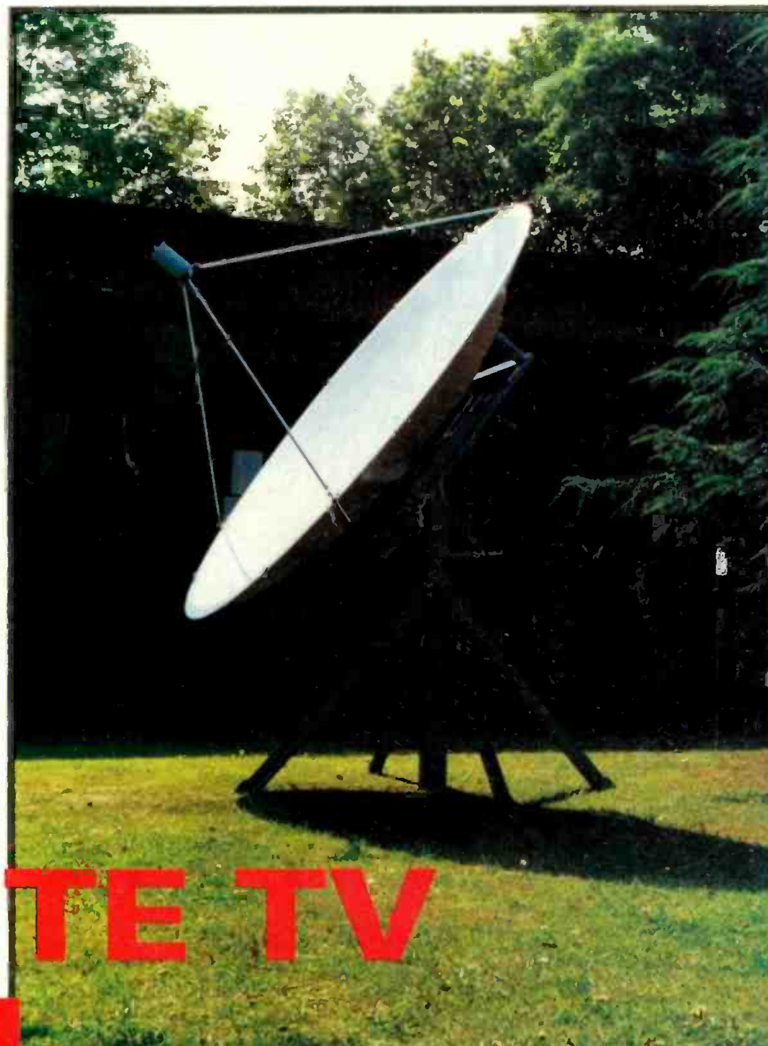
PRACTICAL NOVEMBER 1986 · £1.25

ELECTRONICS

SCIENCE AND TECHNOLOGY



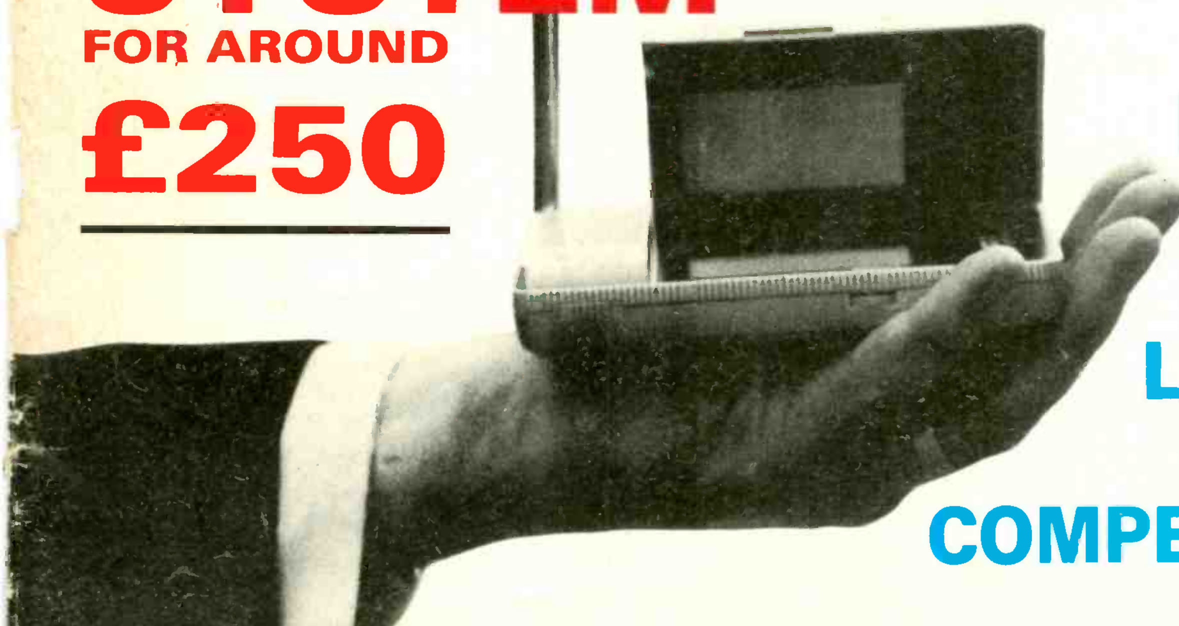
WIRELESS BABY ALARM

IR REMOTE JOY STICK

LCD TV REVIEW

DESIGN AND TECHNOLOGY

BUILD YOUR OWN D.I.Y. SATELLITE TV SYSTEM FOR AROUND £250



FREE TO ENTER POCKET L.C.D. TV FUN COMPETITION!

THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS AND COMPUTER ENTHUSIASTS

P.E. PROJECT KITS

MAGENTA

Full kits include pcb's, hardware, cases (unless stated otherwise), IC sockets, wire, nuts & bolts. Article reprints extra 70p each.

THIS MONTH'S KITS – S.A.E. OR PHONE FOR PRICES

PASSIVE INFRA-RED DETECTOR July 86	£38.46
ECHO/REVERB UNIT July 86	£41.95
THERMOCOUPLE INTERFACE FOR DVM Jun 86	£15.98
NOTCHER EFFECTS UNIT May 86	£31.46

DIGITAL CAPACITANCE METER

A superb instrument with a five digit 0.5 inch LED display giving direct readout of pF, nF and uF from 1pF to 1,000 uF.
Exceptionally easy to use. A crystal timebase eliminates setting up procedures.
Ideal for schools, labs, and industry as well as electronics enthusiasts from beginners to experts.
Complete kit – including PCB, case, all components and hardware, **£39.57.** Reprints of article 70p.

TTL LOGIC CHECKER May 86	£20.95
SOUND ACTIVATED SWITCH Apr 86	£41.55
SCRATCH & RUMBLE FILTER (Stereo) Apr 86	£18.89
PHOTOGRAPHIC TRIGGER UNIT Apr 86	£35.68
TEMPERATURE/ANLOGUE INTERFACE Apr 86	£43.87
SPECTRUM HARDWARE RESTART (uncased) Mar 86	£28.49
AMSTRAD I/O Mar 86	£24.18
FIBREOPTIC AUDIO LINK Mar 86	£27.65
FIBREOPTIC CABLE	80p/metre
LOGIC PROBE Feb 86	£14.15
COMPUTER MOVEMENT DETECTOR Feb 86	£17.43
SPECTRUM SPEECH SYNTH & 8-BIT I/O PORT Jan 86	29.58
HIGH PERFORMANCE STEPPING MOTOR DRIVER Dec 85	£22.98
EXTRAS: Transformer £5.98; Case £2.95; BBC lead & plug £1.98; Motor-1D35 £14.50; MD200 £16.80.	
COMMODORE USER PORT EXPANDER Nov 85	£11.98
MODEL RAILWAY TRACK CONTROL Nov 85	£44.98
'SQUINT' ROBOT EYES Nov 85	£9.55
TOUCH CONTROL PSU Oct 85	£31.22
MODULATED SYNDRUM Oct 85	£29.24
RS232 TO CENTRONICS CONVERTER Sept 85	£49.44
CAR BOOT ALARM Sept 85	£12.89
COMPUTER ENVELOPE SHAPER Aug 85	24.39
VOLTMETER MEMORY ADAPTOR July 85	£11.99
STYLUS KEYBOARD FOR COM 64 Jun 85	£10.50
SYNTHESISER INTERFACE FOR COM 64 Jun 85	£17.26
AMSTRAD SYNTHESISER INTERFACE May 85	£27.90
CYLINDER THERMOSTAT May 85	£23.95
BBC POWER CONTROL INTERFACE Apr 85	£22.98
GUITAR ACTIVE TONE CONTROL less case Sept 83	£14.36
PROGRAM CONDITIONER June 83	£22.40
AUTO TEST SET May 83	£41.54
WIPER DELAY Apr 83 less relay	£9.89
BATTERY TESTER Apr 83	£15.90

EDUCATIONAL SETS

ADVENTURES WITH ELECTRONICS

An easy to folow book suitable for all ages. Ideal for beginners. No soldering, uses an S/Dec Breadboard. Gives clear instructions with lots of pictures. 16 projects – including three radios, siren metronome, organ, inter-com, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec breadboard and all the components for the projects.
Adventures with Electronics **£3.58.** Component pack **£20.98** less battery.

HIGH PERFORMANCE STEPPING MOTOR DRIVER

As featured in December issue
Kit including PCB, I.C. & All Parts £22.98
Transformer 30V 18VA **£5.98 extra**
Case (houses PCB only) **£2.95 extra**
Lead & Connector for BBC Computer **£1.98**
Motors – ID35 **£14.50** – MD200 **£16.80**
TEA1012 also available separately **£6.88.** Data **£1,99**

STEPPING MOTORS

BBC STEPPER MOTOR INTERFACE KIT £13.99 PCB, driver IC, components, connectors and leads included. Demonstration software, listings, circuit diagram, pcb layout and construction details given. Requires unregulated 12Vdc power supply.
INTERFACE KIT (ref PE) 13.99
OPTIONAL POWER SUPPLY PARTS £4.67

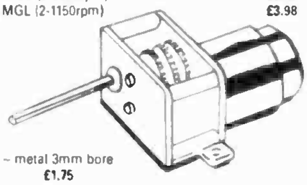
PE HOBBYbus

Kit including double sided p.c.b. excluding DIN sockets **£49.98.** DIN 41612 a+c sockets **£2.20** each or 10 for **£18.**

DC MOTOR SETS

MOTOR – GEARBOX ASSEMBLIES 1.5V–4.5V
Miniature precision made. Complete with quality electric motors. Variable reductions ratios. Long 3mm dia output shafts.

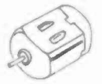
Small unit – type MGS (3-2200rpm)	£3.49
Large unit – type MGL (2-1150rpm)	£3.98



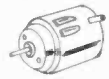
PULLEY WHEELS – metal 3mm bore	
10mm dia	£1.75
20mm dia	£1.84
30mm	£1.99
METAL COLLAR WITH screw — 3mm bore	24p
FLEXIBLE SPRINT COUPLING 3mm L31mm	68p
FLEXIBLE METAL COUPLING 3mm	£2.98
DC MOTOR 1.5V–4.5V RPM 4,400–8,700 Shaft dia 2mm L10mm. Body 29x38mm	
DC MOTOR TYPE – Dc28	£1.98
FLEXIBLE STEEL SPRING DRIVING BELT	47p

12" long. Joins to itself or 2 more can be joined where long lengths are needed.

MINI MODEL MOTORS 1.5–3V



TYPE MM1 **59p** TYPE MM2 **61p**



BBC HEART RATE

BBC Heart Rate Monitor — Ready Built £35.99

Practise relaxation or monitor fitness with this plug-in heart rate monitor. Connects directly to the BBC computer. Programs give continuous heart rate displays, bar charts, graphs etc. Supplied with sensor, software & instructions – ready to plug in and use.

DRY BATTERY CHARGER

AS FEATURED IN P.E.

We have produced a full kit of parts to build the Dry Battery Charger featured in the August issue of P.E.

This is a designer approved full kit of parts complete with Case, PCB, and a set of four special top quality Battery Holders.

The metal case lid swings open so that the batteries are fully enclosed during charging for complete safety.

Any number of batteries (up to 4) can be charged at a time. The kit is supplied in 3 versions for AA cells, C cells, or D cells. These differ only in the type of battery holders and charging resistors supplied.

Conversion kits are available to change between types.

DY BATTERY CHARGER KITS

AA cells	– **£24.12**
C cells	– **£25.27**
D cells	– **£26.57**

VERKON DC-DC CONVERTERS

These compact efficient voltage converters allow one or two NICAD or ALKALINE cells to be used as the power source for circuits requiring 6, 9, 12, 14 or 20 volts. The economy and reliability gains that come from this arrangement are excellent – just compare the cost of a single NICAD cell with that of a NICAD PP3. This is only part of the story – we have a full leaflet which shows how to calculate the savings which can be made. Just send a stamped addressed envelope for more information, performance curves etc.

VERKON DC-DC CONVERTERS

V6	6 volts from 1 Nicd or Alk-Mn	**–£7.28**
V9a	9 volts from 1 Nicd	**–£7.28**
V12	12v from 1 Alk-Mn	**–£7.28**
Vt12	14v from 2 x Nicd	**–£8.63**
Vt18	20v from 2 x Nicd	**–£8.63**

KAYCOMP MICROPROCESSOR TRAINER AND SINGLE BOARD COMPUTER

68000

A new single board training and evaluation system for the 16-bit 68000 Series Microprocessor. A standard working system in kit form costs just **£110.00 including VAT.** Programs are developed and written with the aid of an on-board monitor program. The system is programmed and run via an RS232 link from either a standard terminal or a BBC Computer programmed to act as a terminal (we supply the necessary software). Optional extras include a line by line assembler, a peripheral I/O port and timer, and a G64 bus interface. Full sets of technical literature, programming information and manufacturers' data sheets are available to accompany the system.

AVAILABLE FROM STOCK NOW
PHONE OR WRITE FOR FULL DETAILS REF PE10

68705 MICROCONTROLLER TRAINER

A stand-alone unit with hexadecimal keyboard and 9-digit seven-segment display. Uses a control oriented 68705 microprocessor with a comprehensive monitor system. A bank of 8 LEDs and switches allows I/O control programs to be run before connecting to 'real' external circuits. An A/D–D/A board is also available along with full support literature. An excellent introduction to machine code programming right down to 'bit' level. Used in many educational establishments. A complete system costs under £50.
All in stock – Phone or write for details PE10

68000 'Kaycomp' system with monitor program, 8MHz system clock, 2k x 16 RAM, and RS232 duart interface (in kit form need +5, +12, −12V supplies)	**£110.00**
68230 P.I.T. add-on	**£11.97**
G64 bus interface add-on	**£5.49**
8k x 16 RAM upgrade	**£9.24**
Assembler + disassembler program	**£24.46**

CATALOGUE

Brief details of each kit, book contents, and illustrations and descriptions of our rang eof tools and components are all included. Robotics and Computing section included.
Our advert shows just a selection of our products.
Up to date price list enclosed. Official orders welcome.
Catalogue & Price List – Send £1 in stamps etc or add £1 to your order. Price list only 9x4 SAE.
Catalogue free to schools/colleges requested on official letterhead.

SHOP NOW OPEN – CALLERS WELCOME

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24 hr Answerphone for credit card orders.

OVERSEAS: Payment must be sterling.
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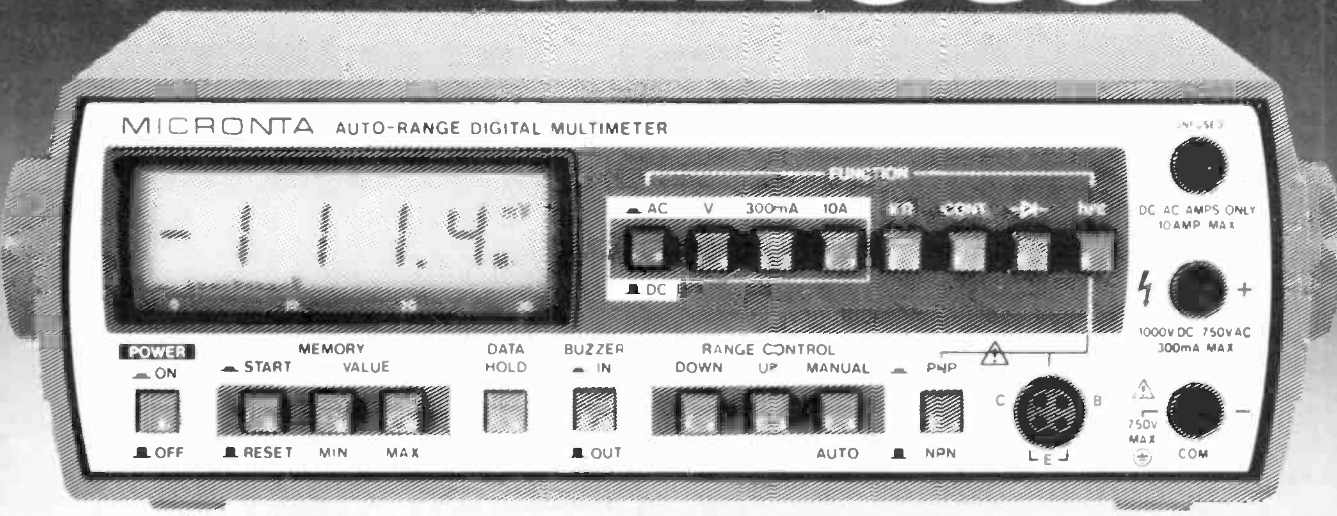
EUROPE: UK PRICES plus 10%.
ELSEWHERE: write for quote.

Micronta® The ultimate Multimeter



Benchtop Auto-Range Digital Multimeter. Convenient all-pushbutton operation. Built-in 31-segment bargraph provides a simultaneous analogue-type display that makes peaks and trends more apparent. Built-in transistor checker with front-panel pin socket gives you true hfe (gain) measurements of small signal types. Separate diode-check mode for open/short/leakage tests of semiconductor junctions. Memory function stores minimum and maxiumum values of a changing input and displays them at the touch of a button. Data-hold mode freezes both display readings until you reset. High-contrast 3²/₃ digit LCD has indicators for all measuring units, operating modes and low battery alert. Full autoranging with manual up and down override. Measures to 1000 volts DC, 750 volts AC (accurate from 45 Hz to 10 kHz). AC/DC current to 10 amps. Resistance to 30 megohms. Input impedance: 10 megohms on DCV/ACV ranges, more than 100 megohms on DC 300 mV range. Dual detented carrying handle doubles as a stand. 2¹¹/₁₆ x 8 x 4³/₄". Fused and overload protected. Includes test leads. Requires 4 "C" batteries.
22-195 .... **£79.95**

Digital Logic Probe And Pulser... Speed Up TTL/LS And CMOS Testing

Digital Logic Probe. Colour-coded LEDs indicate high, low or pulsed logic states (up to 10 MHz). Simultaneous tone output frees your eyes for faster testing. Has switches for normal or pulse modes. CMOS or TTl/LS testing. Input impedance 100k ohms. Minimum detectable pulse width: 50 ns. Operates from 4.7 to 15 VDC. **22-303** **£14.95**

Digital Logic Pulser. Together, the pulser and probe make an effective diagnostic team for testing today's digital circuits. Produces single 5 μs pulse or a continuous 5 Hz pulse train at the push of a button. Features overload protection and low output impedance. Operates from 4.7 to 15 VDC.
22-304 .... **£16.95**

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01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Master Series
AMB15 BBC MASTER Foundation computer 128K .... £435 (a)
AMB12 BBC MASTER Econet computer 128K (only ANFS) .... £348 (a)
AMC06 Turbo (65C102) Expansion Module .... £87 (b)
ADF13 Rom Cartridge .... £13 (d)
ADF10 Econet Module .... £49 (c)
ADJ22 Ref. Manual Part I .... £14.50 (c)
ADJ23 Ref. Manual Part II .... £14.50 (c)
ADJ24 Advanced Ref. Manual .... £19.50 (c)

ACORN ADD-ON PRODUCTS
Z80 2nd Processor .... £329 (a)
6502 2nd Processor .... £162 (b)
Multiform Z80 2nd Processor .... £299 (b)
Acorn Teletext Adaptor .... £125 (b)
Acorn IEEE Interface .... £278 (a)

UPGRADE KITS
1770 DFS Upgrade for Model B £43.50 (d)
Dual Disc Controller Board for Model B Incl. 1770 controller .... £35 (c)
1.2 OS ROM .... £7.50 (d)
DNFS ROM .... £17.50 (d)
ADFS Rom (for B with 1770 DFS & B Plus .... £26 (d)
64K Upgrade Kit for B Plus .... £35 (d)

ECONET ACCESSORIES
Econet Starter Kit .... £85 (d)
Econet Socket Set .... £34 (c)
Econet Bridge .... £174 (b)
File Server Level 1 .... £75 (d)
File Server Level II .... £210 (d)
Printer Server Rom .... £41 (d)
10 Station Lead set .... £26 (c)
Adv. Econet User Guide .... £10 (d)

COMMUNICATIONS ROMS
Termulator .... £25 (d)
Communicator .... £49 (d)
Commstar .... £28 (d)
DATABEEB .... £24 (d)

BBC FIRMWARE & SOFTWARE
Database Management Systems, Word Processors, Languages, Spreadsheets, Utilities
ZFP .... £229 (a)
TZDP 240 ZEP 100 with Technomatic PDP800P dual drive with built in monitor stand .... £469 (a)
For full details on the wide range of above packages please write to us.

TORCH UNICORN products including the IBM Compatible GRADUATE in stock
For detailed specification or information on our comprehensive BBC range please write to us.

DISC DRIVES

These are fully cased and wired drives with slim line high quality mechanisms. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. All 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

PD800P (2 × 400K/2 × 640K 40/80T DS) with built in monitor stand .... £249 (a)
PD800P (2 × 400K/2 × 640K 40/80T DS) .... £269 (a)
TS400 1 × 400K/1 × 640K 40/80T DS .... £109 (b)
PS400 with psu 1 × 400K/1 × 640K 40/80T DS .... £129 (b)

3.5" DRIVES
1 × 400K/1 × 640K 80T DS TS35 1 .... £109 (b)
PS35 1 with psu .... £124 (b)
2 × 400K/1 × 640K 80T DS TD35 2 .... £199 (b)
PD35 2 with psu .... £219 (b)

3M FLOPPY DISCS

High quality discs that offer a reliable error free performance for life. Each disc is individually tested and guaranteed for life. Ten discs are supplied in a sturdy cardboard box.

5¼" DISCS
40 SS DD £10:50 (d) | 40T DS DD £12:75 (d)
80T SS DD £14.75 (d) | 80T SS DD £16:00 (d)

3½" DISCS
80T SS DD £18 (d)
80T DS DD £25 (d)

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives... 3½" £16 (d), 5¼" £14.50 (d)
Single Disc Cable .... £6 (d)
10 Disc Library Case .... £1.80 (c)
40 Disc Lockable Box .... £14 (c)
Dual Disc Cable .... £8.50 (d)
30 Disc Case .... £6 (c)
100 Disc Lockable Box .... £19 (c)

PRINTERS

EPSON
LX-80NLQ .... £195 (a)
Optional Tractor Feed .... £20 (c)
FX85 (80col) NLQ 8K RAM .... £315 (a)
FX105 (136col) .... £449 (a)
JX90 4 colour printer .... £420 (a)
LQ800 (80col) .... £495 (a)
LQ1000 .... £729 (a)
LQ1500 (136col) 2K buffer .... £875 (a)
LQ1500 (136col) 32K buffer .... £950 (a)
Integrex Colour Printer .... £549 (a)

PLOTTERS
Epson H180: A4 4 colour Plotter .... £345 (a)

TAXAN
KP810 80 Col NLQ £220
KP910 156 Vol NLQ .... £379 (a)
JUKI 6100 Daisy Wheel .... £289 (a)
HR15LX (Serial) .... £285 (a)
HR15LX (Serial) .... £365 (a)

Paper:
2000 Sheets Fanfold:
9.5" x 11" .... £13 (b)
14.5" x 11" .... £18.50 (b)
Labels: (per 1000)
3.5" x 17/16" Single row .... £5.25 (d)
27/16" x 17/16" Triple row .... £5.00 (d)

ACCESSORIES

EPSON
FX plus sheet feeder .... £129.00 (b)
LX80 Sheet feeder .... £49.00 (b)
Paper Roll Holder .... £17.00 (d)
FX80 Tractor attachment .... £37.00 (c)
Interfaces: 8143 RS232 .... £28.00 (c)
8148 RS232 + 2K .... £57.00 (c)
8132 Apple II .... £80.00 (c)
8165 IEEE + cable .... £65.00 (c)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX/MX80 .... £5.00 (d)
RX/FX/MX100 .... £10.00 (d)
LX80 .... £6.00 (d)
Spare pens for H180 .... £7.50/set (d)
FX80 Tractor Attachment £37 (c)

KAGA TAXAN
RS232 Interface + 2K Buffer .... £65 (c)
Ribbon KP810/910 .... £6.00 (d)

JUKI:
RS232 Interface .... £65 (c)
Spare Daisy Wheel .... £14.00 (d)
Ribbon .... £2.50 (d)
Sheet Feeder .... £182 (a)
Tractor Feed Attachment .... £129 (a)

BROTHER HR15:
Sheet Feeder .... £189 (a)
Tractor Feeder .... £99 (a)
Ribbons Carbon or Nylon .... £4.50 (d)
Red Correction Ribbon .... £2.00 (d)

BBC Printer Lead:
Parallel (42") .... £7.00 (d)
Serial .... £7.00 (d)
Printer Leads can be supplied to any length.

MICROVITEC

All 14" monitors now available in plastic or metal cases, please specify your requirement.

14" RGB
1431 Std Res .... £179 (a)
1451 Med Res .... £229 (a)
1441 Hi Res .... £375 (a)

14" RGB with PAL & Audio
1431 AP Std Res .... £199 (a)
1451 AP Med Res .... £275 (a)

Swivel Base for Plastic 14" Microvitecs .... £20 (c)

20" RGB with PAL & Audio
2030CS Std Res .... £380 (a)
2040CS Hi Res .... £685 (a)

TAXAN 12" RGB

SUPERVISION III with amber/green option .... £330 (a)
MITSUBISHI XC1404 14" RGB Med Res IBM & BBC Compatible ... £229 (a)

MONOCHROME MONITORS:

TAXAN KX1201G Hi Res 12" Etched Green Screen .... £90 (a)
TAXAN KX1203A Hi Res 12" Etched Amber Screen .... £105 (a)
PHILIPS BM7502 12" Hi Res Green Screen .... £75 (a)
PHILIPS BM7522 12" Hi Res Amber Screen .... £79 (a)
Swivel Base for Kaga Monochrome fitted with Digital Clock .... £21 (c)

MODEMS

— All modems listed below are BT approved

SPECIAL OFFER

MIRACLE 3000:
A new range of microprocessor based modems offering of upto 2400 baud, full duplex. Features include 'HAYES' protocol compatibility, auto answer, auto dial, speed buffering, printer port, data security option etc. Mains powered.
WS3000 V2123 (V21 & V23) .... £295 (b)
WS3000 V22 (as above plus 1200 baud full duplex) .... £495 (b)
WS3000 V22bis2400 (as above plus 2400 baud full duplex) .... £650 (b)

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. WS2000 £102 (b)

GEC DATACHAT 1223:
BABT approved modem complying with CCITT V23 standard. Supplied with software .... £75 (b)
Data Cables for above modems available for most computers.

SPECIAL OFFER

2764-25 .... £2.00
27128-25 .... £2.50
6264LP-15 .... £3.40

ATTENTION

All prices in this double page advertisement are subject to change without notice.
ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

Serial Test Cable
Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end using a 10 way switch making it possible to produce almost any cable configuration on site.
Available as M/M or M/F £24.75 (d)

Serial Mini Patch Box
Allows an easy method to reconfigure pin functions without rewiring the cable assy.
Jumpers can be used and reused. £22 (d)

Serial Mini Test
Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
Connects in Line. £22.50 (d)

GANG OF EIGHT
INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. £395(b).

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II .... £195(b)
Adaptor for 2764/2564. £25.00(c)

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... £47 (c)
UV1T as above but with a timer .... £59 (c)
UV140 erases up to 14 eproms at a time .... £88 (b)
UV141 as above but with a timer .... £88 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS
No of Ways

	9	15	25	37
MALE:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

TEXTOOL ZIF
SOCKETS 24-pin £7.50
28-pin £9.00 40-pin £12

EDGE CONNECTORS

	0.1"	0.156"
2 × 6-way (commodore)	—	300p
2 × 10-way	150p	—
2 × 12-way (vic 20)	—	350p
2 × 18-way	—	140p
2 × 23-way (ZX81)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	—
2 × 36-way	250p	—
1 × 43-way	260p	—
2 × 22-way	190p	—
2 × 43-way	395p	—
1 × 77-way	400p	500p
2 × 50-way (S100conn)	600p	—

EURO CONNECTORS

DIN 41612	Plug	Socket
2 × 32 way St Pin	230p	275p
2 × 32 way Ang Pin	275p	320p
3 × 32 way St Pin	260p	300p
3 × 32 way Ang Pin	375p	400p
IDC Skt A + B		400p
IDC Skt A + C		400p

For 2 × 32 way please specify spacing (A + B, A + C).

MISC CONNS
21 pin Scart Connector 200p
8 pin Video Connector 200p

AMPHENOL CONNECTORS

	Solder	ZDC
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p 36way 750p

GENDER CHANGERS
25 way D type
Male to Male £10
Male to Female £10
Female to Female £10

RS 232 JUMPERS
(25 way D)
24" Single end Male £5.00
24" Single end Female £5.25
24" Female Female £10.00
24" Male Male £9.50
24" Male Female £9.50

4-way 90p 6-way 105p
8-way 120p 10-way 140p

RIBBON
(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

TECHNOLINE VIEWDATA SYSTEM

Using 'Prestel' type protocols for information and orders phone 01-450 9764. 24 hour service, 7 days a week.

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	40p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	80p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74164	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74L893	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/	829/140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	80p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	£8
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS783	£21

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S85	300p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	300p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	40p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	60p
4053	60p
4504	60p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	90p
4096	90p
4097	270p
4098	75p
4099	90p
4501	38p
4502	55p
4503	36p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	260p
14490	420p
14495	450p
14500	850p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40163	100p
40173/4067	120p
40174	100p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1100p
AM7910DC	£25
AN103	320p
AY-1-5050	100p
AY-3-1350	450p
AY-3-8910	450p
AY-3-8912	500p
CA3019A	100p
CA3028A	110p
CA3048	70p
CA3059	325p
CA3080	180p
CA3080E	78p
CA3086	40p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	130p
CA3140E	48p
CA3140T	100p
CA3160E	90p
CA3161E	200p
CA3162E	600p
CA3189E	270p
CA3240E	180p
CA3280G	270p
D7002	£8
DAC1408-8	300p
DAC0800	300p
DAC0808	300p
DG308	300p
HA1366	180p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	400p
ICM7216B	£22
ICM7217	750p
ICM7555	90p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	350p
LF347	120p
LF351	60p
LF353	90p
LF355	90p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	80p
LM318	150p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	40p
LM348	60p
LM358P	50p
LM377	300p
LM380N-8	150p
LM380	150p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	180p
LM392H	110p
LM393	100p
LM394CH	400p
LM709	38p
LM710	48p
LM711	100p
LM723	60p
LM725CN	400p
LM733	65p
LM741	22p
LM747	70p
LM748	30p
LM1011	480p
LM1014	180p
LM1801	300p
LM1830	290p
LM1871	300p
LM1872	300p
LM1886	580p
LM1889	480p
LM2917	300p
LM3302	80p
LM3900	60p
LM3909	100p
LM3911	180p
LM3914	350p
LM3915	340p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	450p
MB3712	200p
MC1310P	150p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	200p
MC3401	70p
MC3403	60p
MF10CN	400p
MK50240	800p
MK50398	750p
ML920	500p
ML922	400p
MM6221A	300p
NE531	130p
NE544	190p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	80p
NE5532P	150p
NE5533P	180p
NE55334P	120p
NE5534AP	150p
OP-07EP	500p
PLL02A	500p
RC4136	55p
RC4151	200p
RC4558	55p
S566B	220p
SAA1900	£18
SFF96364	800p
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	700p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	180p
TDA2004	240p
TDA2008	320p
TDA2020	320p
TDA2030	280p
TDA2593	500p
TDA3810	750p
TDA7000	380p
TEA1002	700p
TL061CP	40p
TL062	90p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	36p
TL082	56p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
UA759	320p
UA2240	150p
UAA170	170p
UCN4801A	550p
ULN2003A	75p
ULN2004A	75p
ULN2068	290p
ULN2802	180p
ULN2803	180p
ULN2804	180p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	500p
XR210	400p
XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	100p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E8	225p
ZN447E	£9.50
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	680p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A		+ve		+ve	
5V		7805	45p	7905	50p
6V		7806	50p	7906	50p
18V		7808	50p	7908	50p
12V		7812	45p	7912	50p
15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	250p
78H05KC	5A 5V	575p
78H12	5A 12V	750p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T	3A+VAR	225p
LM350T	5A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	650
79HGKC	5A+VAR	675p
78GUIC	1A+VAR	225p
79GUIC	1A+VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	400p
6502A	450p
65C02A	£15
6800	250p
6802	300p
6809	650p
6809E	£8
68B09	£10
68B09E	£12
68000-LB	£38
8035	350p
8039	420p
80C39	700p
8080A	420p
8085A	300p
80C85A	900p
8086	£22
8088	1750p
8741	£12
8748	£16
TMS9980	£14.50
TMS9995	£12
Z80	250p
Z80A	280p
Z80B	550p
Z80CMOS	750p
(CMOS Z80)	

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	480p
6551	550p
6821	150p
68B21	300p
6829	£12.50
6840	375p
68B40	800p
6850	180p
68B50	300p
6852	250p
6854	650p
68B54	800p
6875	500p
8154	850p
8155	380p
8156	380p
8205	225p
8212	200p
8216	160p
8224	300p
8226	425p
8228	550p
8243	260p
8250	950p
8251A	325p
8253C-5	350p
8255AC-5	320p
8256	£18
8257C-5	400p
8259C-5	400p
8275	£29
8279	£11
8282	300p
8284	460p
8287	380p
8288D	950p
8755A	£18
TMS9901	£14
TMS9901	500p
TMS9902	500p
TMS9911	£18
TMS9914	£14
Z80PIO	240p
Z80APIO	250p
Z80BPIO	500p
Z80CTC	250p
Z80ACTC	275p
Z80BCTC	500p
Z80DART	650p
Z80ADART	700p
TMS4500	£14
TMS9901	500p
TMS9902	800p
Z80DMA	700p
Z80ADMA	750p
Z80ASIO-0/1/2 /9	700p
30BP10	500p
30BCTC	500p
Z80DART	800p

Electrically programmable and erasable PROMS

2816-30	£15
9306	450p

EPROMs

2516+5v	350p
2516-35	550p
2532	450p
2532-30	550p
2564	£11
2708	400p
2716+5v	350p
2716-35	550p
2732	450p
2732A-2	900p
2732A-35	£7
2764-25	290p
27C64-25	£10
27128-25	250p
27128-30	800p
27256	£5
TMS2716	500p

CRT CONTROLLER

CRT5027	£18
CRT5037	£12
CRT6545	£8
EF9364	£8
EF9365	£25
EF9366	£25
EF9367	£38
MC6845	650p
MC6845SP	650p
MC6847	650p
SFF96364	£8
TMS9918	£15
TMS9928	£10
TMS9929	£10

INTERFACE ICs

AD558CJ	775p
AD561J	£20
AD7581	£15
ADC0808	1100p
AM25S10	380p
AM25LS2521	350p
AM25LS2538	380p
AM26LS31	120p
AM26LS32	120p
D7002	£8
DAC80-CB1-V	£28
DM8131	600p
DP8304	350p
DS3691	350p
DS8830	140p
DS8831	150p
DS8832	150p
DS8833	225p
DS8835	280p
DS8836	150p
DS8838	225p
MC1488	60p
MC1489	60p
MC3446	250p
MC3459	450p
MC3470	475p
MC3480	850p
MC3418L	990p
MC3486	250p
MC3487	250p
MC4024	550p
MC4044	550p
MC14411	850p
MC14412	750p
ULN2003	78p
ULN2004A	75p
ULN2068	290p
ULN2802	180p
ULN2803	180p
ULN2804	180p
75107	90p
75108	90p
75109	120p
75110	90p
75112	160p
75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	500p
75161	350p
75162	400p
75172	300p
75182	90p
75188	60p
75189	60p
75365	150p
75450	50p
75451	50p
75452	70p
75453	70p
75454	70p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	120p
8T96	120p
8T97	120p
8T98	120p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
88LS120	300p
9602	300p
9636A	180p
9637AP	160p
9638	180p
ZN426E8	350p
ZN428E8	350p
ZN427E	600p
ZN428E8	450p
ZN429E	210p
ZN447E	800p

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2016-150	400p
2101	400p
2102	250p
2107B	500p
2111A-35	400p
2114-3L	250p
2147	400p
4116-15	200p
4416-15	300p
4532-20	250p
4816AP-3	300p
5101	370p
5514	450p
5516	550p
6116P-3	350p
6116LP-3	400p
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6264LP-15	340p
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74S189	225p
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100 KHz	400p
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Freq in MHz	
1.8432	225p
2.00	255p
2.45760	200p
2.5	250p
2.662	250p
3.12MHz	175p
10.00MHz	175p
3.276	150p
3.5795	100p
4.00	140p
4.194	150p
4.43	100p
4.608	250p
4.9152	200p
5.000	150p
6.00	140p
17.734	200p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.50	250p
10.70	150p
11.00	300p
12.00	150p
14.00	175p
14.318	160p
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20 pin	45p		

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14 pin	10p	24 pin	24p
16 pin	11p	28 pin	26p
18 pin	18p	40 pin	30p
20 pin	18p		

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8 pin	30p	22 pin	75p
14 pin	30p	24 pin	75p
16 pin	42p	28 pin	100p
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OPTO-ELECTRONICS

		MAN4640	200p
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MAN71/DL707	100p	MAN8910	120p
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TIL32	75p	TIL78	75p
TIL31A	120p	TIL81	120p
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9368	350p

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Dear Sir,

May I commend you for bringing the nuclear debate into the columns of Practical Electronics, while expressing disappointment at the poor quality of the United Kingdom Atomic Energy Authority's contribution.

Here was a golden opportunity to put the nuclear case forward to an informed readership which would be able to grasp the science behind the issue.

Instead, William McMillan took nearly a page to tell us nothing and put forward the bizarre view that 2,500 deaths at Bhopal may be beneficial in producing 'positive information' to improve chemical industry safety in the future.

McMillan studiously avoided the problem areas of nuclear waste, cost and construction difficulties, the unreliability of some reactors, leaks and the other spectres raised by the anti-nuclear lobby.

His 'case' can be summarised in one sentence: A fifth of our electricity is nuclear; demand for electricity is rising; other countries use nuclear power; death, destruction and disaster make the future safer for the survivors and don't give children and pensioners matches to play with if you've got a gas cooker.

I believe a case can be made for nuclear power within the context of a comprehensive energy policy, but McMillan's slipshod and uninformative advocacy has not increased my confidence in that view.

Yours faithfully,

Robert G. Rae

Dear Sir,

After reading your editorial in P.E. August 86 I would like to agree with you wholeheartedly regarding your statement 'we have a collective responsibility to promote, educate and stimulate interest in the subjects which so dramatically affect our lives and the world in which we live.'

This letter is simply to let you know that as a Lecturer in the South Bradford Work Practice Unit (which opens its doors to approx. 1400 fourth-formers per year in the Bradford area – each youngster normally attending for one week) I believe this responsibility presents an exciting challenge. If we can offer new technology in such a package as to be attractive to the younger generation and open their eyes sufficiently for them to want to be part of this, then Britain may once again be amongst the world leaders in science and technology.

Within the Work Practice Unit I have attempted to achieve this by presenting electronics and robotics as an exciting challenge. The most rewarding aspect being when a youngster with little or no previous knowledge and in many cases a fear of technology, requests more information on buying components, building circuits and using their home computer to control robots (better than playing games?). I am pleased to be in a position which enables my personal enthusiasm for electronics and new technology to generate this interest in others. This especially applies when there are magazines such as yours around providing the backup and in keeping my own knowledge up to date.

I am not sure if you are aware of the existence of Work Practice Units in Bradford, but should you express interest as to the range of our activities in the South Bradford unit I would be only too willing to supply this information (South Bradford Work Practice Unit, Bradford & Ilkley Community College, Smith Street Buildings, Bradford BD7 1AY).

Lawrence Hamburg

Dear Sir,

I am the owner of an MTX 512 micro manufactured by Memotect Ltd. I have also been getting your electronics magazine since 1981 but have *never* seen any interfacing projects specifically for this computer.

Most are either for the BBC or Spectrum owners and although they are in the majority, are not the only computer owners. There are almost 4000 MTX owners, and since the price was lowered to £69.95 for the 32K version 'MTX 500' and £119.95 for the 64K version there will soon be a lot more MTX owners.

Although it is often possible to adapt many of your published interfaces for my MTX the software is the most awkward and almost impossible part (in particular if it is for the BBC micro).

Therefore would it be possible to include the MTX computers in the 'PE Hobby Bus' project before I lose faith in your magazine altogether. One very important project for the hobby bus which would also be of interest to radio amateurs like myself would be an RTTY (Radio Teletype) unit with programmable baud rates, tone shifts and also different word lengths, ie 5 bit BAUDAUT or 8 bit ASCI etc.

Yours sincerely,

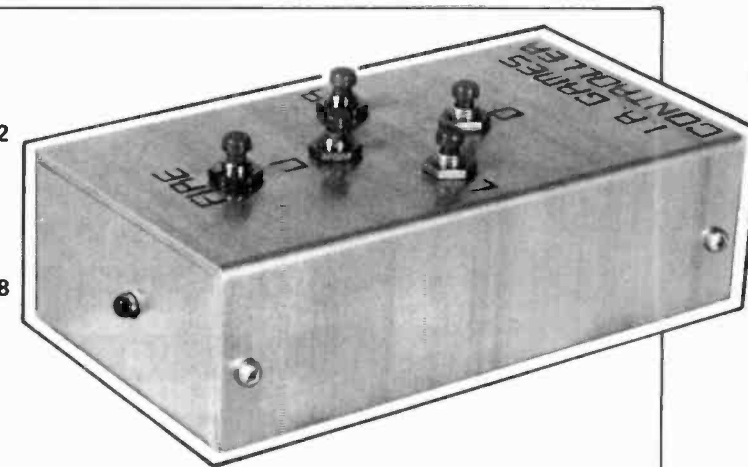
James J. McCarthy

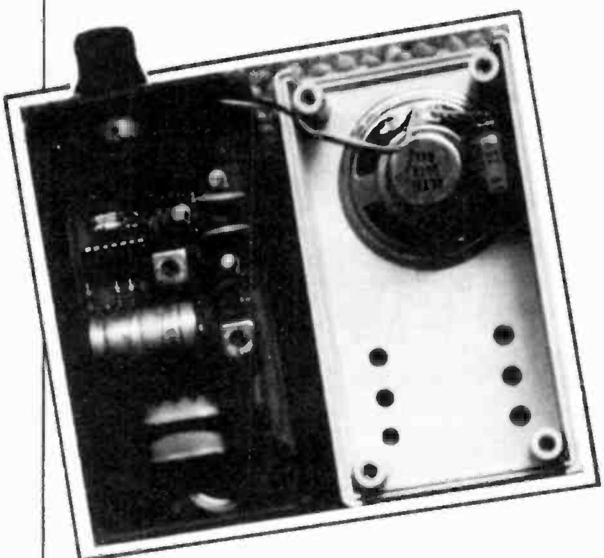
NEWS AND REVIEWS

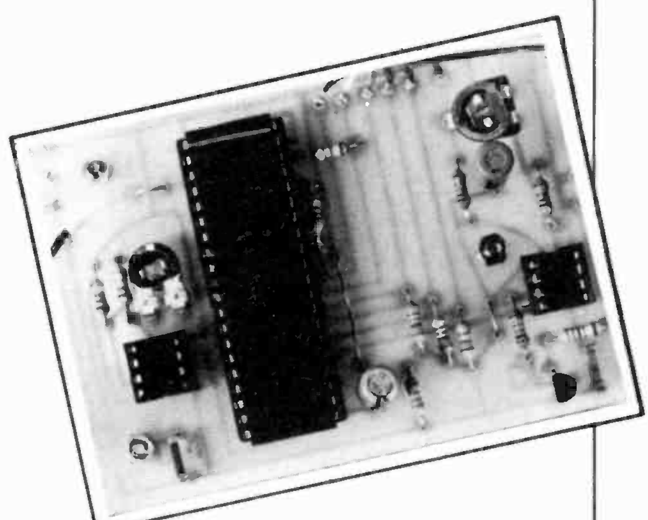
REGULAR FEATURES

PE SERVICES

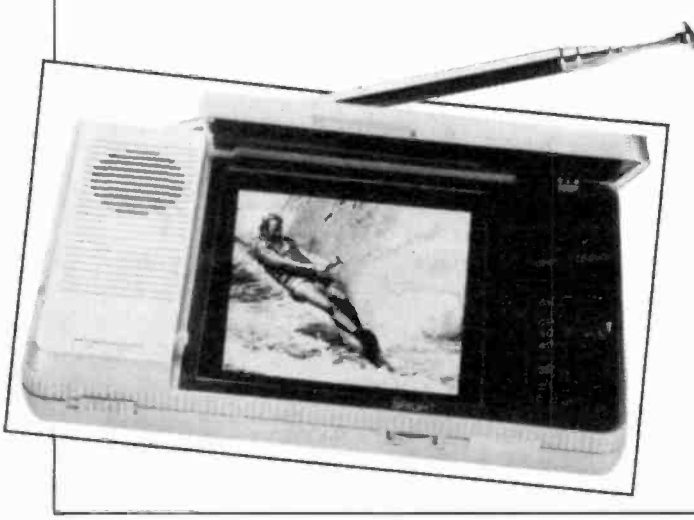
PROJECTS TO BUILD







DESIGN AND TECHNOLOGY



KIT AND PCB SERVICE

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Frequency Changer	SET 172	£40.06	£45.56
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Fuzz (Smooth)	SET 209F	£15.08	£19.58
Guitar Modulo	SET 196	£19.06	£23.56
Guitar Overdrive	SET 56	£23.54	£29.04
Hand Clapper	SET 197	£22.19	£26.69
Multi-Processor	SET 189	£53.53	£61.33
Reverb – Stereo	SET 203	£32.04	£36.54
Rhythm Generator	SET 240	£54.49	£59.99
Ring Mod (Simple)	SET 179	£19.40	£23.90
Storm Effects	SET 154	£18.10	£23.60
Tom-Tom Synth	SET 190	£14.87	£19.37
Tremolo	SET 136	£11.12	£15.62
Vibrato	SET 137	£23.55	£29.05
Wah (Auto & Manual)	SET 140	£18.86	£24.36
Wah (Triggered)	SET 58	£14.34	£18.84

CONTROLLERS

Bass Boost	SET 138B	£9.12	£13.62
Compander	SET 238	£18.49	£22.99
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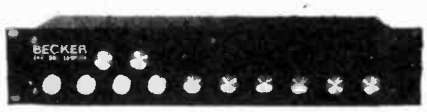
Fader (Voice Op)	SET 167	£17.72	£22.22
Graphic Equaliser	SET 217	£20.83	£25.33
Guitar To Synth	SET 173	£35.91	£41.41
Headphone Amp Mono	SET 156M	£13.57	£18.07
Headphone Amp Stereo	SET 156S	£22.15	£26.65
Hum Cut	SET 141	£12.31	£16.81
Microphone Pre-amp	SET 144	£10.43	£14.93
Mixer 4 channel Mono Simple	SET 256	£15.49	£19.99
Mock Stereo	SET 213	£19.87	£24.37
Sustain	SET 222	£20.81	£25.31
Tone Control	SET 139	£15.51	£21.01
Treble Boost	SET 138T	£9.12	£13.62
Vocoder	SET 152	£72.15	£79.95
Vodalek Robot Voice	SET 155	£13.81	£18.31

OTHERS

Metronome	SET 143	£16.85	£21.35
Roger (2-Gong)	SET 126	£12.13	£16.63
Roger (Single)	SET 127	£9.41	£13.91
Sirens (Drum Trig)	SET 199	£19.25	£23.75
Sirens (Multi)	SET 151	£16.66	£21.16
Voice Op Switch	SET 123	£15.91	£20.41



PE & EE KITS

		Unboxed	Boxed
Chorus Flanger (PE*)	SET 235	£54.49	£59.99
Cybervox (EE*)	SET 28	£39.26	£44.76
Disco Light Control (PE*)	SET 245F	£57.00	£62.50
Echo-Reverb (PE*)	SET 128	£52.16	£57.66
Mixer 4ch Mono (PE*)	SET 229M	£44.45	£49.95
Mixer 4ch Stereo (PE*)	SET 229S	£82.15	£89.95
Noise Gate (PE*)	SET 227	£22.11	£26.61
Phaser (PE*)	SET 226	£36.86	£42.36
Reverb – Mono (EE*)	SET 232	£22.85	£2.35
Ring Modulator (PE*)	SET 231	£40.08	£45.58
Signal Gen (PE*)	SET 233	£41.46	£46.96
Thunder & Lightning (PE*)	SET 250T	£26.00	£29.50
Wind & Rain Storm (PE*)	SET 250W	£26.00	£29.50

* = Kit as Published

COMPUTER PROJECTS

'Scope Simulator (PE*)	SET 247	£39.00	£44.50
Dig Delay & Mcs (PE*)	SET 234	£162.00	£198.50
Mini Sampler (PE*)	SET 246	£69.50	£75.00
Rhythm Gen (Computer)	SET 185	£29.14	£34.64
Synth to Computer	SET 184	£21.65	£26.15
Chip tester – 24 pin (PE*)	SET 258F	£35.80	£39.30
Chip tester – 16 pin (PE*)	SET 258S	£29.00	£32.50
Mini Music Tuner (EE*)	SET 259	£19.00	£22.50
Signal Tracer (EE*)	SET 261	P.O.A.	P.O.A.

FOOT PEDALS

Linkafex Chorus	SET 204	£37.26	£42.96
Linkafex Delay	SET 206	£36.39	£42.09
Linkafex Equaliser	SET 216	£19.73	£25.43
Linkafex Flanger	SET 207	£29.22	£34.92
Linkafex Fuzz	SET 209L	£17.54	£23.24
Linkafex Modulo	SET 211	£19.71	£25.41
Linkafex Overdrive	SET 215	£19.43	£25.13
Linkafex Phaser	SET 205	£28.68	£34.38
Linkafex Sustain	SET 223	£20.77	£26.47

GEIGER COUNTERS

PE Geiger, audio & meter output – Unit 264

with heavy duty box as published	£69.50
with normal black steel box	£59.50
without box	£55.00
POCKET Geiger, LED readout – SET 271	£39.50
READY BUILT (new design) sound, meter and computer output – SET TZ-272	£75.50

PCB SERVICE

Chorus Flanger (Jan 85) PCBS 235A-B	(SET)	£9.06
Dig Delay-MCS (June 85) PCBS 234A-E	(SET)	£29.50
Disco Light (Dec 85) PCBS 245A-B	(SET)	£7.17
Echo-Reverb (Sep 84) PCBS 218S-B	(SET)	£8.14
Mini Sampler (Jun 85) PCBS 234A-b	(SET)	£11.00
Mixer (Jan 86) PCB 229A	(EACH)	£3.10
Noise Gate (May 85) PCB 227A		£4.35
Phaser (Oct 84) PCBS 226A-B	(SET)	£7.44
Ring Mod (Dec 84) PCB 231A		£5.27
Scope Simul (Dec 85) PCB 247A		£3.33
Signal Gen (Feb 85) PCB 233A		£4.53
Storm Effects (Jun 86) PCB 250A	(EACH)	£6.07
Geiger Counter (PE Aug 86)		£4.53
Chip tester (Aug 86)		£6.55

PARTS & CATALOGUE

Boxes – Linkafex Robust Diecast, SET 234 19 inch steel rack, others Black Steel & Aluminium. All kits include PCBs, parts, instructions. Free wire & solder with boxed sets. Further details in Catalogue of over 70 kits – Send 9 x 4 S.A.E. (Overseas Catalogue send £1.00 or 5 IRCS).

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Mail order, CWO, CHQ, PO, Access, Visa. Details correct at press, E&OE. Add 15% VAT. Add P&P – unboxed kits £1.00 each, SET 234 £3.50. Other boxed kits £1.50 each. PCBS add 70p total regardless of qty. Insurance 50p per £50. Overseas P&P in catalogue.

Text photocopies – DDL-MCS £1.50, others 50p each. Send large stamped envelope.

BECKER-PHONOSONICS, Dept PE6N, 8 Finucane Drive, Orpington, Kent BR5 4ED. Tel: 0689 37821.

PE SCIENCE AND TECHNOLOGY

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We regret that lengthy technical enquiries cannot be answered over the phone.

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All correspondence relating to advertisements, including classified ads, should be addressed to: **The advertisement manager, Practical Electronics, 25 Glenhurst Avenue, Bexley, Kent DA5 3HQ. Tel. (0322) 521069.**

PE Services

Practical Electronics offers a wide range of services to readers including: p.c.b.s, books, subscriptions, back numbers, and software listings. However, due to increased administration costs we can no longer provide photocopies of articles over three years old. Also the availability of back numbers is rapidly declining.

In order to avoid disappointments, in the future, we suggest that you take out a subscription. Not only will you avoid missing an issue but you will also save money and in most cases receive your copy before it is in the local newsagents.

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MY BIT AT THE BEGINNING – 4

Practical Electronics (published for 22 years) is one of the oldest 'electronics' magazines around today. Over the years there have been difficult times and much change, none more so than in recent months. PE has had two changes of editorship, a new owner, new publisher, a change of address and naturally a host of associated problems. (I'll say no more about that.)

But these are, I'm pleased to say, now behind us and it's time to look forward to the next 22 years of publishing a successful, first class electronics magazine.

In order to provide top quality editorial which caters for newcomers as well as our existing readership, I have formulated a forward schedule, for 1987, which comprises a balanced selection of articles and ensures that all future issues will contain something of interest to everyone. As well as our now famous constructional projects, there will be, each month, a broad range of special features which cover technology, design, experimentation, and home micro interfacing. Also in order to provide more extensive back up, our p.c.b. service has been improved to include printed p.c.b. patterns, the book service will be providing a much wider range of titles and we will have more exclusive offers such as our pocket multimeter which is proving extremely popular.

As British Rail would say, "We're getting there". We just hope to get there faster!

Richard Barron

DID YOU KNOW?

Practical Electronics has been around for 22 years this month. Happy Birthday!

Amstrad have launched a new range of IBM PC Compatible computers – The cheapest being around only £399.

Since the mid-1970's the world market for electronic components has risen at an average annual rate of 12 percent. However Western Europes share of the total market is only around 20 percent.

NEXT MONTH

In the December issue of PE we have a host of special features and special offers and we're giving away a catalogue worth 70p- FREE! (See page 37 for details)

OUR DECEMBER 1986 ISSUE WILL BE ON SALE FRIDAY, 7th November 1986

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WHAT'S NEW . . .

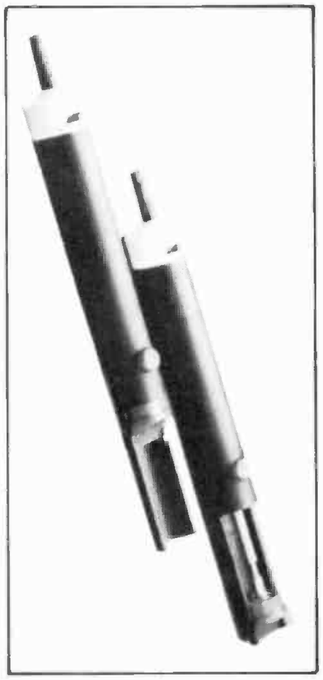
POINTS ARISING

GEIGER COUNTER AUGUST 1986
In Fig.5, C15 and C16 were marked as R15 and R16. C28 was shown the wrong way round on the p.c.b. layout. C19 and C20 should be shown connected to ground not REF.

PERCUSSION SYNTHESISER OCTOBER 1986
On Fig.2 IClb pin 5 should read pin 10 and C10 should be 100u, not 100p.

Pocket Geiger Counter

A miniature pocket sized Geiger Counter has been released by Becker Phonosonics. Known as the Geiger-mite, it is battery operated, and measures only 40 x 56 x 85mm. The primary readout is by an l.e.d. indicator that flashes in response to each nuclear radiation impact. Additionally, it has an output suitable for use with a crystal earpiece for audio monitoring. Its output is also compatible with TTL and computer inputs for impact count analysis. Using the sensitive ZP1310 Geiger-Muller tube it is the infant relative of the Geiger counter recently published in Practical Electronics. The price is only £46.92, including VAT and postage and is available in readily assembled kit form, with full constructional details, solely from Phonosonics.



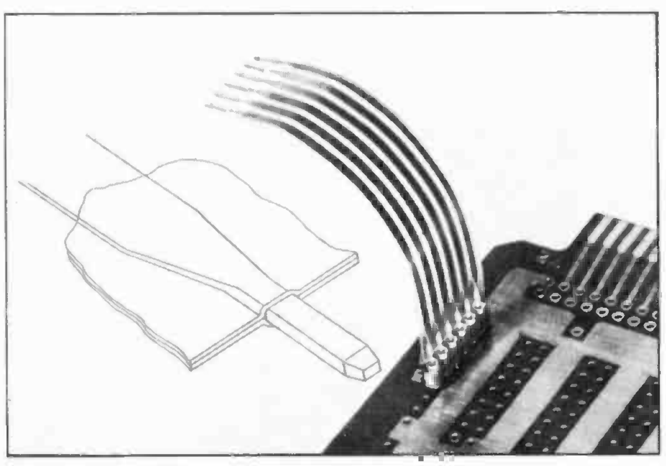
Flat Cable

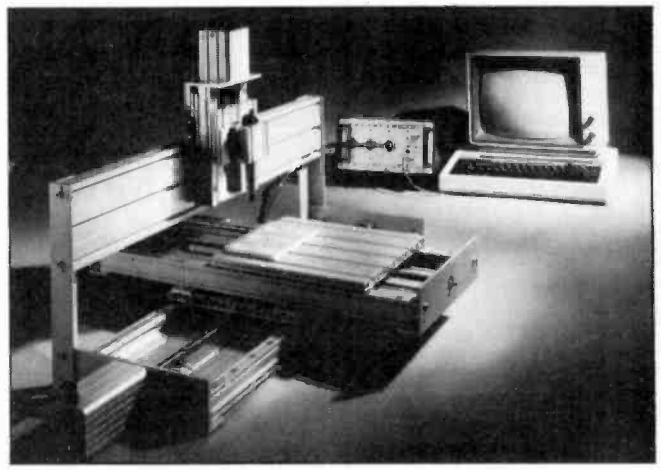
A new series of flexible jumper cables has been introduced by Aries Electronics. The solid pin and transition from solid to flat conductors mean that the conductors are flexible but the pin remains sturdy.

DeciFlex jumpers are available in one, two or three inch lengths.

Pump Relaunch

OK Industries, who have an extensive range of antistatic products, have relaunched their DP3 static-free desoldering pump. Manufactured in line with Ul and MIL standards, it has an easy to clean and change bayonet type conductive tip and sells for just £2.95 inc VAT.





Alarming

Riscomp Limited announce an addition to their range of security products; a new control panel with a difference. Known as the CA1382, the unit provides an extensive range of facilities, and yet its operation has been simplified to the extent that it may be used by all members of the family without considerable instruction. A major contribution to the simplified operation is the automatic system testing which is carried out every time the unit is switched on, with an l.e.d. indicating correct operation. Additionally, the entire operation is controlled by a single key operated on/off switch. A built in exit & entrance buzzer provides audible warning of the unit's operation, whilst the alarm memory allows the unit to be set up without annoyance to the neighbours. Provision for sounding the alarm by means of a personal attack switch, even though the unit may not be switched on, has been included. Housed in an attractive steel case, the CA1382 is available either fully built and tested or in self assembly form. In either case it is accompanied by a comprehensive data sheet which simplifies its installation. Price of self assembly unit: £39.95 + VAT., or fully built & tested: £44.95 + VAT.

More Midi

Binatone International Ltd., the UK's largest privately owned consumer electronics company has recently launched a new midi system. As with most of their products, it offers a wide range of features at an affordable price.

Features include 5-band graphic equaliser, 3-band tuner, headphone and mic sockets, matching speakers and is CD compatible.

Simple As XYZ

Leewood Developments Ltd have produced a range of practical XYZ tables which have real applications in a variety of environments. They can be programmed with any computer or terminal having an RS 232 or 423 capability.

The standard table has a movement of 400mm x 250mm x 60mm making it useful for such tasks as drilling p.c.b.s., small component assembly, routing, cutting or merely as an educational tool. Its own interface contains a microprocessor and operating system ROMs with 2 x 8K RAM for 600 blocks of instruction storage.

Resolution is 200 steps per millimetre, rest to datum point within 1/100mm and interpolation on X and Y axis as standard.

Head Adjustments

Electronic Brokers now supply the Grundig VG1000 video generator which is specially designed for measurement and testing applications. One of its main features is a special pattern output for video recorder testing which permits precise head adjustments to be made.

Other features include digital circle production with permanent memory and zero drift, multi-burst, modulated scale, right and left screen limiting and 75 ohm outputs for colour carrier, vertical blank and sync outputs.

WHAT'S NEW . . .

SM Transformers

Avel-Lindberg have now added what are claimed (not confirmed) to be the first power supply transformers to the ever growing choice of surface mounted devices (SMD's) available to engineers engaged in SMT/p.c.b. design. The Avel type OB/SM flat-pack transformers span a range from 1.8 to 24VA (1.8, 3.5, 5, 8, 9, 12, 15, 19, 24VA). These small rectangular, flat transformers are tested with a one minute 5000V a.c. Hipot test in compliance with IEC 742, VDE 0551.

Dual 50/60Hz primary windings can be series or parallel connected for 120V or 240V operation; and dual secondary windings give 5, 6, 8, 9, 12, 15 and 18Vr.m.s. in parallel and 10, 12, 16, 18, 24, 30 and 36Vr.m.s. when series connected. The non-concentric twin primary and secondary windings are wound on separate bobbins which gives maximum isolation and low inter-winding capacitance. The core construction and winding configuration achieve a near toroidal characteristic with low radiated noise, high efficiency and low temperature rise.

X-Technology

Hitachi have introduced a new high contrast, wide viewing angle LCD that offers an improvement of over 100% in visibility when compared to normal LCD's. This dramatic improvement is achieved using Hitachi's new X-Technology and high duty ratio dynamic drive techniques.

At ten inches long the new LCD – the LM585X – is screen size compatible to a ten inch CRT. It has 640 x 200 pixels and an effective display area of 220 x 166 mm.

The LCD's low power consumption, coupled with the fact that it is just 12mm thick, make it ideal for portable applications in modern equipment such as pocket TV's (see our special offer).

Who Cares?

Portable phone technology has now been extended to the "Carephone". Carephones take the form of a pendant which can be worn around the neck and linked to an Answercall machine.

For the old, handicapped or ill, this new equipment from BT should prove to be very popular and potentially life-saving.

Free Modems from Micronet

Micronet have a large stock of Modems and are issuing them free of charge to members who subscribe to both Micronet and Prestel for one full year in advance.

The modems available are the VTX5000 for the Sinclair Spectrum and the Modem 2000 for the BBC.

Masterswitch

Originally designed to switch a number of signal sources, eg. computer, video recorder etc. into one TV set, the MASTERSWITCH can find a use wherever manual switching of low level radio frequency or video signals is required. Applications may be found in Amateur and CB radio, in schools and laboratories, or in conjuntion with the domesticTV installation.

Tiny Switch

What is claimed to be the smallest snap-action switch on the market has been announced by Cherry Electrical Products Ltd. Measuring only 8.2 x 2.7 x 10.6mm, Cherry's new ultra-miniature DH series occupies only 70% of the space required for a conventional micro-miniature switch.

Ideal for use in miniature equipment applications e.g. consumer electronics, pocket recorders, wrist watches, audio and optical equipment, as well as professional portable systems, the ultra-miniature DH switch weighs only 300mg. Despite its small size the DH switch can handle currents of up to 0.5Amp and is available with either silver or gold plated contacts. Current breaking capacity of the silver plated versions is 50mA to 500mA at 24VDC and 5 to 50mA for the gold plated contacts.

5V at 100A

High efficiency Victor modules now available from Powerline Electronics enable a 5 volt switched-mode power supply capable of supplying 100A to be built using only four modules.

Each module measures only 6x12 cm with a height of 12mm, yet the unusually high switching frequency of 2 MHz in this application gives power conversion efficiency levels in excess of 80%, coupled with very low ripple. Basic output accuracy is 2%, but adjustment is possible by applying a control voltage to the TRIM input.

CATALOGUE CASEBOOK

Over the last month we have received the following catalogues:

A brochure from ***Branco Tools Ltd.***, outlining their range of ***Jokari cable strippers.*** Details from Branco Tools Ltd., 7 Birchway, Prestbury, Cheshire, SK10 4BD.

Toolrange's catalogue of ***Consumables and Accessories*** from: Toolrange Ltd., Upton Road, Reading, Berks, RG3 4JA.

The ***home toolshop*** catalogue from: ***Toolmail (GMC) Ltd.***, 170 High Street, Lewes, E. Sussex. (price £1.95).

A free colour brochure on the new ***A/D co-processor*** board for the ***MultiBus*** system from: ***GE Datel UK Ltd.***, Belgrave House, Basing View, Basingstoke, Hants, RG21 2YS.

Powerlines Shortform catalogue of ***laboratory PSUs*** from: Powerline Electronics Ltd., 5 Nimrod Way, Elgar Rd., Reading, Berks.

The complete range of ***RS products*** available in the ***Electromail*** catalogue (688 pages, price £2.50) from Electromail, PO Box 33, Corby, Northants, NN17 9EL.

A new leaflet from ***Hitachi*** on their family of high speed ***single chip processors*** from: Hitachi Electronic Components. Tel: (0923) 46488.

RF Products 6-page catalogue of ***communications filters*** and multicouplers from: ***RF Products inc.***, Davis & Copewood Sts, Camden, New Jersey 08103, USA.

WHAT'S HAPPENING . . . WHAT'S TO COME . .

FIRM CONTACT

Further details of the products, services and companies mentioned in the News pages of Practical Electronics may be obtained from the following sources:

OK Industries UK Ltd, Barton Farm Industrial Estate, Chickenhall Lane, Eastleigh, S95 5RR.

Texas Instruments Ltd, Hill and Knowlton (UK) Limited, 5-11 Theobalds Road, London WC1X 8SH.

Aries Electronics, Alfred House, 127 Oatlands Drive, Weybridge, Surrey, KT13 9LB.

Electronic Brokers Limited, 140-146 Camden Street, London, NW1 9PB.

Riscomp Limited, 51 Poppy Road, Princes Risborough, Bucks HP17 9DB.

Phonosonics, 8 Finucane Drive, Orpington, Kent, BR5 4ED.

Másterpiece Products, Masterpiece Cabinets Ltd., Annscroft, Shrewsbury, SY5 8AN.

Leewood Development Ltd., Leewood Works, Upton, Huntingdon, Cambs., PE17 5YQ.

Mitsubishi Electric Corporation, Public Relations Department, 2-3 Mrunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan.

Engineering Information Department, BBC Broadcasting House, London W1A 1AA.

Matthey Electronics, Burslem, Stoke-on-Trent, ST6 3AT.

Bal Components Ltd., Bermuda Road, Nuneaton, Warwickshire, CV10 7QF.

In-car total information systems

We have heard quite a lot about in-car navigation systems over the last few months. Several companies have showed prototype designs of their systems and seem to have been able to disguise their faults and shortcomings fairly well.

One of the latest systems is a joint venture from the Mitsubushi Electric Company and the Japan Radio Company. They claim that it is the first practical automobile navigation system using satellites and it will be commercially available in 1989.

The new system is a combination of a global positioning system (GPS) and a stand alone navigational system consisting of a GPS receiver, geomagnetic sensor, speed sensor, control unit, map generator and colour CRT (Should be an l.c.d.?)

The thinking behind this combination is that conventional navigation systems cannot be accurate over a period of time because of accumulated error. Using both systems, even when a car is in a tunnel, say, and thus unable to receive satellite information, the stand-alone system takes over using information from its sensors. Mitsubushi say that *"in the future, a total information system will be developed for a more comfortable driving environment with reduced psychological burdens on the driver. It will have a computer to control a display panel and all the separate systems, such as self diagnosis, driving information, air conditioning, television, audio and and mobile phone systems. Operation, display and monitoring of these systems will be done on a CRT display".*

l.c.d Trend

The trend towards portable computers, test instruments and computers has created a massive worldwide demand for large l.c.d.s. They are getting bigger, more reliable and with the associated electronics, very easy to use. Many of the old problems associated with CRTs do not exist in l.c.d. technology. They are low voltage operated, light and now, fairly easy to produce.

Hitachi, one of the world's leading manufacturers of l.c.d.s., are introducing a powerful new controller which is software compatible with the HD6845 CRTcontroller. This allows CRT to l.c.d. conversion with the minimum of effort.

The HD6345, as it is called, provides high speed parallel data transfer allowing a high resolution display to be controlled with up to 400 x 640 pixels. In addition, it has many built-in functions such as scrolling, blinking and inversion. Obviously as the l.c.d. technology advances the implications to designers are enormous. Already in Japan, you can get a truly flat l.c.d. TV which literally hangs on the wall like a picture. The future might bring portable video phones, high resolution pocket TV's and.... You tell us.

Calculating Markets

Texas Instruments, who have had years of experience in the calculator business, now offer a solar powered calculator aimed specifically at the education market.

They see a need to make all school work more relevant, stimulating and engaging as well as encouraging practical skills and promoting real-life application of knowledge. They say, "in order to fulfil these aims the education system will need equipment which assists and excites pupils to cope with the radical changes". According to them, the TI 31 Solar is just such a machine. It's sleek, useful and comes complete with slide on carrying case, owners manual and a two year guarantee.

Logical Changes

The world of standard TTL and CMOS devices is changing. Texas Instruments, Philips and Signetics who are jointly developing advanced CMOS logic (ACL), have had to move away from the standard pin-out of logic i.c.s. to gain the advantages of advanced bi-polar speeds and CMOS low power.

The new ACL family provides great improvements over the previous limits of CMOS technology. They use one-micron technology to give three times the speed of high speed CMOS and yet still offer 24mA of output current.

COUNTDOWN

If you are organising any electrical, computing, electronic, radio or scientific event, big or small, drop us a line. We shall be glad to include it here. Address details to COUNTDOWN, Practical Electronics, 16 Garway Road, Bayswater, London W2 4NH.

PLEASE NOTE: Some of the exhibitions and events mentioned here are trade only or may be restricted to certain visitors. Also please check dates, times and any other relevant details with the organisers before setting out as we cannot guarantee the accuracy of the information presented here.

Instrumentation 87, Feb 25–26, Harrogate Exhibition Centre, March 25–26, Bristol Crest Hotel.
Audio 86, Nov 12–15, Olympia 2.
Sound Comm 86 Oct 1–2, Manchester.
Test and Trancducer, Oct 28–30, Wembley Conference Centre.
Drives/Motors/Controls & PC Systems, Nov 25–27, NEC, Birmingham.
Pascal 3 day course (residential), Herts.
Laboratory Manchester 87, April 8–9.
British Electronics Week 87 Olympia, April 28–30.
British Manufacturing Technology Week 87, Olympia, June 2–5.
IEEIE Lectures (various), Oct–Nov 86.
International Packaging Show, Metropole, Brighton, Oct 7–9,

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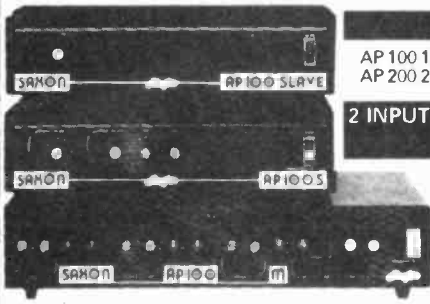

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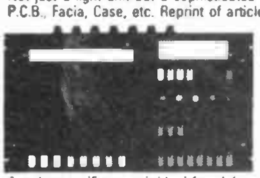

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Registered disabled people are welcome to apply.

Salaries start at £5,817 at age 19 to £6,920 at age 25 and over during the training and then £7,954 at 19 to £10,162 at 25 and over as a Radio Officer. Increments then follow annually to £13,777 inclusive of shift and week-end working allowances.

For full details and application form 'phone **0242 32912/3 or write to:**

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Recruitment Office, Government Communications Headquarters, Oakley, Priors Road, Cheltenham, Gloucestershire, GL52 5AJ.

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THE LEADING EDGE

REPORT BY BARRY FOX

LAST year Richard Branson, head of the Virgin music and airline empire, missed out on winning back the Blue Riband prize for the fastest Atlantic crossing by literally a few miles. After running the best part of 3000 miles at up to 50 knots his boat, *Virgin Challenger*, hit a piece of driftwood and sunk just 138 nautical miles short of the finishing line.

The boat went down with a load of high tech electronics centred on a Data General computer which had been logging performance. The plan had been to send all the logged data back to the control centre, above the Virgin Megastore in London's Oxford Street, by radio telex. But the system proved too complicated for its own good. The waves buffeting the boat made the electrodes inside the video screen shake so much the image was unreadable. The telex link worked well for the first two days of the crossing, but then the system failed. The inverter, which converted the boat's 24 volt DC supply to 240 AC 'mains', blew a 20 amp circuit breaker. It wouldn't re-set. One theory at the time was that in the high sea, the boat propellors left the water, so the engines ran fast while off-load and the generator created a voltage surge. The 24 volt supply on the boat was always varying widely, from as little as 2 volts up to 40 volts.

Within days of the sinking, the Virgin crew were planning 'next time'. Branson decided to spend £1.5 million on a new boat to be called *Virgin Atlantic Challenger II*. It made the run in June 1986 and broke the record. Branson has got his money back on publicity. Electronics companies who provided the equipment have won plenty of publicity too. The boat was built in just five months from design to launch, almost a record in its own right.

The little known side to the story is that the military was thrilled to see Branson investing millions in *VAC II*. It gave the RAF a one-off chance to try tracking a 22 metre craft running 3,000 nautical miles at 50 knots. Also *VAC II* confirmed the military's worst fears about serious weaknesses in the new technology of communications navigation, on which modern weapons like the Cruise missiles depend for guidance.

Behind all the ballyhoo the key requirement was to track the position of *VAC II* so that the 2000 people in a string of back-up teams always knew exactly where she was. The boat crew needed to receive weather forecasts, shipping traffic information and advice on how far it was from the next refuelling stop. Last year there were sensors all round the boat, which provided the data for dispatch by radio telex via British Telecom's maritime radio station at Portishead, near Bristol. This year DG adopted a completely different approach which could well point the way to future mobile communication in hostile conditions. There were no automatic sensors, but data was still sent by telex. This fifty year old technology is much more reliable for communicating technical data than crackly speech radio.

ONLY ONE MICRO

DG put an Eclipse 32 bit minicomputer into the control centre above the Virgin Megastore in Oxford Street and used it to send radio telexes to *VAC II*. The only computer on the boat was a tiny lap-top Microscribe, the size of a paperback book. This has a liquid crystal display screen which is unaffected by buffetting. The Microscribe is made in Wales with 320K RAM memory. Data General wrote software which lets it work like the trip computer in a car. When the *VAC II* crew entered their position and speed, the LCD screen immediately told them the best position for the next mid-Atlantic refuelling stop and what speeds were needed to stay inside the record. The lap-top also worked as a portable telex terminal, sending data and messages back to the control centre minicomputer when speech radio failed because of interference. A thermal printer gave hardcopy text. The Microscribe and printer are battery-powered and thus independent of the erratic power supply on the boat which wrecked last year's system. The difficult part was to build a battery charger for the Microscribe which would tolerate the 2–40 volt swing supply. A small British firm, repair of Milton Keynes, built a stabilized circuit which produced a rock steady 12 volts charging.

Because the boat bounced violently at racing speed, the lap-top had to be secured by Velcro pads to the operator's knee. Although the publicity pictures show an operator daintily typing text, in mid Atlantic the only way to get messages through was to grasp the computer with both hands and type with thumbs. The telexes were full of typing mistakes but still decipherable.

The boat carried equipment from Racal which receives signals from the two satellite navigations systems Transit Satnav (satellite navigation) system and Navstar GPS (global positioning system). Satnav relies on satellites which orbit the earth and can only be contacted for 20 minutes every hour. Accuracy depends on how long a vehicle stands still, taking a series of plots from the moving satellite. This is of little use to a craft racing at 50 knots to break a record. Navstar is in theory far more accurate. The vehicle takes three simultaneous readings from three satellites. The received signals are time-coded and comparison of the different delays gives a positon reading which is only accurate to a few tens of metres. The US military conceived Navstar but only got the money to realise the plan by promising to transmit two signals, one coded for military use only and the other 'clear' for civilian use. Navstar needs 18 satellites in geostationary orbit. So far only 7 have been launched. The NASA Challenger shuttle, Titan and Ariane

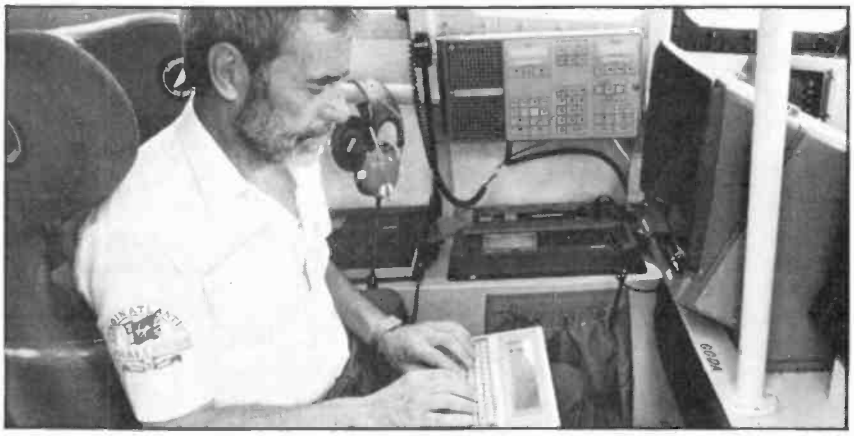
Branson's Blue Riband bid – good for him, good for England and good for the military – the stories behind the story.

failures have delayed completion by two years. Branson's crew gave up trying to use the satellite system and relied instead on the conventional Loran and Omega systems which give bearings from a chain of radio beacons. The military is embarrassed by the satellite system delays because weaponry including the Cruise missile relies on Navstar.

The RAF jumped at the chance of dropping spare fuel filters from a Nimrod out of St Mawgan in Cornwall. Using EMI Searchwater radar the Nimrod found the tiny *VAC II* in thick fog, and dropped canisters exactly 50 metres in front of the invisible target from a height of 20 metres. They were picked up and in the engine room within two minutes.

There is a neat irony in the decision by Branson's crew to carry also an inexpensive hand-held radio direction finder, made by Lokata of Falmouth. This is the gadget which fell foul of the Ministry of Defence when Lokata filed a patent in 1982. Without realising it, Lokata had re-invented a short range missile guidance system, as for instance used by the Exocet. Lokata is a radar receiver without a transmitter. It simply pinpoints the radar beams which other ships and beacons transmit. The London Patent Office stopped Lokata selling the gadget because it was a defence secret. But under pressure from the MP for Falmouth, the MOD relented. Boats, including *VAC II*, now carry it as a battery powered back-up to the main radar.

The much publicized radio silence from *VAC II* while the crew struggled to purge water and air from the fuel supply underlines the risk of putting high technology electronics on a small boat. *VAC II* was carrying two radar scanners and two 250 watt SSB radio transmitters in addition to the satellite navigation equipment and conventional Decca marine navigation equipment. When all this was switched on it drew around 80 amps of power. While the engines were shut down the only source of power was the boat batteries. Using the navigation and communications electronics without the engine running would very soon have flattened the batteries. There would then have been no power left to start the engines again.



There's another irony in Branson's success. British Telecom proudly announced that it had provided telex terminals, telex lines and a dedicated radio telex link to help keep the crew in touch with base. "Telex is the largest and most widely spread text messaging service in the world" puffed BT. "It is available for more than 200 countries with 104,000 users in the UK and two million worldwide." By coincidence BT's proud announcement came on the same day that its telex service chiefs were having a crisis meeting in London to try and decide what could be done about the appalling service offered by 'telex enquiries'. This is the control room in London which helps telex users find the numbers to call.

The only approved way into telex enquiries is via the operator on 100. The staff are working on antiquated equipment in a cramped room with no space to put extra seats. As a result it is often impossible to get a telex enquiry answered during working hours. The phones are either all engaged or just ring and ring and ring. "We are acutely aware of the problem," admits BT. "The new building won't be ready for two years. We are urgently examining what we can do in the meantime."

It's lucky for Richard Branson he didn't need to check telex enquiries while racing for the Blue Riband. He would have reached England before he got his answer!

One thought for the future. If Virgin does anything like this again, and wants anything more than superficial press coverage, will they please use a little more common sense in laying out the control room press facilities. This year, as last year, the press could have as much to eat and drink as they liked, chat at the free bar, watch pop videos and generally lig and pose as only the pop press know how. In a back room, where there was really no room for visitors, a constant stream of fascinating radio message came over the comms system. I was lucky enough to get 'backstage' for a while, and hear what most people were missing.

Why on earth couldn't the Virgin empire have rigged up a relay system so that the radio telephone chats were there for anyone else to hear – either by loudspeaker in an ante room or through headphones? Most of the Virgin staff were far too busy fawning over the TV crews to help the less glamorous press with more serious interest. PE

Virgin control room – Central London

REPORT BY BARRY FOX

INFRA RED COMPUTER CONTROLLER

BY R.A. PENFOLD

Freedom for joysticks

A remote control joystick unit which gives you the freedom you need for action packed computer games. This project may find other applications in computer control such as turtle graphic systems.

ALTHOUGH infra red remote control seems to have become commonplace with consumer electronics such as television and hi-fi equipment, it is something that has yet to have much impact in the computer world. This is perhaps a strange state of affairs since it is something that could be more useful and advantageous when playing computer games than for changing television channels (or whatever). This infra red remote control system is designed to replace a standard Atari/Commodore type joystick, and it will operate with any software that is compatible with an ordinary joystick. The receiver simply plugs into the joystick port and is powered from the computer. The hand-held controller is battery powered, and has five push button switches (up, down, left, right, and fire) which are used to control the on-screen action. The unit could actually be wired up to a conventional joystick if preferred, but for a hand-held controller ordinary push button switches are generally much easier to use. The system will operate reliably over a maximum range of about 4 metres or so.

Being a switch type controller it is obviously incompatible with joystick ports that are intended for operation with potentiometer type joysticks (such as the BBC and Dragon joystick ports). It can be adapted to operate with joystick ports which have a slightly non-standard Atari/Commodore games port, such as the Amstrad computer's joystick port. It can also be connected to a user port such as the one on the BBC model B machine, but when used in this manner it is obviously only suitable for use with custom written software. These are topics which are considered in more detail at the end of this article.

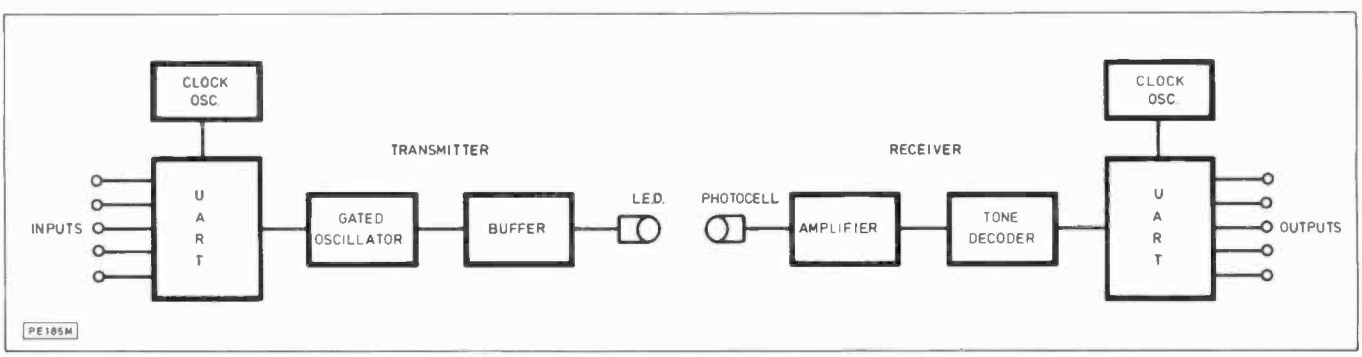


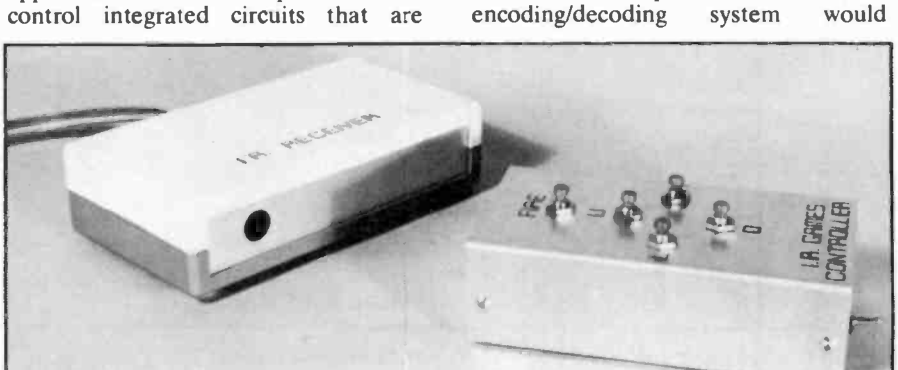
Fig. 1. *Double encoding/decoding system*

Providing a simple on/off infra red link is not particularly difficult, but the

ENCODING/DECODING

current application requires something well beyond straightforward on/off switching. Some means of encoding five switching actions onto the on/off link is required, together with complementary decoding at the receiver to recover the five original signals. The obvious approach is to use the special remote control integrated circuits that are available, and these have the advantage of taking care of all the encoding and decoding processes. Their disadvantage is that they require supply voltages which can not easily be provided at the receiving end by the +5 volt output of the joystick port.

An alternative is to utilize UARTs (universal asynchronous receiver/transmitters) to provide the encoding and decoding. However, in order to give reliable results it would not just be a matter of driving the infra red l.e.d. from the transmitting UART, and then amplifying the signal from the photocell to a suitable level to drive the receiving UART. With serial communications the shape of the transmitted waveform is all important, and any time distortion ('smearing') of the waveform is likely to result in corrupted data. A tone encoding/decoding system would



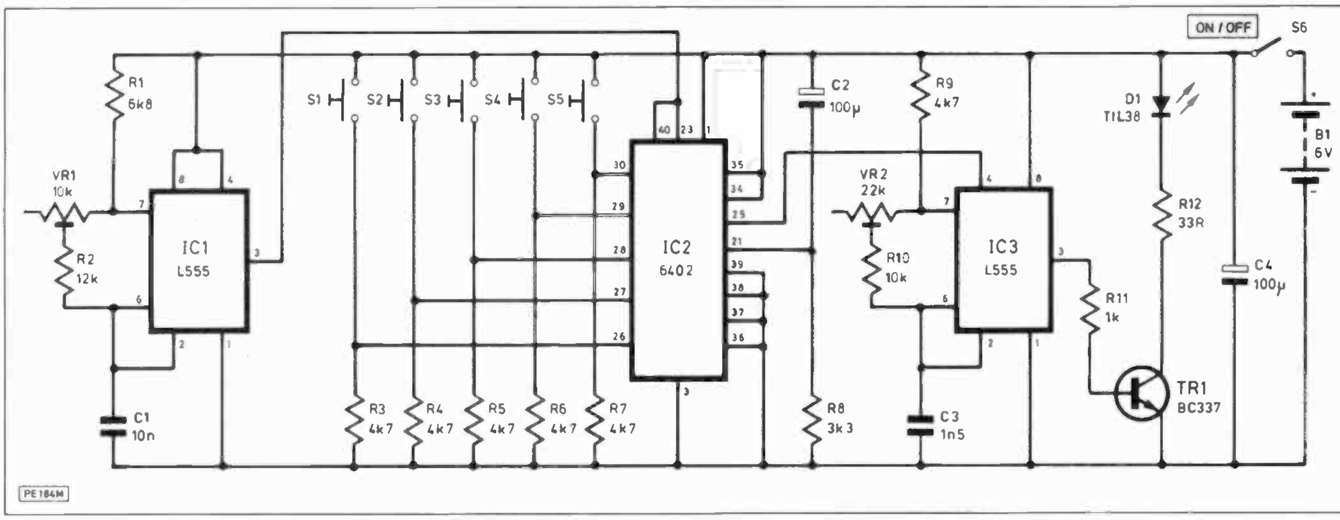


Fig. 2. *Controller unit circuit diagram*

therefore need to be used in conjunction with the UARTs. This gives a double encoding decoding system of the type outlined in Fig. 1.

A clock oscillator at the transmitter sets the rate at which the UART transmits data (the baud rate). The output signal from the UARTstarts with a pulse having a duration of 16 clock cycles, and this is the start bit. It is required to provide synchronisation at the receiving UART. Then the output it set to the logic level dictated by the first input, and again the duration is sixteen clock cycles. This process is repeated, in sequence, for inputs two to five, and finally a stop bit equal to sixteen clock cycles is produced. The purpose of the stop bit is mainly to ensure that there is a reasonable gap between one byte of data and the next. In this case the circuit is arranged so that the UART provides a continuous stream of data, and almost as soon as the stop bit of one byte has finished the start bit of the next byte is commenced.

The output signal from the UART is used to gate a high frequency oscillator, and this in turn drives the infra red l.e.d. via a buffer stage which provides a suitably high drive current for the l.e.d.

A photocell at the receiver converts received infra red pulses into small electrical pulses, and these are then boosted to a usable level by a high gain amplifier. A tone decoder converts the tone signal back into the serial waveform which is fed to the receiving UART. A clock oscillator again determines the baud rate, and this must obviously be set to accurately match that of the transmitter if accurate decoding is to be provided. When the UART detects a start bit, it then samples the input waveform at the appropriate times to determine the state of each bit. The detected states are stored in a data latch, and when a complete set of five data bits has been received, the correct five bit word is set up on the outputs. This word is latched on the outputs until a new byte has been received and is transferred to the outputs.

Although this system lacks extreme simplicity, it seems to work well in practice and is reasonably inexpensive to implement. The UART and other stages at the receiver will operate well from a 5 volt supply, and the transmitter can be powered economically from a 6 volt battery. This arrangement was therefore the one which was adopted for the final system.

CONTROLLER CIRCUIT

The full circuit diagram of the hand-held controller unit appears in Fig. 2.

IC2 is the UARTand it is the industry standard 6402 device. Although serial interface devices are highly complex and often have quite high current consumptions, the 6402 is a CMOS type which draws only a fraction of a milliamp in this circuit where it is operating at a fairly modest speed. All the standard serial word formats are available, and the required format is progrmamed into the device by setting pins 35 to 39 to the appropriate logic levels, and taking pin 34 high in order to load the control word into the device. In this case a word format of one start bit, five data bits, and one stop bit is selected.

C2 and R8 provide IC2 with a reset pulse at switch-on. R3 to R7 pull the five data inputs of IC2 low, but push button switches S1 to S5 pull their respective inputs high when they are activated.

IC1 is a 555 timer connected in the astable mode. It acts as the clock oscillator and sets the baud rate at approximately 300. Originally a higher baud rate of about 1000 was tried, but a reduction to 300 gave better reliability, and is still fast enough to give no noticeable delay between operating one of the push button switches and the computer providing a response. VR1 enables the baud rate to be trimmed to

COMPONENTS . . .

CONTROLLER

RESISTORS

R1	6k8
R2	12k
R3–R7,R9	4k7 (6 off)
R8	3k3
R10	10k
R11	1k
R12	33

All resistors 0.25W 5% carbon

POTENTIOMETERS

VR1	10k sub-min hor preset
VR2	22k sub-min hor preset

CAPACITORS

C1	10nF poly layer
C2,C4	100μ 10V radial elect (2 off)
C3	1n5 poly layer

SEMICONDUCTORS

IC1,IC3	L555P (2 off)
IC2	6402
TR1	BC337
D1	TIL38

MISCELLANEOUS

S1,S5	Momentary action push button switches (5 off)
S6	SPST sub-min toggle switch
B1	6 volt (4 x HP7 in plastic holder)

Case about 133 x 70 x 38mm; Printed circuit board PE PCB Service order code PE124; PP3 style battery connector; 40-pin d.i.l. i.c. holder; 8-pin d.i.l. i.c. holder (2 off); Wire, solder, etc.

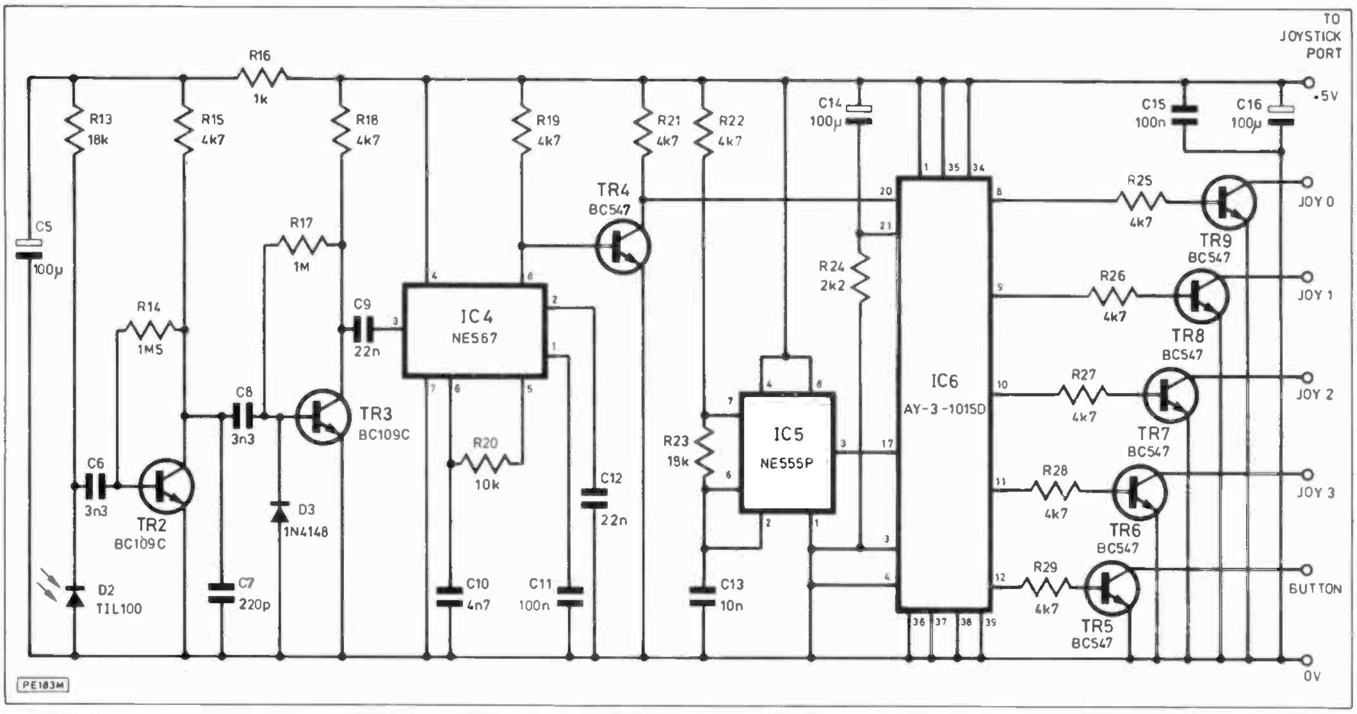


Fig. 3. *Receiver unit circuit diagram*

COMPONENTS . . .

RECEIVER

RESISTORS

R13,R23	18k (2 off)
R14	IM5
R15,R18,R19,R21, R22,R25–R29	4k7 (10 off)
R16	1k
R17	1M
R20	10k

All resistors 0.25W 5% carbon

CAPACITORS

C5,C14,C16	100µ 10V radial elect (3 off)
C6,C8	3n3 poly layer
C7	220p ceramic plate
C9,C12	22n poly layer (2 off)
C10	4n7 poly layer
C11	100n poly layer
C13	10n poly layer
C15	100n ceramic

SEMICONDUCTORS

IC4	NE567
IC5	NE555P
IC6	AY-3-1015D or 6402
TR2,TR3	BC109C (2 off)
TR4–TR9	BC547 (6 off)
D2	TIL100
D3	1N4148

MISCELLANEOUS

SK1 9-way D socket; case about 153 x 84 x 39mm; Printed circuit board PE PCB service order code PE124; 40 pin d.i.l. i.c. holder; 8 pin d.i.l. i.c. holder (2 off); 7-way ribbon cable; Wire, solder, etc.

precisely match that of the receiver. The clock signal is also fed to the Control Register Load input of IC2, and this provides the required continuous data stream from the unit. It is advantageous to use a low power version of the 555 for IC1 in order to minimise the battery drain, but a standard type will operate in the circuit.

IC3 is another 555 astable, and again it is advisable to use a low power type in order to minimise battery drain. This oscillator is gated by the serial output of IC2, and the gating is achieved simply by driving pin 4 of IC3 with the serial signal. This switches off IC3 when pin 4 goes low, and gates it off when pin 4 is taken high. VR2 permits IC3's operating frequency to be adjusted to suit the tone decoder at the receiver. TR1 acts as the buffer stage at the output of IC3, and it drives infra red l.e.d. D1 at a current of about 100 milliamps. The overall current consumption of the circuit is considerably lower than this figure though, since the l.e.d. is driven with a roughly squarewave signal, and the average l.e.d. current is only about 50 milliamps. Also, the oscillator and D1 are gated off for a proportion of the time. The current consumption is therefore largely dependent on the number of push button switches that are operated, and varies between about 12 milliamps under stand-by conditions, to around 65 miliamps with all five switches activated. Of course, in normal use no more than two or possibly three switches at a time would normally be operated, and the average current consumption is only around 25 milliamps. This can be economically provided by four HP7 size batteries connected in series.

RECEIVER CIRCUIT

The circuit diagram for the receiver unit is shown in Fig. 3, and as will be apparent from this, the receiver is slightly more involved than the transmitter.

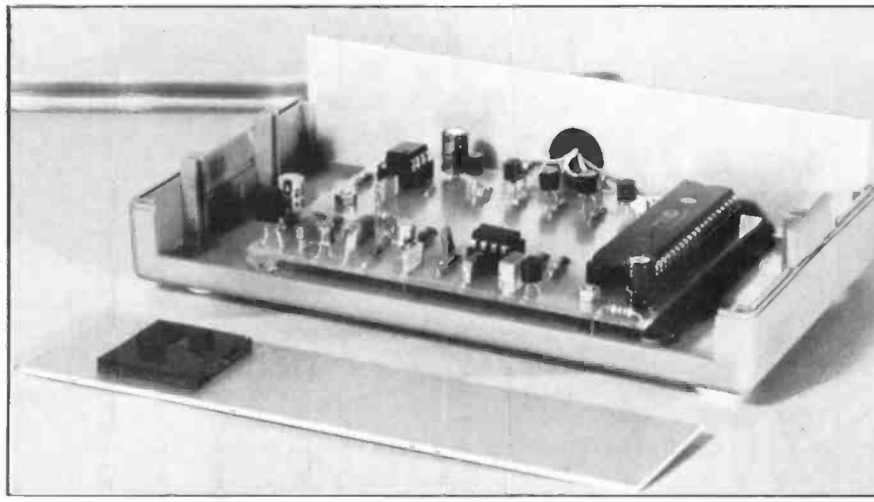
IC6 is the receiving UART, and this can be another 6402 type, or the somewhat less expensve alternative of an AY-3-1015D can be used. In the interests of minimising current consumption the AY-3-1015D is only recommended for use in the receiver and not in the transmitter. C14 and R24 provide the reset pulse at switch-on, and the program inputs set the same word format as for the transmitter circuit. IC5 is a 555 connected in the astable mode, and it acts as the clock oscillator. IC5 can be a standard 555 since there is no advantage in keeping the current consumption of the receiver down to a very low level.

When a push button in the controller is activated the corresponding data output of IC6 goes high. However, in order to simulate a joystick it is a short circuit to ground that is required when one of the buttons is operated. The requested switching action is obtained by driving a common emitter switching transistor (TR5 to TR9) from each data output of the UART. Incidentally, the UARTs have eight data inputs and outputs, but where a word format of less than eight data bits is selected it is the most significant bit or bits that become inoperative.

The UART is preceded by the amplifier and tone decoder circuits. D2 is the photocell, and this is a large area photodiode with built-in infra red filter.

It is reverse biased by R13, and the pulses of infra red light cause an increase in its leakage current which generate negative voltage pulses at its cathode terminal. These are coupled by C6 to the input of a high gain common emitter amplifier based on TR2. C7 slightly restricts the upper freqeuncy response ofTR2 which helps to give reduced noise and improved stability. Further amplification is provided by another common emitter amplifier built around TR3. D3 prevents the input waveform from being seriously distorted when the input signal is strong enough to overload TR3. This is important as this distortion could prevent the tone decoder from functioning properly.

The tone decoder is a phase locked loop type built around IC4, an NE567 which is specifically designed for this purpose. It has what is essentially a standard phase locked loop configuration with a current controlled oscillator (CCO), phase comparator, and lowpass filter. It has some additional stages which are a quadrature phase detector, a voltage detector, and an open collector output transistor. The phase detector is effectively an electronic switch which is opened when the output of the CCO is positive going, and closed when this signal is negative going. The input signal is fed to the electronic switch, and when the phase locked loop has achieved lock, positive half cycles will pass through the switch but negative half cycles will be blocked. In other words a simple half wave rectifier action is provided. The output signal from the electronic switch is smoothed by C11, and the resultant strong positive bias is fed to the voltage detector. The latter is activated and switches on the output transistor.



If lock is not achieved the electronic switch will be operated with what is random phasing when compared to any input signal. This gives no significant bias voltage at the output of the switch, and the output transistor is switched off. R19 is a load resistor for the output transistor, and the decoded serial output signal is available at pin 8 of IC4. Unfortunately it is of the wrong polarity to directly drive the input of the UART, but TR4 inverts the signal and provides IC6 with an input of the right polarity.

CONTROLLER CONSTRUCTION

Details of the controller printed circuit board are provided in Fig. 4. IC2 is a CMOS device and as it is also a fairly expensive component the use of a (40 pin d.i.l.) IC holder for this device should be regarded as mandatory. Do not fit IC2 into place until the rest of the components have been fitted to the board, and leave it in its antistatic packaging until that time. Handle the device no more than is absolutely necessary. Fit pins to the board at the points where connections to the off-board components will be made, and do not overlook the three link wires.

The case needs to be a reasonably small type which can be comfortably and easily hand-held, but obviously it also needs to have adequate dimensions to take the board plus the batteries. The latter are four HP7 size cells fitted in a plastic battery holder. Connections to the holder are via a standard PP3 style battery clip. The prototype controller is housed in an inexpensive aluminium case which has approximate dimensions of 133 by 70 by 38 millimetres. This is just about large enough to accommodate everything, with the component panel mounted at the front of the unit, and D1 aimed through a 'window' drilled at a suitable position in the front panel. This leaves room for the batteries to fit into the space at the rear of the unit in a short style battery holder. The component panel must be mounted on spacers or stand-offs so that the connections on the underside of the board are kept clear of the metal case.

On/off switch S6 is mounted out of the way on the rear panel, leaving the top panel free for the control switches. The switches on the prototype are arranged in a fairly logical pattern, but it might be worthwhile experimenting with different layouts. For example, placing the direction switches in an arc with the firebutton beneath might look a little strange, but it should enable the buttons to be easily operated with one hand while the unit is held in the other. Whatever layout is used it will take a short while for users to become accustomed to it, but before long use of the unit should become almost instinctive. Inexpensive push button switches are used on the prototype, but in the light of experience it would probably be better to use a type having

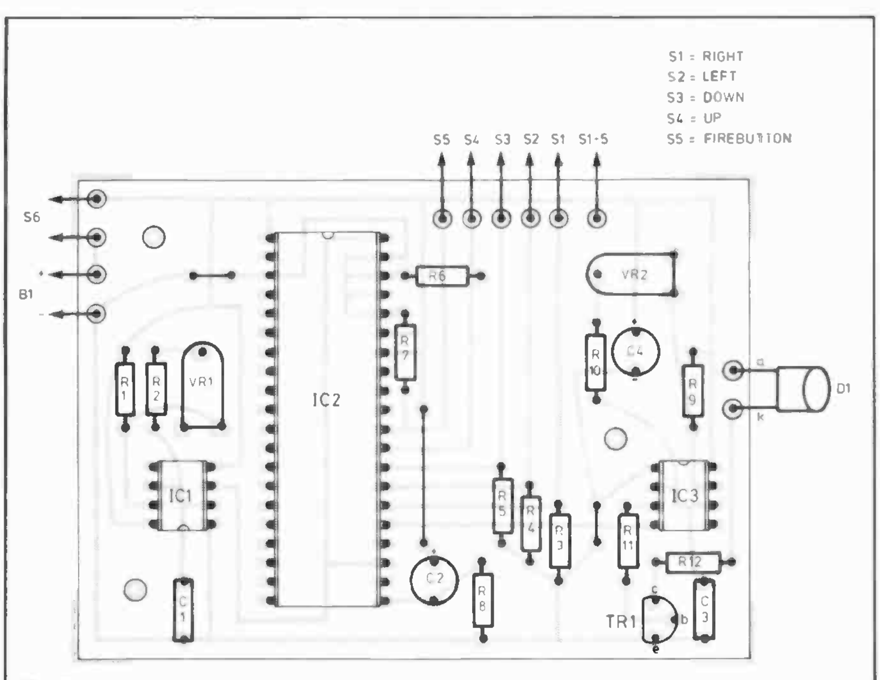


Fig. 4. *Transmitter p.c.b. and wiring details*

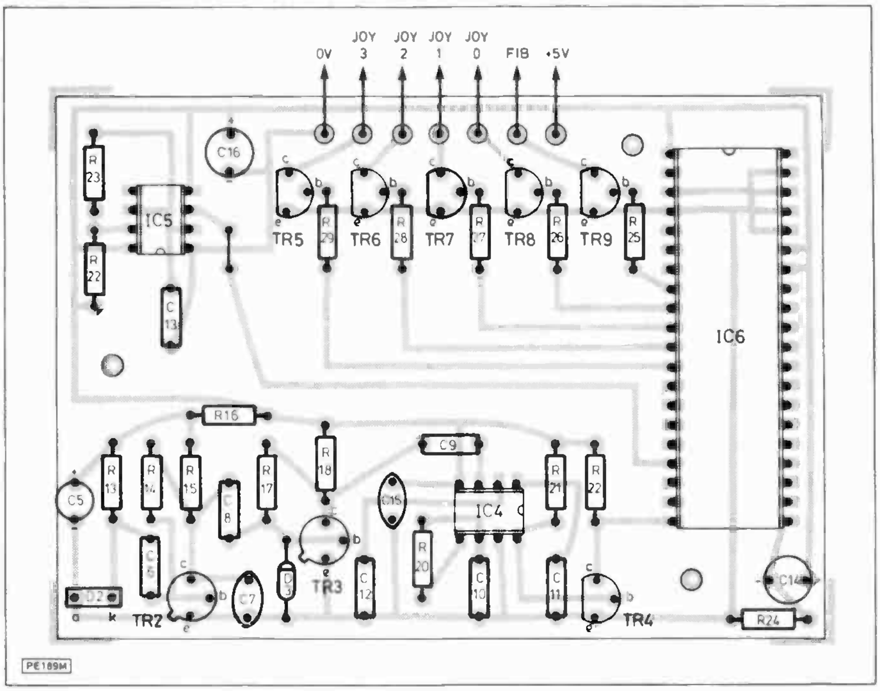


Fig. 5. *Receiver p.c.b. and wiring details*

a large button. However, make sure that the proposed switches do not require more depth than the case can provide. Also, the switches can not be mounted on the rear section of the top panel as they would be obstructed by the battery beneath.

To complete the controller the small amount of hard-wiring is added. A piece of six way ribbon cable provides a neat way of connecting the board to S1 to S5.

RECEIVER CONSTRUCTION

Refer to Fig. 5 for details of the receiver printed circuit board. The antistatic handling precautions outlined earlier should, of course, be borne in mind when dealing with IC6. Be careful to fit D2 the right way around – the side which carries the type number etc. should be facing towards C5 and R13.

A plastic box with metal front and rear panels and outside dimensions of 153 by 39 millimetres makes a neat and functional housing for the receiver unit. The printed circuit board is mounted on the base panel using 6BA fixings which should include spacers about 6 millimetres long. These prevent distortion and possible damage to the board when it is bolted in place, and also serve to bring D2 to a more suitable height. There are deep mounting pillars moulded into the base panel, but these are of no value in this case, and might actually get in the way. If this should happen they can easily be drilled away using a drill bit of about 10 millimetres in diameter.

A 'window' for D2 must be drilled in the front panel to provide an exit route for the cable to SK1. This hole should be fitted with a grommet to protect the cable. The cable is a piece of 7 way ribbon cable about half a metre in length, and SK1 is a 9 way D-type. Fig. 6 gives connection details for SK1. Be careful to identify each lead correctly and to avoid any crossed wires. The use of 'rainbow' ribbon cable is very helpful in this respect.

There are two stages of alignment of the unit. First RV2 must be adjusted to give a suitable carrier frequency so that the basic infra red link is established, and then VR1 must be set to give a transmitter baud rate which precisely matches that of the receiver. Ideally an accurate frequency counter would be used to measure the centre frequency of the phase locked loop, and to then measure the output frequency of IC3 so that it could be set to the same frequency. Similarly, the output frequency of IC5 would be measured, and RV1 would be adjusted to give the same output frequency from IC1.

It is not too difficult to set up the unit quite accurately without the aid of any test gear. Start with VR1 at a roughly central setting, and then adjust VR2 to find a setting that provides a link between the controller and the receiver. In fact there should be a narrow range of settings that give an effective link,

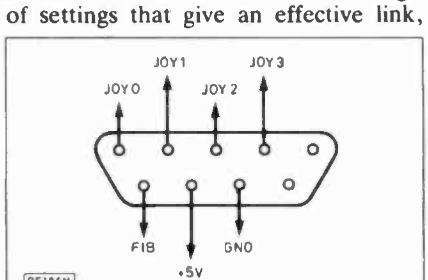


Fig. 6. *Connections to the 9-way D connector*

and VR2 is set at the centre of this range. The unit may work perfectly well at this stage, but if the transmitter and receiver baud rates are not reasonably accurately matched one or more of the control switches will have the wrong effect. Adjustment of VR1 should correct this, and there should be a fairly wide range of settings that give correct operation. VR1 is adjusted to roughly the middle of this range.

When using the unit bear in mind that it is quite directional, and that the transmitter must be roughly aimed at the receiver, with no obstructions in between. Alignment is much more critical near the maximum range of the system than it is at short range.

OTHER COMPUTERS

It should be possible to use the unit with other computers that have a controller input for switch type joysticks. However, although some computers have controller ports that are very similar to the standard Atari/ Commodore type, they are not all totally compatible. For example, Fig. 7 provides details of the Amstrad joystick port. This has obvious similarities with the Atari/Commodore type, but one difference is that the 5 volt supply output

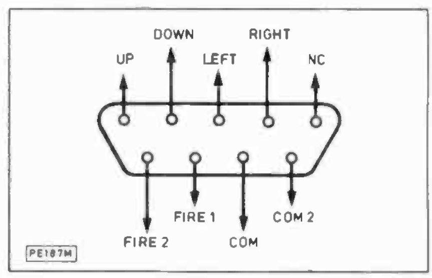


Fig. 7. *Amstrad joystick port has crucial differences to the standard Commodore/ tari type*

is replaced with a second firebutton input. Also, there are two 'common' terminals, and this permits two joysticks to be connected to the port.

The unit could be connected to the user port of the BBC model B computer, driving (say) inputs PB0 to PB4. No pull-up resistors would be needed on the open collector outputs of the unit as these are present on the user port inputs. A drawback of this method is that commercial software is incompatible with the controller, but there should be little difficulty in writing one's own software to suit the system, and it might be possible to make suitable modifications to published games software for the BBC machine.

With a little modification the system could possibly be used in applications other than games control. For instance, turning the system on its head it should be quite feasible to transmit five bit codes from an output port and to use them to control a 'turtle' or other device where the lack of a connecting cable would be very advantageous. PE

SPACEWATCH

BY DR PATRICK MOORE OBE

Is there life on Mars?

THE supernova 1986G in the strange galaxy Centaurus A continues to provide astronomers with valuable data, even though it has now declined so much that it has become very hard to identify. Spectra have indicated the presence of calcium clouds in between Centaurus A and our Galaxy; their existence has been confirmed by new studies of the spectrum of a supernova seen some years ago in the spiral galaxy M 83 in Hydra, which belongs to the same group as Centaurus A. Evidently the light from both supernovæ has come to us via the same intergalactic cloud. Incidentally, the M.83 supernova was another of Evans' discoveries; his grand total is now thirteen – easily a record for an amateur observer. It does show what can be done with sufficient patience and skill; Evans' largest telescope is a 16in reflector, which by professional standards is tiny.

Sadly, two of the world's great experts in the field of meteorite study have died: Lincoln La Paz, at the age of 88; and H.H. Nininger, at the age of 99. La Paz, whom I knew well, was the founder of the Institute of Meteoritics at the University of New Mexico, Albuquerque; Nininger has probably been the world's most enthusiastic and skilful collector of meterorites. His collection is now at the Arizona State University.

At the moment the American programme of exploring the planets by unmanned space-craft is in abeyance. The Galileo probe to Jupiter (by-passing the asteroid Amphritrite on the way) is one of the projects to be postponed indefinitely, and of course the Space Telescope has no hope of being launched before 1988 at the earliest. The European launcher Ariane has also run into trouble. It may well be that the next

Continued on page 41

The Sky This Month

THIS is not a particularly good month for planets. For observers in the southern hemisphere both Mercury and Venus are well placed – Venus actually comes to its greatest brilliancy, magnitude −4.6, on October 1st – but both are too far south to be properly seen from Britain. Mars is still an evening object, but the magnitude has now fallen to −0.5, two magnitudes fainter than it was during opposition in July; Saturn sets soon after the Sun; and although Jupiter is on view for much of the night, it also is rather low for British observers.

Halley's Comet, incidentally, is almost impossible to see this month with any telescope. It remains in the constellation of Crater, but is above the horizon only during daylight, and of course it has faded very considerably. Regrettably it must be said that amateurs in general have seen the last of it, though the major observatories will continue to follow it for a year or two yet.

The Moon is new on October 3rd and full on the 17th. On October 3rd there is a rather interesting eclipse of the Sun. It is annular along most of the track, but total for a maximum length of one-third of a second over a small part of the North Atlantic. The annular path begins between the north-eastern part of Asia and North America, extending between 18.56 GMT and 19.15 GMT, and has a maximum length of 2.6 seconds. The partial phase is visible from much of North America, the Arctic area, Iceland and the northern part of South America. The region of totality is in the Iceland–Greenland area, but does not cross dry land, so it will be interesting to find out if anyone actually sees it! Because the Sun is still 'quiet', the shape of the corona will be of the spot-minimum type.

There is also a total eclipse of the Moon, on the 17th. This at least will be visible from Britain. It begins at 17.30 GMT and ends at 21.06 GMT, with the total phase extending between 18.41 and 19.55. It is some time since we saw a good total eclipse; this will provide a good opportunity for photographic enthusiasts. (Incidentally, it is interesting to recall that at the total lunar eclipse of last April, not visible from Britain, most observers – including myself – who had the good fortune to be in the southern hemisphere made use of totality to carry out final observations of Halley's Comet; but the Rev. Robert Evans preferred to make his regular scan of galaxies in the hunt for supernovæ – which is why he can be sure that the supernova, in Centaurus A, which I discussed in last month's article, was not visible then.)

The Orionid meteors last from the 15th to the 25th of this month, and the Taurids begin in the 26th, but neither shower is particularly prolific. Vesta, the brightest of the asteroids, comes to opposition on October 3rd, but as its magnitude is only 6.4 it will not be visible with the naked eye. Binoculars will show it, but it looks exactly like a star. If anyone cares to search for it, here is the position: RA Oh 49m, declination −7°45′.

As the evenings draw in, some of the magnificent winter groups start to make their entry; the Pleiades in Taurus are now quite high soon after dark, Capella rising, Vega descending. The main October group is Pegasus, which is high in the south. This is the best time of the year to look for Fomalhaut, the southernmost of the first-magnitude stars to be visible from England. Do not confuse it with Diphda or Beta Ceti, which also lies below the Square of Pegasus; Fomalhaut is much the lower-down of the two, and is a magnitude the brighter. Fomalhaut, incidentally, is one of the stars found by the IRAS satellite to have a huge infra-red excess, possibly indicative of planet-forming material.

Ursa Major, the Great Bear, is at its lowest in the north, which means that the W of Cassiopeia is not far from the zenith. The west is occupied by large, rather faint and formless constellations, of which the best-known are Hercules and Ophiuchus. Also low in the south-west are the dim Zodiacal groups of Capricornus and Aquarius. The 'summer triangle' (Vega, Debeb, Altair) is still much in evidence; of the three, only Altair actually sets as seen from Britain.

EXPERIMENTAL ELECTRONICS

BY THE PROF.

Class conscious circuits

P.E. has published dozens of amplifier designs over the years, many of which have been variations of pretty much the same circuit. This article deals with a less common type of audio amp which could be used in many applications.

IN DAYS gone by things were very simple as far as classes of amplification were concerned, with just the three basic types to choose from. These days there are so many different types that it could prove difficut to track them all down, and there seems to be some confusion as to what's what when it comes to the more obscure types. For the experimenter these "new" classes of amplification represent an interesting alternative to the more usual class B type which has a lot in its favour, but perhaps suffers from "familiarity breeding contempt", with super-fi designs raising far less interest than they once did.

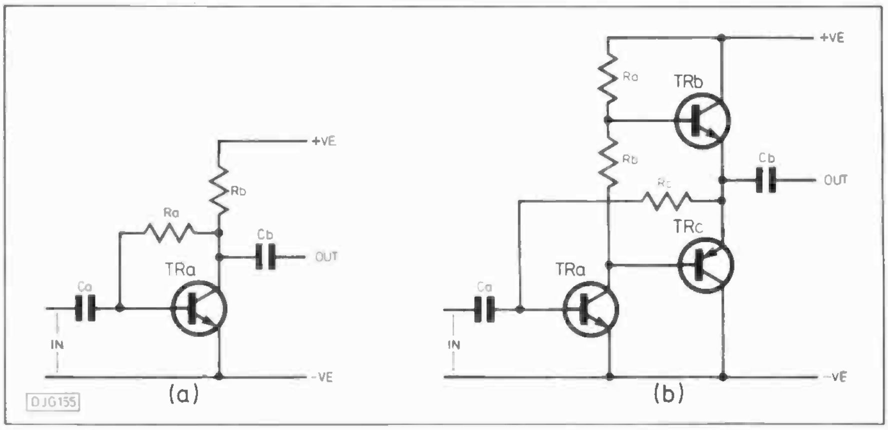


Fig. 1. *Class A amplifiers*

CLASS CONSCIOUS

Probably most readers will be familiar with the operation of class A and class B designs, but we will consider these briefly here as they have relevance to other types of amplifier, and most of the "improved" types are really variations of one or other of these (usually class B variations).

Class A amplifiers are the ordinary type as used in normal low level stages, with the basic method of biasing beings as shown in Figure 1(a). Ra biases TRa so that approximately half the supply voltage appears the collector of TRa, and Ra connects to the collector of TRa rather than the positive supply rail in order to introduce negative feedback which partially compensates for variations in current gain from one device to another. Having the collector at half the supply voltage permits the highest possible peak to peak output voltage swing before either set of output half cycles becomes clipped. Ca and Cb are merely d.c. blocking capacitors.

Class A amplifiers work very well at low power levels, and it would be reasonable to ask why not simply step up the power levels for high power applications? This is not so much a problem with fidelity as with wasted power. In fact in sheer performance terms class A power amplifiers are difficult to beat, but output devices and power supplies that would normally be associated with something like 2 x 40W amplifiers could be struggling to give 10 watts per channel in a class A set up. For maximum efficiency the loudspeaker would need to be connected in place of load resistor Rb, but this would still leave as much power being dissipated in TRa as in the speaker, and there would be a high quiescent current through the loudspeaker which would shift the cone off its normal central position. This would give less than optimum results from the loudspeaker, and it would be more normal to use transformer coupling or some other arrangement which avoids having the quiescent current passing through the speaker. This introduces losses though (and probably a reduction in fidelity as well), and a typical class A power amplifier offers only about 20 to 25% efficiency, and there are plenty that are less efficient than this. Class A amplifiers are also inefficient in that they consume the same average power regardless of whether they are driven at full power or there is no output at all.

The class B arrangement of Fig. 1(b) is a class A driver stage followed by a complementary emitter follower output stage (TRb and TRc). On positive output excursions TRb drives the loudspeaker, while TRc drives it on negative output half cycles. The two output devices have only about unity voltage gain, but their high current gain provides the circuit with a low output impedance so that a loudspeaker can be driven with a peak to peak potential which is something approaching the supply voltage. In practice the output transistors are often Darlington Pairs or some similar arrangement, with power MOSFETs featuring here in up-market designs. Class B circuits seem too good to be true in that there is no quiescent bias through the output stage, and this helps to keep down the power consumption under practical operating conditions. It is also advantageous in applications where battery power has to be used.

In practice it is unusual to have zero bias through the output stage due to problems with crossover distortion. With

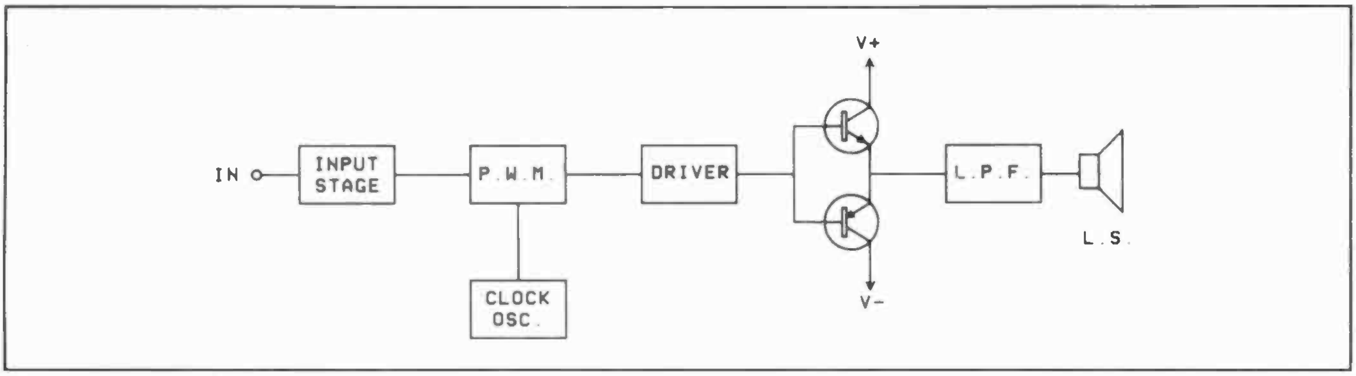


Fig. 2. *Class D amp block diagram*

the bases of TRb and TRc simply wired straight together and Rb omitted, about 1.3 volts peak to peak would be needed at the collector of TRa before any output signal at all would be produced. This is due to the forward bias of about 0.65 volts or thereabouts needed before a silicon transistor will start to conduct. Rb overcomes this problem by providing a quiescent forward bias of about 1.3 volts. In a real amplifier the output transistors are often biased to the point where a substantial stand-by current flows, and this is done to bypass the early (and far from linear) part of their transfer characteristics. Usually a significant amount of negative feedback has to be used as well in order to get the crossover distortion down to really low levels, and the quiescent bias has to be carefully stabilised in order to prevent thermal runaway and the destruction of the output transistors.

DIGITAL AUDIO

Although many people seem to be under the impression that class C amplification is a form of exotic audio amplification, it is in fact a very simple form of radio frequency amplification. The amplifying device is reverse biased, which can effectively be achieved with a bipolar transistor amplifier by omitting any bias components at all. This results in the amplifying device only conducting for part of one half cycle, and efficiency figures in excess of 90% can be achieved.

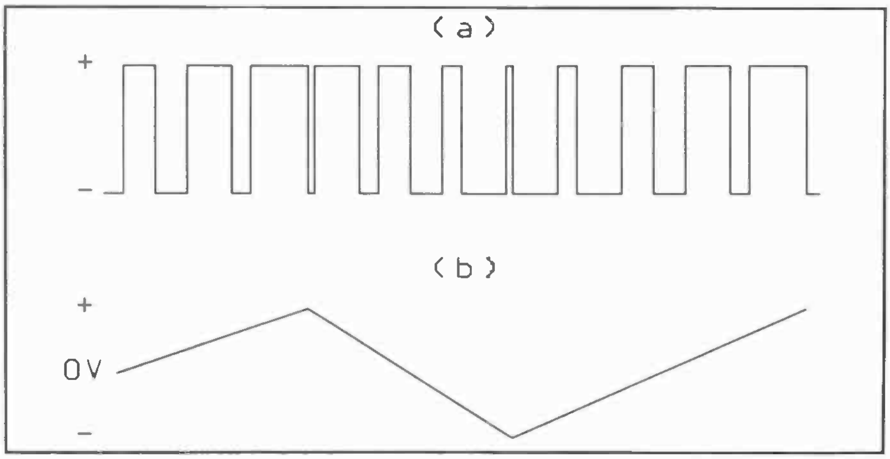


Fig. 3. *PCM output (a), produced by input waveform (b)*

Unfortunately, the load has to be a tuned circuit so that the "ringing" effect of this resonant circuit fills in the missing part of the output waveform. It is for this reason that class C is only applicable to RF amplification.

Class D is the original form of improved audio power amplifier, and it was a feature of some Sinclair audio designs of the sixties (I seem to remember a module for use in a class D set up was published in *Practical Electronics* at about that time). In more recent times it has been used in the Sony TA-N88 2 by 160 watt amplifier of the late seventies-early eighties. It is a modified form of class B amplifier which offers increased efficiency and other

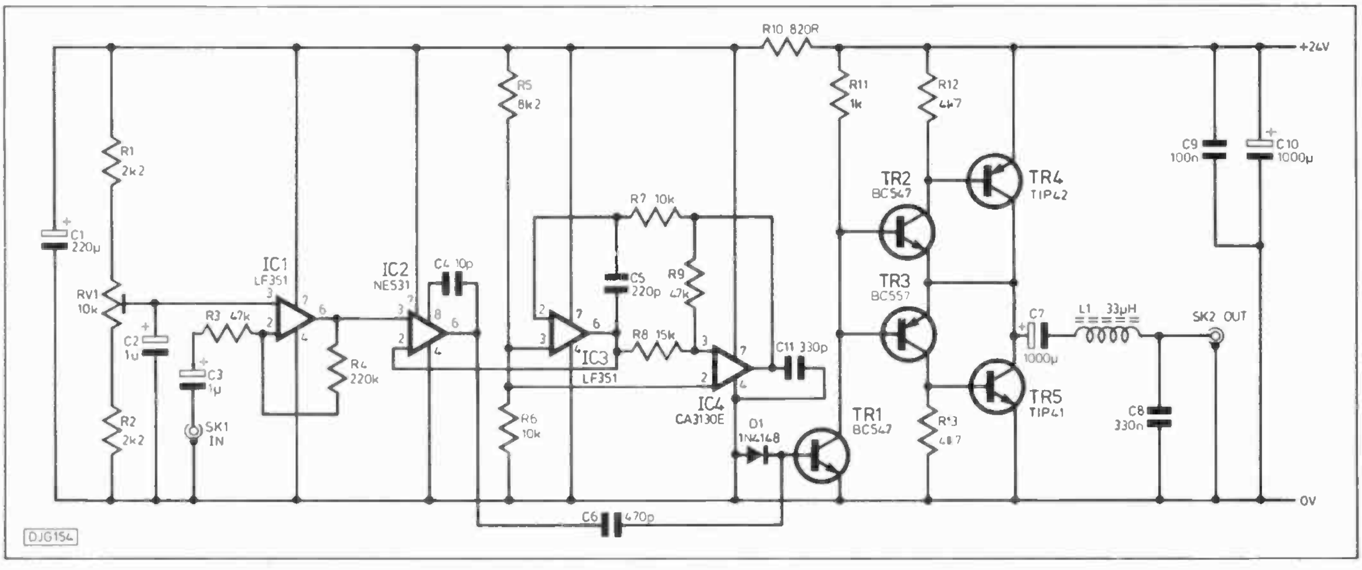


Fig. 4. *Typical circuit example of a practical Class D amplifier*

advantages, although this system is not without its drawbacks as well. With class B circuits offering in the region of 60 to 70% efficiency there may not seem to be much point in striving for lower losses. The point to keep in mind here is that the wasted power is mostly lost in the form of heat in the output transistors. While improved efficiency may not greatly reduce the size of the power supply needed for a given output power, it does enable smaller power transistors with much smaller heatsinks to be used.

Fig. 2 shows the general make up of a class D amplifier. The perfectly ordinary input stage is followed by a pulse width modulator and clock oscillator, and these care at the heart of the system. The clock has an operating frequency that is typically 100kHz to 200kHz, and the output of the pulse width modulator is a pulse stream at this frequency. The mark-space ratio of the output signal is 1 to 1 under quiescent conditions, but it varies in sympathy with the input signal voltage. The pulse width increases and decreases in proportion to the input signal voltage, so that the average output voltage is identical to the input voltage. Fig. 3 helps to explain this process, and it simply shows a triangular input waveform and the corresponding output waveform.

The signal from the pulse width modulator is fed to a conventional class B driver and output stage, or what is almost a conventional set up. In this case the usual quiescent bias to the output transistors is not needed as they are simply being switched between the fully off and fully on states. Not only does this totally eliminate any problems with crossover distortion, it also prevents any form of non-linearity through the driver and output transistors from adversely affecting performance. Problems with thermal runaway causing the destruction of the output transistors are also totally banished.

Although the output signal may not look very much like the original audio input, when fed to a loudspeaker it would probably give an output of quite respectable fidelity. This occurs due to the very poor ultrasonic performance of an ordinary loudspeaker, which results in it responding to the average output voltage rather than to individual pulses. This is not a satisfactory way of doing things though, since from the electrical point of view we would then have what is effectively a class B amplifier driving the loudspeaker flat-out regardless of the audio input level. Even allowing for the fact that the loudspeaker's impedance would probably be relatively high at the frequencies involved here, this could give a level of efficiency more in keeping with an unimaginative class A design rather than one intended to be super-efficient.

The lowpass filter at the output provides the solution to the problem, and this should ideally provide about 80dB of attention at the clock frequency. The main purpose of the filter is to block the clock signal so as to give an output signal that is equal to the average output voltage (the wanted audio output), whilst ensuring that the individual pulses do not drive large currents through the loudspeaker. It also ensures that in a multiway speaker system all the output power is not directed to the tweeters, with the dire consequences that could result from this. Another important role of the filtering is to reduce the radio frequency interference radiated by the loudspeaker leads to an insignificant level.

On the face of it this method has advantages as far as distortion is concerned, but apart from reducing the quiescent bias through the output stage to zero it seems to have little advantage over a class B circuit as far as efficiency is concerned. Things are not quite what they seem though, and the crucial point as far as efficiency is concerned is that the output transistors act as switches. When in the off state one of the output devices passes no significant current, and although it is subjected to virtually the full supply voltage, it consequently dissipates no significant power. There is a similar state of affairs when an output device is switched on, but this time it is subjected to a low voltage but passes a high current. When fully turned on the voltage across the device will be low but significant, and it is this factor that makes the output stage less than 100% efficient. However, in excess of 90% can be achieved which is certainly quite impressive.

DRAWBACKS

With all its advantages it is fair to question why class D circuits have not taken over from the class B variety years ago? Far from a takeover happening, class D designs have remained a rarity and have achieved no real commercial success. The first point that has to be made is that class D circuits are not genuinely distortionless. Linearity in the driver and output stages might not be important, but linearity through the pulse width modulator is. In practice low levels of distortion can be achieved here, but distortion products will not be immeasurably low. Power supply regulation is also crucial to the linearity of the system, since any loading of the supply on signal peaks will reduce the average output voltage, tending to flatten the peaks and cause distortion.

These problems are not severe though, and excellent distortion performance can be achieved. It is probably the switching of the output devices at high speed which has proved to be the fatal flaw. For the circuit to achieve good performance the output transistors must switch at very high speed, and this combined with the fairly high voltages and low impedances involved results in strong radio interference being generated. To combat this a case which provides good screening is really needed, together with a high slope lowpass filter at the output. Unfortunately, the output filter must obviously be a passive type capable of handling large currents with minimal losses. There is no point in having a 95% efficient output stage and a lowpass filter which wastes most of the output power. This can lead to a situation where a matchbox size 2 by 50 watt amplifier requires a massive and very expensive output filter in order to make it really usable.

Another factor working against Class D is simply that its initial gimmicky image is one that it has never really lived down, and the same is perhaps also true of its early reputation for poor reliability. From my own experience with amplifiers of this type, I would say that the main problem with them is that while they are very straightforward and easy in theory, in practice it can be difficult to better the overall performance of even a quite modest class B design.

D CIRCUIT

Probably many electronics enthusiasts are familiar with the basic principle of class D amplification, but I doubt if many have ever constructed one, or even heard the results from a ready made type. A practical class D amplifier can be very much less complex than one might think, and results from a simple home constructor design are sufficiently good to make it well worthwhile giving it a try. The circuit of Fig. 4 provides a good starting point.

IC1 is the input amplifier, and it operates as a simple inverting amplifier having a voltage gain of just under five times. Lowpass filtering could be included in this stage to prevent stray RF pick up from producing heterodyne whistles by reacting with the clock oscillator. No problems of this type experienced with the prototype but a capacitor of a few picofarads in parallel with R4 should rectify matters if any difficulties of this type should be experienced. RV1 enables the quiescent output voltage of the input stage to be adjusted, and this is set to optimise the large signal handling performance of the circuit.

The pulse width modulator is comprised of comparator IC2 and clock oscillator IC3/4. The latter is a conventional square/triangular waveform generator having IC2 as the Miller Integrator and IC3 as the trigger circuit. In this case it is the triangular waveform from the output of IC2 that is required. C11 smoothes out some irregularities on the squarewave signal which would otherwise cause severe distortion on the peaks of the triangular waveform. It is important to have a good quality clock signal as the distortion level on the audio output signal is directly related to this.

Fig. 5 helps to illustrate the way in which the pulse width modulator functions. In (a) the input signal (represented by the dotted line) is at its quiescent level, which is half way between the signal peaks of the clock oscillator. The output of the comparator goes high when the clock signal is at a higher voltage than the input voltage level, or low when it is not, giving the required 1 to 1 mark space ratio output signal. A higher input voltage results in the clock being higher in voltage than the input signal for a smaller proportion of the time, giving shorter output pulses as in (b). A lower input voltage has the opposite effect with longer output pulses. This gives the desired effect with an average output voltage that is inversely proportional to the audio input level. The inversion through the modulator could be avoided by swopping over the inputs to the comparator, but obviously the inversion is of no real consequence.

The pulse width modulated signal is at a frequency of about 200kHz, and it is coupled by C6 to a virtually conventional class B output stage. It differs from the standard configuration in that no biasing components are needed as the circuit is driven hard into clipping, and as explained previously, the components to provide the usual quiescent bias through the output stage are unnecessary for class D operation. Each half of the complementary output stage consists of two common emitter amplifiers with 100% negative feedback. In theory these provide better efficiency than the Darlington Pair arrangement of Fig. 6, with a lower voltage drop through each output transistor when it is in the on state. In practice the original output stage used in Fig. 4 seems to give greater output voltage swing, but with significant amounts of current mysteriously disappearing into the output transistors. Possibly a lack of switching speed somewhere results in both output transistors becoming briefly switched on simultaneously on each transition, but for whatever reason the alternative output stage of Fig. 6 represents a safer alternative for those who are not determined to squeeze the last milliwatt of output power from the unit.

L1 and C8 are the output lowpass filter, and this gives around 30 to 40dB of attenuation at 200kHz. This is sufficient to protect any tweeters in the loudspeaker system against an excessive power level, but it does not guarantee a low level of RF radiation. Lowering the cut-off frequency of the filter to improve attenuation of the pulses is not a good idea as it would result in severe attenuation of the higher audio output frequencies. A multistage filter could be used, but it must not provide a low load impedance at the clock frequency. Other alternatives would be to use a tuned circuit of the "wavetrap" type to provide the main filtering, or to raise the clock frequency so that greater clock attenuation is provided by a given lowpass filter. Bear in mind though, that massive clock attenuation does not give a better sound than that obtained with a filter of moderate performance.

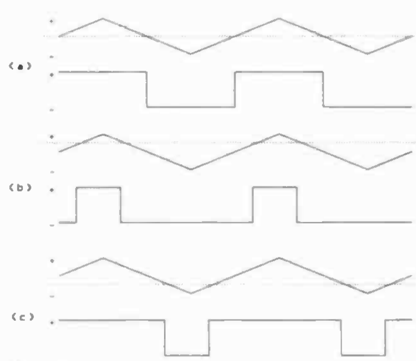


Fig. 5. *In each pair of waveforms the upper one is the clock oscillator signal with the dotted line representing the input voltage. The lower waveform is the PWM output.*

CONSTRUCTION

Reasonable care needs to be taken with the component layout and wiring of any power amplifier, and class D types are certainly no exception to this. In particular keep the wiring around the driver and output stage short, avoid earth loops, and try to keep the input stage reasonably well isolated from the output stage to avoid stray feedback between the two.

The main constructional problem is the inductor in the output lowpass filter (L1), which must not be an ordinary RF choke. These have a resistance value which is far too high and a current rating which is far too low. An inductor of the type used in loudspeaker crossovers is required. The value of this component is not very high, and it would not be too difficult to wind a suitable component using about 18 swg enamelled copper wire (which is what I managed to do after a little experimentation). The core must be a material suitable for audio use though, or this component could introduce significant amounts of distortion.

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IMPROVEMENTS

An output power of about 8 watts RMS is available into an 8 ohm impedance loudspeaker, or something approaching double this into a 4 ohm type (with C8 increased to 680nF and L1 reduced to 180μH). A much higher output power could be obtained by boosting the supply voltage, but the value of R10 must then be increased to maintain the supply voltage to the low level stages at about 12 volts. With the output transistors mounted on small finned heatsinks they seem to become no more than warm, and the circuit certainly achieves significantly better efficiency than a class B equivalent.

The audio output quality is reasonable, but is certainly below hi-fi standards. The obvious way to improve matters would be to use a more complex clock oscillator offering a more linear signal, and class D circuits can certainly achieve low levels of intrinsic distortion. However, bear in mind that it is quite possible to use negative feedback to obtain reduced distortion, and that the average class B design if used open loop would sound very much worse than this amplifier. An initial test with some feedback gave encouraging results. R4

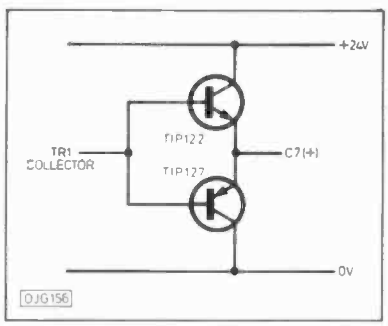


Fig. 6. *Darlington Pair*

was raised to 1M to boost the open loop gain of the input stage, and then a 330nF capacitor and a 220k resistor in series were used to couple the negative feedback from the loudspeaker to pin 2 of IC1 (but note that the inputs to IC2 must be swopped over in order to give the correct phasing). Apart from reduced distortion another benefit of using overall negative feedback is that it will tend to iron out the small amount of high frequency roll-off introduced by the output filter. Do not be tempted to set the cutoff frequency of the filter too low and then compensate for this with feedback, as the result would be poor power bandwidth performance.

Class D amplification certainly represents an interesting field for the experimenter with its difficult but not insurmountable problems, and it is a worthwhile sphere of operation for the audio circuits enthusiast who has difficulty getting excited about class B designs any more. PE

A NOVICE'S APPROACH TO DIY SATELLITE TV

BY ANDREW RANDLE

Build a complete set-up for around £250

Despite its high cost, enthusiasm for home satellite TV reception is growing rapidly especially in the US and Western Europe. Now it is available for anyone with a bit of know how, time and patience, a limited budget and Practical Electronics - Read On!

As PART of an 'A' level course I have just successfully completed my own satellite TV system for the 11GHz 'cable' band. I have been involved in researching, designing and constructing the system over the last two years or so. I aim to give some helpful tips to the would be constructor from my own experiences. I cannot go into every constructional detail and modification I made to get my system usable as it would take far too long and is beyond the scope of this article. I purely intend this to be a guideline to the potential constructor and to give an idea of what is involved in such a project before it is actually undertaken. All the books and magazine articles which I have read tend to make it sound a relatively straightforward project to take on, indeed at the simplest level it is quite straightforward although there are problems which I came across which I had not previously seen highlighted in the various texts.

Because I have a severely limited budget, I aimed to make the dish and electronics as cheaply as possible. This meant keeping things 'simple' when compared with some of the very sophisticated commercial equipment which is now widely available. A commercial system may cost £1000 or more, I could not afford this so I set myself a limit of £300 material costs. The resulting project actually cost me nearer £250 as I was able to obtain some materials from local sources quite cheaply.

DISH CONSTRUCTION

This was the most time-consuming and physically 'hard work' part of the project. It is very useful to have an obliging helper. I am lucky to have a practically minded father who was as enthusiastic about the project as I and was more than willing to help me with the hard manual work, such as mixing concrete. I decided to build a two metre GRP reflector with an F/D ratio of 0.5, i.e. the focal point occurs one metre above the centre of the dish. On reflection I think a two metre dish is possibly the largest that an 'amateur' can successfully build by himself using the techniques I am about to describe; for a larger dish different methods would need to be employed in order to maintain accuracy. I cannot stress enough the need for strict accuracy control when creating the paraboloid mould – constant checking and modification is required in order to keep errors to the absolute minimum, ideally within ±0·5mm! This type of tolerance is very difficult to achieve and can only be striven for by the hobbyist constructor.

After much deliberation I decided to create a paraboloid shape by rotating a shaped profile around a mound. There are other methods such as constructing a wooden 'plug' in quadrant form, once a satisfactory quarter mould is built four castings can be made and then joined to form a dish. I personally did not opt for this method because of the difficulties in joining the pieces together accurately, also if a mistake is made on the mould then it is moulded four times over. There are merits in using this alternative method such as portability, i.e. if the dish can be broken down into four pieces it could be easily moved in a family car from one site to another if the need arose. In the solid form a trailer is required (or in my case a helpful teacher's horsebox!).

Also if the only place available for moulding is a small garage then you may have no choice but to use this method. I

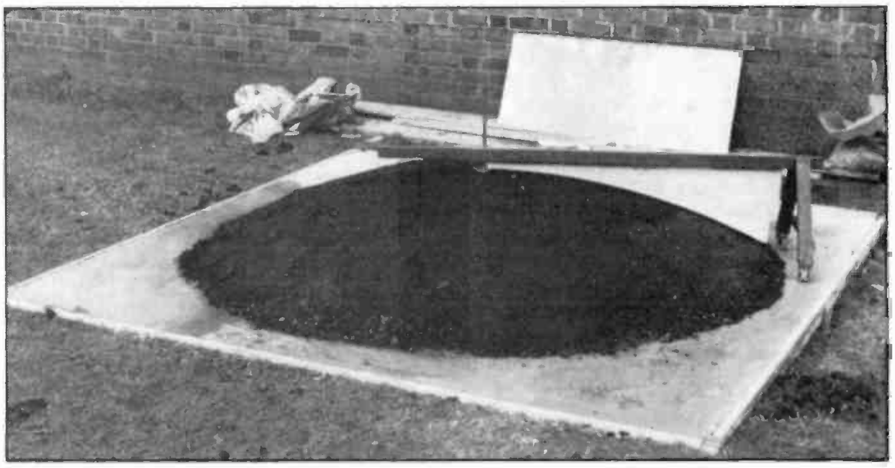


Fig. 1. *Rough parabola made from earth, rubble and slag using the profile as a guide.*

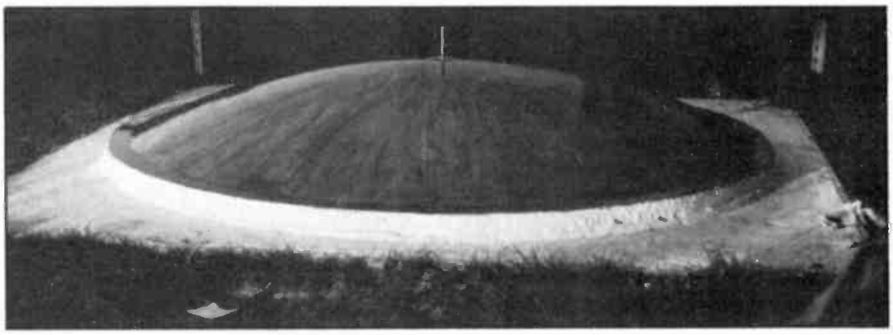


Fig. 2. *A high gloss finish is obtained by coating the mould with 'Shellac' or a similar varnish.*

should point out that the styrene fumes given off by curing thixotropic resin such as that used in fibreglassing can be dangerous if the workshop is not well ventilated. Because of this fact I actually moulded my dish outside during the summer. This had two advantages in that I had no problems with ventilation and also it was the middle of the summer holidays so there were no children around my school who could become 'interested'. In fact, I built myself a large polythene cover for the mould in order to protect it from the rain. This also allowed me to maintain a reasonably controlled atmosphere during the curing time of the GRP.

THE MOULD

So how did I actually go about constructing the mould? Firstly, a very flat and level floor is required. Since I was working outside I decided to build myself a 'floor' out of concrete. The floor must be as flat as the dish should be accurate. If the wheels of the profile move up and down as it is rotated then errors occur. Ideally I would have used an existing floor which I could check for flatness. As I did not have a suitable site available I built a good base out of a very wet mixture of concrete – this enabled me to ram the mixture into a level surface easily with a plank of wood. Once set the base can be checked with either a spirit level or by throwing water on and seeing if puddles occur or if it drains away. Once I was satisfied with the base I started work on the mould proper.

The next task was to create a very accurate parabola on paper which I could then stick on to a piece of plywood and cut and file down to. With the advantage of hindsight, it may be a better idea to make the profile out of say aluminium as this would be far less prone to wearing away with use. I constructed the parabola using a simple computer program which utilised the formula:

$$X = \frac{Y^2}{4 \times \text{Diameter} \times \text{f/D Ratio}}$$

Of course you do not have to use a computer for this although I used around ninety separate coordinates. It would be tedious to say the least to do this on a pocket calculator! Armed with my printout of coordinates I then plotted each one onto the back of wallpaper. Certain kinds of wallpaper are ideal as they have small indentations in the back to provide a key for the paste. These marks make it very easy to plot the points accurately. I then glued the paper template onto some plywood and carefully cut down to it. The next task is to think about the design of the actual profile device. I used a simple construction using a central axle and two castors. A point which may be overlooked is the fact that the profile needs some adjustment in height to allow for the various layers of mould. I raised and lowered the castors by drilling several location holes in the 'legs', this gave me three working heights between which I could change. Over the central axle I slipped plastic washers of various thicknesses to correspond to the changes in wheel height. Now I was ready to begin making the parabolic mould.

The bulk of the mould I made from some old slag I found discarded from the school boiler – any rubble, soil or sand is suitable for this part (see fig 1). There is no point in making the whole mould in solid concrete as it would be prone to severe cracking in bad weather. I built up the shape using my profile as a guide. I stopped building about 2cm under the profile to allow for a fairly thin layer of concrete. Again I mixed quite a wet mixture of cement to enable it to be easily used with the profile. Getting the mix right is really a matter of trial and error – too wet and an accurate shape is impossible to obtain, too dry and the profile is difficult to use. I left the concrete mound to dry out for a week before proceeding to the next stage.

The next stage was applying a skin of plaster. I went to several building merchants for advice on the plaster to use. I eventually came up with something known as 'fine casting plaster'. The plaster is quite cheap and very similar to plaster of Paris. I raised my profile about 0·5cm before applying the plaster. This allowed me to fill in any inaccuracies of the concrete and gave me a workable layer to sand down later. The plaster is a very strange substance to use as it 'goes off' and becomes unworkable in around ten minutes. With this in mind a very wet mix was made. This means that the work area becomes very messy with plaster flying around everywhere – old clothes are a must!

After a bit of practice an extremely smooth surface can be obtained straight from the rotating profile, this means that a minimum amount of sanding is required later. You must work very fast and get a good finish first time around as it is very difficult to remove once set should things go wrong. A word of warning here – at this stage I had not built myself any protection from the weather. I applied the plaster and left it overnight to set, unfortunately it rained heavily and in the morning hundreds of tiny pits had occured in the surface. I had to remove the plaster and try again, this is how I know that it is very difficult to remove! The plastering process is possibly the most important part of the mould construction and also one of the quickest. In a warm dry atmosphere the plaster should be completely hard after a day.

Once satisfied with the 'raw' plastered mould I began lightly sanding the shape by hand. The use of electric sanders is forbidden here as large flat areas are likely to be made. A fine grade of glass-paper wrapped around a rubber pad is the best way I found of getting a remarkably smooth surface. Whilst sanding you must keep checking the accuracy of the mould with the profile to make sure too much has not been taken off. After smoothing down, the mould should be sealed with some kind of varnish. I used three coats of shellac which gave the mould an almost 'wooden' appearance, it also gave a really high gloss finish which is essential if a clean release is to be made (see fig 2).

This glossy surface was polished further with the application of lots of beeswax mould releasing compound. Just to make sure I also applied some 'PVAL' which is again a releasing agent. With the mould completed, all that was left now was to 'lay the dish up'. I had heard of several systems of mould construction which are similar to this but use sand as the sole mould material. The sand is apparently sprayed with resin to form a solid surface. I think my method, which perhaps takes more time and effort, is probably more reliable than this. It is essential to end up with a very solid mould to work on. I fear that a sand mould sprayed with resin may well not be strong enough to use rollers on when 'laying up'.

'LAYING UP"

Before I took this project on I knew nothing about fibreglassing techniques. I owe all my knowledge to a local boat builder I contacted who was more than happy to lend me his expertise. There is more involved in GRP work than you may expect so I was glad of his help. To start with you must ensure good ventilation. As I have already said the fumes can be dangerous so beware. It is a good idea to have all your tools, resins, etc. close at hand in case you need to do any alterations quickly. Again resin is a material which becomes unworkable quite fast if it is in the right conditions. It is again a matter of trial and error for the 'novice' to decide how much catalyst is required to a certain amount of resin. If too much is used then resin can be wasted. This should be avoided as it is quite expensive. If not enough catalyst is added then the curing process will take a long time to complete. Also you must ensure that the catalyst is thoroughly mixed with the resin otherwise certain areas may not 'go off'.

Before 'laying up' begins it is essential to tailor the chopped strand mat. This simply means cutting out the fibreglass you are going to use so it can be swiftly positioned once laying up begins. For my dish I applied a heavy 'gel coat' and gave the whole mould a basic three laminates of chopped strand mat. These were layed at right angles to each other to maintain maximum strength. Fibreglass is a very versatile medium to use because everything does not have to be completed in one go. Fibreglass parts can be easily added to cured GRP as required – this means that any inserts or strengthening can be added on different days. On the back of my three laminates I secured eight cardboard ribs. The ribs were made by cutting strips of corrugated card and folding them into a triangular section. These were held together by masking tape.

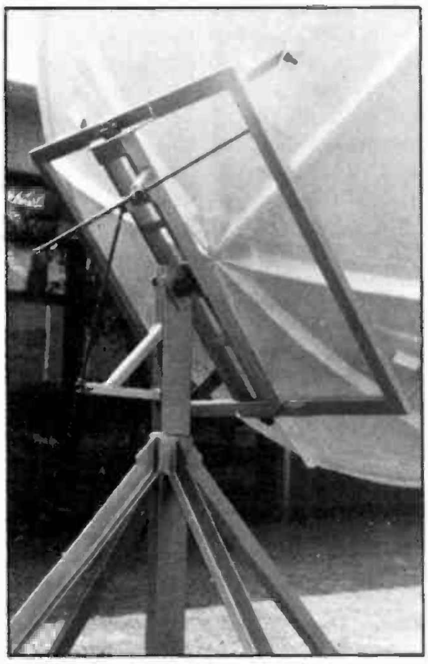


Fig. 3. *The use of a box section square to provide rigidity to the dish. Note the eight GRP ribs for the same purpose.*

Once the basic laminates have cured, the ribs can be held in place on the mould with more tape. It is then a matter of laying GRP strips over the ribs to hold them down and provide the strengthening required. I used eight ribs radially and one ring strengthener around the edge of the dish, this ring was made by laying in a rope. Again retrospectively it may have been better to just use several ring strengtheners as this would have perhaps made the dish more rigid with less weight. The whole point of the strengtheners is to stop the dish moving in the wind. A dish of this size has quite severe wind loading – if the dish moves by a centimetre in the wind then the picture will be lost. Now is the time to make provision for joining the dish to its mount. The way I did this was as follows. I cut out four large metal plates and bent them to approximately the shape of the back of the dish. Prior to this I had drilled lots of large holes in them to allow the resin to impregnate through. To these large plates I welded pieces of angle iron, these were to be the actual linkage points. The design I opted for is such that on the back of the reflector is a large square of box section (see fig 3). This is to provide more rigidity to the GRP. If your system is to have a similar part then the metal plates should be glassed in whilst joined to it. This 'in situ' method ensures that the dish anchorage points are in exactly the right position. Also the reflector does not distort at all if it is not properly cured.

Lifting the dish from the mould is perhaps one of the most satisfying parts of the project – that is providing it comes off cleanly! Releasing the dish again requires the help of more than one person. You start by making about 20 softwood wedges which are driven between the GRP and the mould. As you work your way around the dish several cracking noises may be heard. Do not worry unduly as this is quite normal. When you have forced in about ¾ of the wedges the whole structure should suddenly pop up off the mould. I found that a lot of the plaster had been ripped off with the dish. This is not a problem in one-off production as the mould probably will not be used again. I also found that the shellac had some kind of reaction with the fibreglass resulting in it being stained a pinkish colour, which I removed by wet and dry papering – this also revealed an excellent surface finish. The more work you originally put into the mould the better the dish will turn out.

GRP cures quite quickly, overnight in fact. I left my dish for a week however before I lifted it to ensure that it was

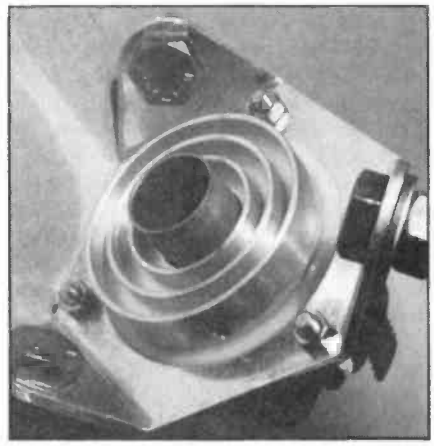


Fig. 4. *The scalar feedhorn for the 11Ghz band.*

properly cured. Once the dish has been cleaned up it is possible to carry out a few preliminary tests to make sure the shape is working. I did this by getting a friend to stand a distance away and speak whilst I held my head at the focus. Interesting effects are heard if things are working properly. By the way if you try this outside, beware of any aircraft that may be around. You could impair your hearing if you happen to be at the focus of the dish whilst a low flying aircraft

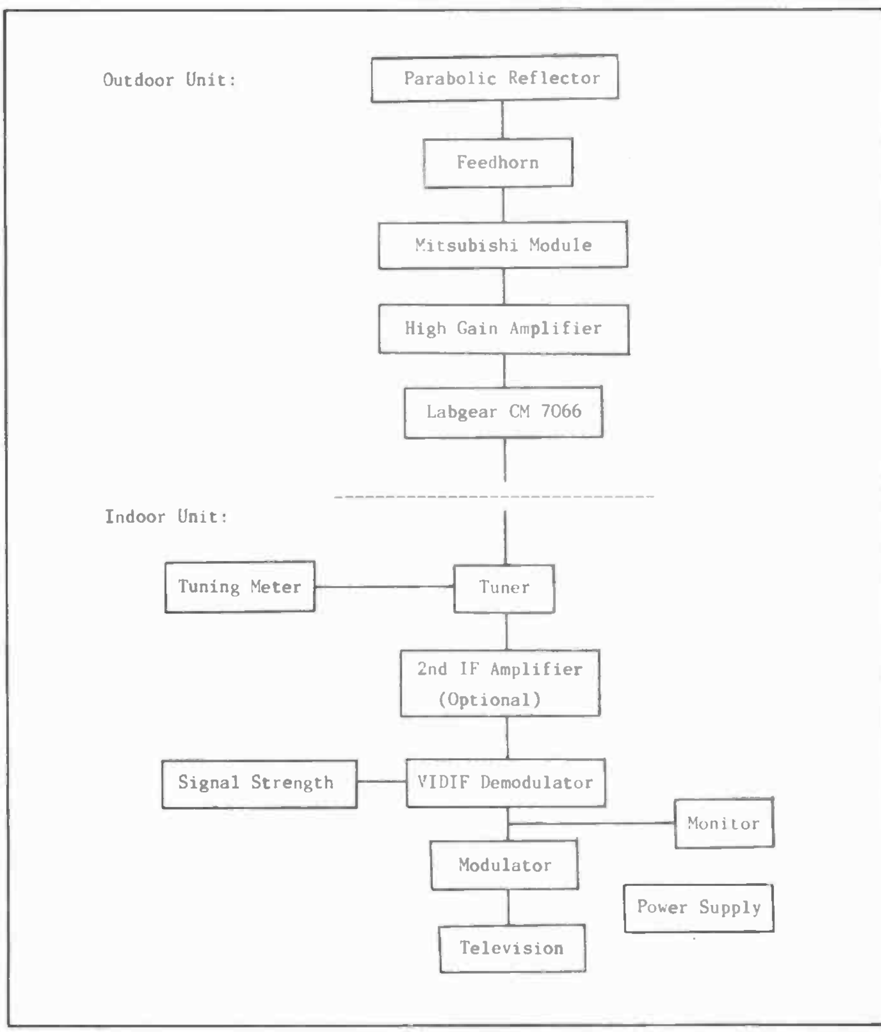


Fig. 5. *Block diagram of the complete system.*

passes over! If the dish is not working at this stage then it should be checked using a male version of the profile. If it has opened out or closed up during curing then it may need adjusting by attaching wires accross the front or back of the dish. Hopefully you will not need to do this if you have been careful during the other stages. Once you have built the reflector you must start thinking about the mounting arrangement.

THE MOUNT

I decided to use a Polar mount as it is easy to use once set up. Other mounts such as Az-El and fixed mounts may be easier to build, though, if you do not feel competent enough in metal work or you lack the facilities required. Actual design of the mount is a matter of personal choice. As long as the mount is sturdy enough to keep the dish still in the weather and it has provision for some kind of fine adjustment, then you should be OK. I constructed my mount out of very heavy pieces of scrap metal. Ideally the mount should be made from extruded sections of aluminium which would make the whole thing far easier to move around. I did not intend to move my dish once it was set up so I was not too worried about this. Some kind of calibration on the mount should be included so the elevation can be accurately set when lining up the dish. There are various novel ways of doing this. I simply drew a vertical line on the main stem of my dish and used a protractor to read off the elevation angle directly. This idea worked well after a bit of practice. An azimuth scale would be an advantage also although I do not think it is as important. If you can be sure of the elevation then it is just a matter of swinging the dish across the geostationary arc until a signal is located. Once positioned a mark can be made for future reference.

REFLECTIVITY

GRP is not reflective to 11GHz radio waves so a suitable coating must be applied to the dish's front surface. I spent a great deal of time researching this particular aspect of the project. All the magazine articles I read on the subject said to use kitchen foil bonded on with resin. This would work fine if you can do it! I tried sticking on foil but found the finish was very rippled and not really good enough. Also there was a problem finding a suitable adhesive which would stand up to the weather. With these problems in mind I set about testing various surfaces for microwave reflectivity.

I was lucky enough to be able to borrow a small microwave source from my Physics department. The microwave source literally enabled me to bounce microwaves off the surface to be tested and measure the relative strength. The surfaces I tested included aluminium paint, metallic 'flake' paint, bronze dust, graphite and nickel, among others. I found that the nickel worked just as well as kitchen foil. The nickel I used came in an aerosol form which I could simply spray the surface of the dish with. This provided both good reflectivity and an excellent surface finish. The nickel I used was of the type used for RF shielding purposes. It is available from RS Components for around £12 per can. I used two cans so it worked out quite economically when compared with the metal sprays and wire gauze used by the 'experts'. The microwave equipment I borrowed was also very useful to check the geometry of the dish. By mounting the receiver at the focal point and 'firing' microwaves at the dish from a large distance away I was able to confirm that my parabola was working as an amplifier.

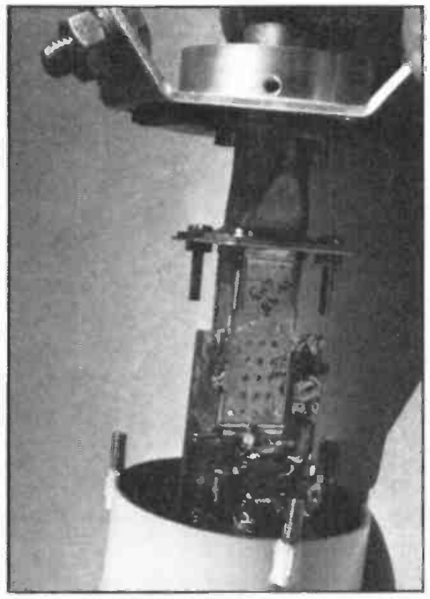


Fig. 6. *The low noise converter. The waveguide is screwed straight onto the Mitsubishi module and the high gain amplifier is soldered to this.*

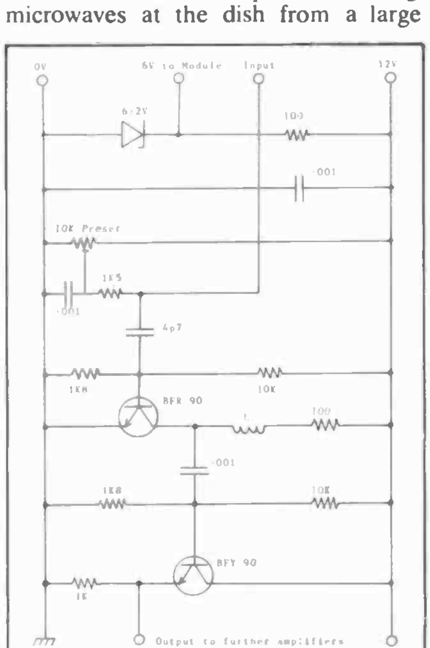


Fig. 7. *Circuit diagram of the high gain UHF amplifier used in the head unit.*

ELECTRONICS

This is potentially the most expensive part of the system. My aim was to build a larger than necessary dish to account for losses due to non 'state of the art' electronics. The trend nowadays is to make smaller and smaller dishes. The reduced amplification with a small dish is compensated for by very sophisticated electronics costing hundreds of pounds, way out of my reach! I am not trying to say that the electronic system I used is the best available, it is simply enough to get you going on a tight budget. It is possible to achieve worthwhile results using this system but with more money the picture quality could be significantly improved. I am about to describe the bare bones of a system.

LOW NOISE CONVERTER

This is usually the part that costs a lot of money. In most systems the head unit consists of the feedhorn, converter and LNA (Low Noise Amplifier). Out of these it is the LNA which is the most difficult to construct and the most expensive. Normally they employ GaAs FETS which are still expensive to buy off the shelf. Because of this fact I decided not to use an LNA at all but to just rely on my large dish, feedhorn, converter and a simple amplifier. The feedhorn I used was of the concentric ring type that is quite common now. These can be made easily providing you have access to machinery to turn such a device. Alternatively, a feedhorn can be made from PCB material and copper strip.

I was again pushed for time so I decided to buy one ready-made. I purchased one from Harrison Electronics for around £45 which is reasonable. The feedhorn they supplied me with consisted of the actual concentric rings made from a piece of turned aluminium mounted on a back plate. It has a wave-guide pipe and flange with a straight forward circular to rectangular transition (see fig 4). The feedhorn is intended to be used with dishes supplied by them so a slight amount of modification was required to enable me to fix the device onto my tripod. It is essential that the tripod is adjustable to allow the feed-horn and LNC unit to be mounted anywhere on the dish, just in case the focus does not appear where it should do! Also peaking of the focus is certain to be required when the dish is initially set up. I achieved adjustment by making three 'polycarbonate' mounting brackets which were screwed onto the edge of the dish. With the use of 'U' bolts and a curve on the mounting bracket I was able to make a very adjustable tripod. This is a point which is often overlooked and can be quite difficult to solve.

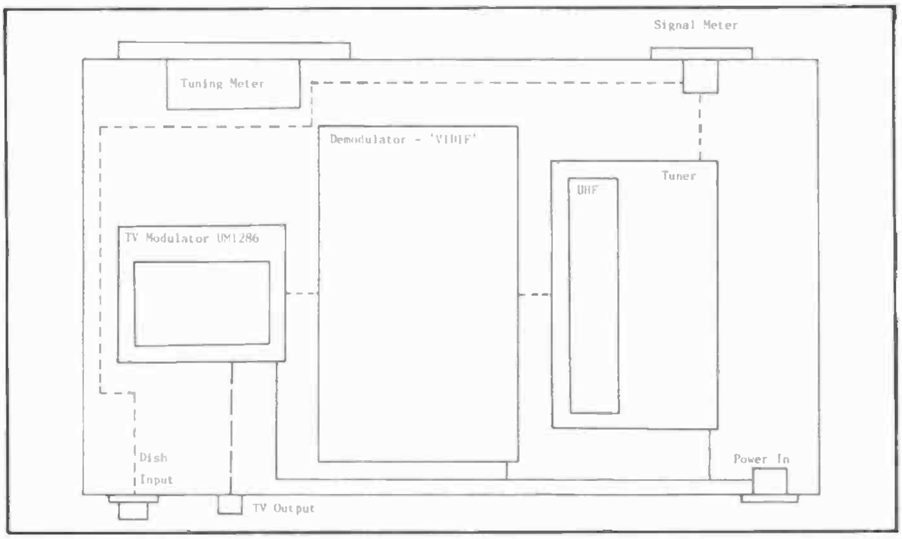
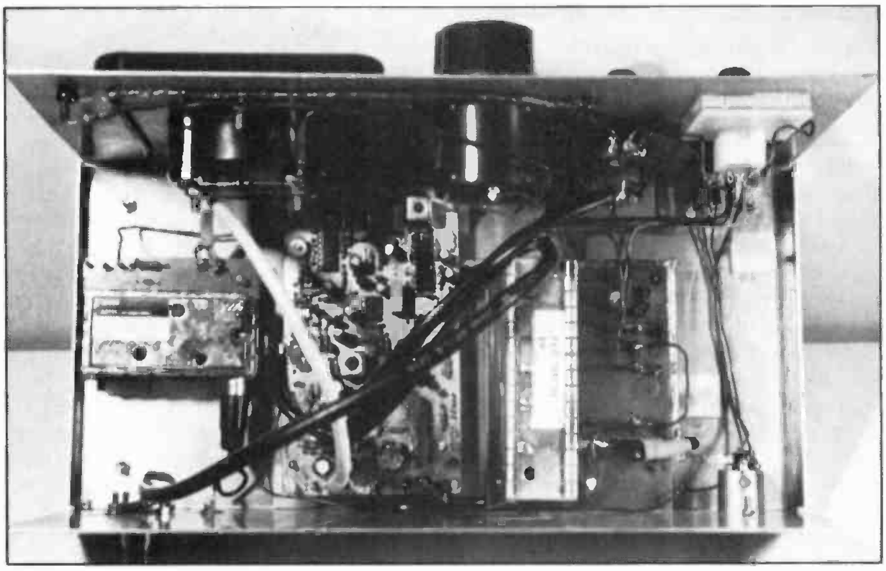


Fig. 8. *Internal layout of the indoor unit.*



Screwed onto the flange of the feedhorn's waveguide was the converter module. The module I used was the famous Mitsubishi Fo-Up 11kf. These were dsigned as microwave detectors but double up as an LNC at a reasonable price. I purchased mine for £30 last year from Aspen Electronics (although the price may have altered now). The unit does require some modifications to enable it to function correctly but is basically ready to go. Be careful to earth yourself when handling the device as static can play havoc with it given the chance! Mounted straight after the modules output pin is a high gain amplifier. This is relatively straightforward to build as long as UHF construction techniques are observed, double sided PC board, short track lengths, etc. I actually soldered the amplifier onto the back of the Mitsubishi module (see fig 6). This made a compact unit which was easy to get at should the need for operational modifications arise. I have included the circuit diagram of the amplifier (fig 7).

I had some difficulty in obtaining the transistors used in the circuit but I eventually found them at Norwich Electronic Components. I mounted the module and amplifier in a copper tube to avoid local signal breakthrough. In order to make the housing completely waterproof I made a rubber washer to seal the join between the feedhorn and tube. This also reduces any electrolytic effects between the two metals. The coax I used to couple the outdoor unit to the indoor unit was extremely low loss and in fact was old transmitting cable. Choice of cable is very important as losses at these frequencies can be very high. Consequently cable runs should be kept to as short a length as possible. The output of the converter is in the region of 500-800MHz depending on the signal being received. This means that normal TV UHF amplifiers can be used from now on. I used a Labgear CM7066 in my coax downlead to provide extra amplification. Several of these amplifiers could be used if need be. The power for the whole system comes from a 12V power supply which I will describe later.

INDOOR UNIT

Again I have tried to keep the indoor electronics fairly simple. The whole system is based on the 'VIDIF' board supplied by Wood and Douglas. The VIDIF is a wideband FM demodulator which is primarily intended for amateur radio applications such as slow scan television. The board is available either ready built for around £60 or in kit form for £40. The kit is quite simple to construct and set up, providing access to basic test gear is available. The VIDIF gives sound provision with a standard 6MHz spacing. This needs altering for satellite use as many different sound IFs exist. Perhaps the best way to do this is to build yourself a little variable oscillator. It should have a range of 0·4MHz to 1·5MHz, this should be mixed in with the sound input signal to produce a difference frequency of 6MHz from 6·4MHz to 7·5MHz. This is a technique commonly used in Europe where several sound IFs are in operation. The oscillator should be tunable from the front panel of the indoor unit as this makes for simple adjustments for the various channels.

Preceding the demodulator board is the UHF tuner, which can be of any type. The output from the dish I fed straight into the tuner's input pin. You may find that an extra amplifier between the demodulator and the tuner helps. I however found it made little difference. The tuner requires a 30V supply to operate the 'varicap' system, this is provided by a diode tripler in the 12V power supply.

That basically is the complete system. In fact I added a UM1286 modulator after the 'VIDIF' so I could connect up

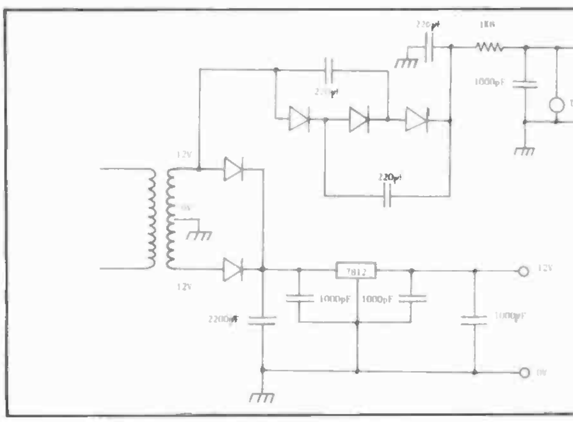


Fig. 9. *The power supply for the system, 12V for the LNC and demodulator and a variable 0 to 30V supply for the varicap tuner.*

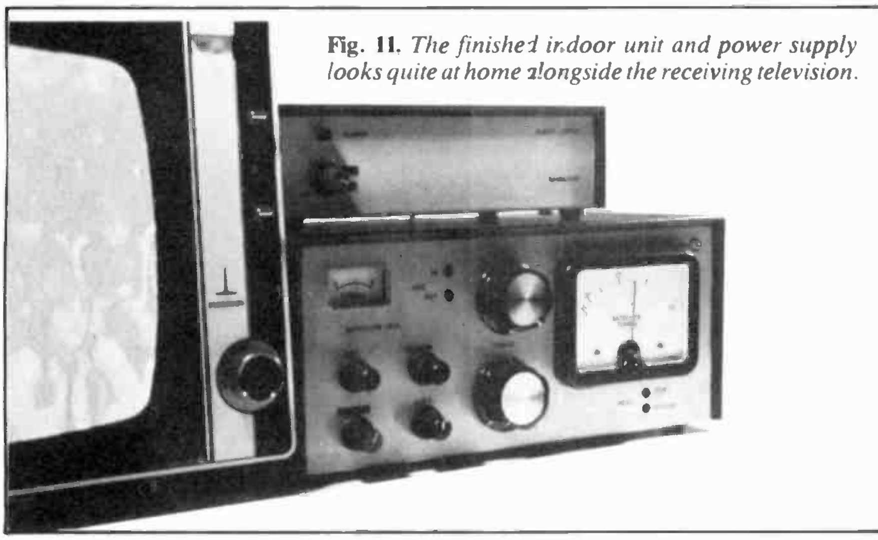


Fig. 11. *The finished indoor unit and power supply looks quite at home alongside the receiving television.*

ACKNOWLEDGEMENTS

I would be lying to say that I completed this project entirely by myself and received no external guidance. I was continually surprised at how willing large companies and individuals were to help me. For detailed information on the various aspects of such a project a polite letter to an appropriate company can pay dividends. There have been many people who have helped and encouraged me over the past two years. I would like to thank all of them. I would particularly like to thank Ray Curtis, Alan Wright, Tony Benson, John Randle and Oliver Matthews for all the practical help and advice they have given me, also Paul Wright of Paul Wright Mouldings Ltd who gave up his own time to help me mould the dish. I must also thank my school's Physics department, RC Snelling TV Ltd and the Marconi group of companies which have all been most helpful. PE

to a TV or monitor. Taking the output straight from the VIDIF into a monitor may be easier to begin with. If you are to use a modulator which tunes to channel E36 then beware that the signal you are trying to receive does not belong there as well or problems may arise.

It is a good idea to screen each individual part of the indoor unit. Local signal breakthrough can be a problem if precautions are not taken. You may spend hours trying to tune into some strange cultural programme on 'The Arc Channel' only to realise that you are actually watching channel 4! Some of these seemingly obvious points are often overlooked in articles written for beginners so I think they are worth stating. It is also a good idea to have a prominent OV rail running through the indoor unit which should be set up in such a way as to avoid feedback loops. If the individual parts of the system are wired together haphazardly then potential problems of feedback may go unnoticed. I wired in a Ov 'loom' made from coax braiding flattened and tinned with solder. This made consequential wiring up simple and easy to follow.

The power supply for the system produces 12V for the LNC and demodulator and has a 30V output for the varicap tuner. The circuit (see fig 9) is quite simple and of standard design except maybe for the trebling achieved by the diodes. This is quite clever in operation. The 220 micro Farad capacitors 'stack' the voltages on top of each other producing quite high values, somewhere around 50V after the third diode so make sure the capacitors used are of an appropriate rating. The transformer itself should be of 500mA and upwards. I used a 1·5A model just to keep everything running without building up too much heat. The TAA 550 and the 7812 regulator can become quite warm in operation so watch out if you are poking around inside!

The 12V for the LNC can be fed down the coax line along with the signal and using capacitors and inductors to separate the components out at either end, or a separate power lead can be used. I used a 12V line going out to the dish, the OV return line being provided by the coax outer.

The whole point of me building this system was to enable me to receive the cable channels currently being broadcast by the Intelsat and Eutelsat satellites. There is no point in listing all the channels here as they are frequently changing and there are lists available in various magazines. Finding the satellite is a lengthy process if you have not got any specialised equipment. I found the best way was to tune through the frequencies whilst an assistant swung the dish through what you think is the geostationary arc. With small adjustments in elevation, the satellite should eventually be found.

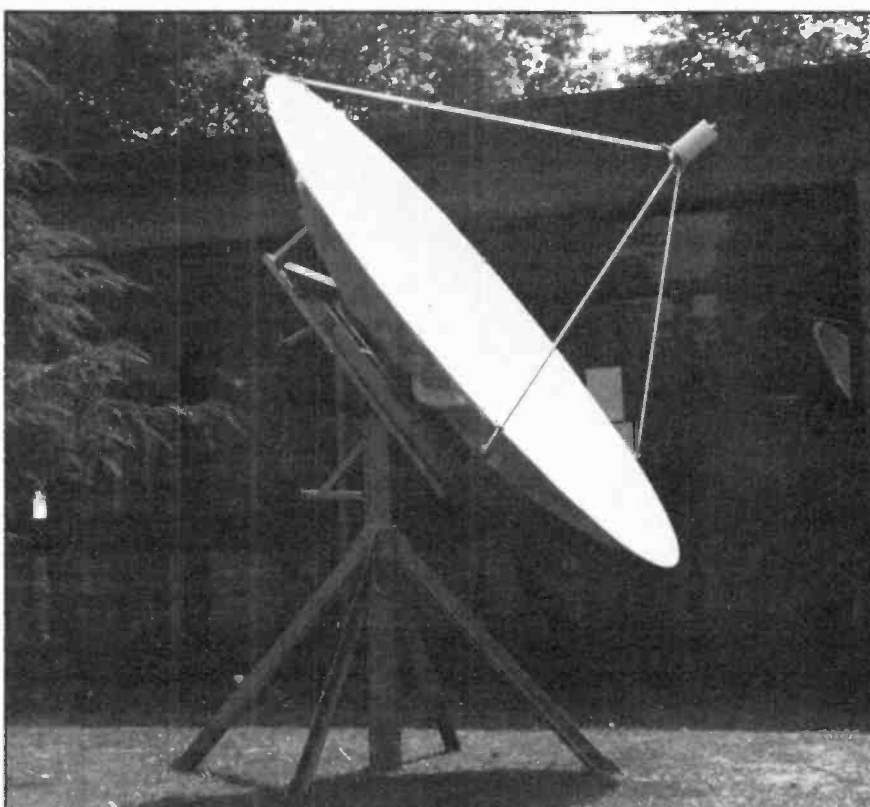


Fig. 10. *The completed outdoor unit.*

Using this system you should be able to receive reasonable but noisy pictures from several different channels. There is no doubt that the addition of an LNA would make the quality of reception far better, certainly as good as terrestrial broadcasts. If you are like me and cannot afford such luxuries then you will have to make do! PE

WIRELESS BABY ALARM

BY R.E. HEAD

Mind at rest when baby at rest!

A through-the-mains audio transmitter and receiver gives a neat solution to messy intercom wiring. Simply plug it in and listen in any room in the house!

Most Baby Alarm systems are hard-wired, and involve running long lengths of thin, rather vulnerable, cable around the rooms, up the stairs etc. Apart form the inherent disturbance and untidiness this leads to, there is little flexibility if it is necessary to move either transmitter or receiver around the house.

The units described in this article were designed to get around these problems by using the household mains wiring. This allows either transmitter or receiver to be located in any room, and easily moved at will. The units can even be used whilst gardening, plugging the receiver unit into a three-core mains extension lead.

Referring to the block diagram, the transmitter unit comprises a frequency modulated oscillator running at approximately 360 kHz., at which the home power wiring presents a fairly high impedance. The modulating signal is provided by a capacitor microphone coupled with an integrated circuit which both amplifies the microphone signal and compresses it. This makes the system sensitive to both whimpers and cries!

The receiver unit has a limiting amplifier tuned to the incoming signal at 360 kHz picked up from the mains wiring. This drives both a signal present detector (to light an l.e.d), and a phase-lock-loop Fm demodulator. The output from the demodulator is passed via a filter and volume control to an integrated circuit audio amplifier and hence to a small loudspeaker. My prototypes of these units fitted into small "Veroboxes".

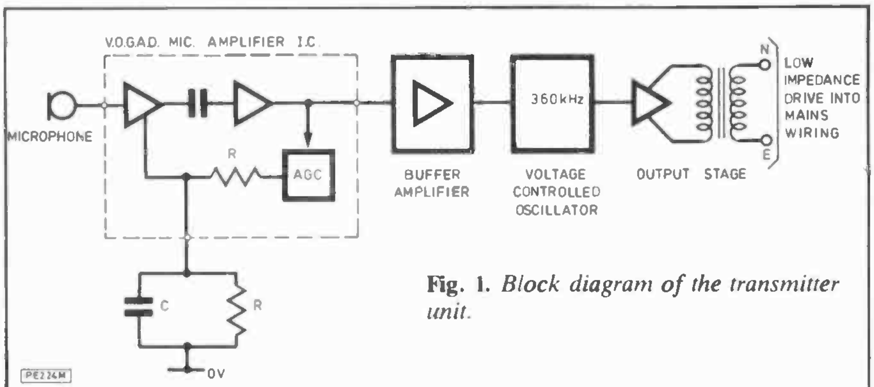


Fig. 1. *Block diagram of the transmitter unit.*

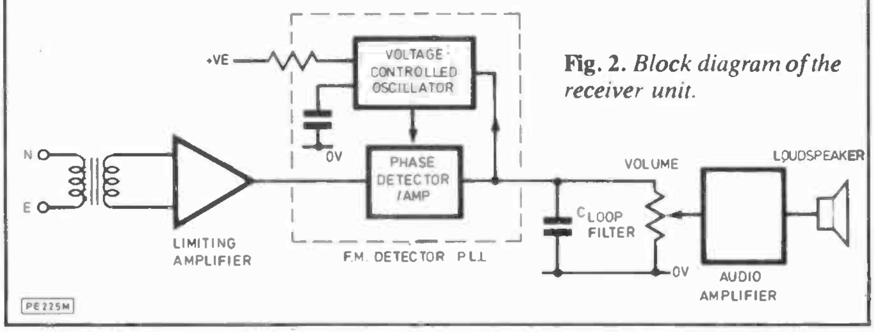
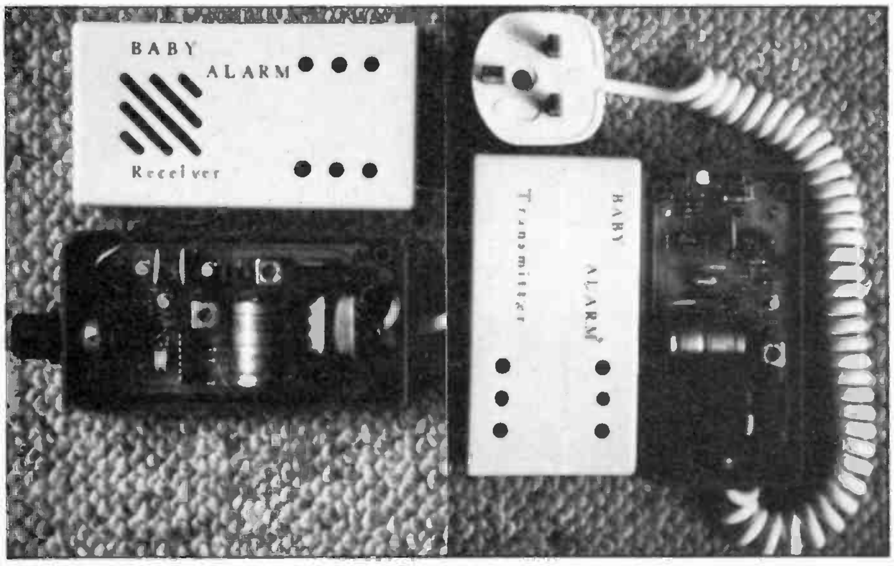


Fig. 2. *Block diagram of the receiver unit.*



TRANSMITTER CIRCUITRY

The capacitor microphone, powered by R2, is connected to the microphone amplifier, IC2, an Electromail Voice Operated Gain Adjust Device (VOGAD) integrated circuit. This device offers some 40dB of gain at maximum sensitivity, reducing to 20dB with high level input signals. It is similar to that found in some domestic cassette recorders offering automatic record level control. The attack/decay characteristic of this AGC circuit is controlled by R1/C3 and is really rather subjective. I have set the attack time to 8mS, and the decay time to 0·5S. The attack time is A = 0·4mS x C3 (0·4x22 = 8·8mS). The decay time is determined by R1, C3, the discharge time of the capacitor.

The output of IC2 is buffered and amplified by IC3, an operational amplifier. The gain of this stage is set to approximately 6.

The frequency modulated oscillator is a 74 series TTL voltage controlled oscillator integrated circuit. This has its

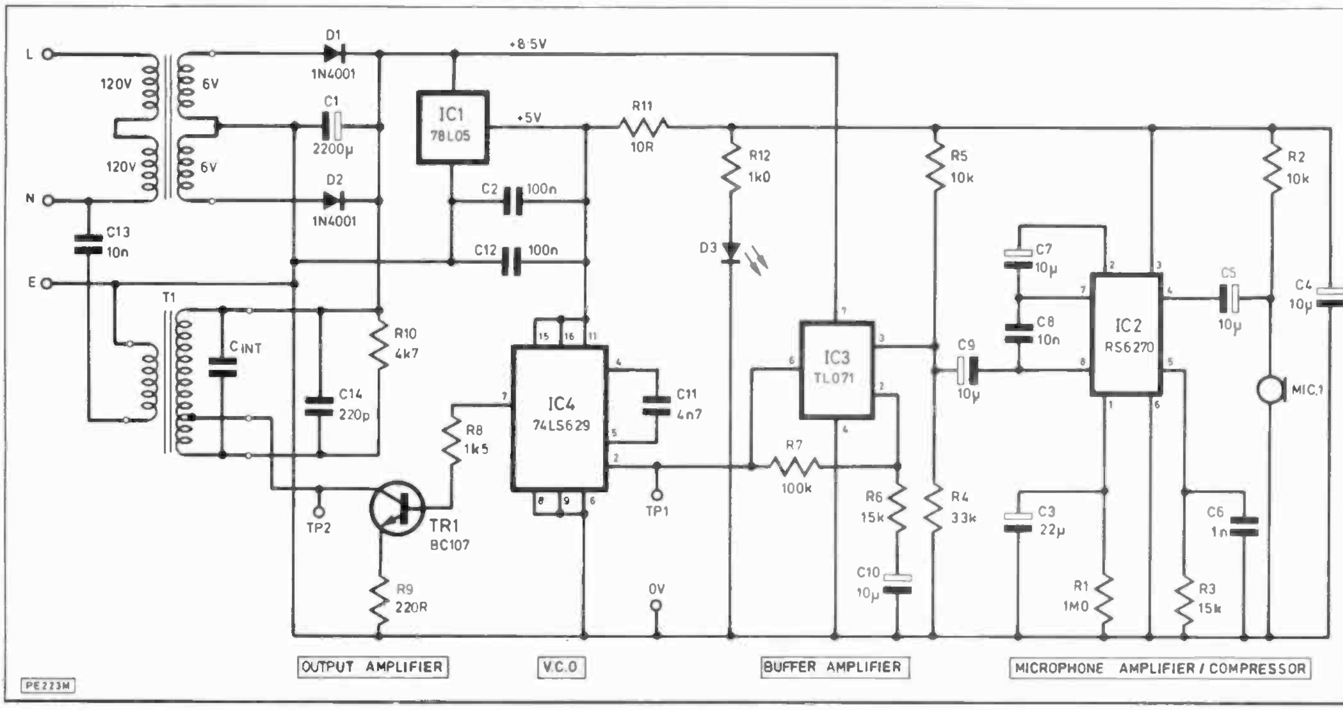


Fig. 3. *Transmitter circuit diagram.*

frequency determined simply by C11, and is set to a centre frequency of 360kHz. The modulating voltage varies the oscillator frequency by +/− 10% maximum deviation under normal use.

The output of this oscillator is buffered by TR1, with a tuned transformer output stage. The coil/capacitor parallel tuned circuit is damped by R10 to cover the 72kHz range of the oscillator. This has the effect of reducing the Q very considerably, but making the output stage extremely easy to tune.

The secondary of this transformer is coupled into the mains via C13 and drives between neutral and earth. The neutral and earth of the mains are linked at the local sub station, but since that is a distance away adequate signal is available throughout the house. The transformer specified (see parts list) is a standard IF transformer with integral tuning capacitor normally resonant around 450kHz. In this design C16 lowers this frequency to 360kHz.

RECEIVER CIRCUIT

The receiver detects the incoming signal between neutral and earth using the same type of coil as the transmitter uses. This is damped to cover the required range and amplified by TR1 driving a second tuned circuit. The secondary winding on this drives the phase-lock-loop integrated circuit, an NE565, arranged as an FM detector.

The oscillator frequency is set by R14, C10, (Fo = 1·2/4 x R14 x C10), to be approximately 360kHz. The phase detector output is filtered by C16, R13 and C18 and coupled by the volume control to the LM380 audio amplifier driving an 8ohm loudspeaker. TR1's collector when receiving the FM signal has several volts at 360kHz on it. This is rectified by D1 and smoothed by C9. The resultant positive voltage biases on TR3 and illuminates the signal present lamp. When no signal is present, TR2 is biased on by R11, R12 which has the effect of muting the audio signal, and avoiding the unpleasant hissing noise of the phase-lock-loop IC trying to lock onto no signal.

These units were designed onto printed boards to fit into small plastic veroboxes – see parts list. If a different type is selected, bear in mind that mains is on the printed board and that the box should be fairly rigid. The units can be produced on stripboard, but the finished units will be rather larger. Also, the IF transformers specified will not readily fit onto 0·1 inch pierced board.

TRANSMITTER CONSTRUCTION & TESTING

Assemble all the components except R10 onto the printed board. The tags on the mains transformer should be inserted with care, as it is possible to break the primary winding connections from the

COMPONENTS . . .

TRANSMITTER

RESISTORS

R1	1M
R2, R5	10K (2 off)
R3, R6	15K (2 off)
R4	33K
R7	100K
R8	1K5
R9	220
R10	4K7
R11	10R

CAPCITORS

C1	2200 μ 10v. electrolytic
C2, C12	100n disc ceramic 30v. (2 off)
C3	22μ 6v. tantalum
C4, C5, C7, C9, C10	(5 off) 10μ 6v. tantalum
C6	1n polystyrene
C8	10n disc ceramic 30v.
C11	4n7 polystyrene (2% type)
C13	10n disc ceramic 1kv.
C14	220p polystyrene (2% type)

SEMICONDUCTORS

IC1	LM78L05 Voltage regulator
IC2	SN 74LS629 Dual VCA
IC3	TL 071 Operational Amplifier
IC4	RS 6270 VOGAD Circuit
TR1	BC107 or BC108
D1, D2	IN4001 1 amp rectifier diode (2 off)
l.e.d	¼ inch

MISCELLANEOUS

IF transformer Cirkit Holdings YRCS 11098; transformer, RS 207-829, pcb type 6v. 3VA.
MIC1, microphone, miniature electret type, two wire;
Printed Board PE order code PE125, box 120x65x40mm, grommet, mains Lead etc.

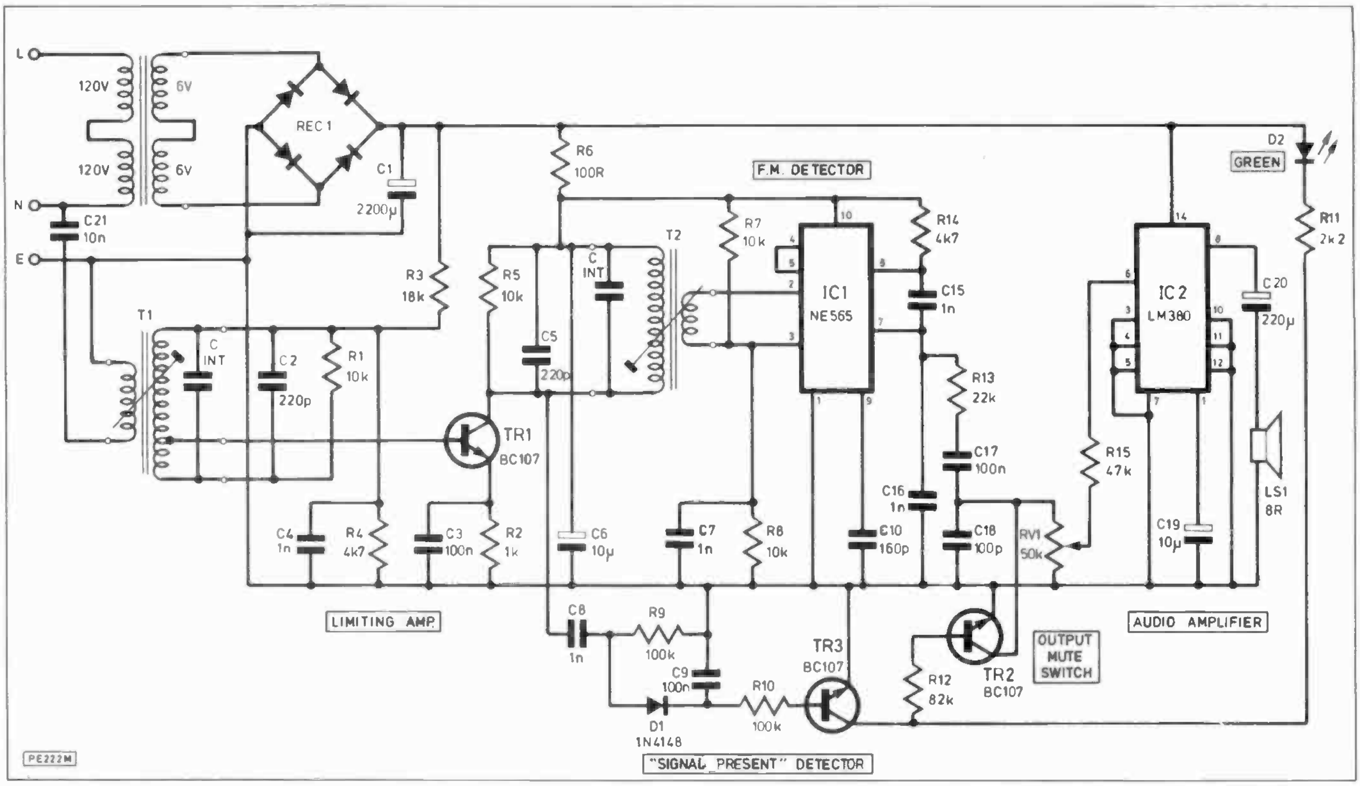


Fig. 3. *Receiver Circuit Diagram.*

tags if forced. Open out the holes on the board if necessary. Additionally, the case tabs on the IF transformer require slotted holes. This transformer has an orange core. Wire a three core 3-5 amp mains lead of the desired length to the printed board. Whilst testing the unit, it is worthwhile fixing a short length of insulating tape to the copper side of the board over the mains transformer connections. This prevents accidents! For safety's sake, when the board is ready for testing, fit it into the box base before applying power. To hold the board, use four off 6 x ¼ inch screws. The base needs holes drilled for the mains lead at one end, using a grommet and a cable clip of some sort. At the other end of the box drill two holes, one a press fit for the microphone, the other for the l.e.d.

When ready, apply power to the unit. The l.e.d. should glow dimly. With a voltmeter, check the volts across C1, which should be in the order of 8-9 volts. Then check the voltage across C2 which should be 5 volts.

Test voltage between oV tag and TP1, this should be 3·8 volts, and if an oscilloscope is available the amplified signal from the microphone should be observed (approximately 600mVp/p). If an oscilloscope is not available, fit R10, and carefully adjust the IF transformer core to the top, then screw in half a turn. If an oscilloscope is available, connect probe to TP2, and adjust the core of the transformer for maximum signal amplitude. Then fit R10.

The lid can now be fitted to the box. If it is envisaged to use the units for long periods of time (i.e. more than 5-6 hours) drill several small holes in the lid of the box to ventilate the mains transformer – see photographs.

RECEIVER CONSTRUCTION & TESTING

Assemble all the components onto the printed board, with the exceptions of R1, R5 and TR2. As I have noted in the details on transmitter construction, observe caution when fitting the transformers on the board, also please fit the board into the box base before applying

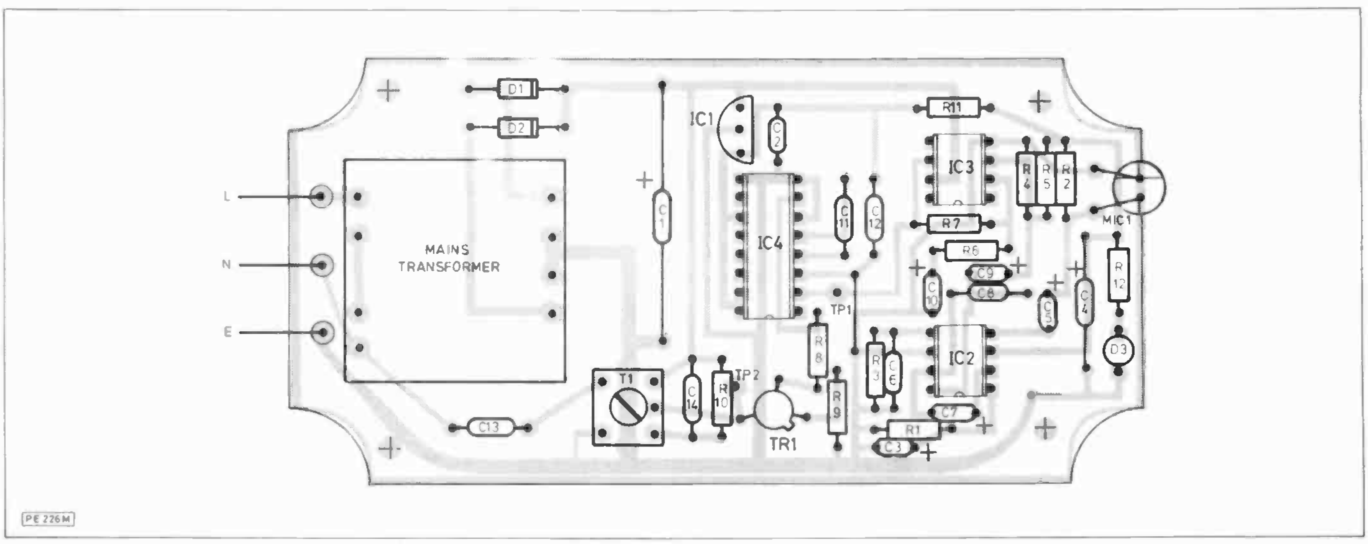


Fig. 4. *Transmitter p.c.b. component layout and wiring details.*

COMPONENTS . . .

RESISTORS

R1, R5, R7, R8	10K (4 off)
R2	1K
R3	18K
R4	4K7
R6	100
R9, R10	100K (2 off)
R11	2K2
R12	82K
R13	22K
R14	4K7 2%
R15	47K
VR1	50K logarithmic miniature

CAPCITORS

C1	2200μ 25v. electrolytic
C2, C5	220p polystyrene (2 off)
C3, C9, C17	(4 off) 100n disc ceramic
C4	10n disc ceramic (miniature)
C6, C19	10μ 6v. tantalum (2 off)
C4, C7, C8, C15, C16	1n disc ceramic (minature)
C10	160p polystyrene (2% type)
C18	100p polystyrene (2% type)
C20	220 μ 16v. electrolytic
C21	10 n 1kv. disc

RECEIVER

SEMICONDUCTORS

IC1	NE565 phase-lock-loop
IC2	LM380 audio amplifier
TR1-TR3	BC107 or BC108
REC1	1 amp bridge rectifier (round type)
D1	IN4148 diode
l.e.d.	¼inch

MISCELLANEOUS

IF transformers, Cirkit Holdings, YRCS 11098, YHCS 11100; transformer, RS 207-829, pcb type 6v. 3 VA; loudspeaker, 8 ohm 2" diameter, (small magnet type, not the ceramic types now available) Printed Board PE order code PE125, box 120x65x40, Grommet, Mains lead etc.

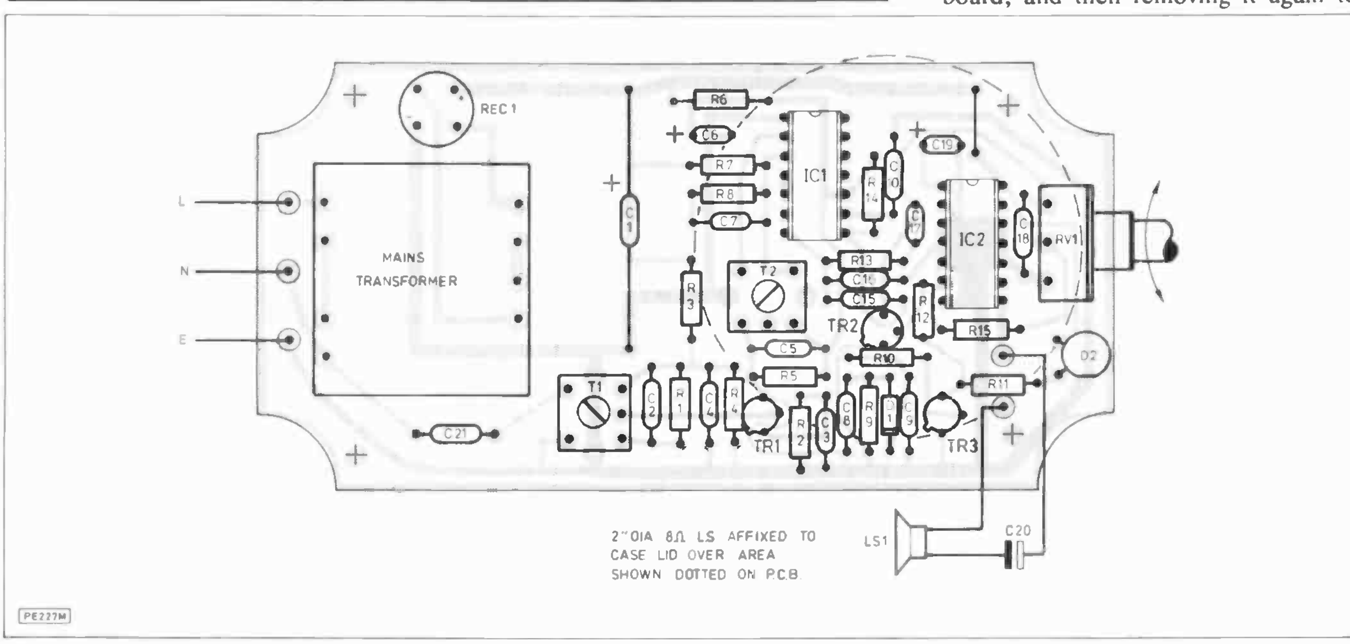


Fig. 5 *Receiver p.c.b. component and wiring details.*

power, as mentioned previously. The two IF transformers are colour coded, the interstage coil is roughly in the centre of the card, and has a black core, the mains coupling coil is at one side of the board, and has an orange core.

For testing purposes, wire the loudspeaker and coupling capacitor up to the board, and drill the box base for the mains lead and potentiometer slightly oversize, as the board can only be slipped into the box at a slight angle.

Apply mains to the receiver unit, (without the transmitter on), and check voltage across C1, which should be in the order of 18 volts. Advance the volume control. A loud rushing noise should be heard from the loudspeaker, without the l.e.d. lit.

Plugging the transmitter in a socket in an adjacent room should cause the l.e.d. to light the receiver, and the rushing noise to stop. If no oscilloscope is available, adjust both IF cores carefully for maximum l.e.d. brightness. However, if you have access to an oscilloscope, connect the probe to TR1's collector (the can) and adjust the cores for maximum signal amplitude. R1 and R5 can now be fitted. TR2 is the noise mute transistor, and when the receiver is working and the signal from the microphone can be heard satisfactorily, switch off, and fit TR2. This should not alter the normal operation of the units, but if the transmitter is not plugged in, the receiver should mute the noise from the phase-lock-loop chip.

The loudspeaker can now be fitted in the lid of the box. As marked with dotted lines on the board layout, fit the loudspeaker and capacitor with glue onto the plastic. I used Bostic for this, which so far has worked satisfactorily.

CONCLUSION

I have built a total of three of these sets, all of which worked more or less first time. The faults I had, apart from fitting the wrong components in the p.c.b.(!), were with the IF transformers. I had one or two of these with shorting primary turns. This was probably bad luck, but if in doubt measure the primary resistance of the winding which should be similar on all three transformers.

Another fault was with the mains transformer, as I mentioned earlier. The fitting of this component should be done with care, in fact I ruined one transformer by carelessly pushing it into a board, and then removing it again to make some measurements. This effectively open circuited the primary windings!

During testing, if an oscilloscope is available, measure the period of the oscillator frequency on the transmitter. This should be in the order of (1/360kHz.) = 2·78μS. Then frequency of the oscillator in the NE565 PLL integrated circuit can be measured at C10, and should also be running unlocked at around about 360kHz. If more than 20% wrong then adjust R14. In the units I made all were within about 10-15% so there should be no problem. PE

INDUSTRY NOTEBOOK

REPORT BY TOM IVAL – PEs NEXUS

The information society is coming. Expert systems software is big business and most hardware firms are catching on as information and knowledge become more important than capital and labour.

IF the electronics industry is any guide we certainly seem to be moving towards 'the information society' propounded some years ago by Daniel Bell, the Harvard University sociologist. The trend appears to be away from sheer production and selling of hardware towards the supply of services and systems which make use of the hardware in a very selective way. New firms are springing up everywhere to do this application work. Computer manufacturers, seeing the light, are buying up software companies and the rights to sell expert systems developed elsewhere.

Ferranti Computer Systems, for example, has just completed its first year as main European distributor for an expert system development tool, Inference Art, from the Inference Corporation of Los Angeles. Sperry has bought the American software company Foundation Computer Systems. Hewlett-Packard has just started to market a software package for the management of maintenance work. Called Maximo, it was developed by the US firm Project Software and Development. H-P has also launched an educational system for controlling test instruments from a personal computer – any computer, not just their own.

SOFTWARE KNOW-HOW

Of course computer manufacturers have always produced their own proprietary software and systems. But they recognize that pure software companies have a more intimate knowledge of and involvement with particular needs in industry, commerce and public services. The very existence of the software firms depends on this close relationship. As an example take the UK firm West Wiltshire Software. This supplies software to over 60 local authorities. Its effectiveness rests on its intimate knowledge of the work of local government. And it gets this knowledge because it is actually owned by a local authority – West Wiltshire District Council.

The current recession in computer manufacturing is generally thought to be part of a business cycle. An upturn is confidently expected. But it could prove to be partly structural as well – like the general decline in manufacturing throughout the industrialized world, accompanied by permanently high levels of unemployment and an expansion of service industries.

Two other applications of information technology are becoming highly significant in industrialized society. One is the powerful combination of data transmission and information retrieval (see Barry Fox on electronic mail in the March issue and Industry Notebook on electronic finance in October). The second is automation in manufacturing industry, which is steadily moving away from the original mechanical methods to systems controlled by electronic data processing.

As an example, the time required for dimensional inspection of metal components like transmission cases is now being reduced by as much as 80–90% through the use of co-ordinate measuring machines based on microprocessors or microcomputers. Here the latest development is to program these machines not by the slow and laborious business of moving a probe over a specimen workpiece but directly from design information stored in the database of a CAD (computer aided design) system.

SOCIAL PATTERNS

All these developments can be seen merely as an intensification of the methods by which information is represented, recorded, manipulated and transmitted. In the beginning we had characters inscribed in stone or clay, then on papyrus and paper. When telegraphy and computers came along the characters were represented by electrical states and signals. But 'the information society' as envisaged by Bell is not simply more of the same thing. It is a qualitative change in the whole structure of society.

Early societies were shaped by the brute fact of scarcity. Then agriculture developed. Land became the major resource, industries were extractive, and we had feudalism. The Industrial Revolution made it possible to manufacture huge quantities of goods cheaply. Capital and labour became the principal resources. Social relations hinged increasingly on money. The labour theory of value was conceived. Problems of food supplies and production of goods are now soluble. Indeed some countries are already experiencing over-production in agriculture and over-capacity in manufacturing.

The next transformation, according to Daniel Bell, is to a social framework based on information and knowledge as main resources rather than capital and labour. Machine technology derived from crafts and trial-and-error methods will be replaced by 'intellectual technology' using scientific method and decision rules. The 19th-century labour theory of value has already been weakened by automation and robots. Labour is being replaced by knowledge and its applications as the new source of added value. In all this, systems for storing, retrieving and processing the information are crucial to the new social framework.

Is this concept of 'the information society' likely to become a reality? Only the historians of the future will be able to say for sure.

JAPANESE HELD OFF

The United States of America has succeeded where the European Community of nations has failed – in keeping the undercutting Japanese traders at bay.

Last year the EEC asked Japan to set an overall limit on its exports to the community. The Japanese government refused this request, saying they would not accept any quantitative target whatsoever. But this year, after a protracted argument lasting for months, the US Department of Commerce managed to get the Japanese chip manufacturers to increase the prices of their semiconductor products in the USA. Apparently the most persuasive part of the Department's argument was that, if no agreement was reached amicably, the US would impose an import duty on the Japanese chips.

Furthermore the Japanese manufacturers have agreed not to sell abnormally cheap products to other countries which might then re-sell them in the USA.

American chip manufacturers, who have secured only about 8% of the semiconductor market in Japan, have long been accusing the Japanese firms of dumping on the US market and so undermining the American electronics industry.

CRUNCH TIME

Since I reported earlier this year on GEC's proposed takeover of Plessey and on the fiasco of the Nimrod airborne early-warning radar, a great deal has happned on both these fronts. In fact they have become linked. Plessey is involved in a possible alternative to Nimrod.

First of all the GEC £1.18 billion bid for Plessey is off. The Monopolies and Mergers Commission has ruled that such a merger would not be in the public interest. It would result in one group having too much of a monopoly in telecomms and military electronics manufacturing in the UK. However, the Commission did suggest that there could be some kind of rationalization in the manufacture of System X electronic exchanges. At present both GEC and Plessey are making them.

EARLY WARNING

As for the airborne early-warning radar, the Government has become thoroughly fed up waiting for GEC Avionics to get the Nimrod system to work properly. After continually stressing the need to reduce public expenditure they are embarrassed to find they have spent some £900 million of taxpayers' money so far to no effect. So the Government has delivered an ultimatum to GEC: either produce a satisfactory system by the end of September or take your place among a string of other firms bidding for the same contract.

BRITISH INTEREST

Five other firms are interested and have submitted proposals: Boeing, Lockheed and Grumman (all American), Marshall Engineering and Airship Industries (British). The Boeing proposal is a version of the existing American AWACS radar (Airborne Warning and Command System) and includes agreements with the UK firms, Plessey, Ferranti and Racal on electronics and software. If the Nimrod project fails the Government will make a firm decision at about the end of 1986.

PE

REPORT BY TOM IVAL
PE's NEXUS

No more chip dumping in the US from Japan

DON'T MISS THE CHRISTMAS SPECIAL ISSUE!

PRACTICAL DECEMBER 1986

ELECTRONICS

IT'S A BIG ONE!

*CHRISTMAS BUYERS GUIDE AND SPECIAL OFFER

*MICRO FORUM IS BACK With ideas for all home micros

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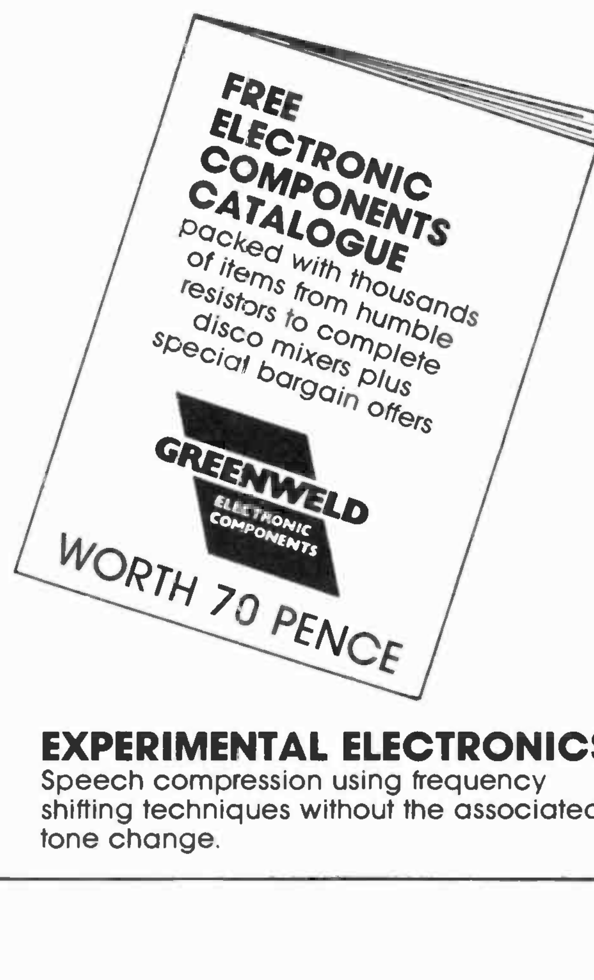


EXPERIMENTAL ELECTRONICS
Speech compression using frequency shifting techniques without the associated tone change.

ON SALE FRIDAY 5th DECEMBER

Continued from last month . . .

The programming voltage (Vpp) is generated on board. There is a Vpp supply rail provided on the PEHB, but this was not used for this programmer for the following reasons.

1. Some eproms require different Vpp levels, such as +12.5V, +21V or +25V. It would be difficult to derive these levels neatly from an off-board supply.

2. Those people who may wish to build the programmer to operate without the PEHB will need a Vpp supply.

For those who will only need one Vpp level, the link LK3 can be changed which will connect the off-board Vpp supply into the programmer. In this case IC11 and its associated components may be omitted.

IC11 is a switching regulator unit, which provides a step-up voltage conversion without the bulky inductors normally required. The component values shown will give a maximum Vpp level of around 26–27V. This can be set accurately using VR2. The voltage divider chain VR2, R9, R10 and R11 within the feedback loop enables setting the Vpp to other values. This is done by linking VPC2 or VPC3 to VPC1 via the configuration socket, so selection of the correct level is automatic when the correct type header is inserted.

VPC1 to VPC2 will give Vpp=21V while VPC1 to VPC3 will give 12V.

The LED, D5 serves as a Vpp ON indicator. In fact it shows that 5V is switched through to IC11 by relay RLA.

The 5V (Vcc) supply to the Zero Insertion Force (ZIF) programming socket is also switched. This reduces any possible problems arising from attempting to insert/remove eproms into a live socket. This switching is carried out by relay RLA. This relay is energised through IC9a, a high current output NAND gate. The inputs to this gate are the host reset line HRST which must be inactive (high) and the 5V control line (PON) which must be active (high).

The yellow l.e.d., D6, provides a visual indication that the ZIF socket is powered up, i.e. it is not safe to insert/remove an eprom.

Some eproms, e.g type 27128 or 27256, employ a fast programming algorithm. To use this programming method requires:–

A. A machine code driver program.

B. A means of switching the supply rail to the eprom *to 6V.*

The machine code driver will have to be written to suit the processor in use, but a simple means of switching and routing the 6V supply is provided by LK4. This utilises the PEHB supply rail provided for an external Vpp supply which should be set to 6V. If it is not required to use this facility then a link should be soldered in the PCB at the LK4 position between c and a.

The fast programming algorithm will be detailed in the data sheet for the eprom type in question.

This only, leaves the configuration header to describe. This feature, whilst not unique, is without doubt the most cost effective means of providing a flexible programmer.

The configuration header consists of two parts, a 24 pin IC socket and a 24 pin header of the type designed for solder connection.

As can be seen from the circuit diagram, all those lines which may need to be connected to different eprom pins are brought to the socket.

All those points to which the above lines may need to be connected are also brought to the configuration socket. Placing a header into the socket, with suitable points linked together configures the programmer to the eprom type in one easy step.

The real beauty of the system is that with the available lines almost any type of non volatile 24/28 pin memory device can be read by making the correct links on the header.

To aid in understanding the functions and facilities of the configuration header the lines available are shown in Fig. 2 and Table 2.

Table 2. *Configuration Socket assignments*

Pin 1. Address line EA11.	PIN 24. ZIF skt pin 2
Pin 2. Address line EA12.	PIN 23. Zif skt pin 20
Pin 3. Address line EA13.	PIN 22. Zif skt pin 22
Pin 4. Chip Select line.	Pin 21. ZIF SKT PIN 23
Pin 5. Output Enable.	Pin 20. Zif skt pin 26
Pin 6. Address line EA14.	Pin 19. Zif skt pin 27
Pin 7. +5Vswitched (VCSW).	Pin 18. TY3 (type line 3)
Pin 8. OV.	Pin 17. Vpp1 (VCSW when PRV=0)
Pin 9. PGM line from timer.	Pin 16. Vpp2 (OE when PRV=0)
Pin 10. TY0 (type line 0).	Pin 15. VPC3 (link to VPC1=12V)
Pin 11. TY1 (type line 1).	Pin 14. VPC2 (link to VPC1=21V)
Pin 12. TY2 (type line 2).	Pin 13. VPC1 (VPC common)

Pins 4 & 5 above would normally be active low for common eproms but as for any of the control lines, they are program driven and can thus assume any polarity or function that may be required. Pin 17. (Vpp.1) becomes Vcsw when PRV is low. Pin 16 (Vpp.2) becomes OE when PRV is low.

COMPONENTS

RESISTORS

R1,R2,R3,R4	3k3 5% 1/8W
R5	10k
R6,R15	330
R7	1R5 4W
R8	1k2
R9	11k
R10	9k1
R11	3k9
R12	470k
R13	4k7
R14	470
VR1	50k 20 turn preset
VR2	2k 20 turn preset

CAPACITORS

C1	220p
C2	470p
C3,C4	100n
C5	22Ω 35V tantalum

SEMICONDUCTORS

D1,D2,D3,D4,D5	IN914
D6	0.2mm Yellow l.e.d.
D7	0.2mm Red l.e.d.
IC1,IC3,IC4,IC5	74LS374
IC2,IC6	74LS244
IC7	74LS138
IC8	74LS86
IC9	74LS38
IC10	555
IC11	TL497A

MISCELLANEOUS

SK1	28pin Zero Insertion Force socket
HDR1	24pin header plug (one per config.)
RLA	SPSTD.i.l. relay 5V 500 ohm min.
RLB	DPCO DIL relay 5V 500 ohm min.
L1	150 mH axial lead inductor (270mA)

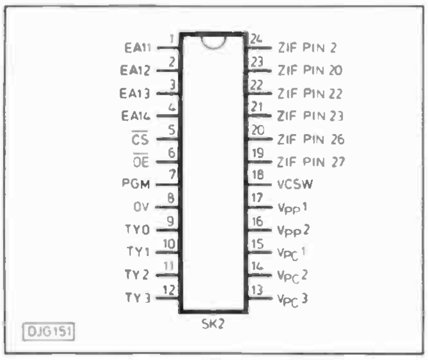
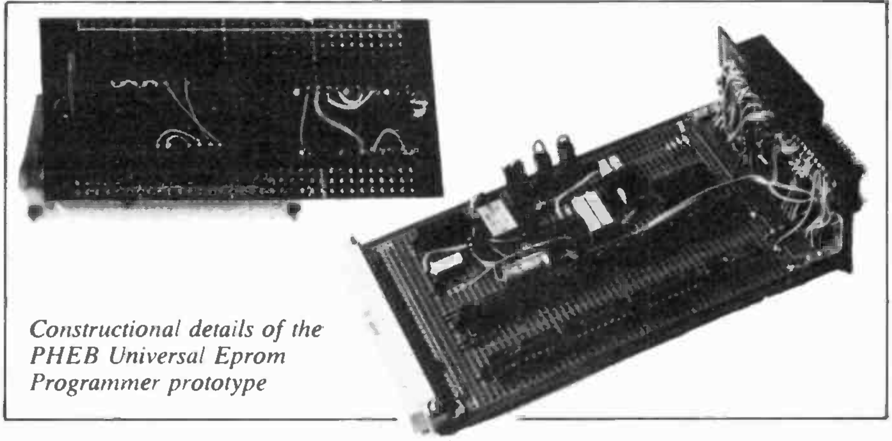


Fig. 2. *Socket Assignments*



Constructional details of the PHEB Universal Eprom Programmer prototype

Brief Basic Programming format

1. Skip round subroutines to Setup and Menu.
2. BUMPADDR Entry with FLAG = 0, increment workspace data pointer, eprom current address pointer. Compare eprom current address to end address. Set FLAG if end reached.
3. GETBYTE GOSUB INVERT then read eprom data lines, invert as per READMASK (type). Exit with eprom data byte.
4a. TOGGLE Exclusive OR control mirror with contents of READMASK (type), write to control port and save in control mirror. Then fall into . . .
4b. INVERT Exclusive OR control mirror with contents of READMASK (type), write to control port and save in control mirror. Then exit.
5. SETOFF Set control mirror to STANDBY (87H), output it to control port. Sets Vcsw and Vpp OFF, all control lines inactive.
6. PROMPT&GET Position cursor on input line, print PR$ at cursor position, get one character, blank input line, exit with character in A$.
7. GET4HEX Position cursor on input line, print PR$ at cursor position, get 1 character 0–9 or A–F in B$, add to A$, repeat for 4 digits then exit or immediate exit on carriage return Chr$ (13).
8. QUIT Set control lines OFF then END.
9. ON5V Set togglebit to PON, GOSUB INVERT, delay then exit.
10. ALLorPART Prompt for (A)LL or (P)ART. If A use default start address of 0000H and default end address (type). If P then pr$="Start Address ?" gosub GET4HEX, pr$="End Address" gosub GET4HEX and use values returned. If value returned = Chr$(13) then use default value.
11. SETCURR Make eprom current address = start address, output current address to eprom address lines.
12. CHECKBLANK gosub ALLorPART, gosub TESTBYTE. OK message if BLKFLAG = 0, NOT ERASED message if BLKFLAG = 1.
13. TESTBYTE check each byte of eprom is = FF hex. BLNKFLAG = 1 if NOT blank, = 0 if IS blank.
14. LIST List eprom data to screen or printer Do until end address reached.
15. PROGRAM Get byte from workspace, output to eprom data lines, set control mirror to write mask (type). Gosub invert. Set toggle bit to TRIGGER. Gosub TOGGLE, wai for BUSY to go inactive then loop. Repeat until end address reached then VERIFY eprom against workspace. OK if same, Program failure if not same.
16. VERIFY Check if eprom data matches workspace data.
17. DUMP Copy eprom data to workspace.
18. LISTWS List workspace data to screen or printer.
19.
1. Set workspace pointer to start of workspace.
2. Set default screen printing limits, i.e. chr/line lines/page.
3. Define default address values.
4. Reset control lines and control mirror to standby (87H).
5. Read header, set TYPE from B0–B3.
6. Zero eprom address lines.
7. Print menu screen, prompt for input, DO command.

20. Set up control ines, default values and strings.
21. MENU PRINT options on screen, Show EPROM TYPE R WORKSPACE STARTADDRESS
22. GOSUB PROMPT& GETconvert A$ to number (A) on a Gosub option (TST BLANK, LISTetc)
23. GOTO menu

The HeaderType identifier lines (pins 9–12) can be read by the controlling program, and are used to report the type of header fitted, on the main menu.

This gives the operator a chance to check the header type is correct for the eprom being used.

These lines are also used by the driver program to set up the correct control line configuration for the eprom.

The correct header links for each eprom type are shown in Table 3.

CONTROL PROGRAM

No matter how flexible or sophisticated the hardware the programmer needs a controlling program. Because of the wide range of possible host computers, a Basic program was felt to be the most common software medium to introduce the concepts of eprom programming.

A program listing in Amstrad Basic, which avoids any exotic machine specific features, is available. It woud not be too difficult to write one yourself to take advantage of extra facilities that your computer may have, such as colour.

However if you are at all unsure of what you are doing we recommend using the listing mentioned as a starting point.

For the more confident, or the speed freaks, a machine code driver will undoubtedly extract the ultimate performance, in fact for serious use with the larger eproms it is almost a necessity from a speed point of view.

Only a brief description of the program segments required can be given here. They are listed in the recommended order for a Basic program listing; with the often used subroutines at the beginning.

The Complete Basic Program listing is available from out Post-Sales Dept. at £2.00 including p&p.
(Its a long program)

VIDEO PICK-UP DEVICES

BY VIVIAN CAPEL

A variety of pick-up lines!

Vidicons, Ultricons, Newvicons, charge-coupled devices, all are seen in video camera specifications. What, though, are their features and how do they work? This article will provide some of the answers.

THE standard video camera pickup device has for many years been the vidicon. This is the generic name given to a group of similar tubes differing mainly in the material used for the target, each being known by a particular trade name.

OPERATING PRINCIPLES

Operating principle is quite simple, being virtually the reverse of the cathode-ray tube in the domestic t.v. receiver. The target is a photoconductive layer, antimony trisulphide in standard vidicons, which is deposited on the end of the tube like the screen in the cathode-ray viewing tube. A cathode heated by a filament, generates a stream of electrons which is deflected over the target area by a scanning magnetic field set up by coils fitted around the tube.

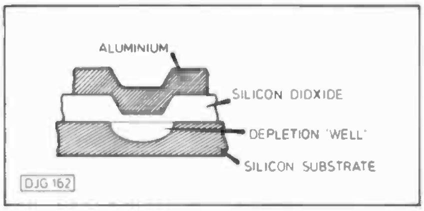


Fig 1 *Construction of single CCD cell.*

The target is connected to a high positive voltage which attracts and returns the negative electron beam to the supply circuit. Surface resistance of the target varies according to the light falling upon it, so the beam current changes in value as the beam scans across the picture image which is focused on the target. This produces voltage variations over a load impedance, which after insertion of sync. pulses to identify the end of each scanning line and frame, constitute the video signal.

Sensitivity of the device can be changed by altering the target voltage. Too great a sensitivity in bright light results in over-contrast, often called "soot-and-whitewash", so the voltage and sensitivity can be set by means of a simple potentiometer. Along with different lens apertures, a wide range of light conditions can be accommodated.

Illumination levels are measured in lux, or sometimes in foot-candles; the relation between these is 1 foot-candle = 10 lux. Around 10-20 lux is the minimum scene illumination to give a viewable picture with a standard monochrome vidicon of 2/3rd inch diameter. Other types using different target materials are more sensitive.

The RCA *Ultricon* for example produces pictures at less than 1 lux. Bright moonlight gives about 0.3 lux, so the sensitivity can be judged from that. The variable sensitivity facility, though, is not available with these tubes.

For colour cameras, filters in the three primary colours are commonly used in front of the tubes, and these considerably reduce the amount of light falling on the target. Sensitivity for colour is therefore lower than with a monochrome camera. Several times the illumination level is required to produce satisfactory pictures.

A major drawback with the vidicon is its vulnerability to burn in. If a bright stationary scene is left on the target for a period, it will produce a permanent image which appears as a ghost with all subsequent pictures. Accidental exposure to a very bright light such as the sun, or studio lamps for only a few seconds, will destroy that part of the target coating affected by it. Another snag is the long lag characteristic, wherby images that move or are panned at low-light, high sensitivity settings, leave trails behind them.

The Ultricon has a much shorter lag time but does not have such a good definition as the standard vidicon. Toshiba's *Chalnicon* tube which has a cadmium selenide target is not quite as sensitive as the Ultricon nor has it so short a lag time, but it has a better resolution. It is also better than the standard vidicon for lag time and sensitivity.

Another version of the vidicon is the *Newvicon* made by Matsushita which has a target made of zinc telluride and cadmium telluride. Its lag time and sensitivity is better than the standard vidicon and Chalnicon but not as good as the Ultricon; resolution though is better than the Ultricon. However it is more prone to burn in than the others with the exception of the standard vidicon.

Spectral response is different for all these tubes, and the prices are several times that of the standard vidicon. It can be seen then, that there is no clear winner out of these, and camera designers must choose the features that they think best, possibly making up for deficient characteristics in the associated circuitry.

THE CCD

There are two problems that all of these tubes have in common when considered for portable battery cameras, and particularly camcorders. One is size; although not bulky, they do take up room when scanning coils, yokes, and ancillary items are included, especially with colour cameras where there is more than one tube, plus filters.

The other is current consumption. Again, while the heater does not take a high current, it all adds up along with the recorder motor and other circuitry. Understandably, camera makers have been exploring other possibilities, especially in the semi-conductor field, for camera pick-up devices.

One that has been around for several years is the charge-coupled device. Until recently, it had not been developed to the stage that it could be used as a commercial pick-up device.

The charge-coupled device consists either of a single line or a lattice of cells consisting of closely spaced metal-oxide semiconductor (MOS) capacitors. These are formed on a silicon substrate on which is deposited a thin layer of silicon dioxide. On this is mounted the individual aluminium elements.

When a voltage is applied across the aluminium element and the silicon substrate, a depletion area is formed immediately under the metal. This could be thought of as a tiny well, empty of electrons. If now a electron beam or a ray of light strikes the silicon at that point, electrons will be released into the well and partly fill it. The amount it is filled is proportional to the intensity of the exciting ray or beam.

The cells are arranged in a linear group of three, and a pulse voltage with a trailing edge is applied to each in turn. This creates a well under the pulsed cell, which is filled in proportion to the light falling on it. The next pulse on the adjacent cell creates a well there, while the trailing edge of the first pulse reduces the depth of the first one. The charge in the first well thereby drains into the second. This in turn decreases in depth as the trailing edge of the second pulse passes, so tipping the charge into the third well which has just formed by the arrival of the third pulse on the third cell.

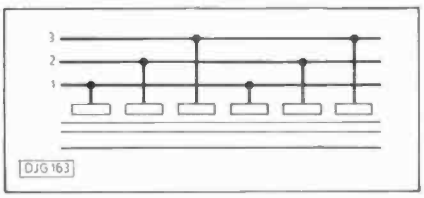


Fig 2 *Connection of groups of three cells in line. Each is clocked in turn by a step pulse which is delayed from the previous one.*

By now the first pulse is completely clear and the well has disappeared, so all is ready for the next trio of pulses. The third cell discharges its contents into the first cell of the next group, and so on down the line. Thus at the end of each line there appears a consecutive string of charges from each group ready to be taken off to form one line of video signal.

This is known as the three-phase CCD, other configurations, using two or four cell groups are possible. Linear charge-coupled devices consist of just a single row of cells, so these must be optically scanned by moving either the image or the CCD across the other for each field. Although simplifying the CCD, it complicates the optical system. The more

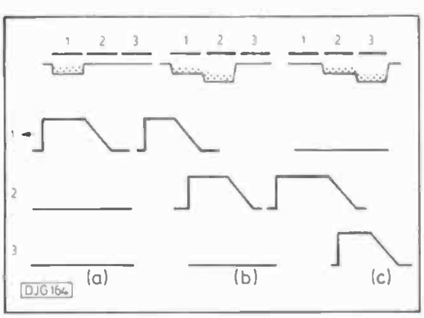


Fig 3 (a) *Pulse on 1st cell creates well which is partly filled from electrons released by illumination on cell surface.*
(b) *Trailing edge of pulse reduces well depth, while pulse on 2nd cell creates a well there. Electrons flow into it from 1st well.*
(c) *Second well in turn reduces as trailing edge passes depositing electrons into 3rd well created by third pulse. Charge is thus moved along the line.*

usual type is the lattice device which forms a rectangle of cells on which the whole of the image is focussed.

The resolution depends on the number of picture elements or pixels, which in this case is the number of capacitors on the substrate, One CCD, the RCA SID 52501 has a matrix of 512 x 320, which is 163,840 cells. These are divided into two areas of 256 x 320 elements each, one being the image area and the other for storage.

It can be appreciated that with numbers of that magnitude it would be virtually impossible to produce a CCD with every single cell perfectly operative. Faulty cells can produce a white or black spot, or more seriously, if they refuse to pass on the charges received, can result in a blank line. The blemish specification, therefore, is an important part of the CCD parameters.

SENSITIVITY

As for sensitivity, the charge-coupled device is better than conventional vidicons, although not quite as good as the Newvicon and Ultricon. The device developed for the Sony 8mm camcorder operates down to 22 lux, which is good for colour. It has 290,000 pixels giving a resolution of 300 lines.

A major advantage of the CCD is the freedom from burn in; the camera can actually be pointed at the sun without damage. It is also claimed to be free from lag. The main features are low current consumption and lack of bulk. All these make the device eminently suitable for portable video cameras and cancorders. PE

Watch out for a Practical Project employing charged-coupled device technology in a forthcoming issue of Practical Electronics

WATCH OUT FOR SOME INTERESTING "VIDEO PROJECTS" APPEARING SOON IN PRACTICAL ELECTRONICS

Continued from page 21
major steps will be taken by the Russians, whose space-station experiments seem to be going well.

LIFE ON MARS: NEW DOUBTS

When the Viking probes landed on Mars in 1976, it was tacitly assumed that they would give a final answer to the question 'Is there Martian life?'. Lowell's brilliant-brained, canal-building civilization had long since been relegated to the realm of myth, and it had also been realized that the dark areas such as the V-shaped Syrtis Major were albedo features, often plateaux, rather than ancient sea-beds filled with vegetation; but most people believed that there would be signs of primitive Martian organisms. The Vikings carried miniature, highly-sophisticated 'laboratories' to search for any living organism and send back their results.

At first there seemed to be some contradictions, and it was generally thought that there must be something very strange about Martian chemistry. Then, after exhaustive analyses, it was generally concluded that no results could show any traces of biological activity, and that therefore Mars must be sterile.

One of the experiments, the so-called labelled-release experiment, gave initial results that seemed to be positive but were later dismissed as being non-biological. This interpretation has now been challenged by two of the experimenters, G. Lovin and P. Straat, who consider that the biological interpretation is, after all, the more likely. They maintain that the other experiments were either not sensitive enough or were, in effect, looking for the wrong signs.

If there is any life, what form is it likely to take? Lovin and Straat support the idea of something akin to terrestrial lichens, which are amazingly durable and can be found in all sorts of unlikely places. The two scientists have studied photographs of the same Martian rock taken by a Viking camera over a period of many months, and infer that greenish patches have shown changes in form and extent which would be expected in the case of lichens.

If this turns out to be correct, Mars will be even more attractive to scientists than it is now. Unfortunately we have little chance of finding out until a new probe is sent there. The Russians have announced a lander-and-rover mission for the early 1990s, but what we really need is a sample-and-return experiment of the type already carried out by the Russians in the case of the Moon. It is reasonable to hope that this will be possible before the end of the century. Then, at last, we will really know whether there is any life on Mars. PE

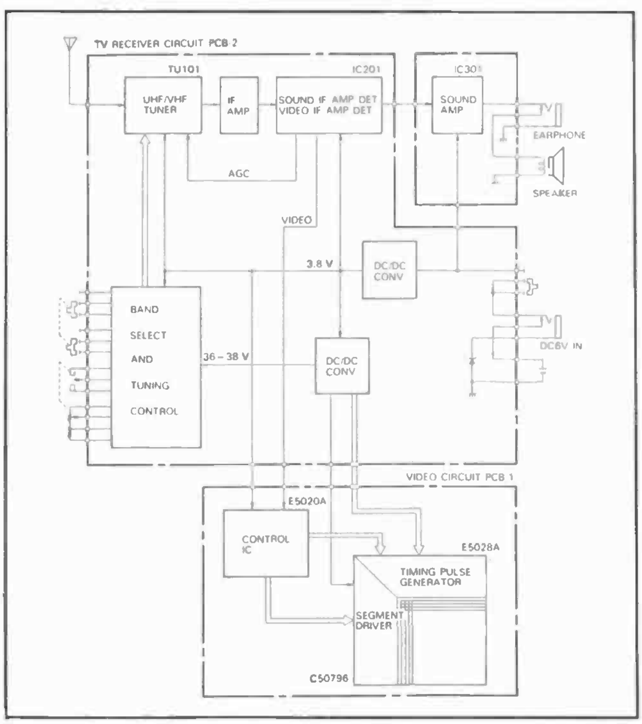
POCKET TVs AND LCD TECHNOLOGY

Pocket TV is currently one of the biggest consumer electronics crazes in America with several companies offering over twenty different models at personal stereo prices. Despite being a British company, Sinclair Radionics, that gave the world its first taste of TV miniturization, pocket TV has not really taken off in this country. This is probably due to the well publicised problems of the first models available.

Since those early days, pocket TV has come a long way. Several manufacturers now offer truly pocket sized sets with good reception, sound and picture quality.

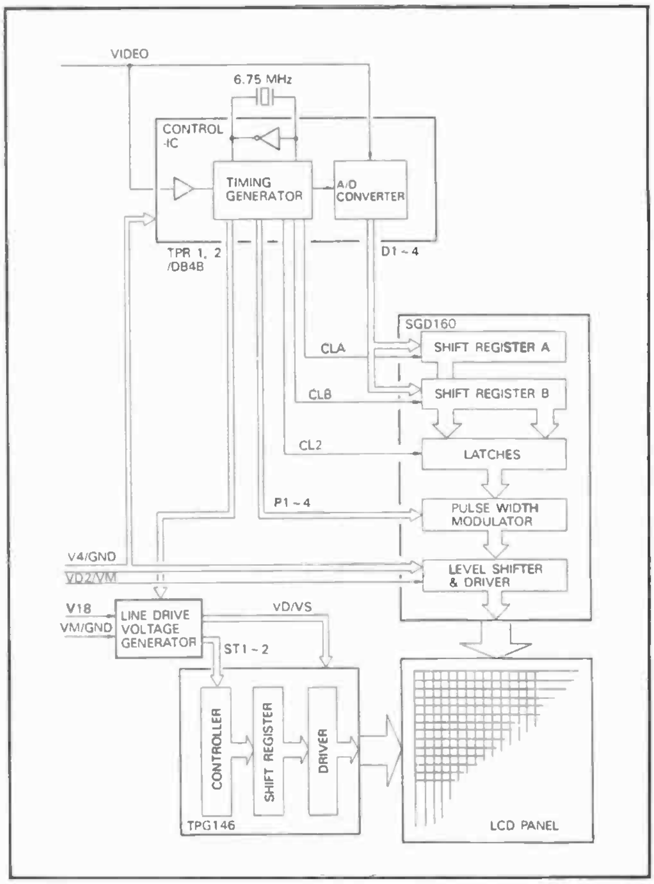
A key to the success of many of the products available, will be the public's acceptance of l.c.d. technology. Traditional TVs use CRTs which are bulky, expensive to produce, consume relatively large amounts of energy and require high voltages to function. Consequently, a number of manufacturers have turned to l.c.d. technology to overcome these drawbacks. L.c.d.s are now easy to produce due to the experience gained by manufacturers of digital watches and pocket videogames, in the seventies. They are cheap, compact and use very little power. Also, because the circuitry required to drive them is lightweight and compact, TVs can now be made which are truly portable, fitting comfortably into the palm of the hand.

One such product is the Citizen 06TA-OA which is a black and white, 2.5inch set available for around £100. It provides excellent reception, good sound quality from its built-in speaker or plug-in earphone and comes complete with battery, rod antenna and carrying case. Backlight for poor light conditions and car adapter are optional extras.



LCD PANEL

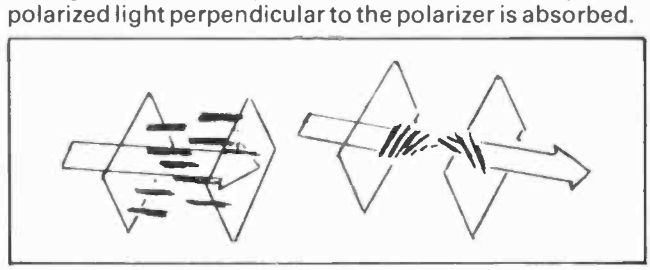
The l.c.d. panel is composed of two sheets of glass facing each other with nematic liquid crystal material filling the tiny gap between them. Two sheets of polarizer cover the outside of the glass and transparent, horizontal line and vertical segment, electrodes are fitted to the inside. Pixels are made at each intersection of the line and segment electrodes.



Molecules of liquid crystal have a spiral structure twisted about 90 degrees whenever the voltage between the segment and line electrode falls below the 1.6V threshold voltage. When the voltage exceeds 1.5V, the direction of the molecules is deflected more perpendicular to the glass surface.

OPERATION

The light from the top glass is polarized and its plane of polarization is twisted in the liquid crystal material along with its spiral structure; then the polarized light passes through the other polarizer where the component polarized light perpendicular to the polarizer is absorbed.



In the absence of an electric field, the light is twisted 90° allowing it to pass through the display. When an electric field is set up the twisting does not take place and the light is absorbed by the polariser.

When a line is selected, +12V~+18V is applied to the line electrode. If −1V~−1.5V is applied to the segment electrode, the pixel on the line electrode is driven with a higher effective voltage than another pixel that the segment electrode that has −1V~+1.5V applied to it. The brightness of the pixels is controlled by the pulse width of +1V~+1.5V and −1V~−1.5V.

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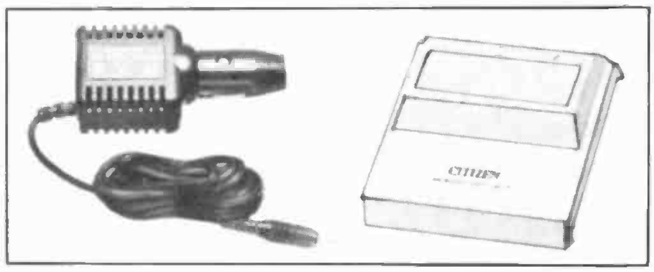

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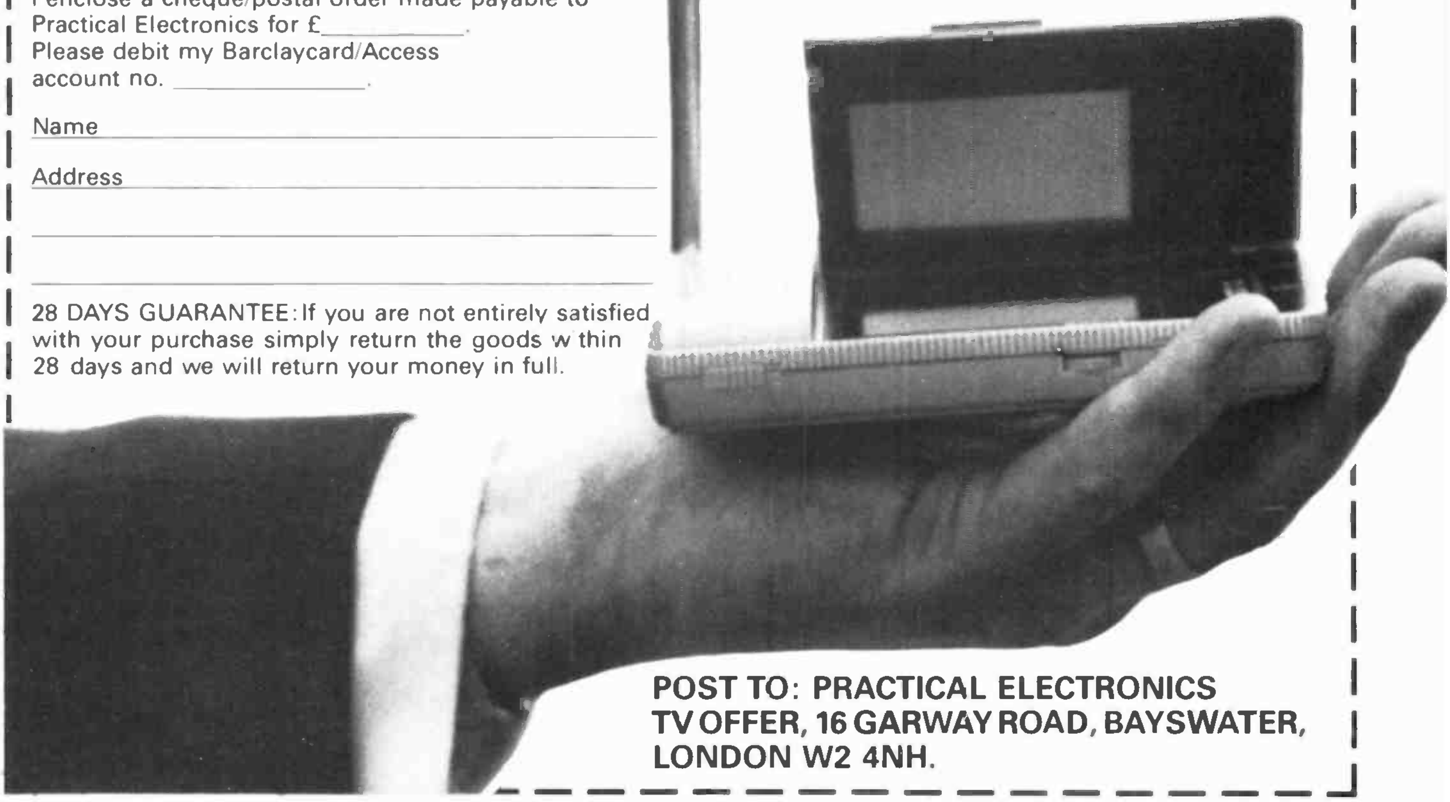

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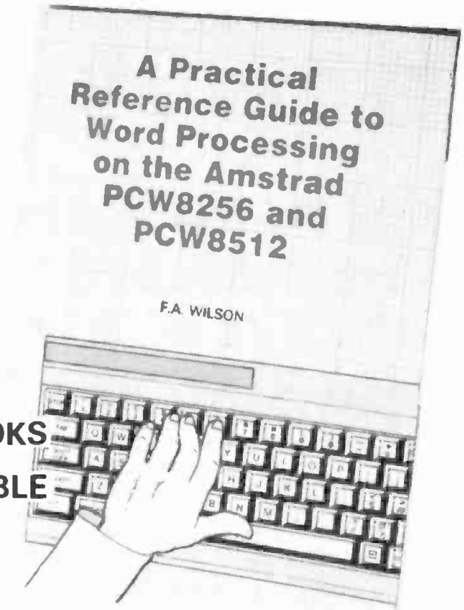

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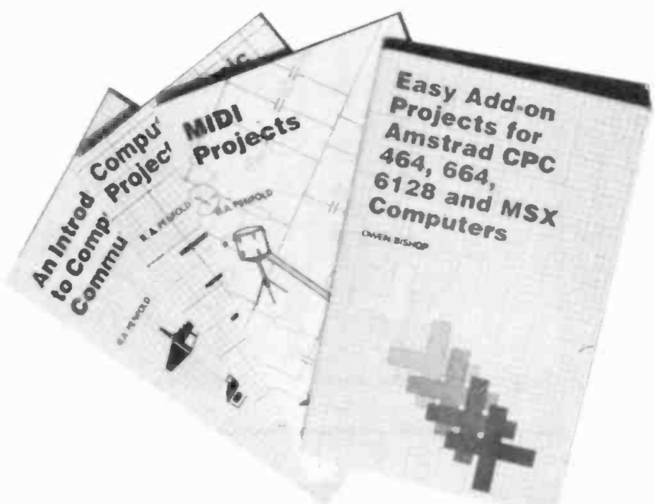

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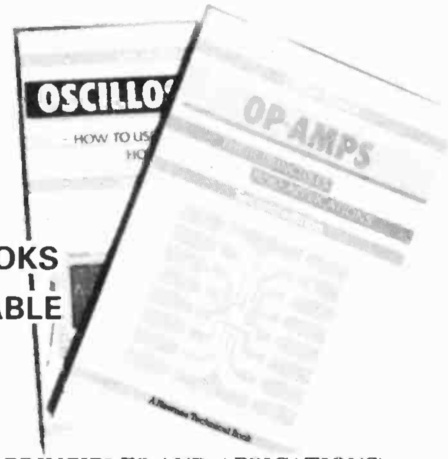

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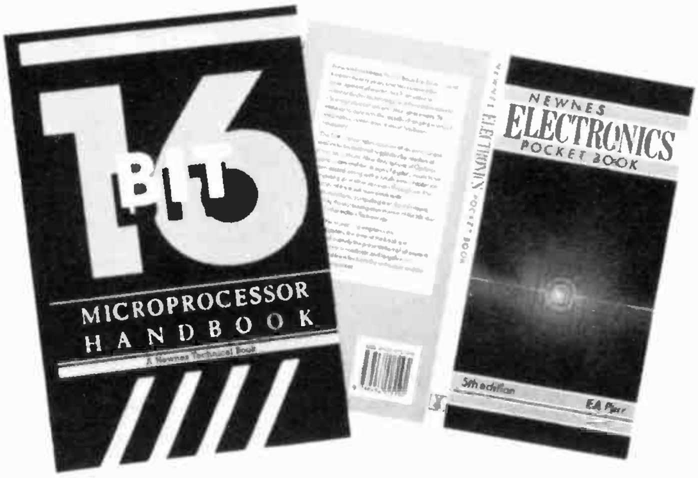

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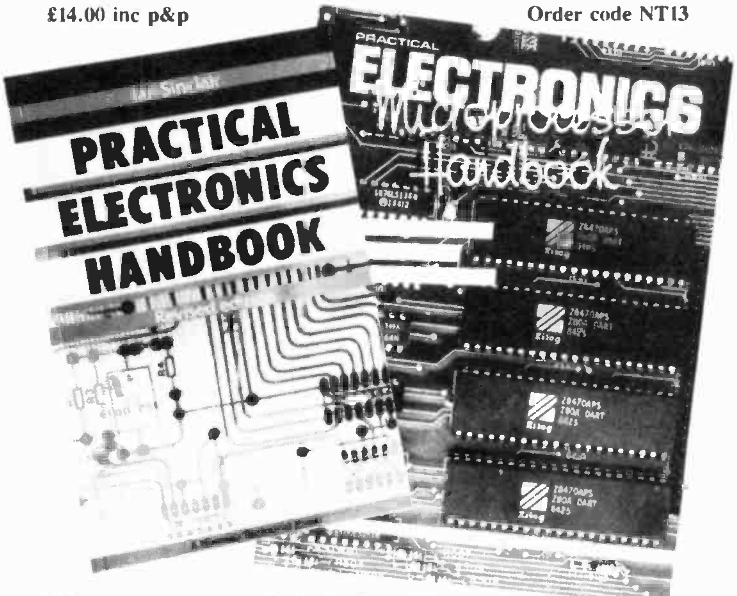

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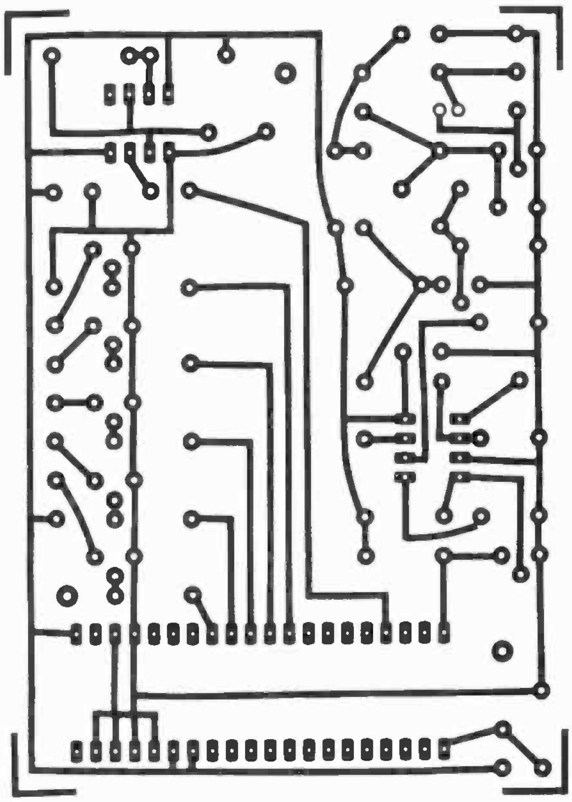

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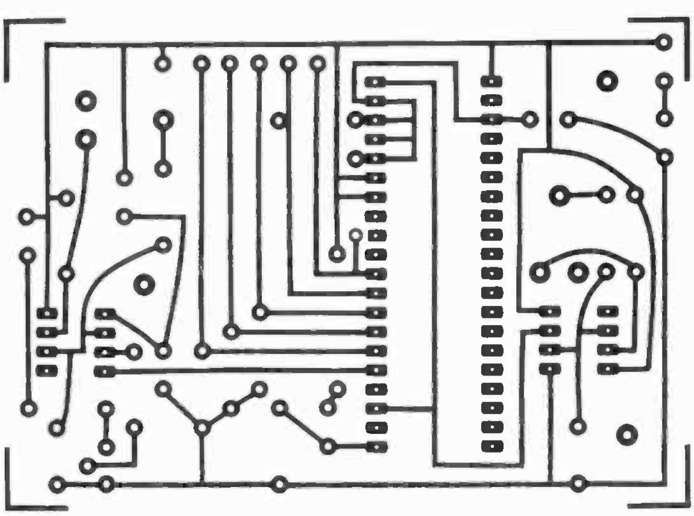

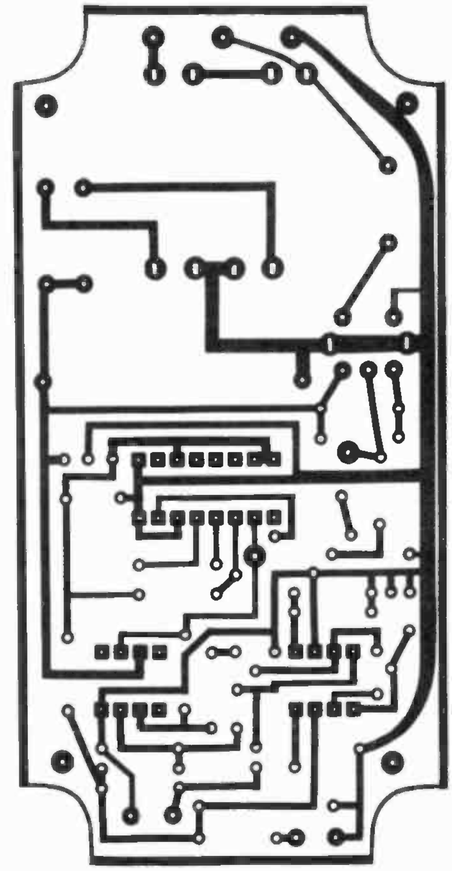

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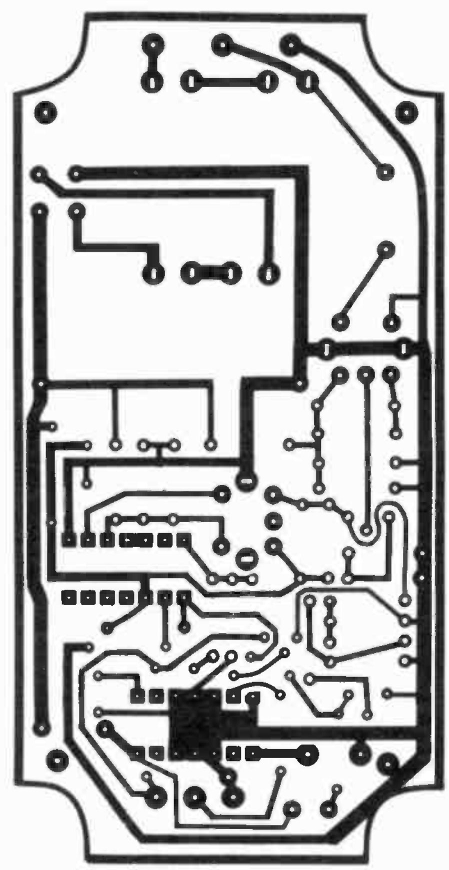

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New Z80 BBC second processor with discs and manuals £320. Also other items, send for list. R.W. Kingdon, Zelmont the Sands, Farnham, Surrey GU10 1LTD. Tel: 0252 22725.

New hand cranked wee megger series 3 MarkIV avo8mkIII multimeter AVO multiminder AVO volyage multiplier mark 7 o feers. Mr. L.T. Cowell, 69 Crewe Road, Haslington, Crewe.

Swap Eddystone 960 transistor RX for Texas T199/4A peropheras (stand) alone thermal printer Rs232 Disc interface. M.J. Lang (Gaduk;, 11 Ramsay Way, Burnham-on-Sea, Somerset.

Wanted plug in tele text adaptor. J. Fulton, Derrynasser, Dromore, Co Tyrone, BT78 3BE.

Pair R.S. Soldering Stations 24 Volt 50 Watt complete with irons, tips, plugs, sponges. £25 each. Dave Owen, West Penyllan, Churchstoke, Powys, Wales. Tel: 05885 329.

Texas silent 700 printer (722) wanted for spares. Also manual or any Info wiring diagrams etc. Mr C. Salter, 19 Saintfield Road, Belfast BT8 4AF. Tel: 0232 642687.

150w switchmode psu+5v@13A +12V@11.5A +12v@1.0A +24v@1.7A +12v@0.2A working perfectly. Tel 59027 after 6.00 pm. S. Cramp, 68 Heath Drive, Chelmsford, Essex.

Sale Practical Electronics 68 number from 1972 to 1986. I will send list. Y. Ferreira, 13 Danehurst St., London SW6 6SA.

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4012	13p
4013	19p
4014	35p
4015	34p
4016	18p
4017	31p
4018	33p
4019	28p
4020	35p
4021	36p
4022	36p
4023	13p
4024	25p
4025	13p
4026	60p
4027	18p
4028	29p
4029	36p
4030	17p
4031	90p
4032	54p
4033	60p
4034	80p
4035	45p
4036	180p
4037	75p
4038	48p
4039	190p
4040	36p
4041	38p
4042	30p
4043	36p
4044	38p
4045	72p
4046	45p
4047	45p
4048	27p
4049	18p
4050	20p
4051	38p
4052	37p
4053	37p
4054	53p
4055	52p
4056	52p
4060	40p
4063	52p
4066	20p
4067	130p
4068	13p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	13p
4082	13p
4085	40p
4086	32p
4089	80p
4093	18p
4094	48p
4095	58p
4098	50p
4099	45p
4501	30p
4502	38p
4503	32p
4504	55p
4505	200p
4506	60p
4507	33p
4508	70p
4510	37p
4511	40p
4512	42p
4513	80p
4514	75p
4515	75p
4516	40p
4517	120p
4518	38p
4519	30p
4520	38p
4521	90p
4522	50p
4526	40p
4527	44p
4528	40p
4529	75p
4532	62p
4551	80p
4553	190p
4555	29p
4556	38p
4557	190p
4583	60p
4584	30p
4585	42p

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74LS04	15p
74LS05	15p
74LS08	15p
74LS09	15p
74LS10	15p
74LS11	15p
74LS12	15p
74LS13	22p
74LS14	30p
74LS15	15p
74LS20	15p
74LS21	15p
74LS22	15p
74LS24	38p
74LS26	15p
74LS27	15p
74LS28	15p
74LS30	15p
74LS32	17p
74LS33	17p
74LS37	16p
74LS38	17p
74LS40	16p
74LS42	32p
74LS47	56p
74LS48	56p
74LS51	16p
74LS54	16p
74LS55	17p
74LS73	28p
74LS74	22p
74LS75	28p
74LS76	28p
74LS78	28p
74LS83	43p
74LS85	45p
74LS86	30p
74LS90	32p
74LS91	75p
74LS92	38p
74LS93	30p
74LS95	47p
74LS96	60p
74LS107	32p
74LS109	34p
74LS112	36p
74LS113	32p
74LS114	35p
74LS122	40p
74LS123	42p
74LS124	85p
74LS125	36p
74LS126	36p
74LS132	40p
74LS133	34p
74LS136	35p
74LS138	35p
74LS139	35p
74LS145	83p
74LS147	120p
74LS148	90p
74LS151	32p
74LS153	40p
74LS154	90p
74LS155	41p
74LS156	47p
74LS157	30p
74LS158	33p
74LS160	48p
74LS161	50p
74LS162	48p
74LS163	46p
74LS164	43p
74LS165	65p
74LS166	74p
74LS168	92p
74LS169	65p
74LS170	80p
74LS174	39p
74LS175	42p
74LS190	55p
74LS191	52p
74LS192	50p
74LS193	51p
74LS194	63p
74LS195	52p
74LS196	62p
74LS197	52p
74LS221	56p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	60p
74LS244	50p
74LS245	50p
74LS247	50p
74LS248	50p
74LS249	82p
74LS251	30p
74LS253	50p
74LS256	80p
74LS257	42p
74LS258	42p
74LS259	58p
74LS280	38p
74LS266	28p
74LS273	52p
74LS279	40p
74LS280	140p
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2532	330p
2716	200p
2732	280p
2764	240p
27128	250p
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4164	110p
6116	160p
8264-15	260p
6502	300p
6802	220p
6809	600p
6821	140p
6840	310p
6850	110p
8080A	400p
8085A	320p
8155	390p
8156	360p
8224	270p
8226	270p
8228	270p
8243	250p
8250	850p
8251	300p
8253	340p
8255	360p
8256A	1200p
8257A	370p
8259	370p
8271	4400p
8272	1300p
8279	650p
8282	400p
8283	400p
8284	600p
8288	1000p
8748	2900p
SP0256AL2	500p
Z80ACPU	180p
Z80BCPU	500p
Z80ADMA	650p
Z80AP10	250p
Z80BP10	600p
Z80ACTC	250p
Z80BCTC	600p
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Z80AS10/1	700p
Z80AS10/2	700p
Z80ADART	680p

74 SERIES

7400	22p
7401	16p
7402	18p
7403	22p
7404	40p
7405	10p
7406	40p
7407	40p
7408	25p
7409	20p
7413	36p
7414	45p
7417	32p
7420	22p
7421	26p
7425	15p
7430	25p
7437	28p
7442	45p
7447	60p
7450	22p
7451	10p
7454	25p
7470	30p
7473	30p
7474	40p
7475	25p
7481	90p
7482	70p
7485	30p
7486	28p
7489	80p
7490	36p
7492	45p
7493	35p
7495	48p
7497	80p
74107	30p
74111	52p
74116	85p
74119	85p
74122	40p
74123	20p
74125	40p
74126	45p
74132	42p
74141	55p
74145	70p
74153	45p
74155	45p
74157	45p
74160	50p
74164	60p
74167	35p
74173	60p
74174	70p
74175	85p
74176	45p
74180	50p
74182	45p
74192	40p
74196	40p
74197	45p
74393	70p

LINEAR IC S

AN-214P	200p
AN-240P	150p
AN-360	120p
AN-7110	140p
AN-7114	160p
AN-7115	160p
AN-7120	140p
AY3-1270	680p
AY3-1350	300p
AY3-8910	360p
AY3-8912	400p
AY5-3600	670p
CA270	40p
CA3046	60p
CA3048	190p
CA3060	280p
CA3080E	70p
CA3086	55p
CA3089E	150p
CA3090AO	300p
CA3130E	80p
CA3130S	100p
CA3140E	38p
CA3189E	250p
CA3240E	90p
HA-1156W	110p
HA-1197	150p
HA-1306W	170p
HA-1319	250p
HA-1339	170p
HA-1342	170p
HA-1366WR	160p
HA-1368	160p
HA-1377	220p
HA-1389	140p
HA-1392	230p
HA-1397	250p
HA-1398	240p
LA-1201	85p
LA-1352	120p
LA-1365	140p
LA-3301	120p
LA-3350	120p
LA-3361	115p
LA-4030	200p
LA-4031	140p
LA-4032	140p
LA-4050	130p
LA-4051	160p
LA-4100	120p
LA-4101	100p
LA-4102SK	140p
LA-4112	250p
LA-4125	210p
LA-4140	70p
LA-4201	120p
LA-4220	120p
LA-4400	190p
LA-4420	140p
LA-4422	130p
LA-4430	130p
LA-4460	170p
LA-4461	180p
LA-5112	120p
LM301	26p
LM311	35p
LM324	35p
LM325	45p
LM339	40p
LM348	60p
LM380	100p
LM381	150p
LM382	130p
LM387	100p
LM709 DIL	30p
LM723	40p
LM741 DIL	16p
LM741 MET	45p
LM747	58p
LM748	35p
LM1458	33p
LM3900	30p
M-51513L	180p
M-51515BL	270p
M-51516	280p
M-51517L	280p
MB3712	150p
MB3730	280p
MB3756	280p
MC1327	70p
NE555	20p
NE556	40p
SAS560	110p
SAS570	110p
SN76003N	140p
SN76110N	70p
SN76115	70p
T28000	52p
TA-7120	55p
TA-7137P	83p
TA-7146F	400p
TA-7193F	400p
TA-7200	200p
TA-7201	200p
TA-7203	180p
TA-7204	110p
TA-7205	80p
TA-7210	200p
TA-7222AP	120p
TA-7310F	100p
TA-7609	270p
TAA550	16p
TBA120S	45p
TBA395	60p
TBA396	60p
TBA520	100p
TBA530	100p
TBA540	100p
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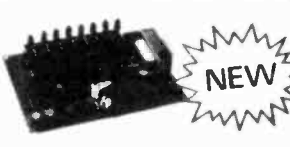

The DL8000K is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY – YES 80! different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching, LED mimic lamps and sound to light LED and a 300W output per channel.
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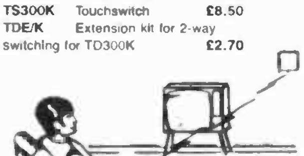

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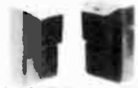

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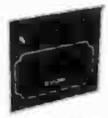

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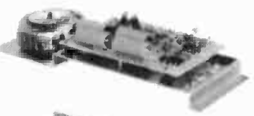

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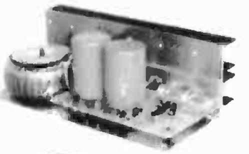

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB, Size 300 × 150 × 100mm. PRICE
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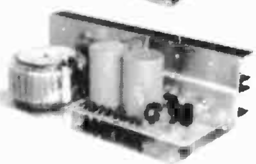

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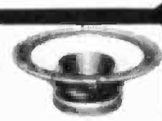

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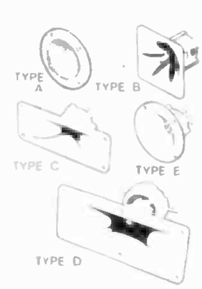

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