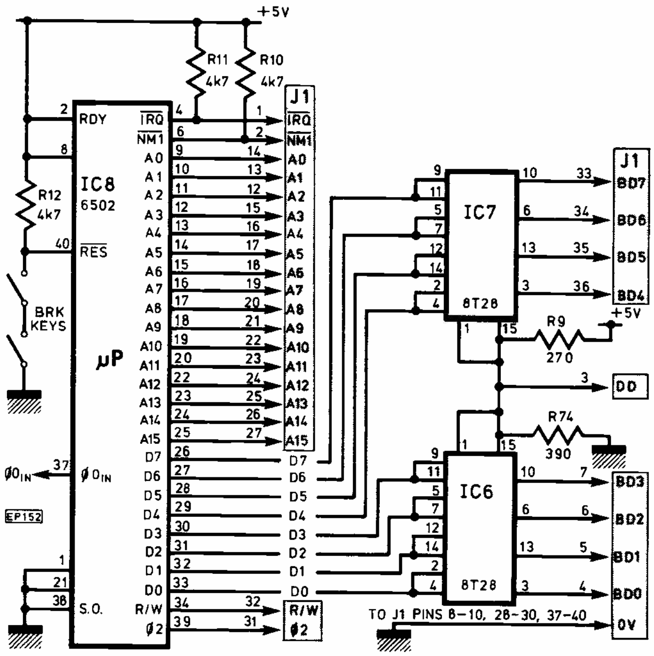


Fig. 2.4. The 6502 microprocessor and expansion socket J1. When pressed simultaneously, the BREAK keys reset the processor

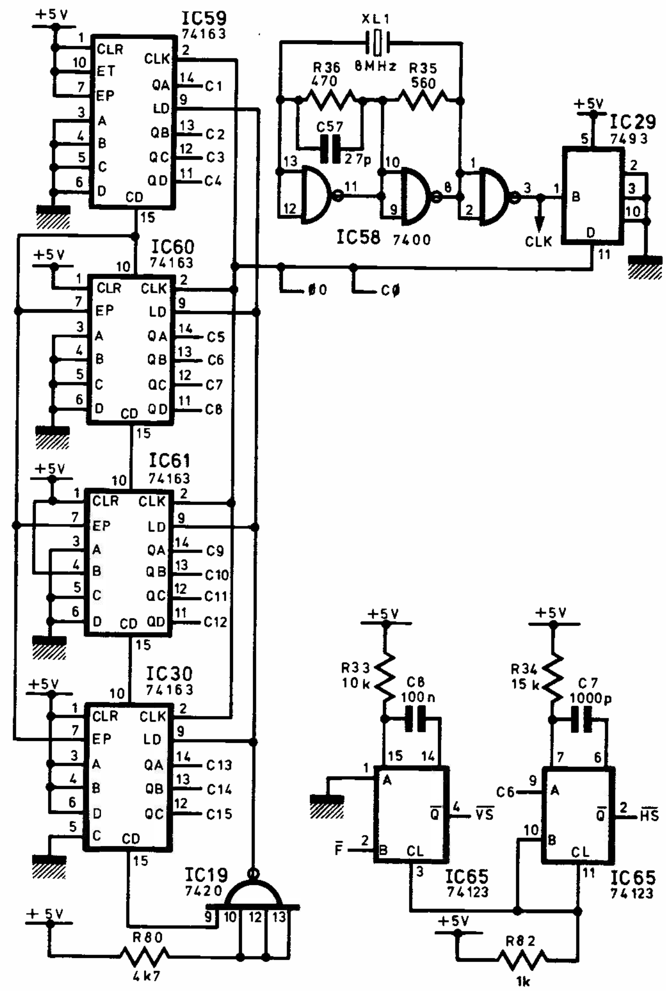


Fig. 2.5. System Clocks

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

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.

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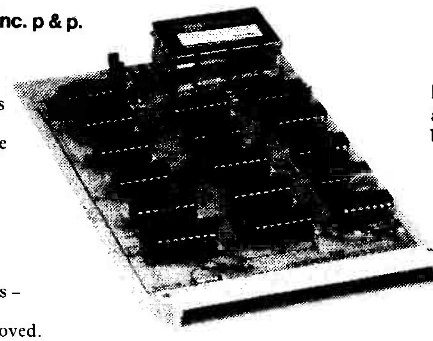

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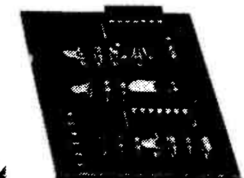

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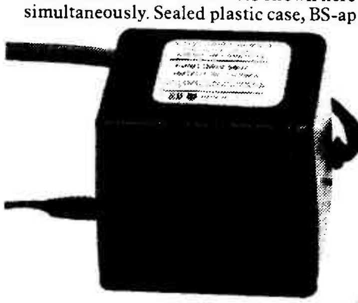

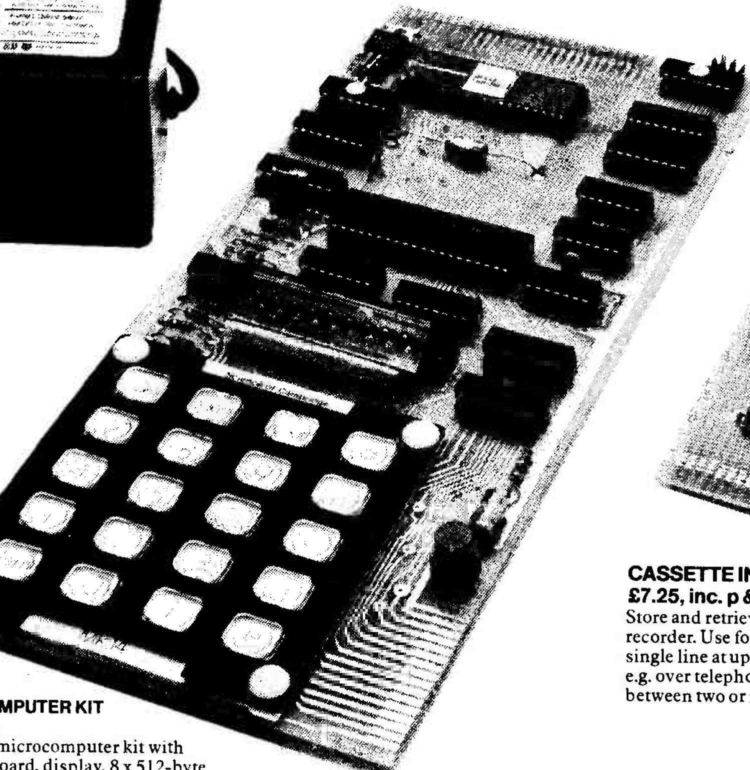

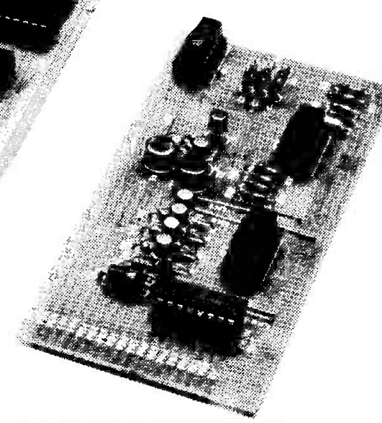

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Strictly Instrumental

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.

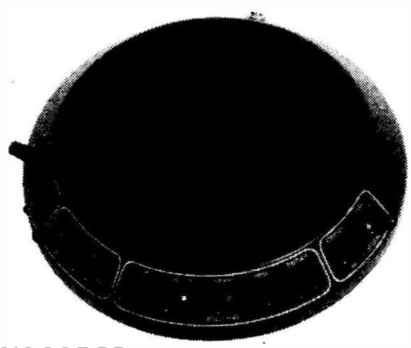
Drummers have used practice pads for years, allowing them to perfect their flam paradiddles relatively quietly! The pad consists of a disc of rubber mounted on a wooden base: using sticks, the bounce obtained is similar to that from a plastic or skin drum head. Synthesised drums (Synare 3, for example) 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 Syndrum 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 0·22μ 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 0·033μ 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 geometery 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 variations. 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 trans-atlantic 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.

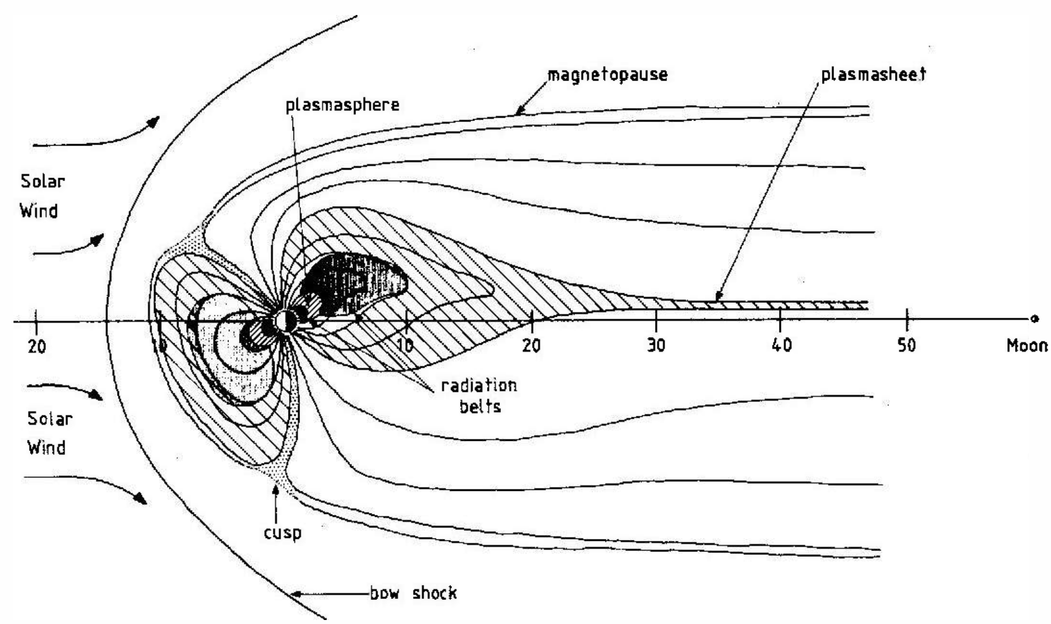
The presence, in Fig. 1, of the feature labelled as the bow-shock can be explained using our bag anology; when the relative speed between the fluid and the bag is supersonic just such a detached shock-wave is set up. The solar wind is supersonic in rather a special sense; its density is too low to support 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



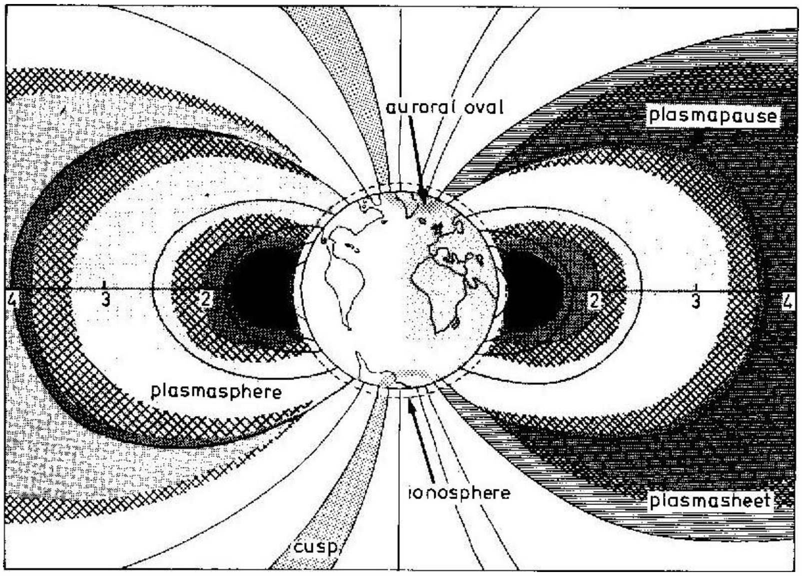


Fig. 2. The region around the Earth, showing the structure in the radiation belts. Also notice the auroral oval; this is the zone around the poles where the aurorae are seen

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/cm^3 at the outer edge.

The edge, known as the **plasmapause,** 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 plasmapause 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 plasmapause 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.

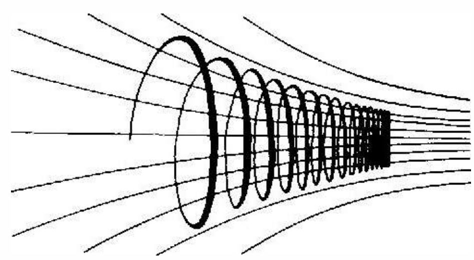


Fig. 3. The spiral path of a charged particle in a non-uniform magnetic field, showing how it may be reflected by a strong field

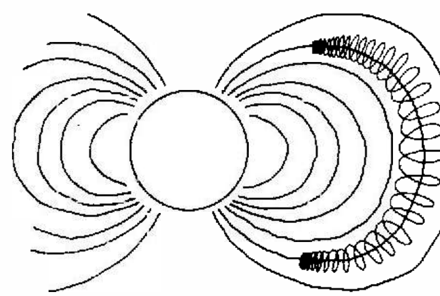


Fig. 4. The motion of charged particles trapped in the radiation belts

The third plasma regime is the "warm" plasma located in the **plasmasheet;** 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.

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.

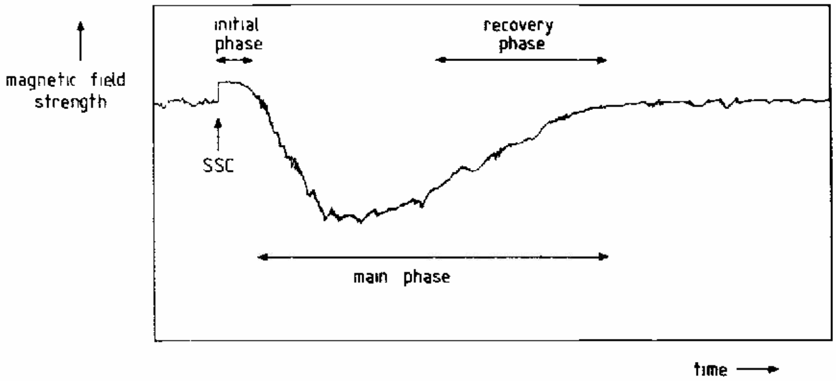


Fig. 5. The change is the Earth's magnetic field during a magnetic storm. The time scale is a few days, and the variations are up to about one part in 100

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

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 radiowaves.

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.

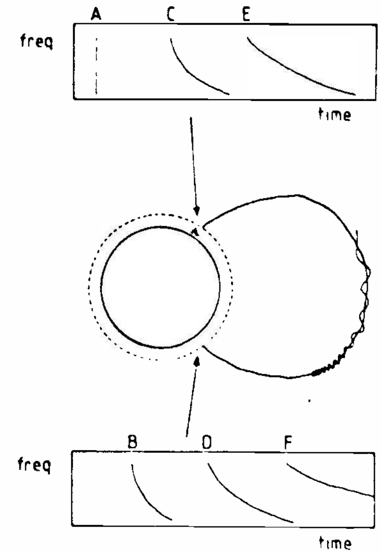


Fig. 6. The path of a whistler in travelling from one hemisphere to the other. The signals received at each end of the field line are shown as frequency-time diagrams. The lightning pulse is shown at A, the one-hop whistler at B, and the whistler after subsequent hops at C, D, E and F

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 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

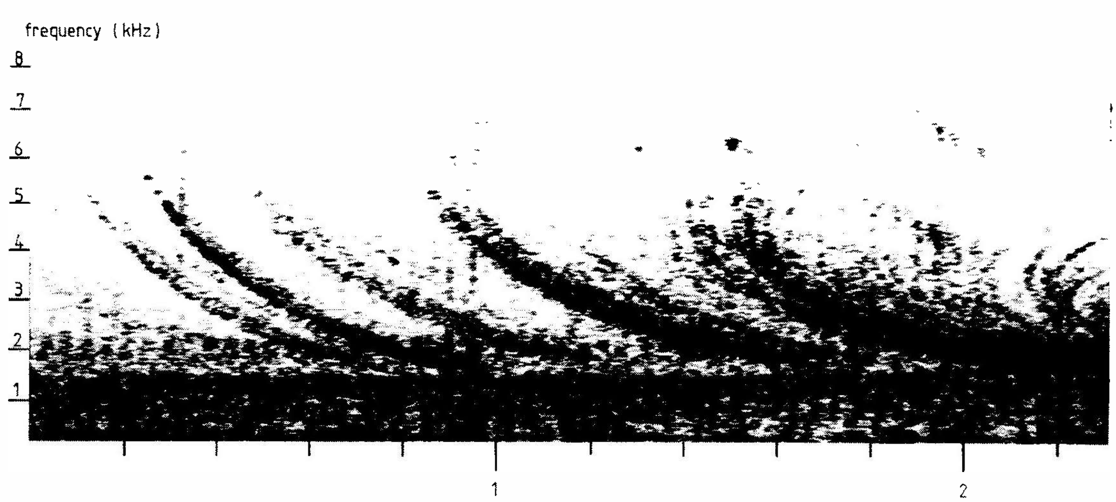


Fig. 7. A group of whistlers recorded at Halley Bay, in Antarctica

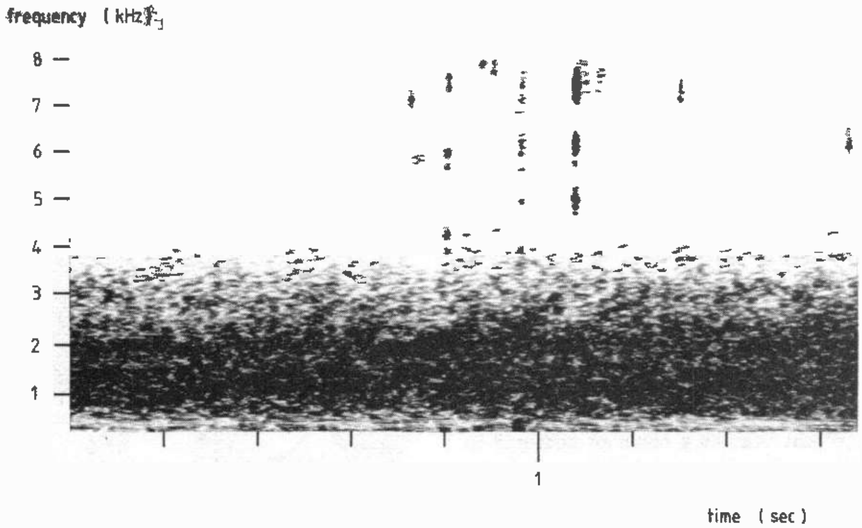


Fig. 8. Chorus at Halley Bay

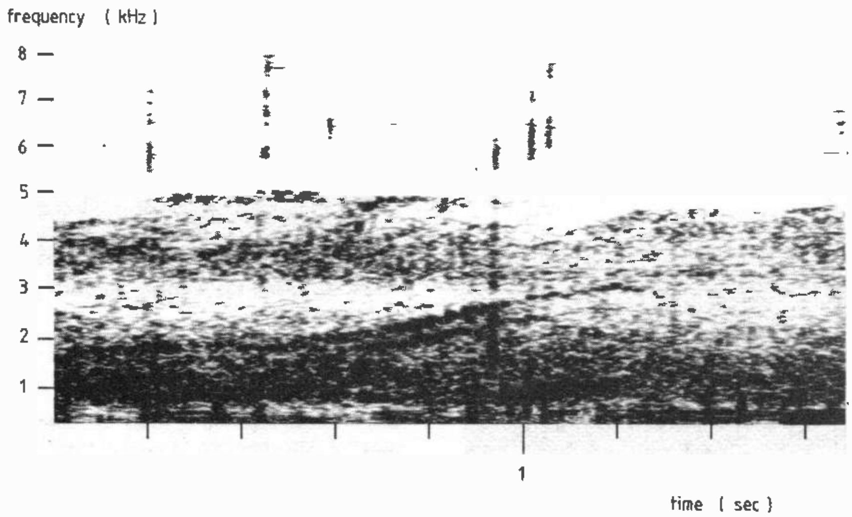


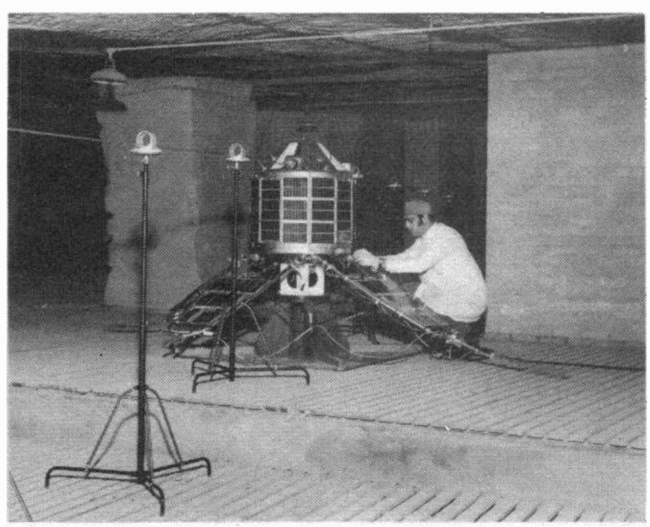
Fig. 9. Risers recorded at Halley Bay

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 aerials of some of the experiments are visible. ***(By courtesy of British Aerospace)***

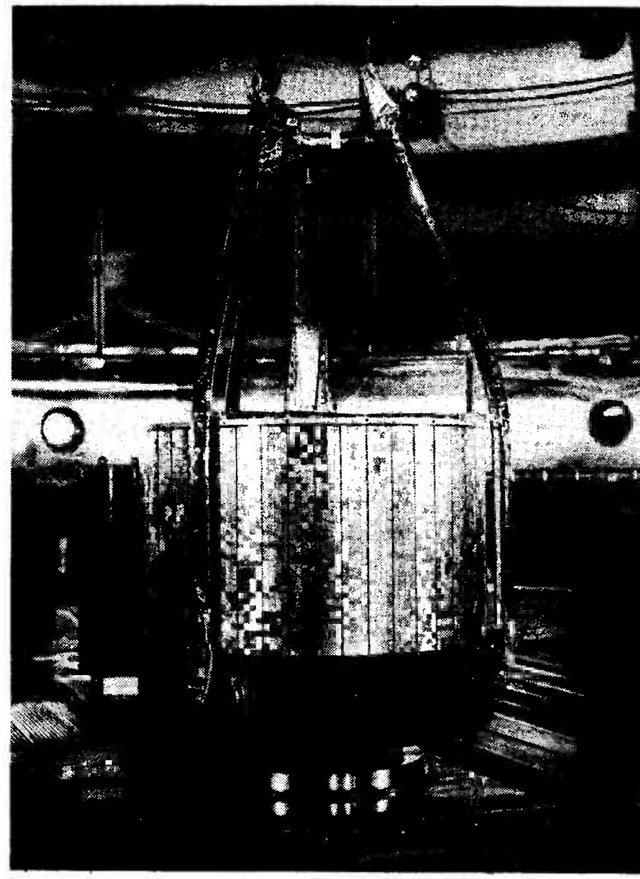
used to observe v.l.f. hiss (amongst other emissions) simultaneously with the detection of low-energy precipitating electrons by an experiment from the University of Iowa, which formed a contribution from the United States.

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.

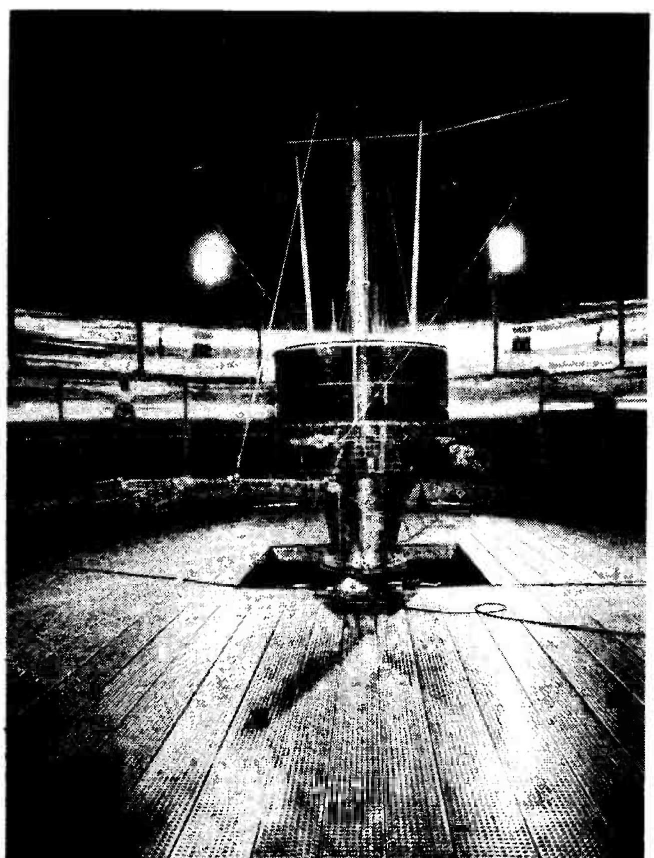
Natural v.l.f. signals were in fact detected at the end of the nineteenth century by workers at the British Post Office, who reported hearing strange noises in telephone circuits; the long telephone lines were acting as aerials. Natural signals were also detected during the first World War as a result 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 scentific 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 sun's magnetic field links to that of the Earth, i.e. is the magnetosphere open or closed; this was mentioned earlier.



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)***

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. ★

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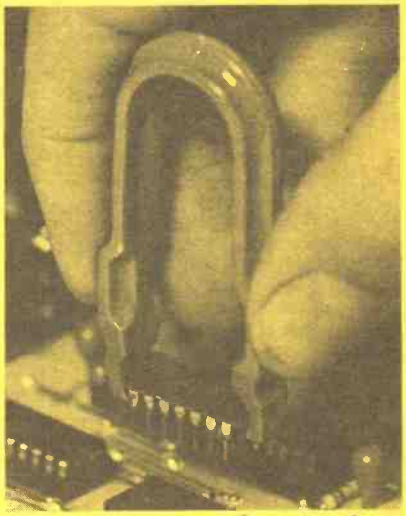

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SMOOTH FUZZ

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.

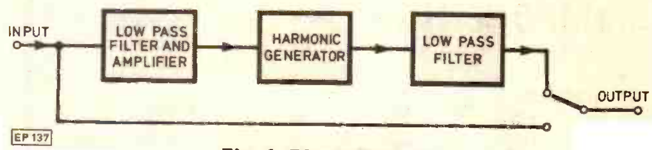
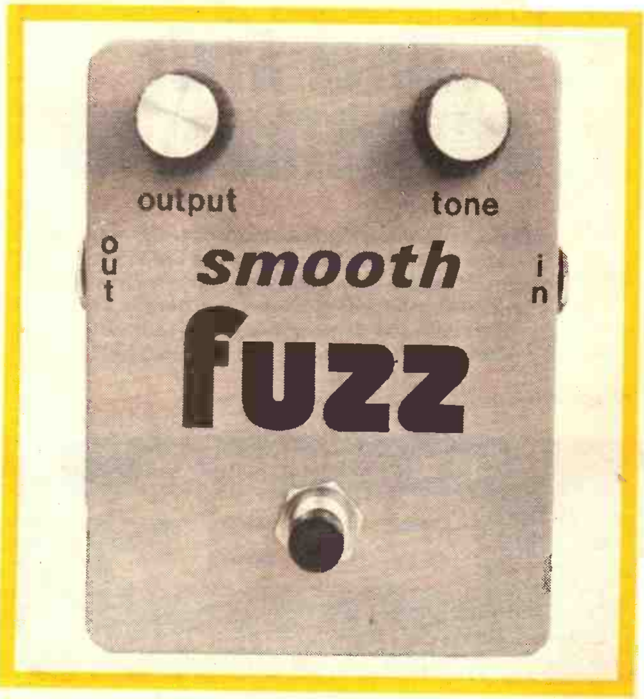


Fig. 1. Block diagram

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.



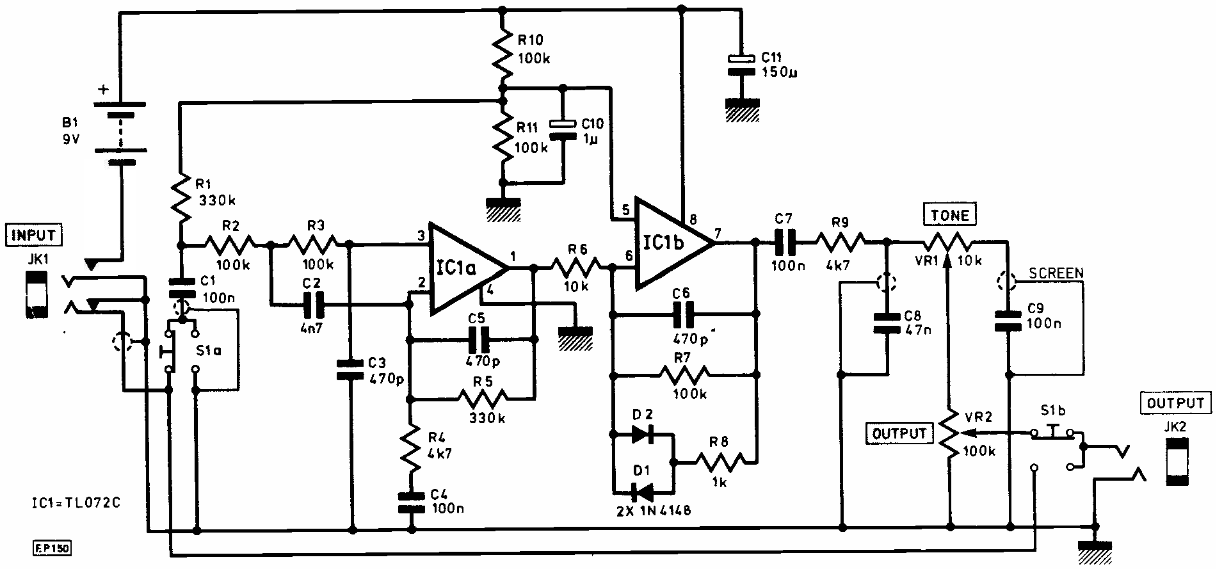


Fig. 2 Circuit diagram

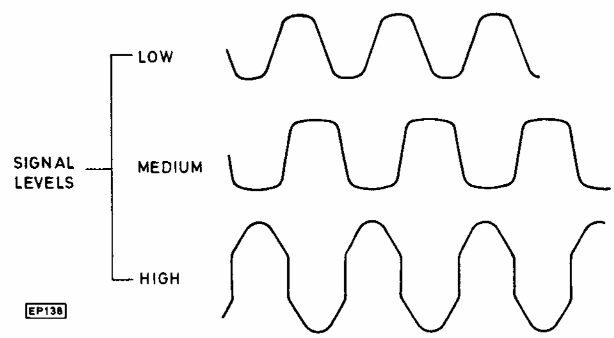


Fig. 3. Waveforms

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 250W polyester film
C5 470p 100V 10% plate ceramic
C6 470p 100V 10% plate ceramic
C7 100n 250W 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 CSOO 043 AOO
PP3 type battery and battery clip
Two control knobs
Two rubber self adhesive feet
Screened lead and connecting wire

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.

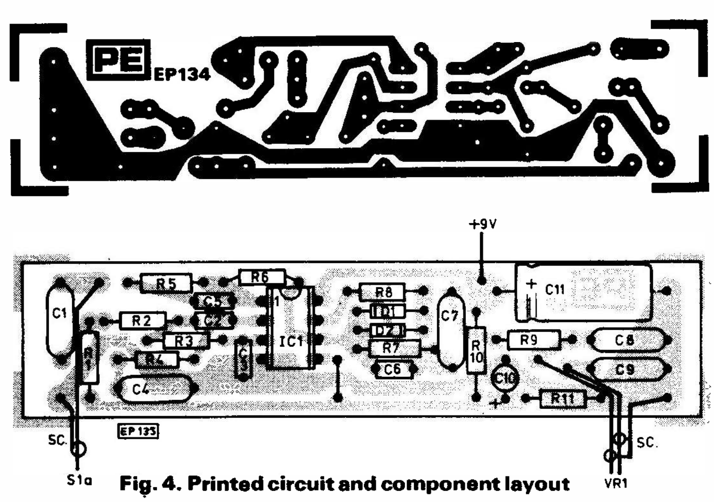


Fig. 4. Printed circuit and component layout

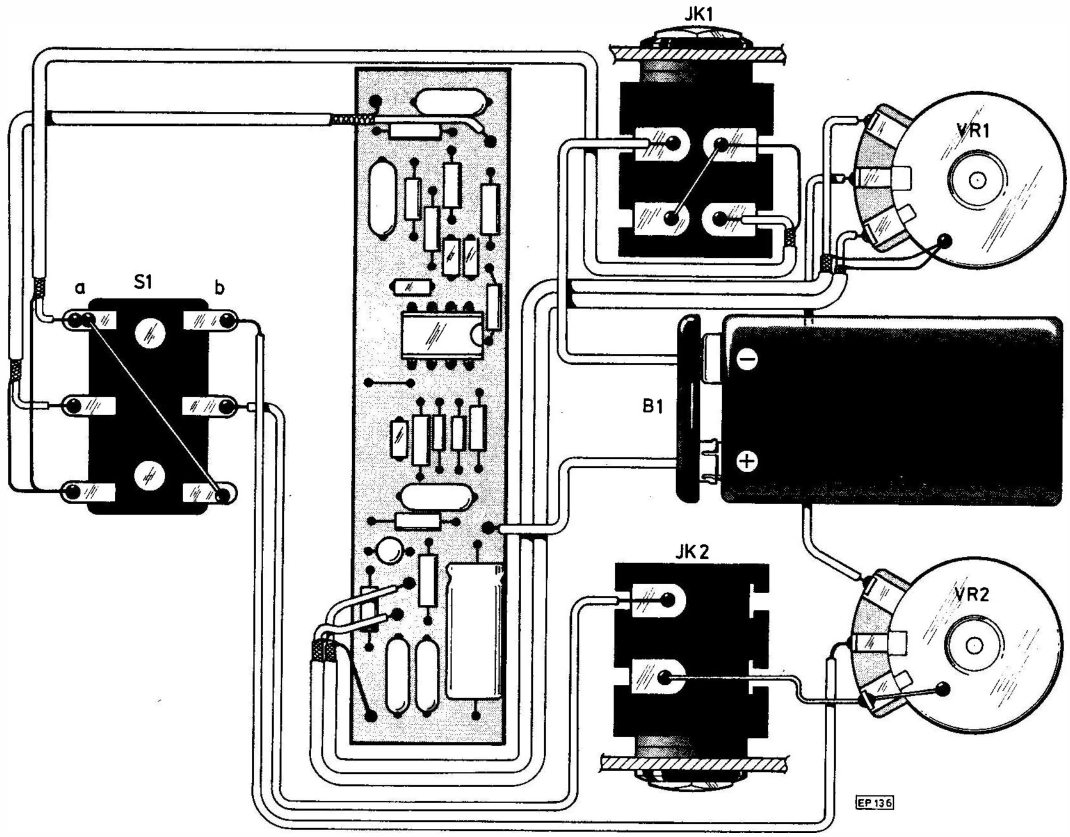
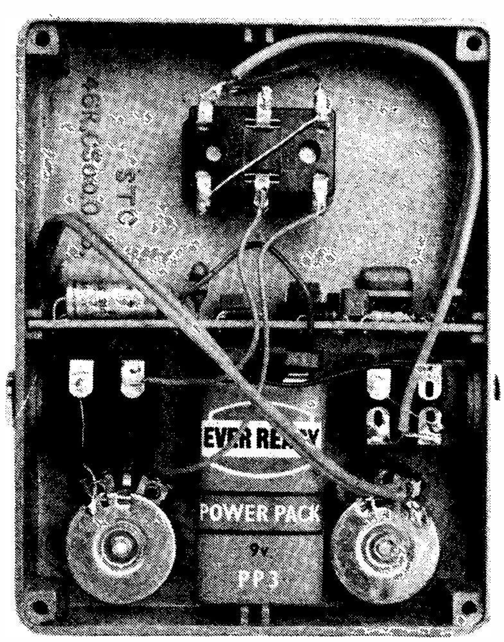


Fig. 5. External assembly to board



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 $\pm 0{\cdot}7$ 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. ★

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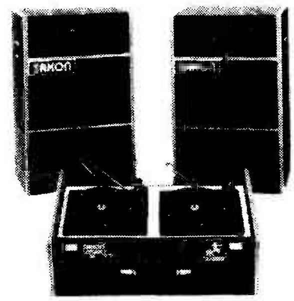

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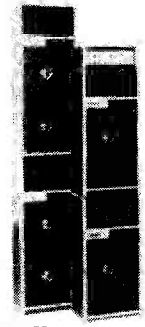

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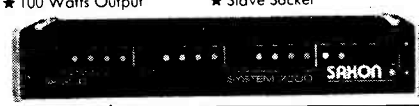

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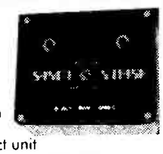

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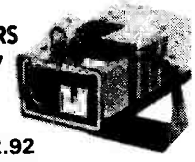

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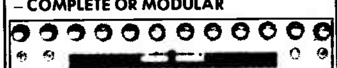

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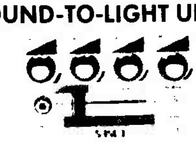

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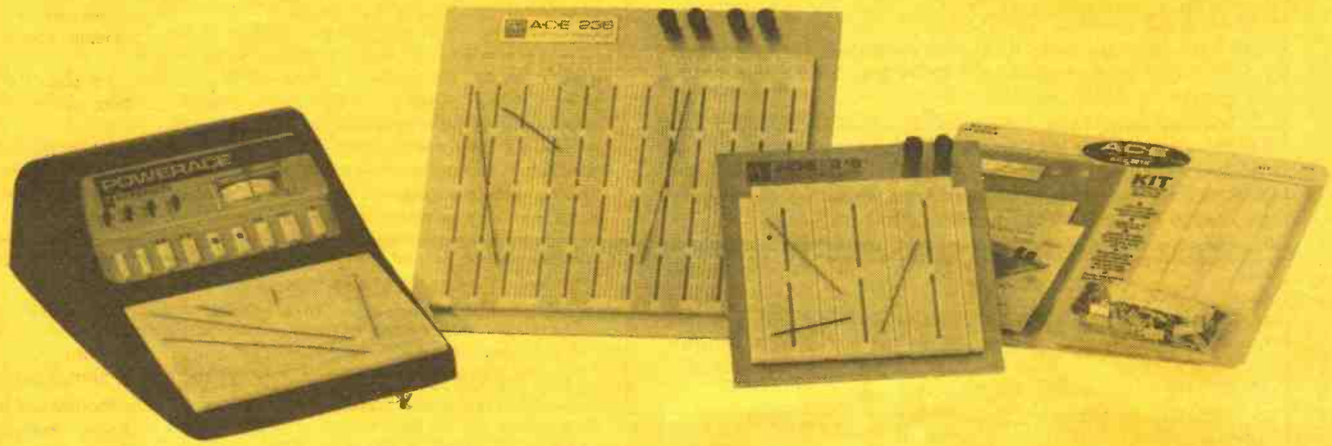
2nd LEKTROKIT ACE 236, a Jumper Wire Kit and 16 Pin Test Clip value approx. £65.

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.

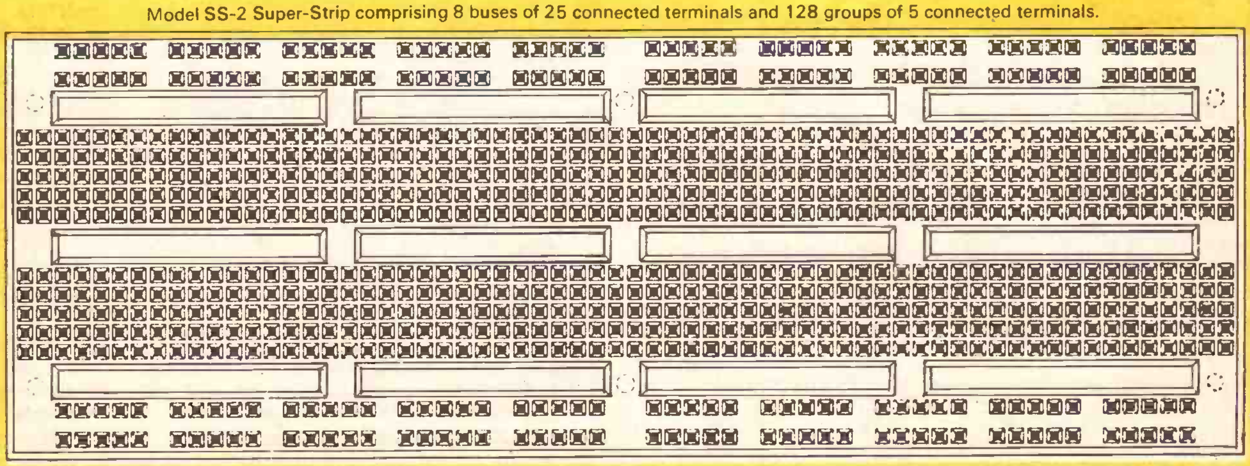
Results will be announced in the February 1980 issue of P.E. and, providing the first prize winner lives in the U.K. he/she will be presented with the prize at Breadboard '79 (Dec. 4–8th 1979).

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 × 8, 4k × 8, and 8k × 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 electroencéphalogram 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 locatiing even the quietest, fastest types of nuclear submarine operating at great depth.

FREE ENTRY COUPON

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(Block letters please)

NAME (Mr/Mrs/Miss) ....

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ADDRESS ....

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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 termperature 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-electro-mechanical equivalent of human eye vision.

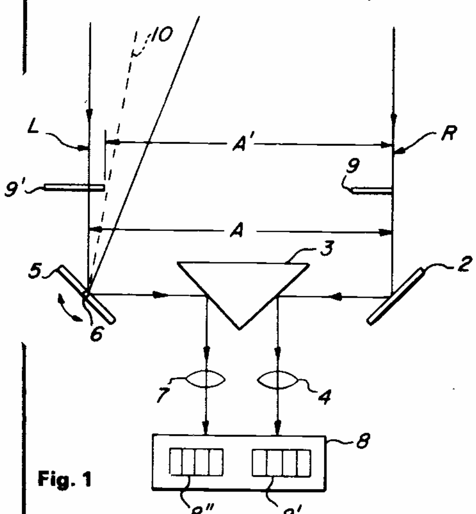


Fig. 1

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 coincidence. 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.

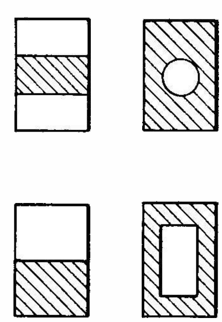


Fig. 2

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

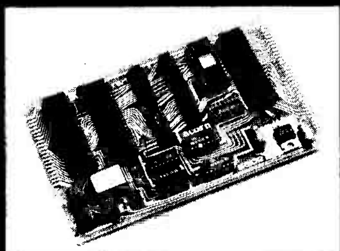
In BP 1 529 985 Communications Patents Ltd. of London SW1 claim novelty in a system for broadcasting stereo sound programmes over a cable TV system. The patent was applied for in 1976 and is granted under the old laws.

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.

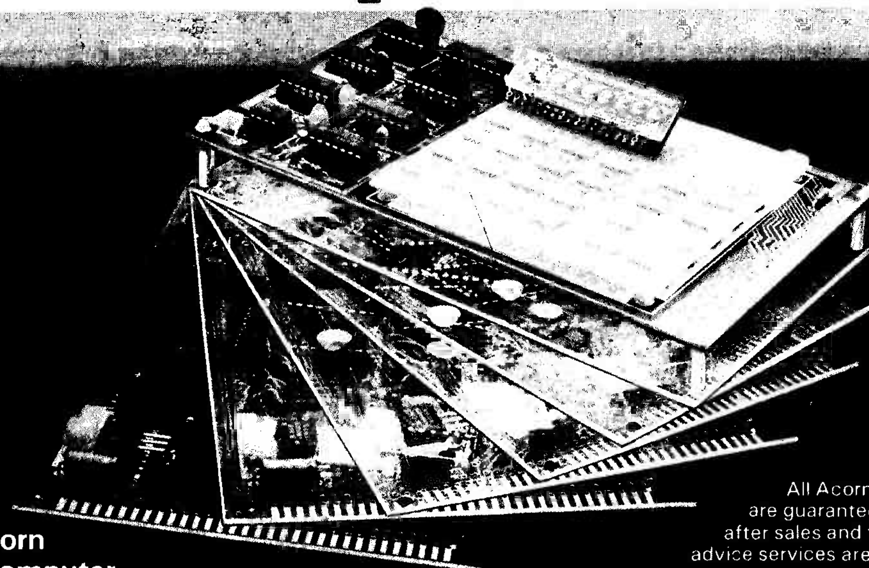
Three Trumps from Acorn



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 × 74S571) giving comprehensive development and debugging facilities. Also available in minimum configuration for low cost OEM applications.

ACORN COMPUTERS LTD.
4A Market Hill, Cambridge, Cambs.



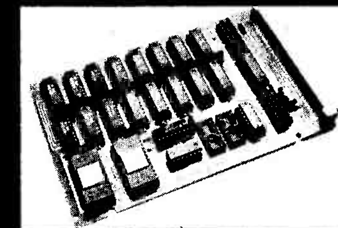
The Acorn Microcomputer

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 unstabilised 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:

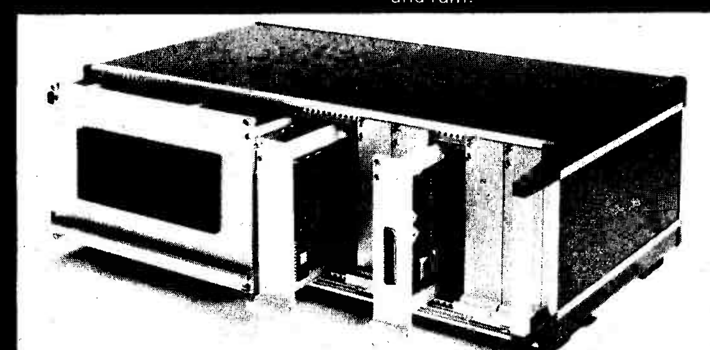
System Program
Set of sub routines for use in programming
Powerful de-bugging facility displays all internal registers
Tape load and store

All Acorn modules are guaranteed and full after sales and technical advice services are available.



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.



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.

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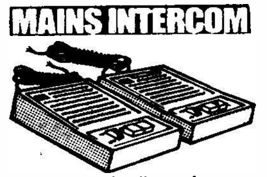

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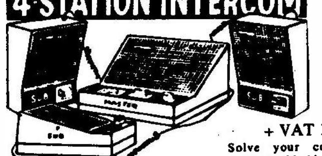

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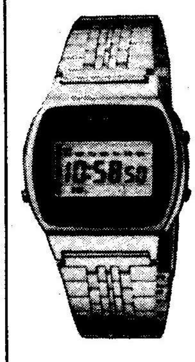

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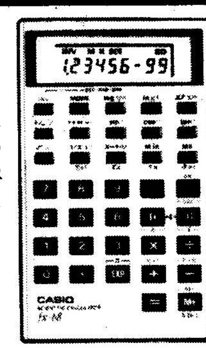

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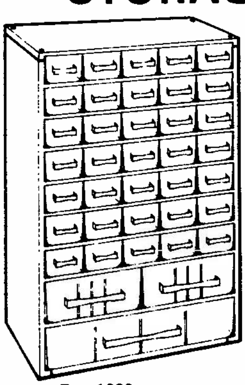

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BA155	0·12	BF258	0·30	OC82	0·74	2N2484	0·23	74107	0·52
BA156	0·10	BF259	0·37	OC83	0·74	2N2646	0·63	74109	0·81
BAW62	0·06	BF336	0·35	OC84	0·74	2N2904	0·29	74110	0·58
BAX13	0·07	BF337	0·35	OC122	1·73	2N2905	0·29	74111	0·81
BAX16	0·10	BF338	0·36	OC123	2·02	2N2906	0·24	74116	2·02
BC107	0·14	BFS21	4·55	OC139	2·59	2N2907	0·24	74118	1·15
BC108	0·14	BFS28	2·56	OC140	3·16	2N2924	0·24	74119	1·73
BC109	0·15	BFS61	0·23	OC141	3·74	2N2925	0·25	74120	0·95
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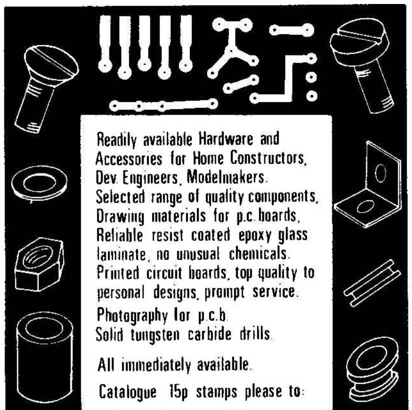

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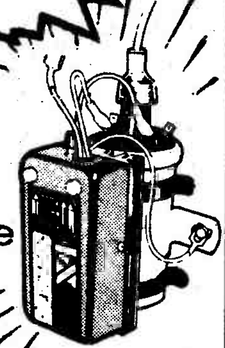

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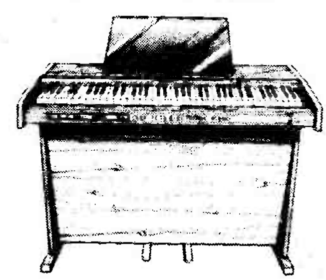

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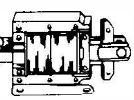

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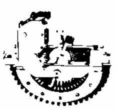

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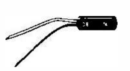

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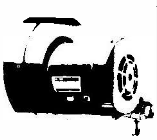

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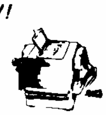

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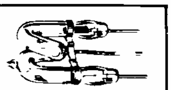

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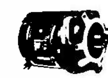

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R. & T

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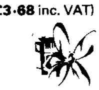

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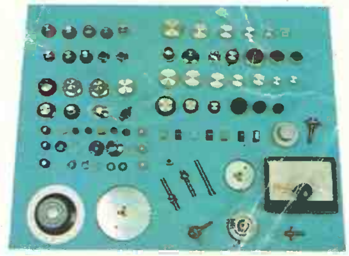

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