

PRACTICAL

DECEMBER 1987 · £1.25

# ELECTRONICS

SCIENCE & TECHNOLOGY

**BURGLAR  
ALARM**

---

**TEACHER  
RADIO**

---

**SOLAR  
CELLS**

---

**ANNUAL  
INDEX**

---

**DESIGN**

SEMICONDUCTOR PRINCIPLES

**COMPUTING**

RS232C TO MIDI CONVERTER

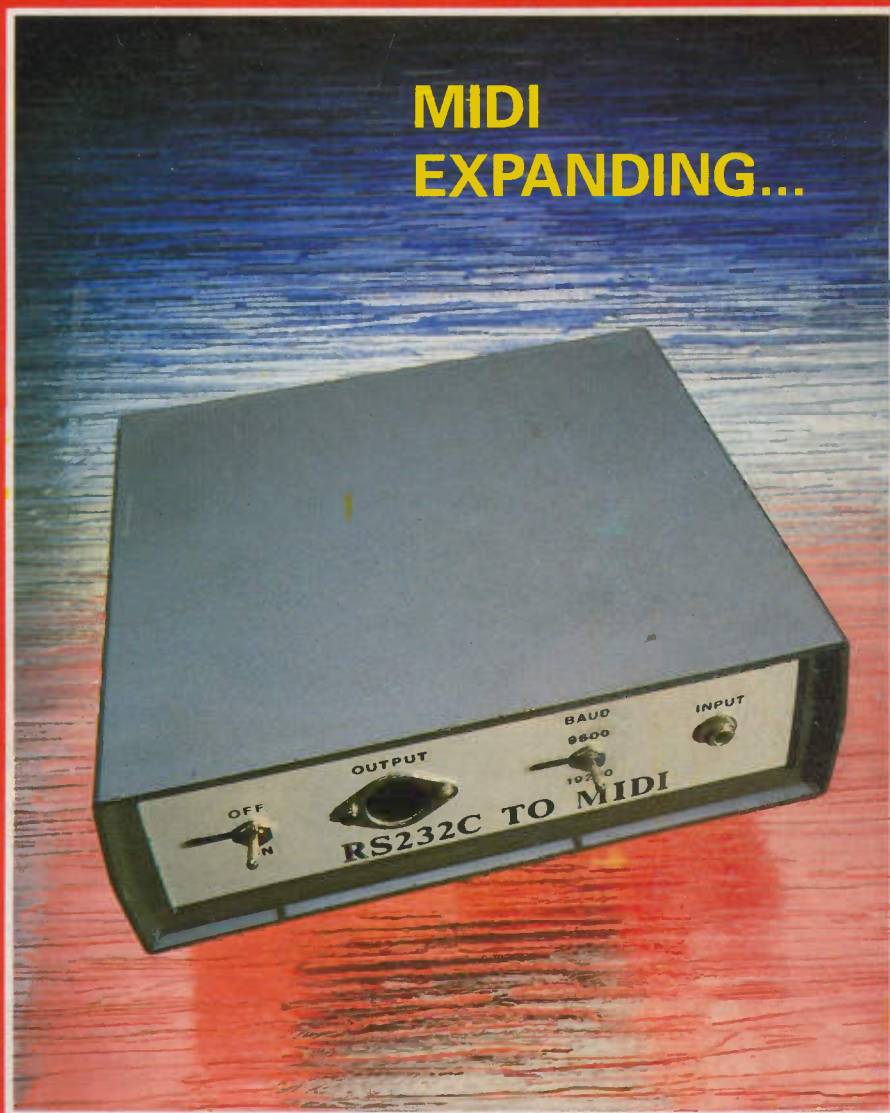
**TECHNOLOGY**

TELEPHONE DEVELOPMENT

**EXPERIMENTAL**

AND PRACTICAL APPLICATIONS

**MIDI  
EXPANDING...**



**PLUS:**

- ★ SPACEWATCH
- ★ LEADING EDGE
- ★ INDUSTRY NEWS
- ★ LOGIC PUZZLE
- ★ MARKET PLACE

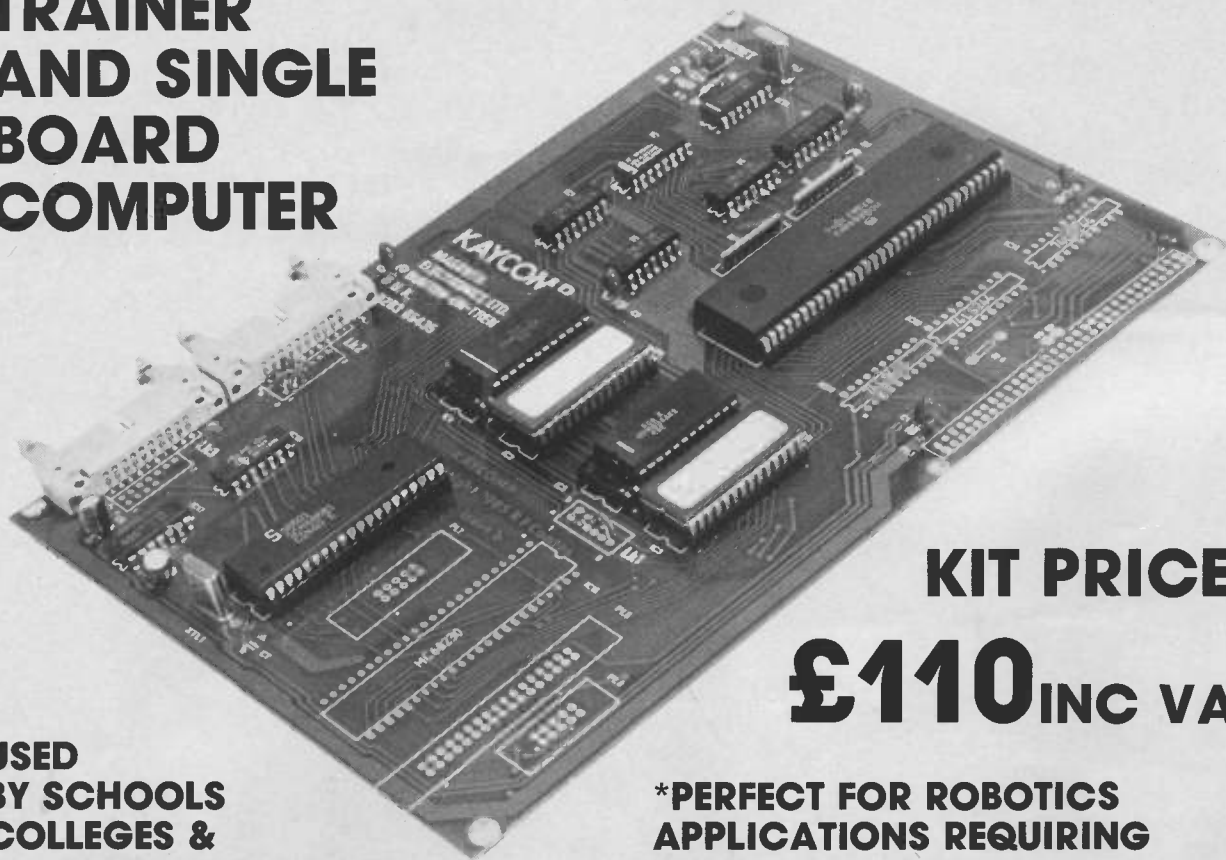
**G.C.S.E. PROJECT  
IDEAS SERIES**

THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS AND COMPUTER ENTHUSIASTS

# KAYCOMP 68000

## MICROPROCESSOR TRAINER AND SINGLE BOARD COMPUTER

**\*LOWCOST\***



**KIT PRICE**  
**£110** INC VAT

### USED BY SCHOOLS COLLEGES & UNIVERSITIES

- Full 8MHz 68000 Processor with 16 bit data bus.
- Top-class monitor program included on two 27128 Eproms.
- Communicates via RS232 interface to terminal, BBC computer, P.C. computer etc.
- Use as a Trainer, or as a stand-alone computer system.
- Fast, powerful processing – Ideal for real time control systems.

### \*PERFECT FOR ROBOTICS APPLICATIONS REQUIRING POWER AND SPEED\*

- Dual U.A.R.T. allows simultaneous connection of printer and terminal.
- Add-on options include: 664 Bus, 68230 P.I.T. 8k and 32K Ram upgrades, and line by line assembler.
- Available from stock now – with support manual and full technical back up.

STANDARD SYSTEM IN KIT FORM	£110.00	68230 P.I.T. ADD ON OPTION	£ 11.97
STANDARD SYSTEM BUILT & TESTED	£169.00	664 BUS ADD-ON	£ 5.49
LINE BY LINE ASSEMBLER PROGRAM (IN EPROM)	£ 27.00	8K x 16 RAM UPGRADE	£ 9.24
POWER SUPPLY	£ 11.99	32K 15 RAM UPGRADE	£ 28.00

OTHER OPTIONS, DATA PACKS, AND LITERATURE AVAILABLE – SEND FOR DETAILS.

## SOLE SUPPLIER – MAGENTA ELECTRONICS – UK & WORLDWIDE

### PE PROJECT KITS

KITS INCLUDE CASES & PCB  
UNLESS STATED.

COMPUTER D.C. MOTOR CONTROL AS  
FEATURED IN NOV ISSUE £24.49  
PCB also available separately \$5.37  
BBC SOFTWARE CASSETTE £4.99

#### CATALOGUE £1.00

This ad shows just a fraction of our wide range of Kits, Tools, Components, Books Etc. Our illustrated catalogue is a must for all electronics enthusiasts.

FREE TO SCHOOLS ETC. WHEN  
ORDERED ON LETTERHEAD

TEACHER POWER Oct 87	£29.95	LOGIC PROBE Feb 86	£14.15
TEACHER LOCKER Oct 87	£22.95	COMPUTER MOVEMENT DETECTOR Feb 86	£17.43
GUITAR TO SYNTH Oct 87	£38.94	SPECTRUM SPEECH SYNTH & 8-BIT I/O PORT Jan 86	29.58
SCOPE STORE JULY 87	£49.99	COMMODORE USER PORT EXPANDER Nov 85	£11.98
SYNTHESISED A.F. GEN. JUN 87	39.98	TOUCH CONTROL PSU Oct 85	£31.22
BRIGHT FUZZ MAY 87	16.59	MODULATED SYNDROM Oct 85	£29.24
ULTRASONIC TAPE MEASURE Mar 87 less case	£26.21	RS232 TO CENTRONICS CONVERTER Sept 85	£49.44
VIDEO FADER Jan 87	£13.28	CAR BOOT ALARM Sept 85	£12.89
VIDEO ENHANCER Dec 86	£29.80	COMPUTER ENVELOPE SHAPER Aug 85	24.39
PASSIVE INFRA-RED DETECTOR July 86	£38.46	VOLTMETER MEMORY ADAPTOR July 85	£11.99
ECHO/REVERB UNIT July 86	£41.95	STYLUS KEYBOARD FOR COM 64 Jun 85	£10.50
THERMOCOUPLE INTERFACE FOR DVM Jun 86	£15.98	SYNTHESISER INTERFACE FOR COM 64 Jun 85	£17.26
NOTCHER EFFECTS UNIT May 86	£31.46	AMSTRAD SYNTHESISER INTERFACE May 85	£27.90
TTL LOGIC CHECKER May 86	£20.95	CYLINDER THERMOSTAT May 85	£23.95
SOUND ACTIVATED SWITCH Apr 86	£41.55	BBC POWER CONTROL INTERFACE Apr 85	£22.98
SCRATCH & RUMBLE FILTER (Stereo) Apr 86	£18.89	GUITAR ACTIVE TONE CONTROL less case Apr 86	£43.87
PHOTOGRAPHIC TRIGGER UNIT Apr 86	£35.68	SPECTRUM HARDWARE RESTART (uncased) Mar 86	£28.49
TEMPERATURE/ANALOGUE INTERFACE Apr 86	£43.87	AMSTRAD I/O Mar 86	£24.18
Mar 86	£28.49	FIBROPTIC AUDIO LINK Mar 86	£27.65
AMSTRAD I/O Mar 86	£24.18	FIBROPTIC CABLE	80p/metre
FIBROPTIC AUDIO LINK Mar 86	£27.65		
FIBROPTIC CABLE	80p/metre		

### MAGENTA ELECTRONICS LTD

135 Hunter Street PE52,  
Burton on Trent  
Staffs DE14 2ST.  
0283 65435

Prices include VAT add £1.00 p&p to all orders. Official orders welcome.

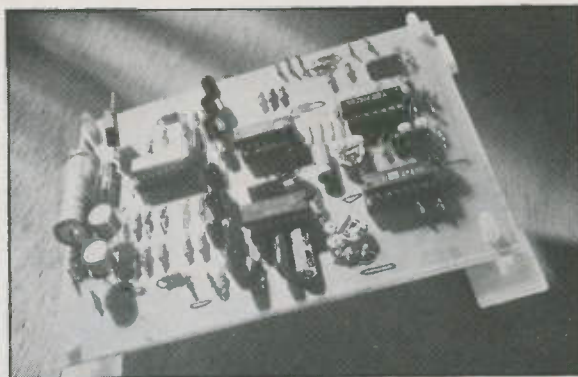
#### SHOP NOW OPEN

Callers welcome 9-5 MON-FRI  
Access/Visa Phone or Post.  
24 hour answerphone.



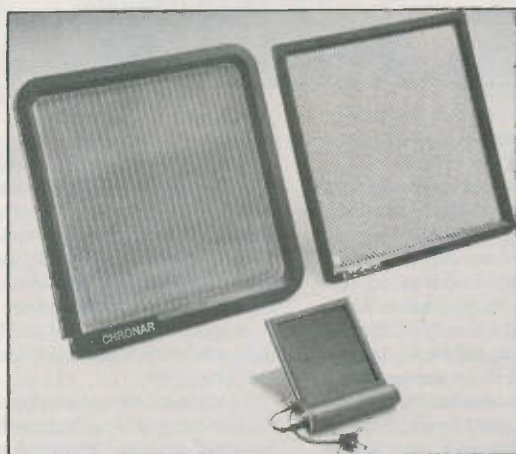
## CONSTRUCTIONAL PROJECTS

- RS232C TO MIDI CONVERTER** by Robert Penfold ..... 12  
Computers with RS232C or Centronics output ports can readily control MIDI instruments with this universal interface.
- TEACHER RADIO** by Tim Pike ..... 35  
The mysteries of radio reception are uncoiled for the benefit of G.C.S.E. students, or anyone else who wants to tune in.
- INTRUDER ALARM CONTROLLERS PART TWO** by Bill Kent ..... 50  
Description and construction of a multizone control board offering several levels of detection.



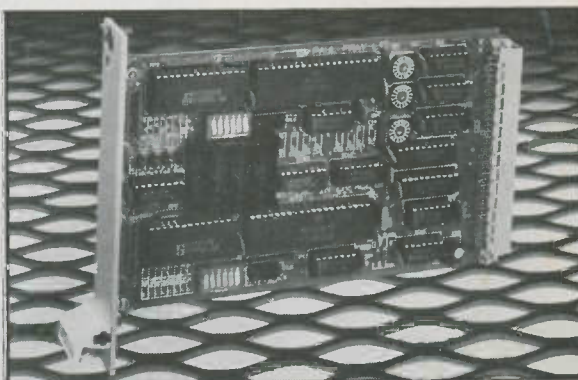
## SPECIAL FEATURES

- SEMICONDUCTORS PART TWO** by Andrew Armstrong ..... 19  
Choosing and using semiconductors can be perplexing unless you know their basics. This month AA explores the route through junction devices.
- RECALLING HISTORY PART ONE** by Barry Drake ..... 26  
The advent of the telephone revolutionised communications, but have you ever wondered how the invention came about, and why lines are deliberately crossed?
- SOLAR CELLS** by Iain Garner ..... 42  
Even in temperate climates there are many consumer applications for solar cells, particularly those made from amorphous silicon.
- ANNUAL INDEX** – January to December 1987 ..... 60



## REGULAR FEATURES

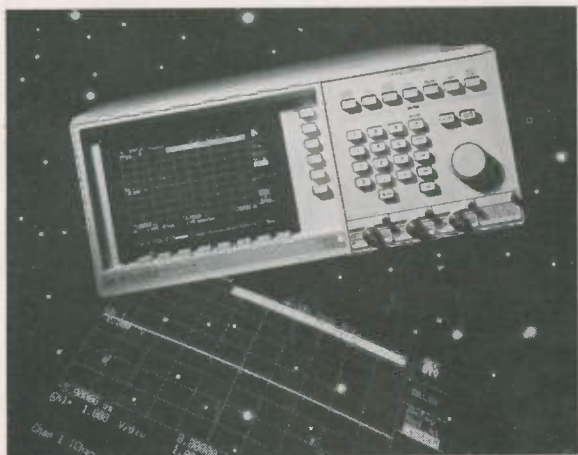
- EDITORIAL** – Technology ..... 9
- LEADING EDGE** by Barry Fox – Who's dat sampling again? ..... 8
- SPACEWATCH** by Dr. Patrick Moore – Remotest known object ..... 46
- INDUSTRY NOTEBOOK** by Tom Ivall – Social profit and loss ..... 57
- MARKETPLACE** – what's new, where and when ..... 4
- PCB SERVICE** – professional PCBs for PE Projects ..... 56
- TRACK CENTRE** – the PCB track layout pages ..... 32
- CHIPCHOP** – a technical logic research analyser ..... 33
- BAZAAR** – Readers' FREE advertising service ..... 58
- POINTS ARISING** ..... 41
- ADVERTISERS' INDEX** ..... 62



## NEXT MONTH . . .

The Yule-Tide issue has a veritable feast of features –  
**SANTALITE CONTROLLER • EGG LED TIMER • KIND MOUSE TRAP**  
**• LEGGO BUGGY DRIVER • INGENUITY UNLIMITED BUMPER BUNDLE • LCD COLOUR TV • TEACHER TALKBACK • HEAT SINKS**  
**• CODED LOCKS** (sorry space didn't allow it this month) •  
**SEMICONDUCTORS • TELEPHONE HISTORY •**  
 AND of course we'll have our regular top line features and latest product information as well.

**IN IT'S SPECIAL SEASONAL COVER THE JANUARY 1988**  
**ISSUE WILL BE HARD TO KEEP YOUR CLAUS OFF!**  
**ON SALE FROM FRIDAY DECEMBER 4TH**  
**DON'T MISS IT**  
**IT'S A GIFT AT £1.25**



**THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS ENTHUSIASTS**

## CATALOGUE CASEBOOK



*We have recently received the following catalogues and literature:*

**British Amateur Electronics Club.** Once again they have produced another Newsletter, full of interesting information and letters. The Hon. Sec., B.A.E.C., 53 High Oaks Close, Locks Heath, Southampton, SO3 6SX.

**Electronic Organ Magazine.** This has been a regular publication for many years, and is a well produced and informative journal. The Hon. Sec., E.O.C.S., The Mill House, Mill Lane, Wheaton Aston, Stafford, ST19 9NL.

*Why not think of joining B.A.E.C., or the E.O.C.S., or both!*

**Electronic Brokers'** brochure and price list of test equipment product ranges, for which they state that they are the number one distributor in the UK. **Electronic Brokers Ltd.** 104-106 Camden Street, London NW1 9PB. 01-267 7363.

**Hobby Drill 2000** catalogue detailing a collection of small tools, mostly based around a compact low voltage miniature drill system, for the hobby enthusiast or electronics professional. **JASP International**, 14 Tudor Close, Wokingham, Berks, RG11 2LU. 0734 782084.

**Audiokits** have released their latest catalogue of precision components and high quality audio amplifier kits, which naturally include the PE 30+30 amplifier (PE Feb-Mar 87), **Audiokits**, 6 Mill Close, Borrowwash, Derby, DE7 3GU.

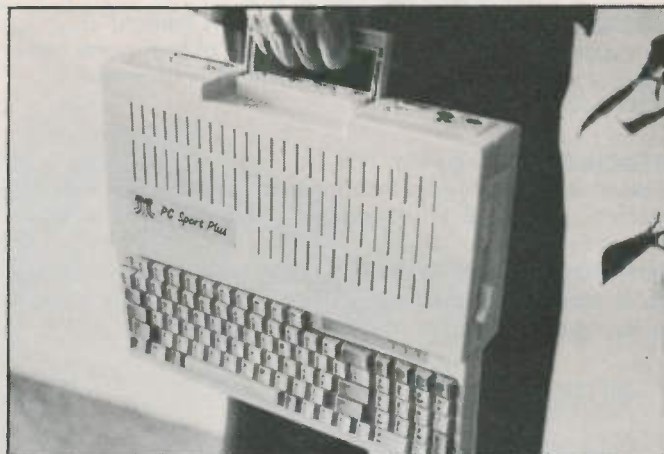
**Phonosonics'** latest short-form catalogue has been received, detailing kits for many projects published in PE, including the **Burglar Alarm** in this issue. **Phonosonics**, Dept 12ED, 8 Finucane Drive, Orpington, Kent, BR5 4ED.

**The British Audio Dealers Association** have published a 30 page glossy colour book on choosing hi-fi, and it's FREE to PE readers. **BADA**, The Sound Advice Centre, 40-41 Great Castle Street, London W1N 7AF.

**Livingstone Hire** have sent a promotional leaflet publicising the electronic equipment that can be hired from them. They claim to be Europe's 'No 1' company offering this service. **Livingstone Hire Ltd**, 2-6 Queens Road, Teddington, Middx. TW11 0LB. 01-977 8866.

**Five Star Connectors** offer 'the best choice ever for connectors'. Their new 200+ page catalogue adds considerable weight to their claim. **Five Star Connectors**, Edinburgh Way, Harlow, Essex, CM20 2DF. 0279 442851.

## WHAT'S NEW



### Sporty Piece

An innovative new portable is the latest addition to the growing range of IBM compatibles from AMT.

Powerful memory features are built into the PC Sport Plus. The conventional memory of 256K can be increased to 640K, and an additional 512K of expanded memory can be added on a separate memory bank giving extra room for packages such as Lotus 1-2-3 and Framework that support the EMS standard. Performance is bettered by few PCs, and PC Sport Plus runs at a turbo speed of 8MHz.

Those fortunate enough to lay their hands on the keys will find a standard layout with the addition of separate cursor keys, assisting numeric input to spreadsheets. Leds, ten function keys and a reset button are present too.

An integral 360K disk drive is built into the right hand side of the computer and an external drive can be connected at the

rear. Communications are available with two serial RS232 ports, 25 pin and 9 PIN, a useful facility on a portable, allowing use of various modems without a converter lead. The display card is CGA (640 x 200) and allows use of both composite video monitors and colour displays. An EGA card is optional and will be available soon.

An eight-bit expansion slot on the left hand side adds growth potential, and an optional 4-slot expansion box is on the way. One unusual feature is specialized circuitry which allows most copy protected software to be backed up. Other features include a battery backed real time clock, parallel port for printer and games port for joystick.

The PC Sport Plus is priced at £499 + VAT. With Dos 3.2, 640K RAM and a monochrome monitor the system costs £703 + VAT.

**Contact: Applied Microsystems Technology Ltd, 1st Floor, 249-251 Cricklewood Broadway, London NW2 6NX. Tel: 01-450 3222.**

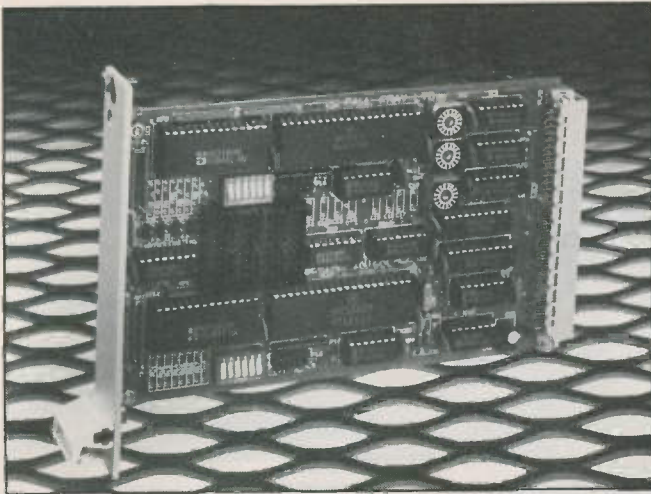
### Pumping Lead

Cooper Tools have introduced two anti-static models to their Weller manual desoldering pump range.

Featuring fine 0.07in (1.9mm) diameter and general use 0.12in (3.2mm) diameter anti-static desoldering nozzles, the DS-AS-100 and DS-AS-110 allow one-handed operation, in conjunction with a soldering iron, to remove suction all the solder from around components requiring replacement on circuit boards.

**For further information contact: Cooper Tools Limited, Sedling Road, Wear, Washington, Tyne & Wear NE38 9BZ. Tel: (091) 416 6062**





### Spider's Web

Paul Fray Limited, the Cambridge-based specialists in interfacing laboratory equipment to micros, has recently announced several new products to complement and extend its Spider 2 real-time package, and to allow its use with Acorn's new RISC machine.

A new version of the Cobweb 1MHz expansion card allows a micro (BBC models B, B+ and Master 128, Acorn Cambridge Workstation or Archimedes) to address up to 16 Mbytes on an industry-standard 'Cambridge Bus' backplane. This backplane can make use of a growing range of interface and memory cards.

A four channel serial interface card provides a large degree of

flexibility: connectors and termination characteristics are available to customer order. Full modem support is implemented.

A 16 channel digital interface card allows 'bomb-proof' connection to laboratory experiments etc., at up to 30V d.c. Each opto-isolated channel may be an input or an output, selected under software control. Spider 2 is found in motor-car endurance testing, saw-mill management, robot supervision, wind-speed measurement, satellite telemetry, nutritional analysis, behavioural pharmacology and many other fields in schools, universities and industry.

Contact: Alasdair Hayden on Cambridge (0223) 66529.

### COUNTDOWN

If you are organising any electronic, computing, electrical, scientific or radio event, big or small, drop us a line. We shall be glad to include it here. Send details to **COUNTDOWN**, Practical Electronics, 193 Uxbridge Road, London W12 9RA.

**PLEASE NOTE:** Some events listed here may be trade only, or restricted to certain categories of visitor. Also, please check dates, times and other relevant details with the organisers before setting out as we cannot guarantee information accuracy.

**Regular courses for R.A.E.**, and also for Morse. Grafton Radio Society, Elizabeth Garrett Anderson School, Riseing Hill Street, London N1.

**Regular weekly courses for Radio Amateurs Exam (C8G 765).** Tuesdays 7.30 to 9.30. Hendon College, Corner Mead, Grahame Park, Colindale, London NW8 5RA. Tel: 0-200 8300.

**Nov 3-Dec 10.** Research and Development Society Silver Jubilee Exhibition. The Design Centre. London. 01-235-6111.

**Nov 5-8.** Reproduced Sound Conference — IOA. Windermere Hydro Hotel. 031-225-2143.

**Nov 10-12.** Drives, Motors, Controls and PC+ Systems '87. National Exhibition Centre, Birmingham. 0799-26699.

**Nov 19-20.** Desktop Publishing. Cumberland Hotel, London. 01-871 2546.

**Dec 17-18.** Underwater Communication Conference — IOA. University of East Anglia, Norwich. 0603 592582.

**Jan 27-28.** Instrumentation Coventry. Trade only. Allesley Hotel, Coventry. 0822 4671.

**Feb 24-25.** Instrumentation Bristol. Trade only. Bristol Crest Hotel, Bristol. 0822 4671.

**Mar 29-30.** Instrumentation Harrowgate. Trade only. Harrowgate Exhibition Centre, Harrowgate, N. Yorks. 0822 4671.

### Ecology Conscious

A recent press release informed me that Vidor batteries are being used in a mole mover; I was intrigued enough to follow up the story.

It turns out that PAL Electronic Systems are the company with the kind hearted design team. Being conscious that wild life has its essential place in nature, they believe that unwanted intrusion by animals is better cured by deterrence rather than destruction. Their environmentally safe electronic device to combat mole infestation puts their hertz where their hearts are.

Known as the Kestrel Molemover, the battery powered device has a probe that is inserted into the soil close to known mole runs. It generates a modulated sound disturbance which makes use of the moles' high sensitivity to sound vibration to encourage them to stay away.

Depending on soil conditions, the Molemover will effectively stop mole damage over an area of 750 to 1100 square metres, and operates in temperatures ranging from  $-20^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$ . Its compact design and light weight of only 1kg, including battery, makes it ideal for use in gardens, parks, golf courses, airfields and other areas where moles can cause problems (no mention of MI5 or MI6 though). The Vidor Powercell Long Life alkaline 1.5V batteries will operate the device constantly for approximately six weeks.



PAL are equally kind to birds and rodents. Their Rat Router uses advanced modulated ultrasonic techniques to evict rodents from reserved residences. Being electrically safe, non-toxic and non-lethal, it is environmentally safe and hygienic for use even in food containing areas.

Their Bird Blaster doesn't use shot guns, but instead emits blasts of sound and light to deter would-be crop raiders without actually scaring them. They also have a Bird Ejector that uses ultrasonics to overcome the problem of birds in and on buildings without killing them. Both units are portable and environmentally safe.

Using electronics in this fashion to guard the interests of both humans and wild life has my encouraging approval. I wonder if they will invent a unit to eliminate bugs from programs.

Contact: PAL Electronic Systems Ltd, PO Box 7, Oadby Industrial Estate, Leicester, LE2 4YE. Tel: 0533 713361.

### Pirate Destruction

A Nigerian court has recently ordered the destruction of 200,000 pirate music cassettes containing works by over 300 classical, jazz and pop artists. This is the latest in a series of legal moves by the local music industry against importers and manufacturers of illicit tapes and follows a recent pledge by a senior government minister that measures to eradicate piracy will be introduced by the end of 1987.

The ministerial statement was made by the Attorney-General, Prince Bola Ajibola, during a top-level seminar organised in Lagos by the Nigerian IFPI group, representing recording companies, the Nigerian Television Authority and the country's musicians' union. Among the speakers were industry officials and leading Nigerian lawyers. In his speech, Prince Ajibola acknowledged that the country's 1970 Copyright Act was obsolete and added that revised and "stiffer" copyright legislation was in the offering. Nigeria is the largest market

for recorded music in Africa, with annual sales of some 23 million records and cassettes. Of these, however, some 70% are pirated, with a retail value of 96 million naira (\$30 million). Although hampered by the inadequate state of the current law, IFPI's Nigerian group has won four major anti-piracy actions in the Lagos courts in the last twelve months. The cases brought against manufacturers, imports and printers involved in piracy, resulted in the imposition of damages totalling over 120,000 naira.

Peter Crockford, IFPI's Anti-Piracy Co-ordinator, commented that "The Attorney General's statement is most encouraging since it is the first formal public commitment by the Nigerian government to the introduction of copyright reforms. IFPI has already submitted its proposals to make prosecutions easier and penalties heavier and we hope to see these included in the forthcoming legislation.

Contact: IFPI Secretariat, 54 Regent Street, London W1R 5PJ.

## CHIP COUNT!

*This month's list of new component details received — mainly chips, but other items may be included.*

**68C257 and 87C257.** Specialised 256Kbit CHMOS Eproms for microcontroller-based systems. (IT).

**83C152.** CHMOS Universal Communications Controller incorporating the 8051 instruction set, and hard wired SDLC-HDLC and CSMA-CD communication protocols. (IT).

**BD1.** Intelligent alphanumeric display, combining a 16 character, 14 segment vacuum-flourescent display and on board controller (HS).

**LM211XB.** High performance LCD screen capable of displaying graphic or alphanumeric data, its 64 × 480 dot matrix format allows up to eight rows of 80 characters. (HT).

**TM2.** Transputer based module. High quality, 95 × 74mm, four layer PCB on which are mounted a T414-15 transputer (capable of 7.5 million instructions per second) and 1Mbyte of DRAM. (CT).

**TP4192.** 500ns A-D converter with 12-bit resolution in three selectable input rages up to 20V. (TP).

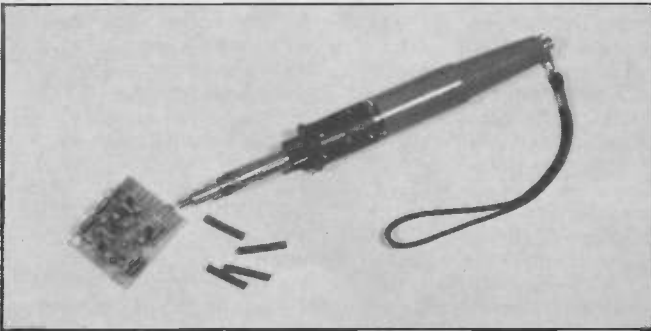
**Manufacturers, and contact telephone numbers for further details.** (CT) Concurrent Techniques, 0424 714790. (HS) High Speed Technology, 0602 587225. (HT) Hitachi, 0923 246488. (IT) Intel, 0793 696204. (MC) MCP Electronics, 01-902 6146.

## Heatshrink

Master HeatTools announce the availability of a range of heatshrink attachments for their Ultratorch 3 in 1 heat tool. With an outside diameter ranging from 8.0mm down to a minute 2.5mm the tips are ideal for small or inaccessible heatshrinking and drying work.

The Ultratorch 3, as well as being a heatshrink tool, can also be used as a soldering iron and is powered by inexpensive butane gas making the unit completely portable.

**Contact: Master Heat Tools, Unit M, Portway Industrial Estate, Andover SP10 3LU Hants. Tel: (0264) 51347/8**



## Bus Battery

The SM256 is a byte-wide memory card for the STE Bus from DSP Design. It has 8 sockets to take any mix of SRAM, EPROM or EEPROM up to maximum of 256 Kbytes. 8 Kbyte, 16 Kbyte or 32 Kbyte chips may be used.

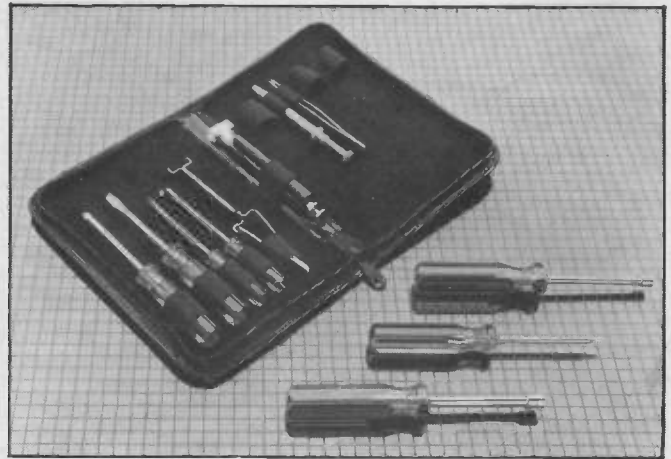
Battery backup is provided on the board, and the user can select which sockets to support. The battery is switched in either when the main 5V supply drops too low or when the STE Bus SYSRST signal is asserted.

Flexible memory addressing allows the card to be mapped

anywhere in the 1Mbyte STE Bus address space and to occupy from 64K up to 256K, depending on the memory chips used. Individual sockets can be made to 'disappear' from the memory map to avoid clashes with other memory devices.

Jumpers allow the user to select the access time of the board, for optimum system performance, from 50 to 250ns in 50ns steps.

The SM256 is available at £139.50 one-off. All enquiries to: **DSP Design Limited, 100 St Pancras Way, London NW1 9ES. Tel: 01-482 1773**



## Chip Kit

A new electronic servicing kit that includes a range of integrated-circuit handling tools as well as screwdrivers and nutdrivers has been introduced by Global Specialists.

The CSK-8 kit contains an i.c. insertion tool with pin straighteners for 14 and 16 pin devices; an extraction tool with pin straightener for 14 to 40 pin

devices; a three-claw parts holder; assembly tweezers; a selection of slotted and Phillips screwdrivers; two nutdrivers; and a torque screwdriver.

The kit is supplied in a zipped vinyl case measuring 23 x 15 x 14 cms and costs £22.50.

**Contact: Global Specialists, Shire Hill Industrial Estate, Saffron Walden, Essex, CB11 3AQ. Tel: 0799 21682.**

## Trading Pops

Pops Electronic Components is a new Company that has been formed to cater for the electrical, electronic and wholesale, trade, specialising in potentiometers, switches, plugs, sockets, leads, fuses, test meters etc.

Pops has been established by Clive Coleman and Peter "Fred" Gosling who between them have over 50 years experience in the wholesale and retail trade. They were formerly with the K. Popper (R.T.C.) Ltd

Organisation, have now set up their own business at Staples Corner, London.

Clive and Fred will be happy to deal with all enquiries from trade customers both old and new, UK and abroad. Small and large manufacturers, technical colleges, universities and schools are also welcome.

**For further information contact: Pops Electronic Components Ltd, Studio D, Unit 9A, Oxgate Lane, London, NW2 7HU. Tel No.: 01 450 4688/9 (24 hour answer phone).**

## Tip Charge

Cirkit has introduced a new rechargeable soldering iron, which is ideal for soldering CMOS and other static sensitive devices and for site work where no mains supply is available.

Rated at 12W with fast warm-up time and small 2mm diameter tip, the unit comes complete with mains charger, wall mounted socket and a 12V car charging

lead which is connected via a vehicle's cigarette lighter. Up to 200 standard joints can be made from one charge of 12 hours.

Featuring an illuminated tip, for which spares are readily available, the soldering iron also has a safety hood for protection during operation.

**Contact: Cirkit Holdings PLC Park Lane, Broxbourne, Hertfordshire EN10 7NQ. Tel: (0992) 444111**



## £1 BAKERS DOZEN PARCELS

Price per parcel is £1.00, but if you order 12 you get one extra free. All the parcels listed below are brand new components. Unless marked s.h.

- 1 - 5 13 amp ring main junction boxes
- 2 - 5 13 amp ring main spur boxes
- 5 - 3 flush electrical switches
- 7 - 4 in flex line switches with neons
- 8 - 2 80 watt brass cased elements
- 9 - 2 mains transformers with 6V 1A secondaries
- 10 - 2 mains transformers with 12V 1A secondaries
- 11 - 1 extension speaker cabinet for 6 1/2" speaker
- 12 - 5 octal bases for relays or valves
- 13 - 12 glass reed switches
- 14 - 4 OCP 70 photo transistors
- 16 - 4 tape heads, 2 record, 2 erase
- 17 - 1 ultra sonic transmitters and 1 ditto receiver
- 18 - 2 15000 mfd computer grade electrolytics
- 19 - 2 light dependent resistors
- 20 - 5 different micro switches
- 21 - 2 mains interference suppressors
- 22 - 2 25 watt crossover units 2 way
- 23 - 1 40 watt 3 way crossover unit
- 28 - 1 6 digit counter mains voltage
- 30 - 2 Nicad battery chargers
- 31 - 1 key switch with key
- 32 - 2 humidity switches
- 33 - 2 aerosol cans of ICI Dry Lubricant
- 34 - 96 x 1 metre lengths colour-coded connecting wires
- 36 - 2 air spaced 2 gang tuning condensers
- 37 - 2 solid dielectric 2 gang tuning condensers
- 38 - 10 compression trimmers
- 41 - 6 Rocker Switches 10 amp mains SPST
- 43 - 5 Rocker Switches 10 amp SPDT Centre Off
- 44 - 4 Rocker Switches 10 amp DPDT
- 45 - 1 24 hour time switch mains operated (s.h.)
- 46 - 1 6 hour clock timeswitch
- 48 - 2 6V operated reed switch relays
- 49 - 10 neon valves - make good night lights
- 50 - 2 x 12V DC or 24V AC, 4 CO relays
- 51 - 1 x 12V 2C 0 very sensitive relay
- 52 - 1 12V 4C relay
- 53 - 2 mains operated relays 3 x 8 amp changeovers
- 55 - 1 locking mechanism with 2 keys
- 56 - Miniature Uniselectors with circuit for electric jigsaw
- 57 - 5 Dolls' House switches
- 60 - 5 ferrite rods 4" x 5/16" diameter aeriels
- 61 - 4 ferrite slab aeriels with L & M wave coils
- 62 - 4 2000 ohm earpieces
- 63 - 1 Mullard thyristor trigger module
- 64 - 10 assorted knobs 1/2" spindles
- 65 - 5 different thermostats, mainly bi metal
- 66 - Magnetic brake - stops rotation instantly
- 67 - Low pressure 3 level switch
- 69 - 2 25 watt pots 8 ohm
- 70 - 2 25 watt pots 1000 ohm
- 71 - 4 wire wound pots - 18, 33, 50 and 100 ohm
- 73 - 4 3 watt wire wound pots 50 ohm
- 77 - 1 time reminder adjustable 1-60 mins
- 78 - 5 5 amp stud rectifiers 400V
- 85 - 1 mains shaded pole motor 1/2" stack - 1/2" shaft
- 86 - 2 5" ali fan blades fit 1/2" shaft
- 87 - 2 3" plastic fan blades fit 1/2" shaft
- 88 - Mains motor suitable for above blades
- 89 - 1 mains motor with gear box 1 rev per 24 hours
- 91 - 2 mains motors with gear box 16 rpm
- 93 - 4 11 pin moulded bases for relays
- 94 - 5 BT valve bases
- 95 - 4 skirted B9A valve bases
- 96 - 1 thermostat for fridge
- 98 - 1 motorised stud switch (s.h.)
- 101 - 1 2 1/2 hours delay switch
- 103 - 1 6V mains power supply unit
- 104 - 1 4 1/2V mains power supply unit
- 105 - 1 5 pin flex plug and panel socket
- 107 - 1 5" speaker size radio cabinet with handle
- 109 - 10 1/2" spindle type volume controls
- 110 - 10 slider type volume controls
- 112 - 1 heating pad 200 watts mains
- 114 - 1 1W amplifier Mullard 1172
- 115 - Wall mounting thermostat 24V
- 118 - Teak effect extension 5" speaker cabinet
- 120 - p.c.b. with 2 amp full wave and 17 other recs
- 122 - 10 mtrs twin screened flex white p.v.c. outer
- 132 - 2 plastic boxes with windows, ideal for interrupted beam switch etc
- 155 - 3 varicap push button tuners with knobs
- 188 - 1 plastic box, sloping metal front, 16 x 95mm, average depth 45mm
- 241 - 1 car door speaker (very flat) 6 1/2" 15 ohm made for Radiomobile
- 243 - 2 speakers' 6" x 4" 15 ohm 5 watt made for Radiomobile
- 266 - 2 mains transformer 9V 1A secondary split primary so OK also for 115V
- 267 - 1 mains transformers 15V 1A secondary p.c.b. mounting
- 330 - 2 6V 0.6V mains transformers .3A p.c.b. mounting
- 350 - 40 double pole leaf switches
- 355 - 1 7uf 660V 50Hz metal cased condenser
- 463 - 2 2 1/2 in. 80ohm loudspeakers
- 454 - 2 2 1/2 in. 80ohm loudspeakers
- 463 - 1 mains operated relay with 2 sets c/o contacts
- 464 - 2 packets resin filler/sealer with cures
- 465 - 3 5A round 3 pin plugs will fit item 193
- 466 - 4 7 segment l.e.d. displays
- 470 - 4 pc boards for stripping, lots of valuable parts
- 473 - 1 5" 4ohm speaker with built in tweeter Radiomobile
- 480 - 1 3A double pole magnetic trip, saves repairing fuses
- 498 - 4 1000uf 25V axial electrolytic capacitors

### TELEPHONE BITS

- Master socket (has surge arrester - ringing condenser etc) and takes B.T. plug ..... £3.95
- Extension socket ..... £2.95
- Dual adaptors (2 from one socket) ..... £3.95
- Cord terminating with B.T. plug 3 metres ..... £1
- Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets ..... £11.50
- 100 mtrs 4 core telephone cable ..... £8.50

### COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500K per disc, which is equivalent to the 3 1/2" and 5 1/4" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of £27.50 including post and VAT. Data available separately £2, refundable if you purchase the drive.

### EVERLASTING BATTERIES!

Well not quite, but if you don't switch it on, the lithium battery has an almost indefinite shelf life, which makes it suitable for emergency, standby & similar applications, also for quartz clocks and instruments that draw only microscopic currents. The lithium battery we have is 3V and about as big and thick as 2p coin. Price 2 for £1 ref BD558. Note these plug into/Dii socket our ref BD553.

### 3 POLE MODEL MOTOR

Will operate from as low as 1.5V and speed will increase steadily as the voltage is increased, at 9V however a governor takes over and the speed remains constant - and ideal motor for models. Size approx 28mm x 40mm easily reversible and with good length spindle 60p each our ref B0553.

### CASSETTE STEREO TAPE HEADS

With mounting brackets and with tape guides pairs, one record/playback and the other erase £1 pair ref B0541.

### OPTO INTERRUPTER

Consists of a IR emitter mounted close to light dependent resistor when light or IR is interrupted the change of resistance can be made to switch or operate a relay - useful for counting, motor stopping etc. Price 2 for £1 ref B0545.



Ex-Electricity Board. Guaranteed 12 months.

### VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95 without case, metal case - £2.95, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/off's per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

### 12 volt MOTORS BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3 1/2" long by 3" dia. They have a good length of 1/2" spindle - 1/10 hp £3.45, 1/8 hp £5.75, 1/6 hp £7.50



### SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/2" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

### This Month's Snip

9" VDU OR MONITOR ideal to work with computer or video camera uses Philips black and white tube ref M24/30BV. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuitry. Requires only a 15V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased (if you are handy with a drill and file you could make a case out of two of our 6 1/2" speaker cabinets). The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £15 plus £3 post. We also have some that failed the line test, again brand new but offered without guarantee at £8 plus £3 post. We do a kit for the 16V 2A psu to operate this monitor price is £3 our ref 3P26.

### SLIDE SWITCH

Sub miniature size only 10mm x 4mm single pole change over or on/off. Price 5 for £1 ref B0553.

### LOW VOLTAGE RELAY

OMRON 3.5V coil, plug in di sockets, 5a c/o contacts. Brand new offered at a silly price 2 for £1 ref B0548.

### POLARISED RELAY

Depending upon its direction dc current as low as 14 Ma makes this open circuit, so it could be used to protect delicate instruments or as an earth leakage, or reverse voltage trip etc. 2 for £1 ref B0549.

### SLOTTED OPTO SWITCH

Infra red emitter and sensor mounted in slotted moulding, so that the emitter beam when broken makes a contactless switch, can be used in electronic ignition, speed sensing etc. etc. Price 2 for £1 ref B0545.

### 24hr TIME SWITCH

Beautifully made with West German precision. Just under 4" square with 15amp c/o contacts can be set anywhere around 24hr dial to the nearest 15 mins also with a override switch. Ref 8P6 but hurry we have only 300. Price £8.

### COMPUTERS

The Acorn "Electron" as used in many schools for games and serious jobs. Works into colour or Black and White TV. Proper price was £199, our Price, tested and working £45 + £3 post, tested but slightly faulty £36 + £3 post and lastly tested but not working £20 + £3 post, all are new and complete with: mains P.S.U., 300 page handbook, TV lead, and starter cassette. Full range of Software also in stock at very low prices.

### TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref B0552 or 3 for £2 ref 2P164.

### POWERFUL IONISER

Generates approx. 10 times more IONS than the E1 and similar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder - a complete mains operated kit, case included. £9.50 + £2 P&P.

## J & N BULL ELECTRICAL

Dept. P.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton 0273 734648 or 203500.

## NEW ITEMS

Some of the many described in our current list which you will receive with your parcel.

### £2 POUNDERS\*

- 2P120 - 1 combined clockwork switch and thermostat for boiler control
- 2P122 - 1 30a rotary switch, surface mounting with pointer knob
- 2P123 - 1 25a rotary switch, surface mounting, cover engraved, high, medium low and off
- 2P124 - 1 28kv .001mfd block condenser
- 2P127 - 1 30a bridge rectifier assembly on heat sinks
- 2P129 - 1 10rpm motor 115V so supplied with adaptor for 230V
- 2P131 - 1 Crouzet motor 230V fits the Crouzet gearbox
- 2P132 - 1 ceiling heat-stat for fire warning or protection
- 2P133 - 1 Circuit breaker 20a, Crabtree ref C50
- 2P134 - 1 9V 500ma psu, plugs into 13a socket
- 2P135 - 10m 10 conductor intercom cable
- 2P136 - 1 2 1/2 wire element for tangential blowers
- 2P137 - 1 Thermo couple, stainless steel tipped for measuring internal heat
- 2P138 - 1 Mains transformer 20V-0-20V 1A upright mounting
- 2P141 - 1 rechargeable battery D size (4 AH) solder tag ended
- 2P142 - 10m 4 pair intercom cable White PVC outer
- 2P144 - 1 mains operated relay with 4 x 8a c/o contacts
- 2P145 - 1 10,000 of 70V d.c. smoothing capacitor
- 2P146 - 1 7,800 of 150V d.c. smoothing capacitor
- 2P147 - 1 10w 100ohm line matching transformer
- 2P148 - 1 Technical information on 3" FDD refundable if you buy fdd
- 2P149 - 5 diff battery operated motor relays
- 2P150 - 1 PSU chassis with all components for 24V 2A d.c. univired
- 2P151 - 1 Metal box 14 1/2 x 14 x 4 with lid add £2.00 post
- 2P152 - 1 Motor start capacitor 80uf 250V
- 2P153 - 1 Two station intercom unused but line reject
- 2P154a - 1 Nicad charger - plug into 13a socket 5.2V .7UA output
- 2P154b - 1 Nicad charger - plug into 13a socket 6V .9VA output
- 2P155 - 1 Mains transformer giving 18, 17, 18 & 20V 50W
- 2P158 - 1 Oven thermostat with temp calibrated knob
- 2P159 - 1 9V 500ma cased with mains lead and output lead
- 2P160 - 1 13a plug adaptor fused takes 3 x 13a plugs
- 2P161 - 1 6" diagonal side cutters
- 2P162 - 1 Stereo Matrix PCB mounting deemphasis K35
- 2P163 - 1 AC Working capacitor 12uf 860V AC or 1500V dc
- 2P163a - 1 AC Working capacitor 14uf 350V AC or 800V dc
- 2P164 - 3 Phone leads 3 mtrs long tags one end B.T. plug other end

### £3 POUNDERS\*

- 3P7 - 1 DC voltage, doubler or halver for 12V to 24V 12V to 12V
- 3P8 - 1 24hr time switch Sangamo, new condition Guaranteed 1 year
- 3P9 - 1 2V 500ma psu plugs in 13a socket
- 3P10 - 1 Mains transformer 50V 2A with 6.3 pilot light winding, upright mounting, fully shrouded
- 3P13 - 1 Noise filter to fit in mains lead of appliance up to 25a
- 3P15 - 1 waterproof case will take 200 watt transformer
- 3P16 - 1 signal box, 3 lamps on face plate of metal box size 5 1/2 x 3 1/2
- 3P17 - 1 choke and starter to work 8" fluorescent tube kit in 125W
- 3P18 - 1 22V 3a mains transformer with bridge rect fitted on top panel
- 3P20 - 1 0-5a ammeter 3 1/2 ac/dc ex equipment
- 3P21 - 1 power factor correction condenser 35uf 350ac
- 3P22 - 1 200va - auto transformer 230 to 115V toroidal encapsulated £1.50 post
- 3P23 - 1 35V-0-35V tapped 20V-0-20V 100va
- 3P24 - 1 3" floppy disc for Amstrad etc.
- 3P25 - 1 7" Electricians pliers

### £4 POUNDERS\*

- 4P11 - 1 Car Radio aerial
- 4P12 - 1 50m low loss co-ax 75ohm + £1 post
- 4P13 - 3 Horsman time and set switches 15amp
- 4P14 - 1 150w mains transformer "C" core 43V 3.5A secondary
- 4P15 - 1 powerful motor 2" stack fitted with gearbox final speed 80rpm mains operated, could operate door opener etc.
- 4P17 - 1 Uniselectors 3 pole 25V, 50V coil standard size
- 4P18 - 1 Volt meter with digital display (DIGIVISDR)
- 4P19 - 1 12V dc motor will fit to gearbox 4P20
- 4P20 - 1 Gear train giving speed reduction

### £5 POUNDERS\*

- 5P86 - 1 Transformer upright mounting 230/240V primary 2 x 100 1a secondary
- 5P88 - 1 Transformer in waterproof metal box 24V 5A add £2 post
- 5P89 - 1 4 bank heating element each 2kw ideal convactor heater
- 5P90 - 1 18" long tangential blower with motor at one end
- 5P91 - 1 14" blower, motor in middle
- 5P92 - 10m Audio co-ax double screened 75ohm super low loss for TV
- 5P93 - 1 6" Alarm bell 24V dc ac
- 5P94 - 1 Current transformer 14v out with 1a dc input
- 5P95 - 1 Vintage phone call
- 5P97 - 1 Impedance matching transformer 0.4-5-8-160 ohm 100 add £150 post
- 5P98a - 1 0-90a ammeter for mounting outside control panel
- 5P98b - 1 0-180a ammeter for mounting outside control panel
- 5P99 - 1 Mains operated blower centrifugal output size app. 5" x 1 1/2"
- 5P100 - 1 Mains splitter 45a switch 3 x 15a fused circuits
- 5P101 - 1 Model motor 1 rpm from 6V reversible

### £7 POUNDERS\*

- 7P1 - 1 Instant heat solder gun - mains with renewable tip and job light

### £8 POUNDERS\*

- 8P1 - 1 Charger transformer 10a upright mounting 230/240 primary 16v 10a secondary
- 8P2 - 1 6" underdome alarmbell suitable for a fire alarm or burglar alarm mains operated.
- 8P3 - 1 heat sink big powerful so ideal for power transmitter
- 8P5 - 1 1/2 hp motor 900 rpm capacitor run
- 8P6 - 1 24hr time switch - 2 on off's 16a c/o contacts 3" x 3" x 1 1/2"
- 8P7 - 1 Silent sentinel invisible ray kit
- 8P8 - 1 Papsit fan 3 1/2 x 3 1/2 x 1 1/2 230V metal bodied

### £10 POUNDERS\*

- 10P13 - 1 reversible motor with gearbox 104rpm Parvalux
- 10P14 - 1 100a time switch 1 on/off per 24hr extra triggers £1 pair
- 10P15 - 1 Max demand meter 230 ac mains
- 10P16 - 1 powerful air mover 2 small type blowers with motor in middle
- 10P18 - 1 mains operated klaxon
- 10P19 - 1 12V alarm bell really loud, mains operated, in iron case + £5 post
- 10P21 - 1 super metal box size 15" x 20" x 7" deep lockable + £3 post
- 10P22 - 1 sensitive volt meter relay
- 10P23 - 1 fruit machine heart 3 fruit wheels each stepper motor operated
- 10P24 - 1 big panel meter face size 4 1/2 x 2 1/2 200uA movement scaled 1-10
- 10P25 - 1 100W audio transformer 50-0-50W primary 8 ohm secondary
- 10P26 - 1 "Secretary" phone auto-dialler complete untested sold as such
- 10P29 - 1 12V engine cooling fan
- 10P30 - 1 instrument psu on pcb has 4 outputs. 12V/5V 6A/12V 5A/5V 5A
- 10P31 - 1 7 day time switch 16a c/o contacts sep switches for each day
- 10P32 - 1 88 rpm 1/6th hp motor reversible

### £15 POUNDERS\*

- 15P1 - 1 kit for 115W hi fi amp
- 15P2 - 1 kit for psu to supply one or two 15P1 amps
- 15P3 - 1 time switch battery or mains operated - 16a c/o contacts, 7 day programmable has 36hr reserve

### £25 POUNDERS\*

- 25P1 - 1 1500 PSI hydraulic pump 24V dc motor, made for operating aircraft under-carriage etc.

**LIGHT CHASER KIT motor driven switch bank with connection diagram, used in connection with 4 sets of xmas lights makes a very eye catching display for home, shop or disco, only £5 ref 5P56.**

# THE LEADING EDGE

BY BARRY FOX

## RED FACES AT PHILIPS

*Advances in digital recording techniques and television picture processing, and the offer of a constructive solution to the "Copycode" debate is received with horror.*

Rock guitarist and composer Pete Townshend of The Who has his own recording studio by the edge of the River Thames near Richmond lock and is using computer disks instead of magnetic tape to record his new album. The recorder, which costs around £100,000, also controls a bank of video recorders so that Townshend can mix and match film sequences in synchronism with the music.

The system is the Synclavier direct-to-disk multitrack recording system, made by New England Digital of Vermont. Instead of using reels of magnetic tape, it converts analogue sound into digital code and stores it on four Winchester hard disks, like computer data. Each disk hold 150 megabytes of data, so the system has a total capacity of 4.8 gigabits. This is partitioned into eight parallel streams to create the equivalent of an 8-track digital track recorder. For studio quality recording the sound signal is sampled at 50kHz and coded into 16 bit words. Each of the eight tracks can then store 13 minutes of music.

The big advantage of the system is that there is virtually instant access to any part of the recording, without time wasted on rewinding tape. Pete Townshend is now using the system to help him write music for films. The magnetic disks are electronically locked to four video tape recorders. Any or all of these contain a sequence of film for which music is to be written, together with shots of Townshend conducting an imaginary orchestra. When the magnetic disks and video recorders are run together, all the musicians making the recording can watch the film sequences and the conductor on a bank of monitor TV screens. The pictures and sound remain in perfect synchronism however many attempts are made at making the recording.

As computer users will well know, Winchester hard disks are never 100% reliable and may "crash" losing all the data. No musician wants to risk losing months of work so the Synclavier incorporates four tape "streamer" cartridges, made by Fujitsu of Japan. At the end of each recording session the four cartridges are run in parallel to make a safety

back-up of the digital data on the disks. It takes less than five minutes to make a bit-perfect back-up of a three minute 8-track sound recording. If the hard disks subsequently crash, the data can be reloaded from the tapes without any loss.

The next generation of domestic video recorders, and TV sets, due to go on sale in Britain this winter will use digital computer techniques to give clearer pictures from poor aeriels and old video tapes. The technique is called 'picture noise reduction', and Japanese shops are already selling sets which make TV pictures look much cleaner and crisper than ever before.

Video noise is always a problem with TV and video. Flecks of white, like snow, or spurious colour spots, like confetti, blemish the picture when the signals coming down from an aerial, or off a video tape, are too weak. Video noise reduction gets rid of the snow and flecks by taking advantage of two electronic phenomena.

When a TV set displays 50 half picture 'fields' a second most of the information in one picture is very similar to the information in the next, because most TV scenes are static views except for a little localized motion. But noise is random. The snow pattern which blemishes one TV picture is completely different from the snow pattern which blemishes the next.

If two TV pictures are added together the useful and wanted picture information is doubled, but the unwanted noise is increased only by a factor of 1.414 ( $\sqrt{2}$ ). So unwanted noise is reduced by around 30% ( $2 - 1.414/2$ ).

So far only professional equipment has taken advantage of this technique, because the solid state memory needed to store the TV pictures for summing is very expensive. Now the cost of solid state random access memory chips is low enough for domestic manufacturers to build picture noise reduction circuits into domestic video recorders and TV sets.

The incoming analogue TV pictures are converted into 6-bit digital code, stored in RAM, summed to reduce noise and then converted back into analogue signals for display on a TV screen in the



usual way.

Japanese company NEC has further improved the system with what it calls "noise wiper" circuitry. Instead of just summing consecutive pictures to reduce noise, the noise wiper sums each new picture with the previous noise-reduced picture, which was itself the sum of two previous pictures.

### DAT SAGA AGAIN

In an extraordinary new twist in the saga of DAT technology and politics a lawyer from Philips of the Netherlands says his company has come up with an ingenious idea for stopping people copying from disc records onto digital audio tape. But this is acutely embarrassing to Philips because it upsets plans by Philips's own subsidiary Polygram to use the much criticised Copycode system.

Copycode, developed by CBS, would suck an identifying notch out of the sound of every record sold to the public. When a tape recorder, compelled by law to incorporate a notch-sensing circuit, is asked to tape a Copycoded record, it simply switches off. Since May 1986 the record companies' world trade body, the IFPI, has been lobbying the Common Market law makers in Brussels and American government to pass the necessary laws.

Doubtless fearing the rebellion against Copycode which is now reaching fever pitch in the audio industry, the IFPI and CBS waited a full year before it demonstrated Copycode to the audio press and recording engineers who would have to use it. And then the demonstrations were given only to a few of the people who worry about what Copycode to the audio press and recording engineers who would have to use it. And then the demonstrations were given only to a few of the people who worry about what Copycode will do to recorded music.

Although the system will dutifully switch off a recorder, it creates an effect on music which the President of the prestigious Audio Engineering Society has described as "castration". In

*Continued on page 45*



# PE SCIENCE AND TECHNOLOGY

VOLUME 23 No. 12  
DECEMBER 1987

ISSN 0032 - 6372

#### Editor:

John Becker

#### Sub-Editor:

Helen Armstrong

#### Technical Illustrator:

Derek Gooding

#### Advertisement Sales:

Ian Forbes, Mike Thorburn,

Richard Murphy

#### Publisher's Assistant:

David Hewett

#### Publisher:

Angelo Zgorelec

#### Editorial and Advertising Address:

Practical Electronics,  
Intra House, 193 Uxbridge Road,  
London W12 9RA  
Tel: 01-743 8888

#### Advertisements

All correspondence relating to advertisements, including classified ads, should be addressed to: **The advertisement department, Practical Electronics, at the above address. Tel: 01-434 0689**

#### PE Services

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

#### Readers' Enquiries

All editorial correspondence should be addressed to the editor and any letters requiring a reply should be accompanied by a stamped addressed envelope.

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

#### Subscription Address:

Practical Electronics, Subscription Dept., P.O. Box 500, Leicester LE99 0AA

#### Annual Subscription Rates:

U.K. £15.00 Overseas £18.00  
Students: Deduct £1 and quote student number.

#### Cover Photo:

Chris Bell

## TECHNOLOGY

*Napoleon, I think it was, said that we are a nation of shopkeepers. I say we are just as much a nation of customers and customs. One custom has been that the December issue of a magazine should celebrate Christmas. Well, here we are, the December issue, but I'm not wishing you Merry Christmas now.*

*'And why not?', you might ask, counting the shopping days left. That's just it, there are too many days left, despite the cover date. PE is published on the first Friday of the month before the issue date. I suppose this helps to prove we are the magazine that presents future technology now. It's actually for reasons of distribution logistics, though it sometimes creates a feeling akin to *deja-vu* and *jet-lag* in the editorial office. This column for example, first hit the keyboard in July, just after you received the August issue!*

*I certainly don't want Christmas on November the 6th, but I am offering a compromise — an early warning present. Unless someone has *St Nicked* it, there is an extremely useful gift attached to the front cover that surpasses seasonal benefits. Full of rainbow hues, this irresistible chart of resistor and capacitor colour codes, plus symbols and circuits should be of long lasting value to any one who is becoming addicted to the fascination of electronics. For more experienced addicts a few formulae are also freely offered.*

*These won't answer imponderables like the current flat rate charge for an ohmless bus driving superconductor, or whether the cut off frequency of a circular SAW filter is subject to Planck's law. They will confirm though, the Ohm's law relationship between resistance, current and voltage, as well as provide equations for calculating capacitor values and time constants. The selection of op-amp circuits should also be highly useful information to experimenters; I've selected those that I believe will have widest appeal.*

*Anyone newly becoming intrigued by electronics should find that the hi-technocolour code charts are invaluable, easy to use, and easy to learn. An interesting point, though, is that although common resistors are usually coded, some other components that used to be coded are now having their identities printed on in alpha- numerics instead. I imagine that it's probably cheaper, and also that possibly it helps those who are colour blind. It is chastening to think that many are afflicted in that way, even amongst regular readers and project builders.*

*Electronics and other technologies have brought many benefits to medical science, in particular in the investigative and corrective fields, but so far as I know, science has not yet come to the aid of those who are colour blind. No doubt it will one day.*

*Meanwhile, we are trying to help other quests for knowledge through this pre-noel present of code crackers and symbolic feasts. I will save the greetings till next month; don't miss the Christmas issue, it's exceptionally interesting.*

THE EDITOR

#### PLEASE NOTE OUR NEW ADDRESS

**OUR JANUARY 1988 ISSUE WILL BE ON SALE FRIDAY, DECEMBER 4th 1987 (see page 2)**

© Intra Press 1987. Copyright in all drawings, photographs and articles published in PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or part are expressly forbidden. All reasonable precautions are taken by PRACTICAL ELECTRONICS to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press. All material is accepted for publication on the express understanding that the contributor has the authority to permit us to do so.

**BBC Computer & Econet Referral Centre**

AMBI5 BBC MASTER £385 (a)	AMB12 BBC MASTER Econet £315 (a)
AMC06 Turbo (65C - 02) Expansion Module	£99 (b)
ADC08 512 Processor	£195 (b)
ADF14 Rom Cartridge	£13 (b)
ADJ22 Ref Manual Part 1	£14 (c)
ADJ24 Advanced Ref Manual	£19.50 (c)
ADF10 Econet Module	£41 (c)
ADJ23 Ref Manual Part II	£14 (c)
BBC Master Dust Cover	£4.75 (d)

**BBC MASTER COMPACT**  
 A free packet of ten 3.5" DS discs with each Compact SYSTEM 1 128K Single 640K Drive and bundled software £385 (a)  
 SYSTEM 2 System 1 with a 12" Hi Res RGB Monitor £469 (a)  
 SYSTEM 3 System 1 with a 14" Med Res RGB Monitor £599 (a)  
 Second Drive Kit £99 (c) Extension Cable for ext 5.25" drive £12.50 (d)  
 View 3.0 User Guide £10 (d)  
 BBC Dust Cover £4.50 (d)  
 ADFS ROM (for B with 1770 DFS & B Plus) £26 (d)  
 ACORN Z80 2nd Processors £329 (a)  
 MULTIFORM Z80 2nd Processor £289 (b)  
 TORCH Z80 2nd Processor ZEP 100 £229 (a)  
 TZDP 240 ZEP 100 with Technomatic PD800P dual drive with built-in monitor stand. £439 (a)

**META Version III** - The only package available in the micro market that will assemble 27 different processors at the price offered. Supplied on two 16K roms and two discs and fully compatible with all BBC models. Please phone for comprehensive leaflet **£145 (b)**.

We stock the full range of ACORN hardware and firmware and a very wide range of other peripherals for the BBC. For detailed specifications and pricing please send for our leaflet.

**PRINTERS & PLOTTERS**

<b>EPSON</b>		
EPSON LX-86	£199 (a)	STAR NL10 (Parallel Interface) £239 (a)
Optional Tractor Feed LX80/86	£20 (c)	STAR NL10 (Serial Interface) £279 (a)
Sheet Feeder LX80/86	£49 (c)	STAR Power Type
FX800	£319 (a)	£229 (a)
FX1000	£449 (a)	<b>BROTHER HR20</b> £329 (a)
EX800	£409 (a)	
LO800 (80 col)	£439 (a)	<b>COLOUR PRINTERS</b>
LQ1000	£589 (a)	
<b>TAXAN</b>		Dotprint Plus NLO Rom for Epson versions for FX, RX, MX and GLP (BBC only) £28 (d)
KP815 (160 cps)	£249 (a)	
KP915 (180 cps)	£369 (a)	<b>PLOTTERS</b>
<b>JUKI</b>		Hitachi 672 £459 (a)
6100 (Daisy Wheel)	£259 (a)	Graphics Workstation (A3 Plotter) £599 (a)
<b>NATIONAL PANASONIC</b>		Pioltmate A4SM £450 (a)
KX P1080 (80 col)	£149 (a)	

**PRINTER ACCESSORIES**

We hold a wide range of printer attachments (sheet feeders, tractor feeds etc) in stock. Serial, parallel, IEEE and other interfaces also available. Ribbons available for all above plotters. Pens with a variety of tips and colours also available. Please phone for details and prices.

**Plain Fanfold Paper with extra fine perforation (Clean Edge):**  
 2000 sheets 9.5" x 11" £13 (b) 2000 sheets 14.5" x 11" £18.50 (b)  
 Labels per 1000s: Single Row 3.5" x 1.716" £5.25 (d) Triple Row 2.716" x 1.716" £5.00 (d)

**MODEMS**

All modems carry a full BT approval

**MIRACLE TECHNOLOGY WS Range**

WS4000 V21/23 (Hayes Compatible, Intelligent, Auto Dial/Auto Answer)	£149 (b)
WS3000 V21/23 Professional As WS4000 and with BELL standards and battery back up for memory	£245 (b)
WS3000 V22 Professional As WS3000 V21/23 but with 1200 baud full duplex	£450 (a)
WS3000 V22 bis Professional As V22 and 2400 baud full duplex	£595 (a)
WS3022 V22 Professional As WS3000 but with only 1200/1200	£350 (a)
WS3024 V22 Professional As WS3000 but with only 2400/2400	£450 (b)
WS2000 V21/V23 Manual Modem	£95 (b)
DATA Cable for WS series/PC or XT	£10 (d)
DATATALK Comms Package * If purchased with any of the above modems *	£70 (c)
PACE Nightingale Modem V21/V23 Manual (Offer limited to current stocks)	£75 (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 £195.00 (b)  
 Adaptor £276.40  
 2564 £25.00

**SPECIAL OFFER**

2764-25 £2.50 (d);
27128-25 £2.75 (d);
6264 LP-15 £2.80 (d);

**RT256 3 PORT SWITCHOVER SERIAL INTERFACE**  
 3 input/1 output or 1 input/3 output manual channel selection. Input/output baud rates, independently selectable 7 bit/8 bit, odd/even/none parity. Hardware or software handshake. 256K buffer, mains powered. £375 (b)

**PB BUFFER**  
 Internal buffer for most Epson printers. Easy to install. Inst. supplied PB128 128K £99 (c)

**I.D. CONNECTORS**

(Speedlock 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
<b>MALE:</b>				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	—
<b>FEMALE:</b>				
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	—

**TEXTTOOL ZIF**

SOCKETS	24-pin £7.50
	28-pin £9.10
	40-pin £12.10

**DISC DRIVES**

5.25" Single Drives 40/50 switchable:	
TS400 400K/640K	£114 (b)
PS400 400K/640K with integral mains power supply	£129 (b)
5.25" Dual Drives 40/80 switchable:	
TD800 800K/1280K	£199 (a)
PD800 800K/1280K with integral mains power supply	£229 (a)
PD800P 800K/1280K with integral mains power supply and monitor stand	£249 (a)
3.5" 80T DS Drives:	
TS351 Single 400K/640K	£99 (b)
PS351 Single 400K/640K with integral mains power supply	£119 (b)
TD352 Dual 800K/1280K	£170 (b)
PD352 Dual 800K/1280K with integral mains power supply	£187 (b)
PD853 Combo Dual 5.25"/3.5" drive with p.s.u.	£229 (a)

**3M FLOPPY DISCS**

Industry Standard floppy discs with a lifetime guarantee. Discs in packs of 10

5 1/4" Discs	40 T DS DD	£12.00 (d)	80 T SS DD	£20.00 (d)
40 T SS DD	£10.00 (d)	80 T DS DD	£15.50 (d)	80 T SS DD
80 T SS DD	£14.50 (d)			£25.00 (d)

**FLOPPICLENE DRIVEHEAD CLEANING KIT**

FLOPPICLENE Disc Head Cleaning Kit with 28 disposable cleaning discs ensures continued optimum performance of the drives. 5 1/4" £12.50 (d) 3 1/2" £14.00 (d)

**DRIVE ACCESSORIES**

Single Disc Cable £6 (d)	Dual Disc Cable £8.50 (d)
10 Disc Library Case £1.80 (d)	30 x 5 1/2" Disc Storage Box £6 (c)
50 x 5 1/2" Disc Lockable Box £9.00 (c)	100 x 5 1/2" Disc Lockable Box £13 (c)

**MONITORS**

<b>RGB 14"</b>		<b>MONOCHROME</b>	
1431 Std Res	£179 (a)	TAXAN 12" HI-RES	
1451 Med Res	£225 (a)	KX1201G green screen	£90 (a)
1441 Hi Res	£265 (a)	KX1203A amber screen	£95 (a)

<b>MICROVITEC 14" RGB/PAL/Audio</b>		<b>PHILIPS 12" HI-RES</b>	
1431AP Std Res	£199 (a)	BM7502 green screen	£75 (a)
1451AP Std Res	£259 (a)	BM7522 amber screen	£79 (a)
All above monitors available in plastic or metal case.		8501 RGB Std Res	£139 (a)

<b>TAXAN SUPERVISION II</b>		<b>ACCESSORIES</b>	
12" - Hi Res with amber/green options		Microvitec Swivel Base	£20 (c)
IBM compatible	£279 (a)	Taxan Mono Swivel Base with clock	£22 (c)
Taxan Supervision III	£319 (a)	Philips Swivel Base	£14 (c)
		BBC RGB Cable	£5 (d)
		Microvitec	£3.50 (d)
		Taxan £5 (d)	Monochrome £3.50 (d)
		Touchtec - 501	£239 (b)

<b>MITSUBISHI</b>		
XC1404 14" Med Res RGB, IBM & BBC compatible	£219 (a)	

**OVERASERS**

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. £59 + £2 p.p. UV1 as above but without the timer £47 + £2 p.p. For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built in timer. Both offer full built in safety features UV140 £69, UV141 £85, p.p £2.50.

**EXT SERIAL/PARALLEL CONVERTERS**

Mains powered converters	
Serial to Parallel	£48 (c)
Parallel to Serial	£48 (c)
Bidirectional Converter	£105 (b)

<b>Serial Test Cable</b> Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end - making it possible to produce almost any cable configuration on site. Available as M/M or M/F £24.75 (d)	<b>Serial Mini Patch Box</b> Allows an easy method to reconfigure pin functions without rewiring the cable. Jumpers can be used and reused £22 (d)	<b>Serial Mini Test</b> Monitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines. Connects in Line £22.50 (d)
--	---	--

**CONNECTOR SYSTEMS**

<b>EDGE CONNECTORS</b> 2 x 6 way (commadore) 0.1 0.156 300p 2 x 10 way 150p — 2 x 12 way (vic 20) — 350p 2 x 18 way — 140p 2 x 23 way (ZX81) 175p 220p 2 x 25 way 225p 220p 2 x 28 way (Spectrum) 200p — 2 x 36 way 250p — 1 x 43 way 260p — 2 x 22 way 190p — 2 x 43 way 395p — 1 x 77 way 400p 500p 2 x 50 way (S100conn) 600p —	<b>AMPHENOL CONNECTORS</b> 36 way plug Centronics (solder) 500p (IDC) 475p 36 way skt Centronics (solder) 550p (IDC) 500p 24 way plug IEEE (solder) 475p (IDC) 475p 24 way skt IEEE (solder) 500p (IDC) 500p PCB Mtg Skt Ang Pin 24 way 700p 36 way 750p	<b>RIBBON CABLE</b> (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
<b>EURO CONNECTORS</b> DIN 41612 Plug Skt 2 x 32 way St Pin 230p 375p 2 x 32 way Ang Pin 275p 320p 3 x 32 way St Pin 260p 300p 3 x 32 way Ang Pin 375p 400p IDC Skt A + B 400p IDC Skt A + C 400p For 2 x 32 way please specify spacing (A + B, A + C).	<b>GENDER CHANGERS</b> 25 way D type Male to Male £10 Male to Female £10 Female to Female £10	<b>DIL HEADERS</b> 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
	<b>RS 232 JUMPERS</b> (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	<b>ATTENTION</b> 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

<b>MISC CONNS</b>
21 pin Scart Connector 200p
8 pin Video Connector 200p

<b>DIL SWITCHES</b>
4-way 90p
6-way 105p
8-way 120p
10-way 150p



*You've heard the one about the drummer, the guitarist and the synth programmer? Well, here's a MIDI interface that even a drummer should be able to operate...*

## RS232C TO MIDI CONVERTER

BY ROBERT PENFOLD

MINI MIDI

ALTHOUGH the MIDI (Musical Instrument Digital Interface) has gradually gained great popularity with manufacturers of electronic instruments, it has not had the same impact in the computer world. A few computers (such as the Atari ST series) have MIDI input and output sockets as standard, but in most cases control of MIDI equipment is only possible with the aid of some external hardware. For some computers there is no ready-made add-on MIDI interface available. If a really advanced computer controlled MIDI system is required there is probably little alternative to opting for commercial software, and to obtain a computer for which suitable software and hardware are available. Even if you have the ability to design the hardware and software, this is the type of thing where the amount of time involved is not so much a matter of man hours as man years!

If a more basic set up is all that is required, the do-it-yourself approach becomes a much more attractive proposition. Something like a simple step-time sequencer program is not too difficult to write, and software to produce a repetitive backing can be very simple indeed. One of the most useful applications of the MIDI system is to provide a programmable backing over which a "live" performance can be played. In many cases it is not even necessary to have separate instruments to provide the backing and the melody line, as most MIDI equipped keyboard instruments can be played simultaneously via the MIDI input and the keyboard.

There are various ways in which a MIDI output can be added to a computer, including a custom design to fit onto the buses of the machine concerned. The aim of the current design is to provide something more universal, and this really means an add-on to be driven from either an RS232C or Centronics port (these being the only common forms of standard interface). Both can provide signals that are readily



convertible to the MIDI standard, and the choice of an RS232C serial port as the signal source was mainly on the grounds that the most popular computer peripheral is a printer driven from the Centronics style parallel output port. With most systems the serial port is the interface which is most likely to be free for use with a MIDI converter.

### EXCHANGE RATES

The unit will provide a MIDI standard output from any RS232C (or RS423) serial port that can provide an output at 9600 or 19200 baud with a word format of one start bit, eight data bits, one or two stop bits, and no parity. Every computer serial interface that I have encountered has been capable of supporting at least one of these options. The unit is essentially a baud rate converter, and as such it could have applications in other fields of computing, although it would require some modification in order to accommodate different baud rates and output signal standards.

A MIDI interface is a form of asynchronous serial interface, and as such it has more than a few similarities to the

RS232C system. There are two areas of incompatibility between these two types of interface. The first one is the non-standard MIDI baud rate of 31.25 kilobaud, which compares with a maximum standard RS232C baud rate of 19.2 kilobaud. In fact the MIDI system did originally use a baud rate of 19.2 kilobaud, but before it was launched commercially an increase to 31.25 kilobaud was made. This gives better synchronisation between channels when all sixteen MIDI channels are in use. Some RS232C interfaces have the baud rate controlled by a crystal controlled clock oscillator and a divide by 'N' circuit, and an output at the correct baud rate for MIDI use might then be possible. This is something that is applicable to very few computers though, and in the vast majority of cases some extra hardware is needed in order to provide the boost in baud rate.

For those who are unfamiliar with the nature of serial signals, the waveform diagram of Fig.1 should help to clarify the way in which the unit functions. The word format used for the MIDI system is one start bit, eight data bits, one stop

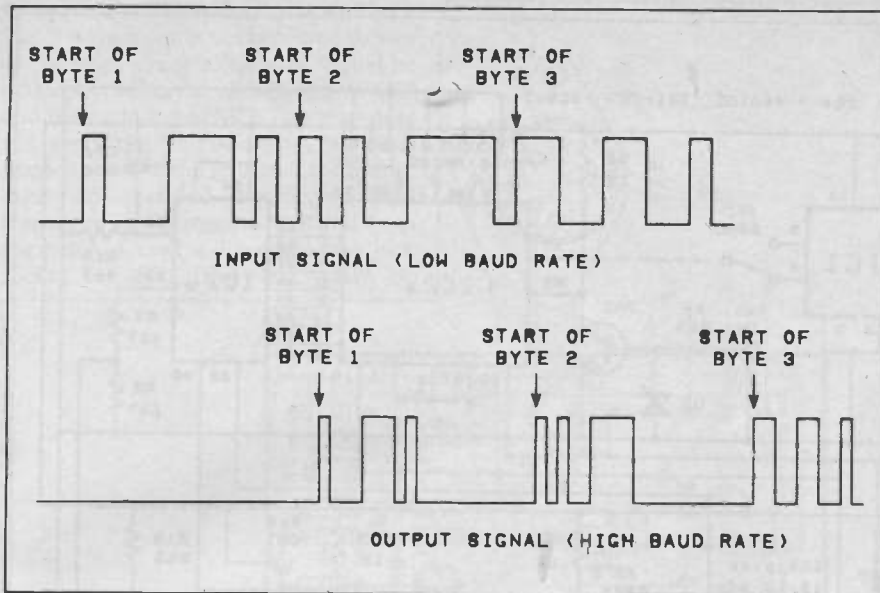


Fig. 1. Input and Output wave forms for a baud rate booster.

bit, and no parity. The start bit is needed for synchronisation purposes, and it indicates to the receiving circuit that a byte of data is about to commence. The receiving circuit can then determine the logic level of each bit by sampling the signal at the appropriate times. As the start bit is the only synchronisation signal, it is essential to the correct operation of the system that the transmitting and receiving baud rates correctly match, and the use of standard baud rates is an essential part of any asynchronous serial system. It is the least significant bit that is transmitted first, running through in sequence to the most significant bit. The stop bit is not really a bit of information at all, and it is just a period during which signal stays at its quiescent level. This is presumably to set a minimum spacing between bytes of data, so that the receiving equipment has time to process one byte before commencing reception of the next one.

On the face of it a baud rate converter merely has to clock data into a shift register at the appropriate rate, and then clock it out again at the new rate. In practice matters are not quite this simple, as the shift register cannot simultaneously clock data in at one rate and clock it out again at a different rate. It is therefore a matter of receiving complete bytes, transferring them in parallel form from one shift register to another, and then transmitting them in serial form from the second shift register. For this reason the transmitted signal is delayed slightly in comparison to the received signal. Because the transmission rate is higher than the reception rate there are larger gaps between the bytes on the transmitted signal than there are on the received signal. Fortunately, neither the delay nor the increased gaps are of any practical consequence.

Note that there is no difficulty in producing an increase in baud rate, but

a conversion in the opposite direction is much more difficult. The problem is simply that data would often be received faster than it could be transmitted. This could be overcome by having a buffer to store accumulated bytes of data, but this would obviously require a relatively complex circuit, and the relative timing of groups of bytes could be significantly altered. This makes such a system a less attractive proposition from the MIDI interfacing standpoint.

### SYSTEM OPERATION

Asynchronous serial reception and transmission is simple in theory, but in practice it generally requires some complex circuitry. Things are greatly simplified by the availability of special serial interface devices, and for a stand-alone unit of this type a UART (universal asynchronous receiver/transmitter) is the most suitable type. A UART forms the basis of this unit, as can be seen from the block diagram of Fig. 2.

The UART can be programmed via five inputs to operate with any of the standard word formats, and it provides all the necessary logic for serial to parallel and parallel to serial data conversion. A level shifter/inverter stage

is needed at the input in order to give an input to the UART that is at suitable voltages (normal 5 volt logic levels) and of the correct phase. The transmission and reception baud rates are controlled by separate clock oscillators, and the clock frequency must in both cases be at sixteen times the required baud rate. The clock signal for the receiver is derived from a 2.45MHz crystal oscillator (or 2.4576MHz to be precise), and this drives the receiver section of the UART via a buffer stage and a divide by 8/16 circuit. The latter is switched to give 9600 or 19200 baud as desired. On the transmitter side a 500kHz oscillator based on a ceramic resonator drives the UART via a buffer stage. The serial output signal is fed to an inverter and then to an open collector driver stage which provides the output signal.

Decoded bytes are fed in parallel form from the receiver to the transmitter, but some simple logic circuitry is needed to ensure that received bytes are actually transmitted. A status output on the receiver section of the UART goes high when a complete byte has been received, and this flag can be reset by taking an input terminal low. In this circuit the signal from the status output is inverted and used to reset itself. A delay circuit is included in order to lengthen the pulse from the status output, so that it can reliably operate an input on the transmitter section of the UART. This input is used to initiate transmission of the byte currently on the parallel inputs, which is, of course, the byte just decoded by the receiver. Thus, as soon as a byte is received it is transferred to the transmitter and clocked out on the serial output.

### THE CIRCUIT

The full circuit diagram for the RS232C to MIDI converter appears in Fig. 3. Taking the receiver section first, the level shifter/inverter circuit is a simple common emitter switch based on TR3. The clock oscillator is a conventional crystal type based on TR1, and having TR2 as a common emitter buffer/amplifier which ensures that the output signal is at a high enough level to drive a logic input properly. IC1 is a

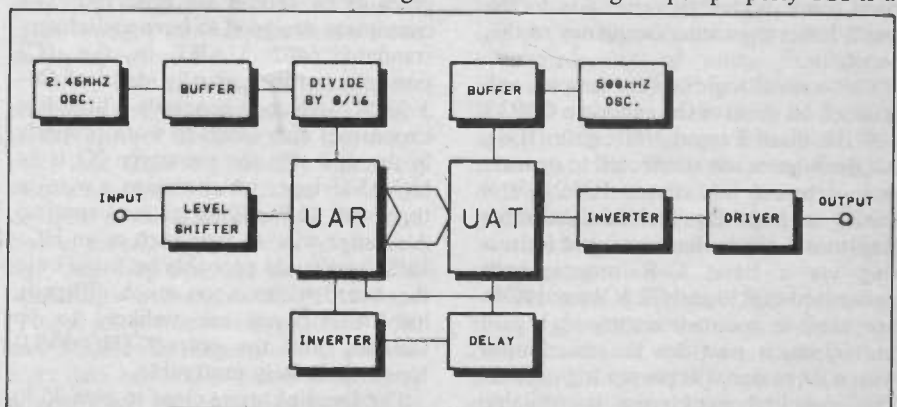


Fig. 2. Block diagram for the RS232C to MIDI converter.

# RS232 TO MIDI

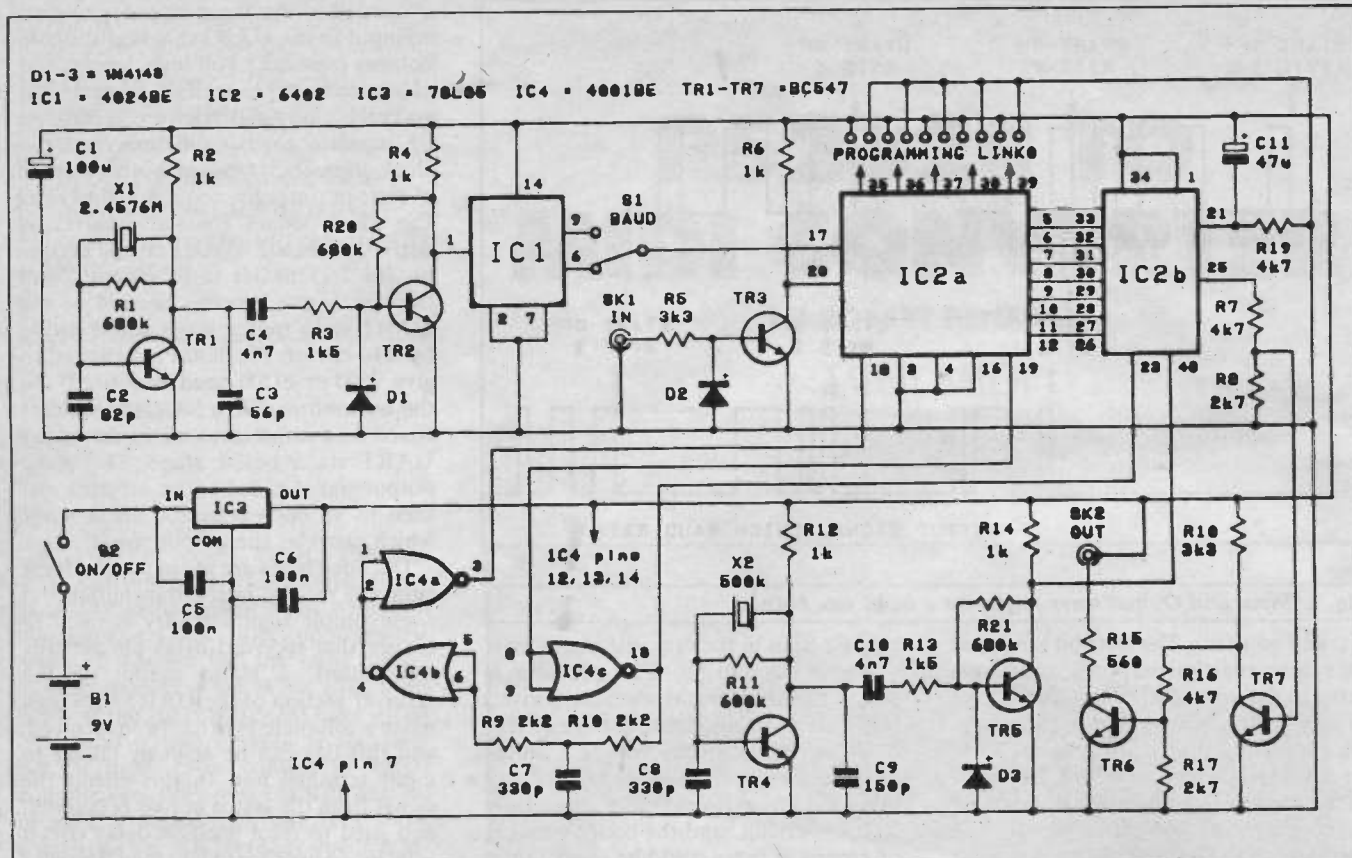


Fig. 3. The circuit diagram for the RS232C to MIDI converter

CMOS 4024BE 7 stage binary ripple counter, but in this case only three or four stages are used, depending on the setting of the baud rate switch, S1. Pin 9 of IC1 gives the divide by 8 action (19200 baud), while pin 6 gives the divide by sixteen action (9600 baud). C11 and R19 provide a positive reset pulse to the UART (IC2) at switch-on.

Turning to the transmitter section, TR7 inverts the serial output signal so as to give an output signal of the correct phase, and TR6 is the output transistor. R15 provides current limiting at approximately the required level of 5 milliamps. The clock oscillator and buffer stage are essentially the same as those used in the receiver section, but the oscillator is based on a ceramic resonator rather than crystal, and the "tuning" capacitors (C8 and C9) have been made higher in value due to the much lower operating frequency of this oscillator.

The control logic is very simple, and is based on three of the gates in a CMOS 4001BE quad 2 input NOR gate (IC4). All three gates are connected to operate as inverters in this circuit. IC4c inverts the signal from the received data status flag, and it drives the reset input for this flag via a basic C-R timer circuit comprised of R10 and C7. IC4a and IC4b are used as a non-inverting high gain buffer which provides the reset input with a drive signal at proper logic levels. The stretched reset pulse is available from both IC4a and IC4c, but it is IC4c which is used to drive the TRRL

(transmit buffer register load) input of IC2.

A 5 volt supply is required, and this is derived from a 9 volt battery via monolithic voltage regulator IC3. The current consumption of the unit is around 20 milliamps or so, and a fairly high capacity 9 volt battery (such as six HP7 size cells in a plastic holder) should be used as the power source. If the computer has a +5 volt output, then there would probably be no difficulty in omitting B1, S1, IC3, and C5, and using the computer to power the circuit.

## CONSTRUCTION

Details of the printed circuit board are shown in Fig. 4. The three DIL integrated circuits are all MOS types. Accordingly, they should all be fitted in holders and the other standard anti-static handling precautions should be observed. The circuit was designed to have an industry standard 6402 UART in the IC2 position, but the virtually identical AY-3-1015D (which is generally a little less expensive) also seems to work properly in the unit. On the prototype X1 is an HC-33/U type, which means a wire-in type with 12.7 millimetre lead spacing. A smaller wire-in type such as an HC-18/U type could probably be fitted onto the board without too much difficulty, but other types are unlikely to be suitable, and the correct (HC-33/U) type is definitely preferable.

The five link wires close to pins 35 to 39 of IC2 program the word format, and fig. 4 shows the correct wiring for the

MIDI format of eight data bits, one stop bit, and no parity (all asynchronous serial systems use one start bit). Obviously other word formats are irrelevant in a MIDI application since the reception and transmission word formats of this unit must be the same. The circuit could be modified to use separate UARTs so that different transmission and reception formats could be used, but this is again of little use in the present context where only 8 bit formats are usable. For anyone using the unit as the basis of a baud rate converter for other purposes the ability to program the unit for different word formats is much more useful. Table 1 gives details of the word formats available, and the logic levels needed at the five programming inputs for each of the available formats.

The prototype is housed in a case which has approximate outside dimensions of 170 by 145 by 55 millimetres, but it should be possible to squeeze everything into a somewhat smaller case if desired. The controls and sockets are mounted on the front panel, and the printed circuit board is mounted on the base panel well to the front of the unit. This leaves space for the battery towards the rear of the case. If six HP7 cells in a plastic holder are used as the power source the battery connector should be a standard PP3 type. Fig. 4 shows the correct method of connection to the output socket (SK2). On the prototype the chassis of SK2 is earthed to the negative supply rail via the metal

front panel and the earth lead of SK1. If this connection is not provided by way of the front panel a link wire should be added between the chassis tag of SK2 and the earth tag of SK1. This lead does not carry the output signal, but it is needed to earth the screen of the output cable so that no significant radio frequency interference is radiated from the cable. I used a 3.5 millimetre jack socket for SK1, but this could be

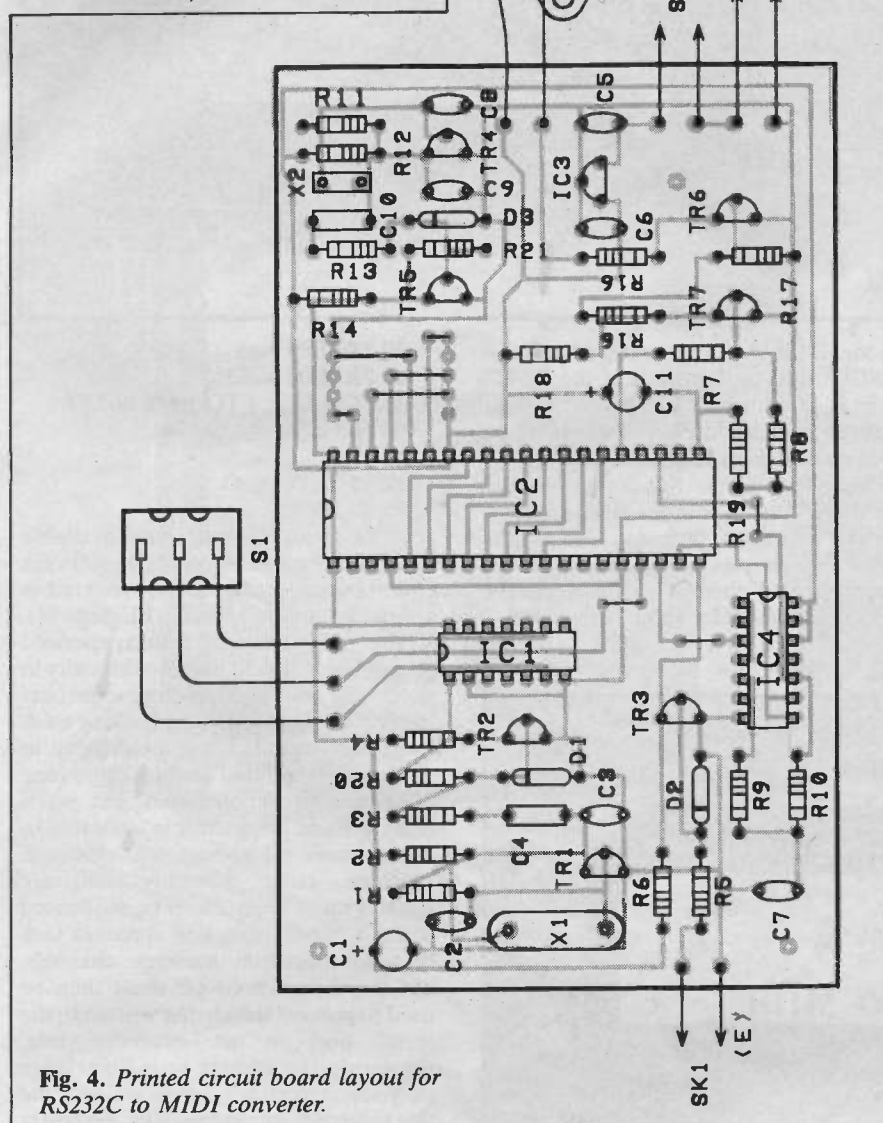


Fig. 4. Printed circuit board layout for RS232C to MIDI converter.

changed for any type of connector which you consider more convenient with your particular set up. The standard RS232C connector is a 25 way 'D' type, but the cost of one of these is not really justified when only two lines are implemented.

#### IN USE

The output couples to the MIDI instrument via a standard MIDI lead (i.e. pins 4 and 5 of one plug connect to pins 4 and 5 respectively of the other plug). Only the signal earth and transmitted data terminals of the RS232C (or RS423) port are used. With some computers the CTS (clear to send) handshake input must be taken to the active state before the port can be persuaded to output any data. If this

should prove to be the case, simply linking the CTS and RTS terminals should give the desired results. In most cases though, the handshake lines can simply be ignored.

Before the unit can be tested, the computer's serial interface must be set to the correct word format and baud rate, and there are usually operating system commands to facilitate this. With the BBC model B for example, the word format defaults to the correct eight data bits, one stop bit, and no parity. The operating system commands \*FX8,7 and \*FX8,8 select transmission rates of 9600 and 19200 baud respectively. If only an eight data bits and two stop bits format is supported, this should give perfectly satisfactory results. Where the higher

#### COMPONENTS

##### RESISTORS

R1, R11, R20,	
R21	680k (4 off)
R2, R4, R6, R12,	
R14	1k (5 off)
R3, R13	1k5 (2 off)
R5, R18	3k3 (2 off)
R7, R16, R19	4k7 (3 off)
R8, R17	2k7 (2 off)
R9, R10	2k2 (2 off)
R15	560

All 1/4W 5% carbon or better.

##### CAPACITORS

C1	100 $\mu$ 10V radial elect
C2	82p ceramic plate
C3	56p ceramic plate
C4, C10	4n7 polyester layer (2 off)
C5, C6	100n ceramic (2 off)
C7, C8	330p ceramic (2 off)
C9	150p ceramic plate
C11	47 $\mu$ 10V radial elect

##### SEMICONDUCTORS

IC1	4024BE
IC2	6402 or AY-3-1015D
IC3	uA78L05 (+5V 100mA reg)
IC4	4001BE
TR1 to TR7	BC547 (7 off)
D1, D2, D3	1N4148 (3 off)

##### MISCELLANEOUS

SK1	3.5mm jack
SK2	5 way (180 degree) DIN socket
S1	SPST sub-min toggle
S2	SPDT sub-min toggle
X2	500kHz ceramic resonator
B1	9 volt (e.g. 6 x HP7 in holder)

Printed circuit board, case about 170 x 145 x 55mm, 14 pin DIL i.c. holder (2 off), 40 pin DIL i.c. holder, battery connector, stand-offs, wire, pins, etc.

##### CONSTRUCTOR'S NOTE:

The PCB may be bought through the PE PCB Service. A full kit of parts is available from Magenta.

baud rate is supported it is probably best to opt for this one, as it permits better synchronisation of notes in chords. However, if the unit is driven from a BASIC program, it is likely to be the speed of the program rather than the serial port that limits the rate at which data can be transmitted. Acorn do not guarantee reliable operation at 19200 baud, but I experienced no difficulties when using this rate.

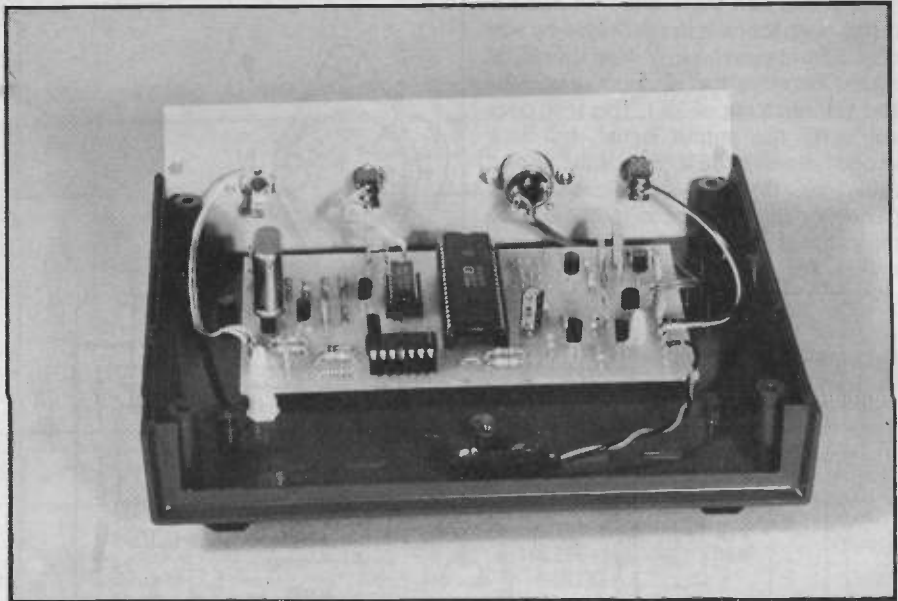
With most computers the operating system provides some way of directing data to the serial port, but where possible it is generally better to write data direct to the serial interface hardware. For instance, with the BBC

TABLE 1

6402 WORD FORMATS

PIN Number	Data Bits	Parity	Stop Bits
35 36 37 38 39			
L L L L L	5	ODD	1
L H L L L	5	ODD	1.5
L L L L H	5	EVEN	1
L H L L H	5	EVEN	1.5
H L L L X	5	NONE	1
H H L L X	5	NONE	1.5
L L L H L	6	ODD	1
L H L H L	6	ODD	2
L L L H H	6	EVEN	1
L H L H H	6	EVEN	2
H L L H X	6	NONE	1
H H L H X	6	NONE	2
L L H L L	7	ODD	1
L H H L L	7	ODD	2
L L H L H	7	EVEN	1
L H H L H	7	EVEN	2
H L H L X	7	NONE	1
H H H L X	7	NONE	2
L L H H L	8	ODD	1
L H H H L	8	ODD	2
L L H H H	8	EVEN	1
L H H H H	8	EVEN	2
H L H H X	8	NONE	1
H H H H X	8	NONE	2

H = High, L = Low,  
X = either state will do.



model B the transmit register of the 6850 ASCIA used as the basis of the RS423 port is at address &FEO9. Any values written to this address will therefore be transmitted from the serial port.

Initially a simple test routine should be tried. Staying with the BBC model B as our example computer, this simple program enables note values to be entered, and then it switches on the appropriate note for about one second.

```
10 INPUT A
20 ?&FEO9 = 145
```

```
30 ?&FEO9 = A
40 ?&FEO9 = 63
50 FOR D = 1 TO 1000: NEXT
60 ?&FEO9 = 129
70 ?&FEO9 = A
80 ?&FEO9 = O
90 GOTO 10
```

There is insufficient space available here for information on MIDI software codes, but this has been fully covered in a separate article anyway (PE Sept 87). Even a relatively inexperienced programmer should have no difficulty in producing a simple step-time sequencer to enable a short repetitive backing track to be produced. It is not too difficult to write a program that enables quite long sequences to be produced, but when using a Basic program it is advisable to use no more than about four channels. Machine code assembly language enables more channels to be sequenced without there being any apparent lack of synchronisation between channels, but a software hold-off must then be used to prevent data being written to the serial port at an excessive rate. Obviously the greater your knowledge of your computer's hardware and the finer your programming skills, the better your prospects of fully exploiting the interface



## MAKE YOUR INTERESTS PAY!

More than 8 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 90 years experience in home-study courses and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for your FREE information pack on the course of your choice (tick one box only).

Electronics <input type="checkbox"/>	Radio, Audio and TV Servicing <input type="checkbox"/>
Basic Electronic Engineering (City & Guilds) <input type="checkbox"/>	Radio Amateur Licence Exam (City & Guilds) <input type="checkbox"/>
Electrical Engineering <input type="checkbox"/>	Car Mechanics <input type="checkbox"/>
Electrical Contracting/Installation <input type="checkbox"/>	Computer Programming <input type="checkbox"/>
GCE over 40 'O' and 'A' level subjects <input type="checkbox"/>	

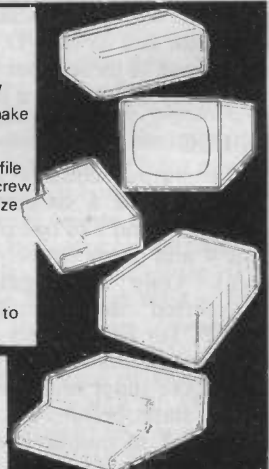


Name \_\_\_\_\_ P. Code \_\_\_\_\_  
Address \_\_\_\_\_  
International Correspondence Schools, Dept EDSC 7, 312/314 High St.,  
Sutton, Surrey SM1 1PR. Tel: 01-643 9568 or 041-221 2926 (24 hrs).

You've finished your project . . .  
... Now COMPLETE it!

### Build an enclosure to fit it exactly

ENCORE has been developed and designed to make any enclosure to the exact dimensions you want. Brand new ENCORE is an ingenious but simple extruded strip system that you can shape, bend, file and cut. Incorporated in the section profile is a screw fastening hole. When the plastic sheet is cut to size the drilled holes will register exactly using the jig and drill supplied with each kit. Our trial kit is just £11.50 which includes VAT, delivery and the free jig and drill. Try ENCORE for your current project you'll be surprised what a clean professional finish it gives to any kind of project.



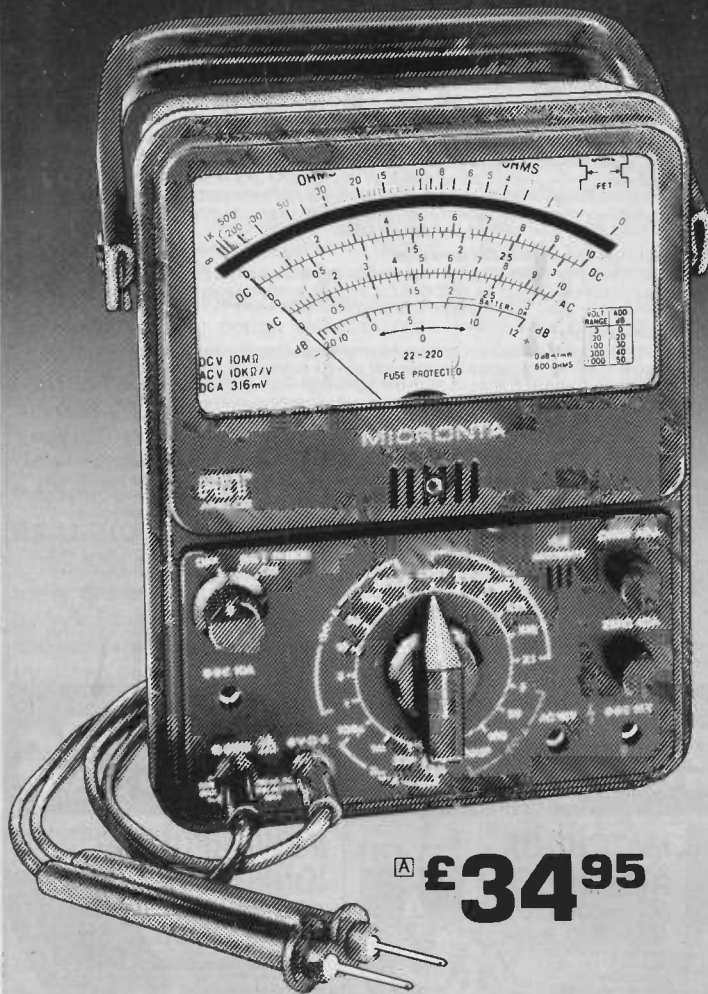
Send for full details, FREE LEAFLET and price list

ENCORE ENCLOSURES  
UNIT 3  
WILLAND INDUSTRIAL ESTATE  
CULLOMPTON  
DEVON EX15 2QW  
Phone: (0884) 820955



# MICRONTA®

## NEW PRECISION MULTITESTERS



**A** £34<sup>95</sup>

**A** **28-Range FET VOM.** Perfect for electronics testing! 10 megohms per volt DC sensitivity. Measures: 1000 volts DC in seven ranges and 1000 volts AC in five ranges. DC current to 10 amps, resistance to 100 megohms. Decibels: -20 to +62 dB. Fuse protected. Requires one 9v and one "C" battery. Measures: 7<sup>1</sup>/<sub>16</sub> x 5<sup>1</sup>/<sub>2</sub> x 2<sup>3</sup>/<sub>4</sub>".  
22-220 ..... £34.95



**B** £29<sup>95</sup>

**B** **43-Range Multitester.** 50,000 ohms per volt DC sensitivity. Fuse and overload protected. Measures to 1000 volts DC in 12 ranges and 1000 volts AC in 8 ranges. DC current to 10 amps, resistance to 20 megohms. Decibels: -20 to +62 dB. Requires one 9v and one "AA" battery. Measures: 6<sup>1</sup>/<sub>16</sub> x 4<sup>7</sup>/<sub>8</sub> x 2<sup>3</sup>/<sub>8</sub>".  
22-214 ..... £29.95

# Tandy®

**For The Best In High Quality Electronics**

Over 300 Tandy Stores And Dealerships Nationwide.  
See Yellow Pages For Address Of Store Nearest You

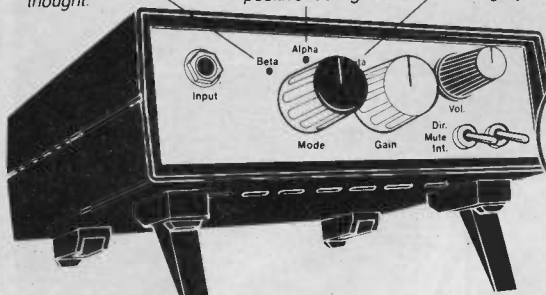
Tandy UK, Tandy Centre, Leamore Lane, Bloxwich, Walsall, West Midlands. WS2 7PS

Are we about to create a race of Supermen?

# Brainwave

**β BETA** - Concentration, problem solving, active thought.  
**α ALPHA** - Relaxation, pleasure, tranquility, positive feelings.  
**θ THETA** - Imagination, creativity, hynagogic imagery.

monitor



**BRAINWAVE MONITOR PARTS SET ONLY**  
**£29.90**  
 + VAT

The ETI Brainwave Monitor must be the most astonishing project ever to appear in the pages of an electronics magazine. It will allow you to hear your brainwaves and judge the relative levels of various types. It will also help you to control your mind more effectively, to be at peak performance in all situations.

**Doesn't my mind work perfectly well when left to its own devices?**

If you've ever been confused, unsure of yourself, shy, unable to pass exams or to impress people at interviews, you know perfectly well that it doesn't. Your mind (and everybody else's) is full of bad habits, inappropriate responses, feelings of inadequacy... all pulling you down. Why should you put up with it?

**Mind training sounds like hard work!**

It can be. If you want to do it the hard way, go and study under a Zen master for fifty years or so. You'll get there in the end! With the brainwave monitor it takes no effort at all. Just the opposite in fact - trying is the one thing you mustn't do!

**How do I start?**

At first you use the monitor's internal indicator to exercise your mind. In direct mode you improve the time percentage; in integrate you concentrate on the amplitude. After that, the choice of direction is yours. With the Alpha Plan you can reach the core of your personality to root out the weakness and replace it with inner strength. Otherwise you can just enjoy the feelings of pleasure and clear headedness that alpha training brings, or the creativity and imagery of the theta state.

**A friend told me I can use brain power to control lights and things. I can't believe it!**

As a matter of fact, you can do more than that! The interface sockets on the monitor allow you to turn lights on and off, control toys and electrical gadgets, play computer games... all with your mind! Are we about to create a race of Supermen? Only time will tell.

The Brainwave Monitor is featured in the September, October and November 1987 issues of ETI. The approved parts set contains: two PCBs, all components including three PMI precision amplifiers, shielded box for screening the bio-amplifier, attractive instrument case with tilting feet, controls, switches, knobs, plugs and sockets, leads and materials for electrodes, full instructions for assembly and use.

Parts are available separately. We also have a range of accessories, professional electrodes, books, etc. Please send a stamped, self-addressed envelope if you just want the lists. Otherwise, an SAE + £2 will bring you lists, construction details and further information.



## SILVER SOLUTION

This powerful silver plating compound must be the greatest revolution in electronics since the IC! Just wipe on with a cloth to plate PCB tracks, connectors, wire, component leads, etc. with a layer of pure silver!

Essential for:

- RF circuits
- Top flight Hi-Fi
- Bio-electronic circuits and silveres

**LARGE BOTTLE (150ml) SILVER SOLUTION £11.20 + VAT!**

N.B. The solution will take to brass, copper, etc. but not to steel or pre-plated components.



## THE ALPHA PLAN

Can you really train your brain to think more effectively?  
 Can you really achieve peak performance in things you're no good at?  
 Can you really overcome fear, shyness, uncertainty?  
 And can you do it all without really trying?

Dr David Lewis's famous Alpha Plan has all the answers. It was recently investigated by a QED television documentary (Alpha - How to Succeed Without Really Trying). And the conclusion? It works!

Dr Lewis's book 'The Alpha Plan' is yours for only **£2.50** (no VAT).  
**Your future is waiting.**

# Complete Parts Sets for ETI Projects

## MAINS CONDITIONER

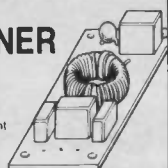
FEATURED IN ETI, SEPTEMBER 1986

It is astonishing how many people buy or build top-flight hi-fi equipment, and then connect it to a noisy, spiky mains supply. Rather like buying a Ferrari and trying to run it on paraffin, you might think. Expecting crystal clear sound, the poor music enthusiast ends up with a muddled, confused mess, and feels that he has somehow been cheated. Is this hi-fi? My music centre sounded just as good!

The domestic mains supply is riddled with RF interference, noise, transient spikes, and goodness knows what else. Computers crash, radios pop and crackle, tape recordings are spoiled and hi-fi sounds 'not quite right'. Why put up with it when the solution is so simple? The ETI mains conditioner is the lowest cost upgrade you will ever buy, and probably the most effective!

Our approved parts set consists of PCB, all components, toroid, enamelled wire, fixing ties, fast response VDR, and full instructions.

**ETI MAINS CONDITIONER PARTS SET ONLY £4.90! + VAT**  
 \*Note: the toroid and VDR supplied are superior to the types specified in the article.



## KNIGHT RAIDER

FEATURED IN ETI, JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns. An LED display on the control box lets you see what the main lights are doing.

The Knight Raider can be fitted to any car. It makes an excellent fog light or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The control box parts set consists of case, switches, LEDs, PCB components, hardware and instructions. The sequence board includes PCB ICs, power FETs, components, hardware and instructions.

**KNIGHT RAIDER CONTROL BOX ONLY £6.90 + VAT!**  
**KNIGHT RAIDER SEQUENCE BOARD ONLY £13.90 + VAT!**

## MATCHBOX AMPLIFIER

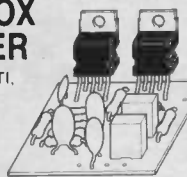
FEATURED IN ETI, APRIL 1986

No ordinary amplifiers, these. When our first customers took an interest, it was for the diminutive size (both modules will fit in a matchbox!), the total disregard for power supplies and speaker impedances, and the impressive power output from these little amplifiers. When they re-ordered, it was for the sound quality!

Two amplifier modules were described, both based on the powerful L165V IC. The single IC version will deliver over 20 Watts with a suitable speaker and power supply. The bridge version can provide up to 50W! Although the specified supply voltage and speaker impedance must be used to achieve maximum power, both modules are quite happy to work from any voltage between 12V and 32V, and will accommodate any type of speaker. The bridge version is ideal for giving a boost to car Hi-Fi systems, driving two 4 Ohm speakers in parallel on each channel for best effect.

Both designer-approved parts sets consist of a roller lined printed circuit board and all components. The L165V ICs are also available individually with a free mm data sheet giving specifications and suggested circuits.

**SINGLE IC MATCHBOX BRIDGE L165V IC**  
**AMPLIFIER SET (20W into 8 Ohms) (50W into 8 Ohms) with dar.**  
**£6.50 + VAT £8.90 + VAT £3.90 + VAT**



## POWERFUL AIR IONISER

FEATURED IN ETI, JULY 1986

ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ozone air is much cleaner and purer, and seems much more invigorating than 'dead air'.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build... and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller lined printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs about a third of the price of the individual components. What more can we say?

**DIRECT ION PARTS SET £9.50 + VAT**



## PROJECT BOX

PROJECT CASE WITH PP3 BATTERY COMPARTMENT

ONLY £2.60! + VAT



## LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the 'Next Great Little IC' feature (ETI, December 1986).

**LM2917 Experimenter Set £5.80 + VAT**

## RUGGED PLASTIC CASE

suitable for mains conditioner and mains controller

ONLY £1.65 + VAT



**SPECIAL OFFER**

Our best selling ioniser kit is now available with an elegant white case.

**WHITE IONISER PARTS SET ONLY £9.80! + VAT**

Prices shown are exclusive of VAT, so please add 15% to the order total. UK postage is 60p on any order. Carriage and insurance for overseas orders £1.50. Please allow up to 14 days for delivery.

*Specialist*

**CONDUCTORS LIMITED**

FOUNDERS HOUSE  
 REDBROOK  
 MONMOUTH  
 GWENT

# SEMICONDUCTORS

## PART 2 : DISCRETE DEVICES BY ANDREW ARMSTRONG

### Junction transistors and long-tailed pairs

*The second part of our series on semiconductors looks at the characteristics and applications of small signal transistors and power transistors, at low and high frequencies.*

In part one we looked at the principles governing silicon semiconductor devices, and got as far as some practical information on some currently available types of diode. In this part we shall look at how to choose and use junction transistors. In general the coverage, though not exhaustive, should be adequate for almost all amateur design and constructional purposes. Inevitably some potentially interesting topics are not covered; to cover everything would take a whole book. In particular, I shall not delve deeply into the subject of RF, which is a specialised topic in itself.

#### REAL JUNCTION TRANSISTORS

Junction transistors are classified in many different ways according to their intended function. We have small signal and power devices, and we have transistors intended for various different frequency ranges, right up to microwaves. In general, the higher frequency transistors are perforce of a lower power rating, because of the charge storage time and junction capacitance associated with power transistors.

Before looking closely at esoteric transistor types, let us consider transistors of the types normally used in amateur construction projects. With the exception of specialised items such as amateur radio transmitters, etc., four major classifications of transistor are used: npn and pnp small signal transistors, and npn and pnp power transistors. This may seem to be an over-simplification, but in fact, many designs which specify a particular type of transistor do so because the designer had that type available at the time, even though a range of other type numbers might be suitable.

By far the most commonly used type is the small signal npn transistor. Many different varieties exist, optimised for such things as low noise, high gain at low collector currents, low saturation voltage and so on. Most amateur construction projects however do not utilise the special characteristics but are designed around a "vanilla" transistor. This mythical device represents the lowest common denominator for a wide range of transistor type numbers. This vanilla specification is shown in Tables 3 and 4 along with the specifications of several other ordinary and not so ordi-

nary transistors. The logical conclusion from this is that in most amateur construction projects any npn transistor from the BC107/BC182/BC237 families will work perfectly well. Clearly an element of judgement must be applied, for example if a higher than normal voltage is used in the circuit a particular transistor type may have been chosen because of its collector voltage rating. Normally however, the author will mention this in the text if it is so.

As well as the basic type number of a transistor, a suffix is often specified. For example, a design may specify a BC183L rather than a BC183. The only difference between the standard and "L" type trans-

istors is that the "L" type has a different pin layout. Specifically the pin connections for the "L" type are in the order B-C-E rather than the more familiar C-B-E. If the wrong type is available, it is usually no problem to bend the legs to fit the PCB, and if necessary special pads are available to form "L" type leads to the more normal configurations. Admittedly, most home constructed projects do not use transistor pads, but they can be helpful sometimes.

There is one transistor I know of which has different specified electrical characteristics in its "L" type form. The BC214LB has a higher gain at high collector currents than the BC214, accord-

Table 3 - NPN Junction Transistors

Type No.	V <sub>cb0</sub> (max) V	I <sub>c</sub> (max) mA	h <sub>fe</sub> @ I <sub>f</sub> typ mA	f <sub>t</sub> MHz	Complement	P <sub>tot</sub> W	Pack age	COMMENTS
BC107	50	100	110 2	150		0.3	TO18	
BC108	30	100	120 2	150		0.3	TO18	
BC109	30	100	180 2	150		0.3	TO18	
BC109C	30	100	420 2	150		0.3	TO18	
BC182	60	200	125 2	150	BC212	0.3	TO92	
BC182B	60	200	240 2	150	BC212B	0.3	TO92	
BC183	45	200	125 2	150	BC213	0.3	TO92	
BC184	45	200	240 2	150	BC214	0.3	TO92	
BC237	50	100	125 150	150	BC337	0.3	TO92	BC237, 238, 239 are TO92 "L" type versions of BC107 etc. BC307 etc are TO92 normal pin connection versions
BF259	300	100	25 30	25		0.5	TO39	Sometimes used as CRT drivers.
BF480	20	20	G <sup>+</sup> 15db	2000 type		0.2	SOT37	Possibly the fastest easily available transistor.
BFY51	60	1A	49 150	50		0.8	TO5	
BFY90	30	50	25 2	1000		0.2	TO72	
BSX20	40	500	40 10	500	2N2906	0.36	TO18	Very fast switching.
ZTX450	60	1A	100 150	150	ZTX550	1W	E line	Good saturated switching.
ZTX650	60	2A	100 500	100	ZTX750	1W	E line	Excellent saturated switching.
ZTX653	120	2A	100 500	100	ZTX753	1W	E line	
2N2219	60	800	100 150	300		0.8	TO5	
2N2369	40	500	40 10	500	2N5771	0.36	TO92	Like BSX20
2N3904	60	200	100 10	300	2N3906	0.5	TO92	
BD131	70	3A	20 150	60	BD132	15W	TO126	
BD139	80	1.5A	40 150	-	BD140	12.5	TO126	
BD787	80	4A	10 200	50	BD788	15W	TO126	Ideal for small switched mode supplies
TIP31	80	3A	20 500	3	TIP32	40W	TO220	TIP31A is rated at 100V, B at 120V, C at 140V
TIP33	80	10A	20 500	3	TIP34	80W	TO218	A, B, C ratings as TIP31
TIP121	80	5A	1000 3A	≈0.1	TIP126	65W	TO220	Darlington power transistor. The device includes two base-emitter resistors and an antiparallel diode between collector and emitter.

Table 4 - PNP Junction Transistors

Type No.	V <sub>beo</sub> (max) V	I <sub>c</sub> (max) mA	h <sub>fe</sub> @ I <sub>f</sub> typ mA	f <sub>t</sub> MHz	Complement	P <sub>tot</sub> W	Pack age	COMMENTS
BCY70	50	200	50 10	250		0.35	TO18	
BC212	60	200	60 2	200	BC182	0.3	TO92	BC212A has h <sub>fe</sub> of 100, B has h <sub>fe</sub> of 200
BC213	45	200	80 2	200	BC183	0.3	TO92	A and B versions as BC212
BC214	45	200	140 2	200	BC184	0.3	TO92	BC214B has h <sub>fe</sub> of 200, C has h <sub>fe</sub> of 350
BC337	50	800	100 100	60	BC237	0.36	TO92	
ZTX550	60	1A	100 150	150	ZTX450	1W	E line	Good saturated switching
ZTX750	60	2A	100 500	75	ZTX650	1W	E line	Exc saturated switching
2N2907	60	600	100 150	200		0.4	TO18	Switching
2N3906	40	200	199 10	250	2N3904	0.5	TO18	Switching
2N5771	15	50	40 50	850	2N2369	0.625	TO92	Fast switching
BD132	45	3A	20 150	60	BD131	15W	TO126	
BD140	80	1.5A	40 150	150		12.5	TO126	
BD788	60	4A	10 200	50	BD787	15	TO126	
TIP32	80	3A	20 500	3	TIP31	40	TO220	A, B, C types as TIP31
TIP34	80	10A	20 500	3	TIP33	80	TO218	A, B, C types as TIP33
TIP126	80	5A	1000 3A	0.1	TIP121	65	TO220	Darlington power transistor. The device includes two base-emitter resistors and an antiparallel diode between collector and emitter.

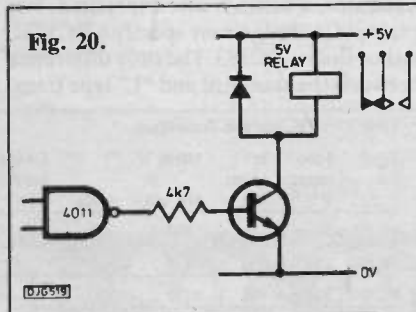
ing to a rather old data book. I cannot be sure it is not a misprint, but in any case the difference is slight.

The suffixes "A," "B," and "C" do relate to different electrical characteristics, normally gain. The standard version of a transistor usually has a very wide gain tolerance, for example 100 to 900. The "A," "B," and "C" versions are selected to gain in three bands, generally covering no more than a 2:1 range. If a BC182B is specified for a project, it could well be because a medium gain transistor is required. If there is nothing else special about the circuit, any small signal npn transistor in the correct gain range will work. Note, though, that not all transistor types are banded in the same gain ranges, so it is necessary to check that any substitute transistor falls in the range required by the circuit.

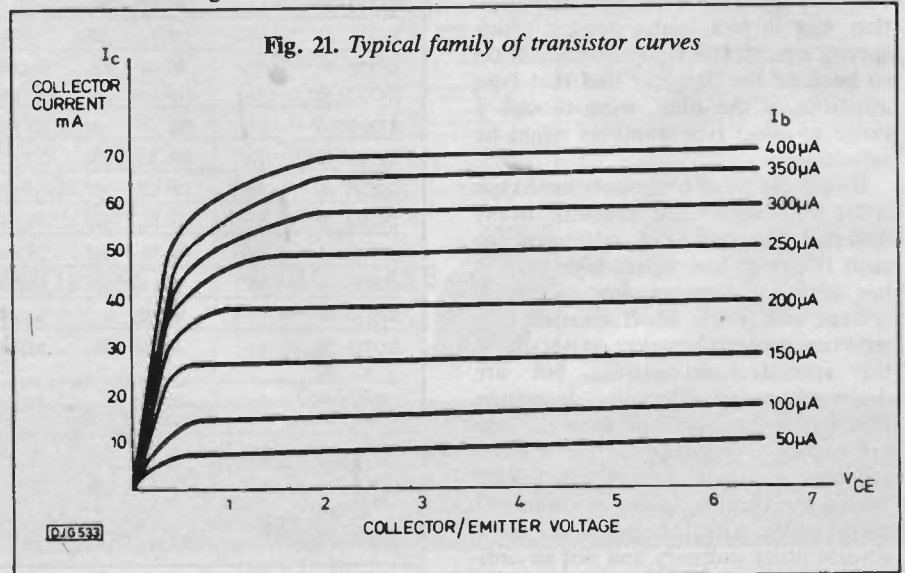
### CRITICAL PARAMETERS

In general it should always be possible to use a transistor with a higher specification in whatever aspect of the spec is important as a replacement for the specified type. If this is not possible, for example if a transistor with too high a gain would cause problems just as would a transistor with too low a gain, then one may often (but not always) conclude that the circuit design is at fault. It is normal to design transistor circuitry so that the passive components around the transistor limit the gain, frequency response etc. This requires a transistor whose specification is significantly better than that being set by the passive components. For example, to make a video amplifier with a frequency response of 20MHz, it is preferable to use transistors with a cutoff frequency  $f_t$  of at least 100 MHz, preferably 200 MHz.

Fig. 20 shows an example of a circuit in which the choice of transistor type is



important. At first sight, one would expect an ordinary vanilla transistor to do the job, but closer inspection shows us that the gain of such a transistor in or near saturation would not be high enough to pass enough current to switch on the relay. A ZTX450 is specified. This transistor has extremely good saturation characteristics and is optimised for switching. Even in this case there are equivalents. Any transistor from the ZTX450 or 650 range would work; there



are no doubt several "2N" types which would do and in fact even a small n-channel power f.e.t. would do the job. A BC182 however would work in about a third of the units constructed. This is the sort of aspect that an author would usually mention.

So far we have considered only npn small signal transistors. The same reasoning applies to small signal pnp types, and indeed many common npn transistors have a pnp complement. Often though the pnp transistor has a slightly lower specification in one aspect or another, as Table 3 shows.

The operating characteristics of transistors are often illustrated by a family of curves of collector current against collector voltage at the various different levels of base current. So common is this representation that transistor curve tracers are produced to show on an oscilloscope screen just such a family of curves. A typical family of curves for a small signal npn transistor is shown in Fig. 21. As the graph shows, at low values of collector-emitter voltage the gain of the transistor is reduced. This effect is more pronounced at higher levels of collector current. From this family of curves it is clear to see that the specified gain of a transistor does not apply under all circumstances.

This dependence of gain on collector current has another effect as well. If the transistor is used to amplify a signal which requires wide excursions of collector current, then distortion due to the non-linearity will occur unless the design is carefully arranged to avoid this. Generally this will involve using local negative feedback, and in the case of an audio amplifier overall negative feedback would be used as well.

### BIAS

To use a transistor in a linear circuit it is necessary to bias it correctly. One might imagine that the way to bias a transistor would be to feed the base with a current of  $1/h_{fe}$  times the required col-

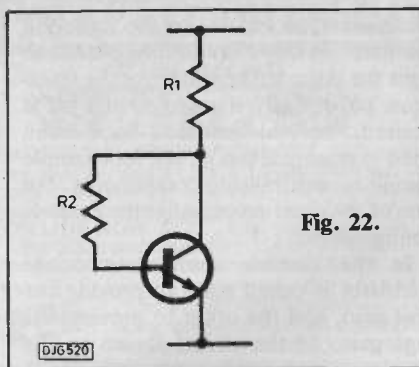


Fig. 22.

lector current. This would work in a limited fashion, but because the gain of a transistor varies from sample to sample of the same type of device, and also varies with current, voltage, and temperature, this method of biasing is not usually appropriate. The biasing scheme shown in Fig. 22 shows the nearest thing to this idea which is at all stable or reproducible.

In this circuit, the value of R1 is calculated to drop half the supply voltage at the required quiescent collector voltage is equal to half the supply voltage. The value of R2 is then calculated so that it passes the nominal required bias current when fed with half the supply voltage. If the gain of the transistor is higher than nominal, the effect is partly compensated by the fact that the collector voltage is lower and therefore the bias current is lower. This stabilising action can compensate for modest variations of gain from the nominal, but wide variations will set the collector voltage outside a reasonable operating range.

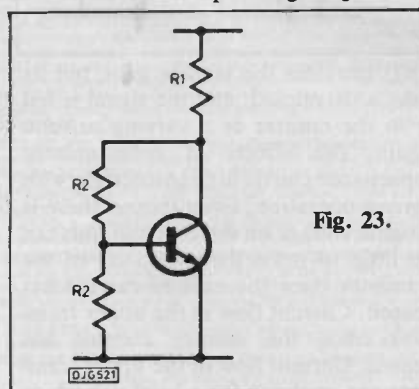


Fig. 23.

Fig. 23 shows an improvement upon this idea in which the transistor's collector voltage is potted down by R2 and R3, so that at the nominal collector voltage, the voltage at the junction of R2 and R3 is approximately 0.65V. In order that the base current drawn by the transistor does not upset this condition too much, the current flowing through R2 and R3 is normally chosen to be at least ten times the anticipated base current. This can lead to a relatively low input impedance, but the stability and reproducibility of the bias point is much better than that of the circuit of Fig. 21. On the other hand, the circuit of Fig. 21 will provide the maximum amplification in a simple stage for low level signals.

## STABILISATION

Neither of these two configurations represents the ultimate instability, and they also suffer from non-linearity. The circuit shown in Fig. 24 represents a significant improvement in terms of both bias point stability and linearity. This circuit is widely used as a standard single stage audio gain block when discrete transistors are used. The addition of the emitter resistor, R4, is responsible for the improved d.c. stability. Its value is usually chosen so that it drops about one volt at the nominal emitter current of the transistor. This tends to swamp out any changes in  $V_{be}$  due for example in changes in temperature.

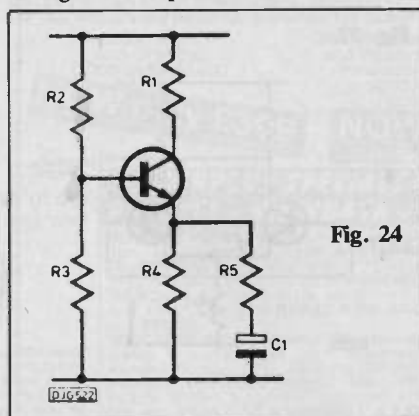


Fig. 24

The values of R2 and R3 are chosen to set the base voltage at approximately 1.65 volts. If R5 and C1 were omitted from the circuit it would work perfectly well in this form, and the voltage gain would be set by the ratio of R4 and R1. If the stage were to be run on a 9V battery, at a current of 1mA, one would probably have a value for R4 of 1k, and for R1 of 3k9, which would give a voltage gain of approximately 4. In many cases a higher a.c. gain would be required. The way to obtain this without compromising d.c. stability is to lower the a.c. emitter resistance, so we add R5 and C1, in parallel with R4. The gain can then be set to any value which the transistor is capable of providing.

There is one disadvantage to higher gain. When a signal is applied to the base of the transistor, the base current varies, and therefore the base/emitter voltage varies, as shown by the diode curves in part 1. This inevitably causes some non-linearity, but so long as the greater part of the signal voltage appears across the emitter resistance, rather than the base/emitter junction, the non-linearity is minimised. However, if a low value is chosen for R5, little signal voltage will appear across the emitter resistor, and the non-linearity will be more pronounced.

## INPUT RESISTANCE

The higher the gain of the transistor, the less non-linearity which will be introduced in any given circumstance. To see why this is so, consider the case of a very low gain transistor. The base current will

be high, and a significant proportion of the current flowing in the emitter resistor will be from the base terminal rather than the collector terminal. Thus, the change in base current for a given signal will also be substantial. On the other hand, a transistor with an extremely high gain would have very low base current, so the change in current for a given signal would be negligible.

This affects the apparent input impedance. If the gain of the transistor is 99, then 100 times as much current flows in the emitter resistor as in the base. These same proportions apply to any change in base current (excepting non-linearities) so the change in emitter voltage is one hundred times as much as would occur from the base current alone. The impedance looking onto the base of the transistor is therefore one hundred times the emitter resistance (including any extra resistor in series with a capacitor in the case of a.c. signals).

Several configurations exist to provide more gain. Fig. 25 shows a darlington configuration. In this two transistors are used in such a way that their current gains multiply. If each one has a gain of 100, then one microamp fed into the base of Q1 would result in an emitter current of  $101\mu A$ , most of which is fed into the base of Q2. The emitter current of Q2 will be 101 times as much again so that the overall current gain would be approximately 10,000. In practice, not all this gain would be realised because a significant current must be bled away by R1 to allow the stage to switch off reasonably fast when the base current of Q1 is stopped. If the value of R1 is too high, then the charge storage in the base of Q2 does not start to decay until Q1 has completely switched off, so that the transistor switching delays are additive. On the other hand, too low a value for R1 results in too low a gain, so that a compromise has to be found. Generally speaking, in an application for which a darlington configuration is required, it will be clear whether gain or switching speed is more important.

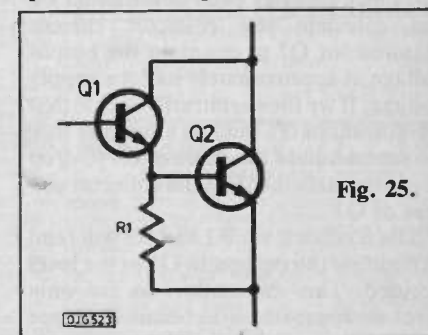


Fig. 25.

As the above current figures illustrate, the current and hence the dissipation in Q1 is very much less than that in Q2. Therefore, a much smaller and faster transistor type may be used for Q1 than for Q2. For example, if a particular darlington switch is required, one might choose a 2N2369 for Q1, and a BD139

for Q2. Suitable combinations of transistors may be chosen for other specific requirements, but it is often more convenient to use a ready-made darlington transistor which may well include R1 and an anti-parallel protection diode across the collector and emitter of Q2. In such a device, the transistor characteristics will have been optimised for the purpose intended.

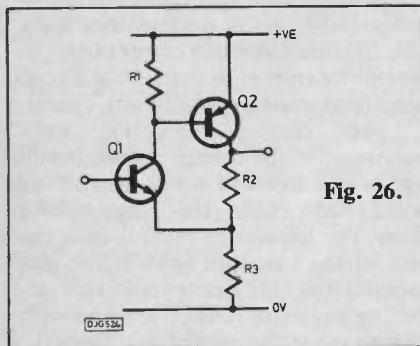


Fig. 26.

## VOLTAGE GAIN

In Fig. 26 we have a configuration which can increase both current and voltage gain. As with simple op amp circuits, the gain is approximately set by the ratio of the feedback resistors, R2 and R3. Clearly, the signal on the emitter of Q1 will be similar to that on the base, at a d.c. level approximately 0.65V lower. If the values of R2 and R3 are low enough that most of the current in them comes from the collector of Q2 rather than the emitter of Q1, then the two resistors form a potential divider from the collector of Q2, and hence the voltage of the collector of Q2 must be whatever would be required at the top of such a potential divider as to give the aforementioned signal on the emitter of Q1.

In order that the ratio of R2 and R3 shall be the main determining factor on the gain of the stage, we must arrange that the current in Q2 is much greater than the current in Q1. A good place start is by determining the required output impedance which is equal to R2 plus R3. Once this has been determined we can calculate the collector current required for Q2 to maintain the output voltage at approximately half the supply voltage. If we then arbitrarily decide that the current in Q1 shall be a tenth of this, we can calculate the value of R1 to drop approximately 0.65V at the collector current of Q1.

The feedback via R2 and R3 will tend to regulate the current in Q1 to the level decided. This calculation so far only gives an approximation because ten per cent of the current in R3 comes from Q1, rather than from Q2, but in practice a little trial and error will be required to choose the exact component values anyway, because of the need to stick to preferred resistor values. This type of circuit can give, for example, reasonable gain at audio frequencies, with acceptable linearity.

## A TRICK OF THE TAIL

A discussion of transistor circuits would not be complete without mention of the long tailed pair. This configuration among its many uses forms the basis of op amp designs. The principle of operation is very simple. The voltage across R3 is more or less constant, and therefore the current through it is more or less constant (sometimes a constant current is shared between Q1 and Q2, according to their relative base voltages. If, as is usually the case, R1 and R2 are chosen to have equal values, then the output voltages are in direct proportion to the current sharing. (Fig. 27).

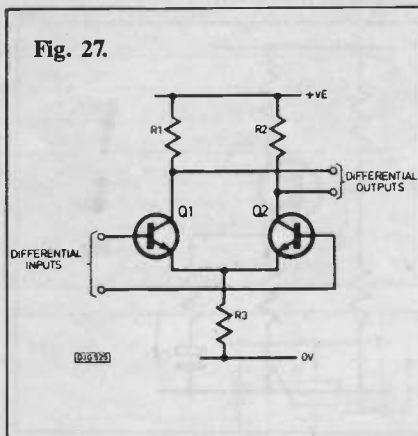


Fig. 27.

In this circuit configuration, as with that of Fig. 22, the precise voltage gain is not defined. It depends upon the change in collector current of the transistor per unit change in base voltage. This parameter is referred to as the mutual conductance, represented by the symbol  $g_m$ . It is not a parameter which is usually specified for junction transistors, because the junction transistor works in such a way that the  $g_m$  is not usually a meaningful parameter. Because of the shape of the base emitter conduction curve, and the relatively constant current gain,  $g_m$  is heavily dependent upon current. In the case of valves and f.e.t.s,  $g_m$  is specified and is much more meaningful.

For the long tailed using pair using junction transistors, however, it is normal to operate the transistors in such a way that there is plenty of gain, and then use external feedback to set the gain of the stage. On ICs, where the transistor parameters can be carefully controlled and matched, the gain of a long tailed pair may more readily be defined, but this is not of concern to the home constructor.

## HIGH FREQUENCY CIRCUITS

If transistors are to be used at high frequencies, another factor becomes significant. Because the collector/base junction of a transistor is a large flat area, it possesses significant capacitance. At high frequencies, this capacitance can couple the signal from the collector directly into the base region. Unfortunately, the signal on the collec-

tor is inverted relative to the signal on the base, so this stray coupling tends to fight the intended operation of the transistor, particularly if rapid switch off is desired. Several methods have been tried to minimise this effect, for example tuning or neutralising components, but one of the most successful is the cascode configuration.

In the cascode configuration, one transistor is called upon to provide current gain, and the other to provide voltage gain. In the circuit shown in Fig. 28, the signal is fed in to the base of Q2. Because the collector of Q2 is maintained at an almost constant voltage by the way in which Q1 is biased, the collector/base capacitance (sometimes referred to as Miller capacitance) has no signal which it can spuriously couple to the base. Therefore, the transistor can operate very fast.

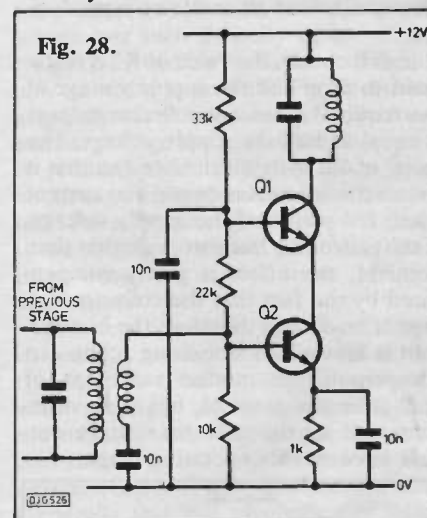


Fig. 28.

Q1 provides the voltage gain, but its base is decoupled, and the signal is fed in to the emitter as a varying current. Again, the effects of collector/base capacitance can do little to interfere with correct operation. Even though there is a signal voltage on the collector, this can do little to resist the switch off of the transistor once the emitter current has ceased. Current flow in the upper transistor once the emitter current has ceased. Current flow in the upper transistor can continue for a brief period, as charge is removed from the base, but this base current results in no emitter current. All the collector current flows out of the base and thus depletes the charge in the region very rapidly.

Not only is this configuration very effective to gain the best high frequency performance, but it can also circumvent the problem of spurious oscillation due to signal coupling via the collector/base capacitance. This type of configuration is widely used in critical RF, video, and switching circuits. It also illustrates the principle of the dual gate m.o.s.f.e.t., so we shall return to it later.

Here endeth the second lesson. Part three will cover linear power and f.e.t.s.

# COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

## THE "ALLADINS" CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HOT LINE DATA BASE

### DISTEL

The ORIGINAL FREE OF CHARGE dial up data base. Buy, browse or place YOUR OWN AD for goods or services to sell. 1000's of stock items, spares and one off bargains. Updated daily. ON LINE NOW. CCITT, 8 bit word, no parity. For 300 baud modems call 01-679 1888 For 1200-75 baud modems call 01-679 6183



## DON'T MISS THE CPM Deal OF THE CENTURY

### The FABULOUS CPM TATUNG PC2000 Professional Business System

A cancelled export order and months of negotiation enables us to offer this professional PC, CPM system, recently on sale at OVER £1400, at a SCOOOP price just over the cost of the two internal disk drives!! Or less than the price of a dumb terminal!!

Not a toy, the BIG BROTHER of the EINSTEIN computer, the DUAL PROCESSOR PC2000 comprises a modern stylish three piece system with ALL the necessities for the SMALL BUSINESS, INDUSTRIAL, EDUCATIONAL or HOBBYIST User. Used with the THOUSANDS of proven, tested and available CPM software packages such as WORDSTAR, FAST, DBASE2 etc, the PC2000 specification, at our prices, CANNOT BE BEATEN!!

The central processor plinth contains the 84K, Z80A processor, DUAL TEAC 55F 5 1/4" Double sided 40/80 track disk drives (1Mbp per drive), PSU, 4K of memory mapped screen RAM, disk controller, RS232, CENTRONICS and system expansion ports, and if that's not enough a ready to plug into STANDARD 8" DRIVE port for up to FOUR 8" disk drives, either in double density or IBM format. The ultra slim 92 key, detachable keyboard features 32 user definable keys, numeric keypad and text editing keys, even its own integral microprocessor which allows the main Z80A to devote ALL its time to USER programs, eliminating "lost character" problems found on other machines. The attractive, detachable 12" monitor combines a green, anti-glare etched screen, with full swivel and tilt movement for maximum user comfort. Supplied BRAND NEW with CPM 2.2, user manuals and full 90 day guarantee. Full data sheet and info on request

PC2000 System with CPM Etc. COST OVER £1400

PC2000 Business System with CPM and 'Ready to Run' FAST Sales and Purchase ledger, supports up to 9000 Accounts, VAT etc. COST OVER £1700

PC2000 Wordprocessor System with CPM and TEC FP25 daisywheel printer

**NOW only £399**

**NOW only £499**  
Carriage & Insurance £1200

**NOW only £799**

## MODEMS

Join the communications revolution with our super range of DATA MODEMS, prices and specifications to suit all applications and budgets.....

- BRAND NEW State of the art products
- DACOM DSL12123 Multi standard 300-300, 1200-75 Auto answer etc £268.00
- DACOM DSL2 123AQ Auto dial, smart modem with multi standard AUTO SPEED detect, and data buffer with flow control etc £365.00
- DACOM DSL2123GT THE CREAM of the intelligent modems auto dial, auto call, index, buffer etc £498.00
- Steebeck SB1212 V22 1200 baud FULL DUPLEX sync or async optional auto dial £485.00
- TRANSDATA 307A Acoustic coupler 300 baud full duplex, originate only, RS232 interface £49.00

Ex BRITISH TELECOM full spec, CCITT, ruggedised bargain offers. SOLD TESTED, with data. Will work on any MICRO or system with RS232 interface.  
MODEM 13A 300 baud unit, only 2" high fits under phone CALL mode only £45.00  
MODEM 20-1, 75-1200 baud Compact unit for use as subscriber end to PRESTEL, TELECOM GOLD, MICRONET etc £39.95 +pp £6.50  
MODEM 20-2 1200-75 baud Same as 20-1 but for computer end £85.00 +pp £6.50  
DATEL 2412. Made by SE Labs for BT this two part unit is for synchronous data links at 1200 or 2400 baud using 2780/3780 protocol etc. Many features include 2 or 4 wire working, self test, auto answer-etc  
COST OVER £800. Our price ONLY £199 +pp £8.00  
DATEL 4800, RACAL MPA4800 baud modem, EX BT good working order, ONLY £295.00 +pp £8.00

### SPECIAL OFFER

MODEM TG2393 - Ex BT, up to 1200 baud, full duplex 4 wire or half duplex over 2 wire line. ONLY £85.00 PER PAIR +pp £10.00

For more information contact our Sales Office.

## MATRIX PRINTERS

SPECIAL BULK PURCHASE of these compact, high speed matrix printers. Built in Japan for the Hazeltine Corporation this unit features quality construction giving 100cps bidirectional, full pin addressable graphics, 6 type fonts, up to 9.5" single sheet or tractor paper handling, RS232 and CENTRONICS parallel interface. Many other features. BRAND NEW and BOXED. COST £420. Our price ONLY £199.00

## RECHARGEABLE BATTERIES

Dry Fit MAINTENANCE FREE by Sonnenschein & Yuasa  
A300 07191315 12v 3Ah NEW £13.95  
A300 07191312 6v 3Ah NEW £9.95  
A300 07191202 6-0-6v 1.8Ah TESTED Ex Equip £5.99

## VDU TERMINALS

Standard VDU data entry terminals at give away prices!!  
QUME QVT108. Current product, state of the art terminal with detachable keyboard, 12" Green screen, 2 page RAM, TVI 925, Hazeltine, ADMSA emulations, software setup, 25 x 80, Clock, Swivel and tilt base. Printer port, Function keys etc. BRAND NEW and BOXED AT ALMOST HALF PRICE ONLY £425.00  
AJ510 - EX RENTAL, Z80 controlled, 15" green screen 24 x 80 display, graphics, cursor addressing, printer port etc. Very good condition TESTED complete with manual only £225.00  
ADDS 520 - Dumb terminal, used, 12" b/w screen RS232 interface and printer port. TESTED. ONLY £125.00. Carriage on terminals £10.00  
100's of other terminals in stock, CALL for more details.

## FREE

Your monitor from its computer!! For only £29.95 it becomes a SUPERB HIGH QUALITY \* COLOUR \* TV SET

The fabulous TELEBOX an INVALUABLE MUST for the owner of ANY video monitor with a composite input, colour or monochrome. Made by a major UK Co. as a TOP QUALITY, stand alone UHF tuner and costing OVER £75 to manufacture, this opportunity to give your monitor a DUAL FUNCTION must not be missed!! The TELEBOX consists of a compact, stylish two tone charcoal moulded case, containing ALL electronics tuner, power supply etc to simply plug in and convert your previously dedicated computer monitor into a HIGH QUALITY COLOUR TV SET, giving a real benefit to ALL the family! Don't worry if your monitor doesn't have sound - THE TELEBOX even has an integral 4 watt audio amplifier for driving an external speaker, PLUS an auxiliary output for superb quality television sound via your headphones or HI FI system etc. Other features include: Compact dimensions of only 15.75" w x 7.5" d x 3.5" h latest technology, BRITISH manufacture, fully tuneable 7 channel push button tuner, AUTO AGC circuit, SAW filter, LED status indicator, fully isolated 240V AC power supply for total safety, Mains ON-OFF switch etc. Many other uses.

LIMITED QUANTITY - DON'T MISS THIS OFFER!!!

ONLY £29.95 OR £24.95 if purchased with ANY of our video monitors. Supplied BRAND NEW with full instructions and 2 YEAR warranty. Post and packing £3.50 \*When used with colour crt.

## COLOUR & MONOCHROME MONITOR SPECIALS

### 'SYSTEM ALPHA' 14" COLOUR MULTI INPUT MONITOR

Made by the famous REDIFFUSION Co. for their own professional computer system this monitor has all the features to suit your immediate and future requirements. Two video inputs: RGB and PAL Composite Video, allow direct connection to BBC/IBM and most other makes of micro computers or VCR's including our very own TELEBOX. An internal speaker and audio amp may be connected to computer or VCR for superior sound quality. Many other features: PIL tube, Matching BBC case colour, Major controls on front panel, Separate Contrast and Brightness - even in RGB mode. Separate Colour and audio controls for Composite Video input, BNC plug for composite input, 15 way 'D' plug for RGB input, modular construction etc etc.

This Must Be ONE OF THE YEAR'S BEST BUYS. PC USER

Supplied BRAND NEW and BOXED, complete with DATA and 90 day guarantee. ONLY £159.00 as above OR IBM PC Version £165.00 15 Day 'D' sct £1.00, BNC sct 75p BBC interface cable £5.50

### DECCA 80 16" COLOUR monitor. RGB input.

Little or hardly used manufacturer's surplus enables us to offer this special converted DECCA RGB Colour Video TV Monitor at a super low price of only £99.00, a price a colour monitor as yet unheard of!! Our own interface, safety modification and special 16" high definition PIL tube, coupled with the DECCA 80 series TV chassis give 80 column definition and quality found only on monitors costing 3 TIMES OUR PRICE. The quality for the price has to be seen to be believed!! Supplied complete and ready to plug direct to a BBC MICRO computer or any other system with a TTL RGB output. Other features are: internal speaker, modular construction, auto degaussing circuit, attractive TEAK CASE, compact dimensions only 52cm W x 34 H x 24 D, 90 day guarantee. Although used, units are supplied in EXCELLENT condition. ONLY £99.00 + Carriage.

DECCA 80, 16" COLOUR monitor. Composite video input. Same as above model but fitted with Composite Video input and audio amp for COMPUTER, VCR or AUDIO VISUAL use. ONLY £99.00 + Carr.

REDIFFUSION MARK 3, 20" COLOUR monitor. Fitted with standard 75 ohm composite video input and sound amp. This large screen colour display is ideal for SCHOOLS, SHOPS, DISCOS, CLUBS and other AUDIO VISUAL applications. Supplied in AS NEW or little used condition ONLY £145.00 + Carr.

### BUDGET RANGE EX EQUIPMENT MONOCHROME video monitors.

All units are fully cased and set for 240v standard working with composite video inputs. Units are pre tested and set up for up to 80 column use. Even when MINOR screen burns exist - normal data displays are unaffected 30 day guarantee.

12" KGM 320-1 B/W bandwidth input, will display up to 132 x 25 lines. £32.95  
12" GREEN SCREEN version of KGM 320-1. Only £39.95  
9" KGM 324 GREEN SCREEN fully cased very compact unit. Only £49.00  
Carriage and insurance on all monitors £10.00

## DC POWER SUPPLY SPECIALS

GOULD OF443 enclosed, compact switch mode supply with DC regulated outputs of +5v @ 5.5a, +12v @ 0.5a, -12v @ 0.1a and -23v @ 0.02a. Dim 18 x 11 x 6 cm. 110 or 240v input. BRAND NEW only £18.95  
GOULD G6-40A 5v 40 amp switch mode supply NEW £130.00  
AC-DC Linear PSU for DISK drive and SYSTEM applications. Constructed on a rugged ALLOY chassis to continuously supply fully regulated DC outputs of +5v @ 3 amps, -5v @ 0.6 amps and +24v @ 5 amps. Short circuit and overvoltage protected. 100 or 240v AC input. Dim 28 x 12.5 x 7 cm. NEW EX £49.94  
Carriage on all PSUs £3.00

## KEYBOARDS

Manufacturer's BRAND NEW surplus

DEC LA34 Un-coded keyboard with 67 quality gold plated switches on X-Y matrix - ideal micro conversions etc £24.95  
AMKEY MPNK-114 Superb word processor chassis keyboard on single PCB with 116 keys. Many features such as On board MICRO, Single 5v rail, full ASCII coded character set with 31 function keys, numeric keypad, cursor pad and 9600 baud SERIAL TTL ASCII OUTPUT!! Less than half price  
Only £69.00 with data. Carriage on Keyboards £3.50

## SURPLUS SPECIALS ON PRESTEL - VIEWDATA - TELEX

PLESSEY VUTEL, ultra compact unit, slightly larger than a telephone features A STANDARD DTMF TELEPHONE (tone dial) with 5" CRT monitor and integral modem etc. for direct connection to PRESTEL, VIEWDATA etc. Designed to sell to the EXECUTIVE at over £600!! Our price BRAND NEW AND BOXED at only £99.00

DECCAFAX VP1 complete Professional PRESTEL system in slimline desk top unit containing Modem, Numeric keypad, CPU, PSU etc. Connects direct to standard RGB colour monitor. Many other features include: Printer output, Full keyboard input, Cassette port etc. BRAND NEW with DATA. A FRACTION OF COST only £55.00

ALPHATANTEL. Very compact unit with integral FULL ALPHA NUMERIC keyboard. Just add a domestic TV receiver and you have a superb PRESTEL system and via PRESTEL the cheapest TELEX service to be found!! Many features: CENTRONICS Printer output, Memory dialling etc. Supplied complete with data and DIY mod for RGB or Composite video outputs. AS NEW only £125.00  
Post and packing on all PRESTEL units £8.50

## EX-STOCK INTEGRATED CIRCUITS

4164 200 ns D RAMS 9 for £11 4116 ns £1.50 2112 £10.00 2114 £2.50 2102 £2.00 6116 £2.50 EPROMS 2716 £4.50 2732 £3.00 2764 £4.95 27128 £5.50 6800 £2.50 6821 £1 68A09 £8 68B09 £10 8085A £5.50 8086 £15 8088 £8 NEC765 £8 WD2793 £28 8202A £22 8251 £7 8748 £15 Z80A DART £6.50 Z80A CPU £2.00. Thousands of IC's EX STOCK send SAE for list.

## DISK DRIVES

Japanese 5 1/4" half height, 80 track double sided disk drives by TEAC, CANON, TOSHIBA etc. Sold as NEW with 90 day guarantee ONLY £85.00  
TEC FB-503 Double sided HH 40 TRK NEW £75.00  
SHUGART SA400 SS FH 35 TRK £55.00  
SIEMENS FDD100 SS FH 40 TRK £65.00  
Carriage on 5 1/4" drives £5.50  
Brand NEW metal 5 1/4" DISK CASES with internal PSU.  
DSK1 for 2 HH or 1 FH drive £29.95 +pp £4.00  
DSK2 for 1 HH drive £22.95 +pp £3.50  
DKSC 3 As DSK1 LESS PSU £12.95 +pp £2.50  
DKSC 4 As DSK2 LESS PSU £10.95 +pp £2.00  
8" IBM format TESTED EX EQUIPMENT.  
SHUGART 800/801 SS £175.00 +pp £8.50  
SHUGART 851 DS £250.00 +pp £8.50  
TWIN SHUGART 851's 2 Mb total capacity in smart case, complete with PSU etc. £595.00  
MITSUBISHI M2894-63 8" DS 1 Mb equiv. to SHUGART SA850R. BRAND NEW at £275.00 +pp £8.50  
DYSAN 8" Alignment disk £29.00 +pp £1.00  
Various disk drive PSU's Ex Stock SEE PSU section.

HARD DISK DRIVES  
DRE/DIABLO Series 30 2.5 Mb front load £525.00  
Exchangeable version £295.00. ME3029 PSU £95.00  
DIABLO 44/DRE4000A, B 5+5 Mb from £750.00  
CDC HAWK 5+5 Mb £795.00. CDC 9762 80 Mb RMO3 etc £2500.00.  
PERTEC D3422 5+5 Mb £495.00  
RODIME 5 1/4" Winchester ex-stock from £150 CALL  
Clearance Items - Sold as seen - No guarantee.  
ICL 2314 BRAND NEW 14" Mb Removable pack hard disk drive, cost over £2000 with data ONLY £199.00  
BASF 6172 8" 23Mb Winchester £199.00

Unless stated all drives are refurbished with 90 day guarantee. Many other drives and spares in stock - call sales office for details.

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value £10.00. Minimum Credit Card order £10.00. Minimum BONAFIDE account orders from Government Depts., Schools, Universities and established companies £20.00. Where post and packing not indicated please ADD £1.00 + VAT. Warehouse open Mon-Fri 9.30-5.30. Sat 10.30-5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export

32 Biggin Way, Upper Norwood, London SE19 3XF  
Telephone 01-679 4414 Telex 894502 Data 01-679 1888

# BI-PAK BARGAINS

Pak No	Qty	Description	Price
<b>RESISTORS</b>			
VP1	30	Assorted Resistors, mixed values and types	£1.00
VP2	30	Carbon Resistors 1/4-watt, pre-formed, mixed	£1.00
VP4	200	1/2-watt Resistors, mixed values and types	£1.00
VP16	50	Wirewound Resistors, mixed watt values	£1.00
VP140	50	Precision Resistors, 1% tolerance	£1.00
VP181	100	Lead 2 watt Resistors, assorted values	£1.00
<b>CAPACITORS</b>			
VP5	200	Assorted Capacitors, all types	£1.00
VP6	200	Ceramic Capacitors, Min. mixed values	£1.00
VP9	100	Assorted Polyester/Polystyrene Capacitors	£1.00
VP10	60	C280 Capacitors, Metal foil, mixed values	£1.00
VP11	50	Electrolytics, all sorts	£1.00
VP12	40	Electrolytics, 47mf-150mf, mixed volts	£1.00
VP13	30	Electrolytics, 150mf-1000mf, mixed volts	£1.00
VP14	60	Silver Mica Caps, mixed values	£1.00
VP15	25	01/250v Min. Layer Metal Caps	£1.00
VP180	25	Tantalum Bead Caps, assorted values	£1.00
VP182	4	1000uf 80v Electrolytics	£1.00
VP192	30	Min. Electrolytics, mixed values, 47mf-1000mf 6/16v	£1.00
VP193	6	Sub Min. Electrolytics, 2 x 1000/2200/3300mf 10/16v	£1.00
<b>OPTOS</b>			
VP24	10	125' Clear showing Red LEDs	£1.00
VP25	10	Mixed shape and colours LEDs	£1.00
VP26	15	Small 125' Red LEDs	£1.00
VP27	15	Large 2' Red LEDs	£1.00
VP28	10	Rectangular 2' Red LEDs	£1.00
VP57	25	Opto special pack, Assorted, Super Value	£2.00
VP130	6	RED 7 Seg. CC 14mm x 75mm RDP FND353 LED Display	£2.00
VP131	4	GREEN 7 Seg. CA. 4' LDP XAN620 LED Display	£2.00
VP133	8	RED Overflow 4' 3 CA x CC 650/950 LED Display	£2.00
VP134	5	GREEN Overflow 4' CA XAN630 LED Display	£2.00
VP138	20	Assorted LED Displays, Our mix, with data	£5.00
VP147	1	Pair Opto Coupled Modules	£8.00
VP159	4	LDT07R LED Displays CA	£1.00
VP203	15	Triangular shape LEDs, Mixed colours	£1.00
VP204	10	Large Green LEDs, 5mm	£1.00
VP205	10	Small Green LEDs, 3mm	£1.00
VP206	10	Large Yellow LEDs, 5mm	£1.00
VP207	10	Small Yellow LEDs, 3mm	£1.00
VP208	10	Large LEDs clear showing Red, 2'	£1.00
VP241	2	ORP12 Light Dependant Resistor	£1.50
VP242	4	Tri-colour LED's 5mm Dia. 5mA 2v R.G.Y.	£1.00
VP243	3	Tri-colour LED's Rectangular 5mm R.G.Y.	£1.00
<b>DIODES &amp; SCRS</b>			
VP29	30	Assorted volta Zenars, 50mw-2w	£1.00
VP30	10	Assorted volta Zenars, low coded	£1.00
VP31	10	SA SCR's T066, 50-400v, coded	£1.00
VP32	20	3A SCR's T066, up to 400v, uncoded	£1.00

Pak No	Qty	Description	Price
VP33	200	Sil. Diodes like IN4148	£1.00
VP34	200	Sil. Diodes like OA20/BAX13-16 40v	£1.00
VP35	50	1A IN4000 Diodes, all good, uncoded	£1.00
VP49	30	Assorted Sil. Rectifiers, 1A-10A, mixed	£1.00
VP141	40	IN4002 Sil. Rectifiers, 1A 100v, preformed pitch	£1.00
VP142	4	40A Power Rectifiers, silicon, TO48 300 PIV	£1.00
VP143	5	BY187 12KV Sil. Diodes, in carriers, 2.5MA	£1.00
VP194	3	4A 400v Triacs, plastic	£1.00
VP187	10	SCR's 800MA, 200v, 2N5064, plastic, T092	£1.00
VP194	50	DA81 point contact germ. Diodes, uncoded	£1.00
VP195	50	DA47 gold bonded germ. Diodes, uncoded	£1.00
VP196	50	DA70-79 detector germ. Diodes	£1.00
VP197	50	GA90 type germ. Diode, uncoded	£1.00
VP198	40	BA248 Sil. Diodes, 350v 2A, fast recovery	£1.00
VP222	20	3A Stud Rectifiers, 50-400v, Assorted	£1.00
<b>TRANSISTORS</b>			
VP38	100	Sil. Trans. NPN plastic, coded, with data	£3.00
VP39	100	Sil. Trans. PNP plastic, coded, with data	£3.00
VP47	10	Sil. Power Trans. similar 2N3055, uncoded	£1.00
VP48	5	Pairs NPN/PNP plastic Power Trans. 4A, data	£1.00
VP50	60	PNP Sil. Switching Trans. TO-18 and TO-92	£1.00
VP51	60	PNP Sil. Switching Trans. TO-18 and TO-92	£1.00
VP52	100	All sorts Transistors, NPN/PNP	£1.00
VP150	20	BC183B Sil. Trans. NPN 30v 200mA Hfe240+ T092	£1.00
VP151	25	BC178 Sil. Trans. NPN 45v 100mA Hfe240+ T092	£1.00
VP152	15	TIS30 Sil. Trans. NPN 40v 400mA Hfe100+ T092	£1.00
VP153	15	TIS31 Sil. Trans. PNP 40v 400mA Hfe100+ T092	£1.00
VP154	15	MPSA56 Sil. Trans. PNP 80v 800mA Hfe50+ T092	£1.00
VP155	20	BF96 Sil. Trans. NPN eqvt BF184 H.F. T092	£1.00
VP156	20	BF96 Sil. Trans. NPN eqvt BF173 H.F. T092	£1.00
VP157	15	ZT750 series Sil. Trans. PNP plastic	£1.00
VP158	15	ZT107 Sil. Trans. NPN eqvt BC107 plastic	£1.00
VP159	15	ZT108 Sil. Trans. NPN eqvt BC108 plastic	£1.00
VP161	25	BC183B Sil. Trans. NPN 30v 200mA Hfe240+	£1.00
VP162	5	SJE451 Sil. Power Trans. NPN 80v 4A Hfe20+	£1.00
VP163	2	NPN/PNP pairs Sil. Power Trans. like SJE451	£1.00
VP164	4	2N6289 Sil. Power Trans. NPN 40v 40w 7A Hfe30+	£1.00
VP165	6	BT33 NPN Sil. Trans. 80v 5A Hfe50-200 T039	£1.00
VP166	5	BT34 NPN Sil. Trans. 100v 5A Hfe50-200 T039	£1.00
VP167	1	BUY89C NPN Trans. TO3 VBC 500, 10A, 100w, Hfe15+	£1.00
VP188	10	BC478 eqvt BCY71 PNP Sil. Trans. TO18	£1.00
VP189	10	EX521 eqvt BC394 NPN Sil. Trans. 80v 50mA T018	£1.00
VP170	10	Assorted Power Trans. NPN/PNP coded and data	£1.00
VP171	10	BF355 NPN TO-39 Sil. Trans. eqvt. BF258 225v 100mA	£1.00
VP172	10	SM1502 PNP TO-39 Sil. Trans. 100v 100mA Hfe100+	£1.00
VP200	30	OC71 type germ. AF Transistors, uncoded	£1.00
VP201	25	OC48 Germ. AF Transistors	£1.00
VP40	40	TTL ICs all new gates - Flip Flop - MSI, Data	£4.00
VP59	20	Assorted IC's linear, etc, all coded	£2.00

Pak No	Qty	Description	Price
VP209	12	74LS00	£2.00
VP210	12	74LS74	£2.00
VP211	10	CD4001B	£2.00
VP212	10	CD4011B	£2.00
VP214	10	CD4069B	£2.00
VP215	10	7418 8 pin	£2.00
VP216	10	555 Timers 8 pin	£2.00
<b>MISC.</b>			
VP17	50	Metric PVS single strand Wire, mixed colours	£1.00
VP18	30	Metric PVC multi strand Wire, mixed colours	£1.00
VP19	40	Metric PVC single multi strand Wire, mixed colours	£1.00
VP22	200	30 Inches total copper clad board	£1.00
VP23	10	40mm track slider pots, 100K Lin.	£1.00
VP42	10	Black heatshinks, fit TO3 and TO220, drilled	£1.00
VP43	4	Power fin heatshinks, 2 x TO3, 2 x TO66	£1.00
VP44	15	Assorted heatshinks, TO1/3/5/18/220	£1.00
VP54	20	Assorted I.C. DIL Sockets, 8-40 pin	£2.50
VP56	100	Semiconductors from around the world, mixed	£10.50
VP81	1	Equant & Drill Kit, PCB, inc. drill, transfers, etc	£4.50
VP83	1	Electronic Buzzer, 6v, 25MA	£0.95
VP84	1	Electronic Buzzer, 9v, 25MA	£0.95
VP85	1	Electronic Buzzer, 12v, 25MA	£0.95
VP86	1	TECASSBUTY Components Pack, semiconductors, caps, etc	£8.00
VP87	1	Telephone pick-up coil with 3.5mm jack plug	£1.25
VP88	1	Pillow Speaker with 3.5mm jack plug	£1.45
VP95	1	Plastic Vics, small, with auction base	£1.75
VP97	1	Logic Probe/Tester, Supply 4.5v-18v, TTL, TTL, CMOS	£8.50
VP99	1	Universal Tester, with ceramic buzzer	£5.00
VP107	1	Piezo Buzzer, miniature, 12v	£1.25
VP108	1	Piezo Buzzer, miniature, 240v	£1.25
VP113	1	Coax Antenna Switch, 2 way	£4.50
VP114	1	Coax Antenna Switch, 3 way	£4.75
VP115	1	High Pass Filter/Suppressor, CBTV	£0.50
VP116	1	Low Pass Filter, VHS/TV Band	£3.90
VP122	1	Precision Morse Key, fully adjustable	£1.85
VP128	1	Miniature FM Transmitter/Babyphone	£7.50
VP144	4	100K Lin multi turn Pots, ideal vari. cap. tuning	£1.00
VP145	10	Assorted Pots, inc. dual and switched types	£1.00
VP149	30	Presets, horizontal and vertical, mixed values	£1.00
VP174	5	DIL Switches, 1 & 2' way slide, 6 way SPST, assorted	£1.00
VP176	30	Fuses, 20mm & 14' glass, assorted values	£1.00
VP177	1	Pack assorted Handwired, nuts, bolts, etc.	£1.00
VP179	5	Assorted Battery holders and clips, PP39, AA/D, etc	£1.00
<b>TOOLS</b>			
VP103	1	6 pc STANLEY Screwdriver Set, Flat & crosspoint	£3.50
VP139	1	Pick-up Tool, spring loaded	£1.75
VP217	1	Helping Hand	£4.00
VP218	1	Waltchman's Screwdriver Set, 6 pieces	£1.75
VP219	1	Miniature Side Cutters	£1.55
VP220	1	Miniature Bent-nose Pliers	£1.55
VP221	1	Miniature Long-nose Pliers	£1.55

# BI-PAK

Send your orders to Dept. PE, BI-PAK, PO Box 6, WARE, HERTS. TERMS CASH WITH ORDER SAME DAY DESPATCH ACCESS BARCLAYCARD ALSO ACCEPTED TEL 0763-48851 GIRO 388 7006 ADD 15% VAT AND £1.50 PER ORDER POSTAGE AND PACKING

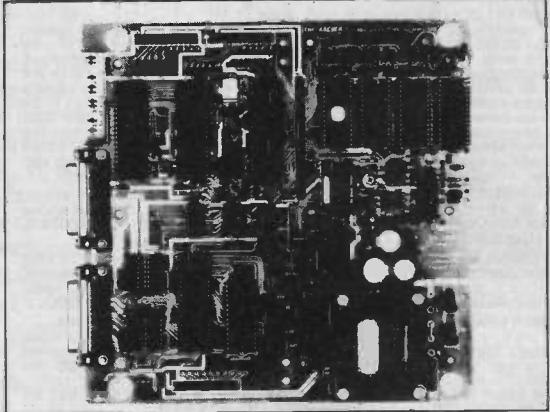


Use your credit card. Ring us on: 0763 48851 NOW and get your order even faster. Goods normally sent 2nd Class Mail. Remember you must add VAT at 15% to your order. Total Postage add £1.50 per Total order.

## The Archer Z80 SBC

The SDS ARCHER - The Z80 based single board computer chosen by professionals and OEM users.

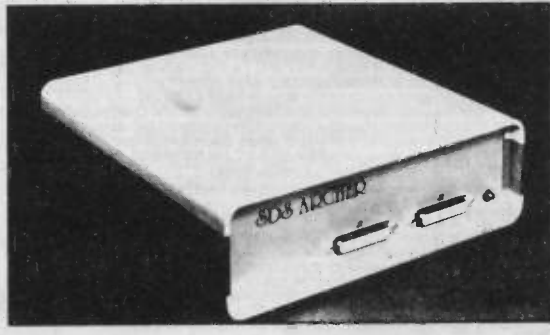
- ★ Top quality board with 4 parallel and 2 serial ports, counter-timers, power-fail interrupt, watchdog timer, EPROM & battery backed RAM.
- ★ **OPTIONS:** on board power supply, smart case, ROMable BASIC, Debug Monitor, wide range of I/O & memory extension cards.



## The Bowman 68000 SBC

The SDS BOWMAN - The 68000 based single board computer for advanced high speed applications.

- ★ Extended double Eurocard with 2 parallel & 2 serial ports, battery backed CMOS RAM, EPROM, 2 counter-timers, watchdog timer, powerfail interrupt, & an optional zero wait state half megabyte D-RAM.
- ★ Extended width versions with on board power supply and case.



# Sherwood Data Systems Ltd

Sherwood House, The Avenue, Farnham Common, Slough SL2 3JX. Tel. 02814-5067



Half List Price

# 6V 16Ah Sealed Batteries

A sealed, maintenance free, lead acid gel battery, the EP6160 is manufactured by Elpower and delivers a massive 6 volt 16Ah capacity from a package measuring only 210 x 140 x 70 mm. Useful for many standby or portable applications, the EP6160 is suitable for deep cycling use and is chargeable from a constant voltage source.

BRAND NEW ..... **£15** P+P £3.00

## INTELLIGENT PRINTER BUFFERS

PB SERIES

PB-64 \*Memory: 64K(installed) \*2mm metal case \*Copy, Bypass, Reset, Self-Test function \*Parallel to Parallel \*Channel: 1-IN 1-OUT £90.00 + VAT P&P £2.50 inc insurance

PB-64-2 \*Memory: 64K(installed) \*2mm metal case \*Copy, Reset, Self-Test function \*Parallel to Parallel \*Channel: 1-IN 2-OUT 2-IN 1-OUT \*Mechanical switch selectable £95.00 + VAT P&P £2.50 inc insurance

PB-256 \*Memory: 256K(installed) \*2mm metal case \*Copy, Bypass, Reset, Self-Test function \*Parallel to Parallel \*Channel: 1-IN 1-OUT £112.00 + VAT P&P £2.50 inc insurance

PB-256-2 Memory: 256K(installed) \*2mm metal case \*Copy, Reset, Self-Test function \*Parallel to Parallel \*Channel: 1-IN 2-OUT 2-IN 1-OUT \*Mechanical switch selectable £135.00 + VAT P&P £2.50 inc insurance

Price Breakthrough!

68000

# Processors

The Signetics SCN68000C8164 is an 8MHz 68000 cpu in a 64pin Ceramic DIL package. Due to its advanced design features the 68000 has become an industry standard in true 16 bit processing. A scoop purchase enables us to offer this popular device at the unbelievable price of

MASSIVE STOCKS MUST BE CLEARED

**£5** P+P £1

## SIEMENS V30141 300 WATT OPEN FRAME SWITCHMODE

A high reliability multirail supply carrying UL and CSA approvals. Built on a rugged aluminium chassis the V30141 accepts 110 or 220Vac input and delivers five outputs: \*5V/35A \*12V/3A \*24V/3.2A \* -12V/0.2A \* -5V/2A

All units burned in and tested. Offered BRAND NEW & boxed Overall size 390 x 225 x 70 mm.

REDUCED TO CLEAR

only **£30** + VAT + £2 p&p

## SUPER SAVINGS ON SWITCHMODES

## GRESHAM LION SWITCHMODE TRIPLE RAIL SUPPLIES

Top quality power supplies originally manufactured for a major OEM. Three outputs on 0.156 molex connector +5V at 6Amps \* +12V at 4.75Amps -12V at 0.5Amps

Semi enclosed in an attractive black enclosure, the units are supplied BRAND NEW with data. Input 240Vac on switched IEC skt. only **£20** + £2 p&p

## NOVEMBER SPECIAL OFFERS

**BBC DISK INTERFACE** leads, 34 way speed-bloc socket to 34 way edge connector. Available in single or twin drive configurations. **SINGLE DRIVE ... £1.50 TWIN DRIVE ... £2.50**  
**UM1286 MODULATORS**-High quality UHF modulators for interface of computer and video 75 Ohm sources to TV sets. Data supplied. **BARGAIN PRICE ... £4.00**

**ELMA INSTRUMENT CASES**-Supplied in kit form, these attractive and easy to assemble enclosures are finished in Pacific Blue and will accept either eurocards or modular components. Size 317 x 140 x 240mm. ONLY **£10.00**  
**NEC MC5808 DBS Local Oscillator Module** 10GHz ECS frequency, 50 ohm o/p **£15.00**  
**LITHIUM CELLS**, Matsushita BR2325, 3V, 23 x 3mm **£1.50**

**PAPST FANS**-Type 4850 120mm low noise axial fans. 240V Brand New **£7.00**  
**SPRITE FANS**-80mm low noise axial fans high performance. 240V NEW **£6.00**  
**FADERS**-Metal body construction. 10K Lin 60mm Mono **£0.60**  
10K Lin 45mm Mono centre stop **£0.60**  
100K Lin 45mm Ster. centre stop **£1.00**

## Semiconductors

Part No	Mfr	Description	Price
FCN2674			
BC4N40	Sig	Prog.Video Controller	£6.00
DAC80-CBI-V	B.Br	12 Bit D-A Converter	£4.00
AD 581JH	A.Dev	10V Prec. Reference	£5.00
K1135A	Mota	Dual Baud Rate Gen.	£2.00
AY-3-1270	G.I	Temperature Controller	£2.00
MAB8031AH-12P	Sig	8-Bit Microcontroller	£3.95
SAB 8085 A2P	Siem	8-Bit Microprocessor	£2.00
Z80A SIO-0	SGS	Serial I/O Controller	£3.50
TDA 1151	Siem	Motor Speed Controller	£1.00

Quantity discounts available on all the above lines. Our range of ICs and Discrete semiconductors includes thousands of top quality parts ex-stock.

## Rechargeable Batteries

A range of YUASA maintenance free rechargeable Lead Acid batteries having many applications in portable & standby situations. Suitable for cyclic and standby use, the sealed construction ensures long life and no electrolyte leakage. All batteries are brand new and available ex-stock at highly competitive prices.

*6 Volt 1Ah	£5.50	*12 Volt 1.2Ah	£10.00
*6 Volt 1.2Ah	£7.25	*12 Volt 1.9Ah	£13.00
*6 Volt 2.6Ah	£8.00	*12 Volt 2.6Ah	£15.00
		*12 Volt 6Ah	£20.00 all prices + P&P

## CAPACITORS

2µF 250Vac Filmcap ACT Polycarbonate	£1.00
100/350V Erie KB411CT	£1.00
2200/16V Rad. Panasonic	£0.25
2200/200V Mallory CGS	£2.00
4700/16V Ax.Mull 032	£0.25
4700/63V Procond 542	£1.10
10000/16V Rad Nich	£0.30
10000/40V Lorlin Computer Grade	£2.00

We carry a full range of Ceramic, Polyester, Polystyrene, Tantalum, Electrolytic, Variable and Trimmer capacitors.

## Industrial Timers

A range of high reliability electromechanical timers by IZUMI DENKO. All units 240Vac and have 5A contact sets RTMSP2N-Octal base, 2 contact sets, start on power-up, power off reset. 0-6sec, 0-210sec, 0-28hr.  
**RTMUM2N**-72mm square panel mount. Screw terminals. Specs as above. 0-35sec, 0-70sec, 0-210sec, 0-7min, 0-35min, 0-210min  
**RTMSP3B**-as above but separate clutch & motor connections  
Reset on Power off. 0-12sec, 0-35sec-0-210sec, 0-28hr  
Application sheets available. All timers only **£10.00**

... stop press ...

**SOLAR PANELS** - 12 ins x 12 ins. 12 Volt 200mA output in British sunlight. Bargain price **£10.00**

# Fuselodge Ltd.



267 ACTON LANE,  
CHISWICK, LONDON W4 5DD  
Telephone: 01-994 6275

Terms of business  
Cheque/PO with order. Mail order. phone for details of p&p charges for your order. Callers Welcome.  
Shop Hours  
9.00am to 5.30pm  
6 days a week.

PLEASE ADD 15% VAT TO ALL PRICES

## Power Supplies

Top quality tested second user units available ex-stock.  
**GOULD MG5-20-5V 20A Switchmode** **£20.00**  
**GOULD MG5-40-5V 40A Switchmode** **£35.00**  
**GOULD MG5-60-5V 60A Switchmode** **£45.00**  
**ELPAC SOLV 30, 12 Volt 4 Amp Linear Stabilized Supplies.** Open frame design on rugged di-chassis. Features low noise and tight regulation from series regulator based on industry standard LM305 i.c. Supplied brand new and boxed, with data. Only **£15.00 P&P £3.00**  
**ADVANCE PMG5-5 5V 5A Linear** **£20.00**  
**ADVANCE PMGD15-1.2. + / -15V 1.2A Linear** **£25.00**  
**ITT PM1500A5 5V 1.5A Powercard Linear** **£10.00**  
**ITT PM3000A5 5V 3A Powercard Linear** **£15.00**  
**MULLARD** Unixex psu's to clear **£2.50**  
Our stock of power supplies is vast and constantly changing. Ring us first for your PSU requirements.

## Relays

**CONTINENTAL** Cradle RLAs.6,12,24V. 2PCO-£1.50 4PCO **£2.00**  
**MARVID** B150 Open power. 240V coil. 5A Silver contacts, all brand new and boxed. 3PCO Type **£1.75**. 4PCO type **£2.25**  
**MARVID** B15E.240V coil.3PCO.5A rated. 11 Pin base **£3.00**  
**AMF** KUP14D55.12Vdc coil.3PCO.10A. Plug-in **£3.00**  
**IZUMI** PCB RELAYS. \*RH1V2-6V SPCO 10A Mini type **£1.50**  
\*RC1V3-12V SPCO 3A-£1.00 \*RD2V2 12V 2PCO 1A Mini **£1.20**  
Always in stock-Glass reeds, DIL Reed relays, Axial Reed Relays, Mini Power, Crystal Can, Octal, SSRs and all bases.

## Motors

**SANYO** 103-606-2 Stepper. 2 Phase 4 pole 6V 3A **£10.00**  
**SHINKOH** 20PMA055 Stepper. 1 Phase 3 pole 28V 1.3A **£10.00**  
**PHILIPS** CONTROLS B82959 Stepper. 2 Phase 4 pole. 14Vdc Step Angle 7.5 Deg. 27.5 Ohms./Coil **£10.00**  
**KAWASAKI** MC609R-A 6V Cassette Motor, 2400rpm **£2.00**  
**MATSUSHITA** MH15R2C 12V Cassette Motor+regulator **£3.00**  
**BERGER-LAHR** RDM 50/8G 12 Volt Stepper Motors. 3mm shaft, 230mA/37Ω per winding. Brand new stock. Only **£6.00**  
DC and AC motors always in stock.

## Bargain

**BREADBOARDS** - exciting new range of solderless proto-typing boards at affordable prices.  
**Budget Series** - 100 Tie Points... **£1.70**. 640 Tie Points... **£5.00**. 840 Tie Points... **£6.50**. Pro Series - 400 Tie Points... **£4.20**. 630 Tie Points... **£7.90**. 1660 Tie Points... **£17.80**.  
**PANEL METERS**, 60mm x 45mm. Cutout 38mm. Attractive Black/Clear plastic construction. Available 50µA, 100µA, 1mA, 1A, 5A, 10A. Brand new & boxed. Only... **£6.00** ea.  
**DRILLS** - Pcb drills 12 Volt. Pin chuck type... **£6.95**. 4mm adjust. chuck... **£7.25**.  
**MAINS DRILLS** - high power 4mm chuck... **£24.75**. Drill kits - 12V drill + bits... **£28.50**.  
**SIRENS** - 12 Volt Ear Piercing 115dB output. Small **£9.50**, Large **£11.50**. Ideal Car Alarms, etc.  
**FERRIC CHLORIDE** - Circuit Etchant Granules. Approx. 250g. Only... **£1.65**/bag.

**££££ WE BUY COMPONENTS FOR CASH ££££**  
We also buy good working **TEST EQUIPMENT, POWER SUPPLIES, COMPUTER EQUIPMENT, PERIPHERALS** and other hardware.

**Please note.** This advertisement represents a fraction of our current stock. It would be impossible to list our vast range of electronic components and equipment. As a broadline distributor we have comprehensive stock of semiconductors (linear, logic, memory, LSI and discretes) resistors, capacitors, switches, optoelectronic products, connectors, potentiometers, fuses, cable, lamps, and new products are constantly arriving. Our technical and sales staff are always available to handle your enquiry.

# RECALLING HISTORY

PART ONE BY BARRY DRAKE

## 1854 CALLING 1987!

*If someone told you that a man name Bell would invent a machine which would still be ringing everywhere in the world a century later, what would you say? Good story, eh? Well, here it is...*

IF readers were asked to design a telephone system using the latest electronic technology, there would be a great many differing approaches to the project. What is certain is that none of them would resemble the system operated by British Telecom today. With a little thought, it is evident that the present system was not designed as such, but is the result of one hundred years of evolution!

Let's look at it another way: I have a pre-war post-office telephone - one of those heavy black instruments with a drawer in the base to contain a selection of telephone numbers. I can take this museum piece, and I can connect it to the Telecom system without modification, and make and receive calls on it. Quite something! Especially when you consider that I can talk to you while you walk around your garden using the very latest cordless instrument. And neither of us will be at a disadvantage with our particular telephone.

The story begins in the middle of the last century with a paper published by Charles Bourseuil, a Frenchman, in 1854, suggesting that sound might be conveyed by wire. The idea was proved by Philip Reis of Frankfurt in 1861 when he succeeded in producing a crude device for transmitting sound by wire using a diaphragm fitted with a contact to make and break a circuit at the frequency of an acoustic signal. This was used in conjunction with an electromagnetic receiver and a battery, and served only to verify Bourseuil's theory, as the signal produced was barely recognisable as speech. In 1876, Alexander Graham Bell, of Edinburgh, although at the time living in America, made two electromagnetic transceivers of a design which was similar to the receiver used subsequently on telephones throughout the world. We've all tried using two headphone or telephone ear-pieces connected together with a long length of twin flex. One person speaks into one device while the other listens to the one at the other end. This is exactly what Bell did. The speech transmitted is faint but usable - but clearly would not stand up to the loss which long lines would occasion, and of course there were no electronic

amplifiers around to solve that problem the easy way.

At the same time as Bell performed his famous experiment, Gray from Chicago is said to have carried out work independently, and along very similar lines.

### NAIL MICROPHONE

A year later, Edison, seeing the great possibilities of Bell's work, solved the problem of lack of signal strength, by his invention of the carbon microphone, (or transmitter as it was then called). The theory behind the carbon transmitter came just a year later during 1878 in a paper produced by Professor Hughes for the Royal Society. He showed that any system of loose contacts can be used as a transmitter (he used three iron nails to demonstrate the theory) and in the same paper used for the first time the word microphone. Over the next few years the carbon microphone was developed into a form identical in all except outward appearance to that still in operation in many telephones today. Thus was established around one hundred years ago, the first of the criteria for the communication system which we use today: that a current of between 25mA and 200mA DC needs to be provided into a loop resistance of some 500 ohms. This represents the 40 ohms or so of the microphone, plus the line and transformer resistances, and all because the first transmitters had a optimum working point in that area.

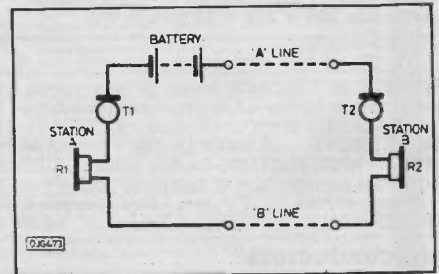
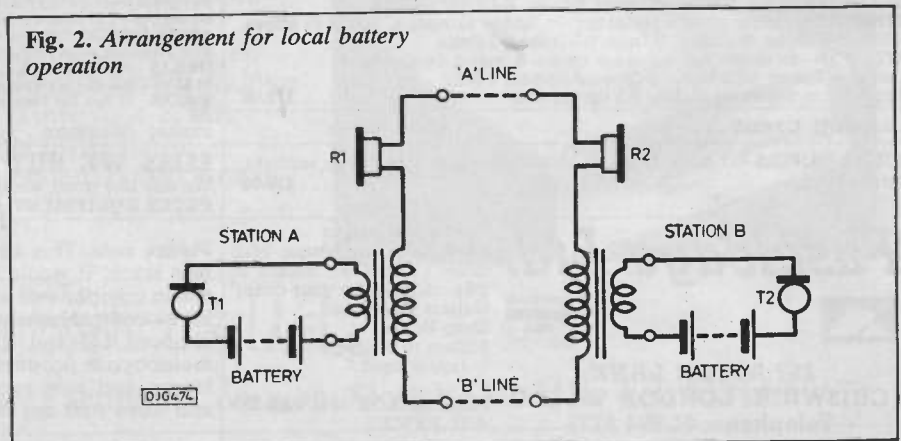


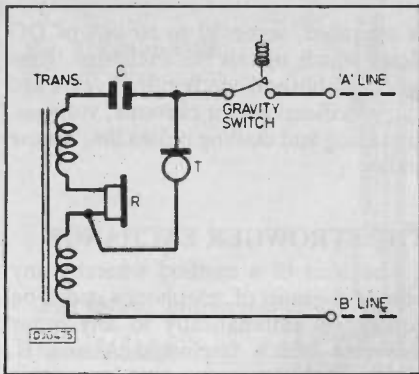
Fig. 1. First telephone system

Although it would clearly have been possible to make a working loop with two receivers and two carbon transmitters all in series with a power source, and this was in fact the basis of the first system, (Fig. 1), Edison soon developed a rudimentary impedance matching and isolating circuit using an induction coil. This was a simple transformer with a core of straight iron wires and which was included in the circuit in order to enable the transmitter to be powered by means of a small local battery; a design which produced a high signal strength on the line with a minimum of power, as there was very little resistance in the transmitter circuit in series with the microphone. Fig. 2 shows the method adopted. In addition, the receiver R is isolated from the path of the DC, a procedure which avoided polarisation and allowed improvements to be made in the design of the receiver.

In later systems, local battery operation was replaced by central battery operation. The arrangement in the subscriber's telephone became that shown in Fig 3.

Fig. 2. Arrangement for local battery operation

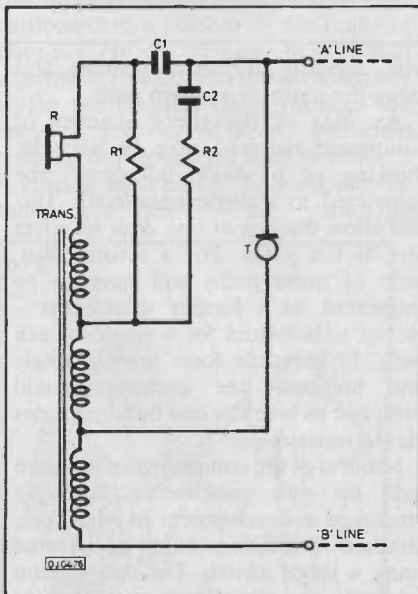




**Fig. 3.** Skeleton circuit of central battery telephone

With this simple arrangement, as also in the arrangements in Figs. 1 and 2, both receivers respond to the same signal equally. This has the unfortunate effect of causing the speaker to speak more quietly than he otherwise would, due to the level at which he hears his own speech, thus severely reducing available signal levels.

The problem was overcome much later by the use of a third winding on the transformer (the Anti Sidetone Induction Coil or ASTIC). The circuit diagram in fig. 4, taken from the familiar 706 telephone shows how this is done. The ASTIC and its associated R/C network causes an antiphase replica of the locally generated speech to be mixed with the signal from the line as it reaches the receiver (earpiece). This action reduces to a very low level the signal due to the user's own speech as reproduced at the local receiver, while placing the full signal from the transmitter on the line pair. The introduction of the ASTIC in the early part of this century was an important one as it allowed the greater signal strengths required by the more complex system that was beginning to develop.

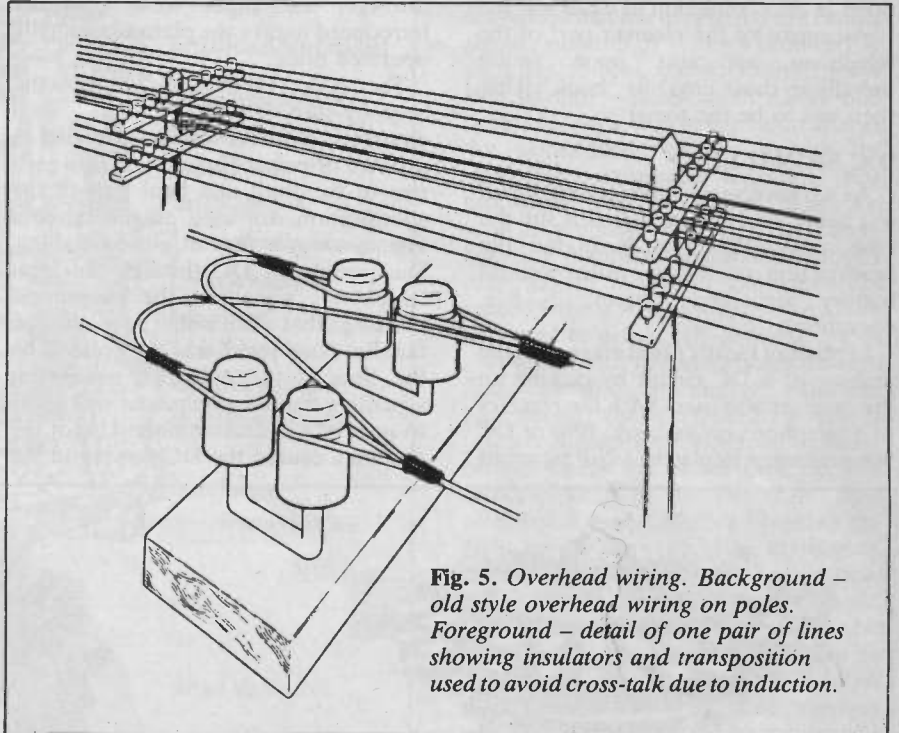


**Fig 4.** Skeleton circuit of 706 telephone in speaking condition

## INDUCTION

In 1882, the telephone was much more than just the scientific toy that it had been up till that time. Chambers' Encyclopaedia of that year was able to say: "While the telephone is already very largely used in America for domestic and business communication, it has been less successful in Britain, the busier lines increasing the difficulties arising from induction."

exchange were becoming common, and means of signalling were being adopted which lead directly to today's practice. I do not propose to cover in detail the development of the signalling systems used - they were many and various. To quote one example though, systems had been adopted in the early days which used an AC bell. These were operated by a small hand-wound permanent magnet alternator (magneto).



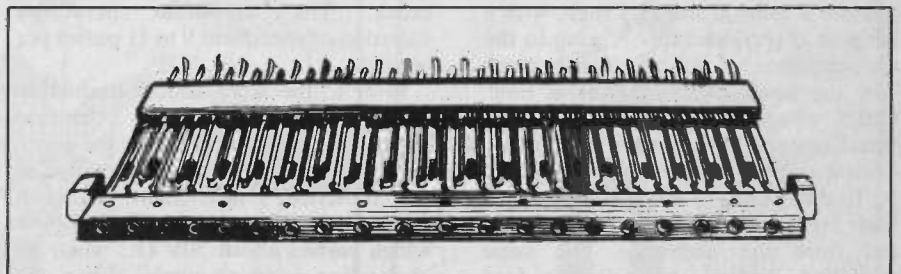
**Fig. 5.** Overhead wiring. Background - old style overhead wiring on poles. Foreground - detail of one pair of lines showing insulators and transposition used to avoid cross-talk due to induction.

The induction referred to was induced 'crosstalk' between adjacent lines, and a great deal of development work was needed before a satisfactory solution was presented. The solution involved balancing the capacitive elements of each line using external capacitors, and also a system of crossing overhead lines (at the support poles), each line-pair crossing with a different frequency and at different poles, (Fig. 5), at fairly frequent intervals, so that lines no longer ran in parallel loops for long distances. The later multipath cables developed for underground use were constructed of many separate twisted pairs of conductors, which achieved the same object.

By this time groups of telephones connected by means of a telephone

To signal the exchange operator, the calling subscriber would operate his magneto. This would activate an indicator at the exchange, there being one for each subscriber. The operator would take the call and ask which number was required. He or she would then signal the called subscriber with the magneto at the exchange, and when answered would establish the call by connecting the two subscriber's lines together with a lead terminated at each end by a jack plug. This was made possible by the fact that all the lines from subscriber telephones terminated at the exchange in jack-sockets, these being manufactured in modular strips as shown in Fig. 6.

To terminate the call, each of the subscribers were required to operate



**Fig. 6.** Jack socket strip

their magneto – a process called “ringing off” (ever wondered where our language got the term from?). It was soon discovered that although subscribers would go to any lengths to establish the call, once the call was completed the process of “ringing off” was frequently forgotten. As this engaged some of the exchange equipment needlessly a better method had to be found. It was evident that the only action which could be relied upon at the completion of a call was the replacement of the receiver part of the telephone apparatus upon (quite literally in those days) its “hook”. This, then was to be the signal.

## DC SIGNALLING

As we have seen above, an AC signal was being used for ringing, as is still the case today. This fact facilitated the introduction of the so called central battery signalling system. (C.B.S. operation).

In place of locally fitted magnetos, the making of a DC circuit by picking up the receiver was used. With the receiver of a telephone on its hook, flow of DC was prevented by placing a  $2\mu\text{F}$  capacitor

## AUTOMATIC DIALLING

By 1879, patents were already being granted for the first system of automatic telephone exchange, and a few years later a patent was granted to Almon B. Strowger for the famous Strowger exchange; The system only now being superseded. The first automatic telephone exchange to be installed in this country was commissioned in 1912 at Epsom, and from then until the 1960s Strowger exchanges were gradually introduced to take the place of manually operated ones.

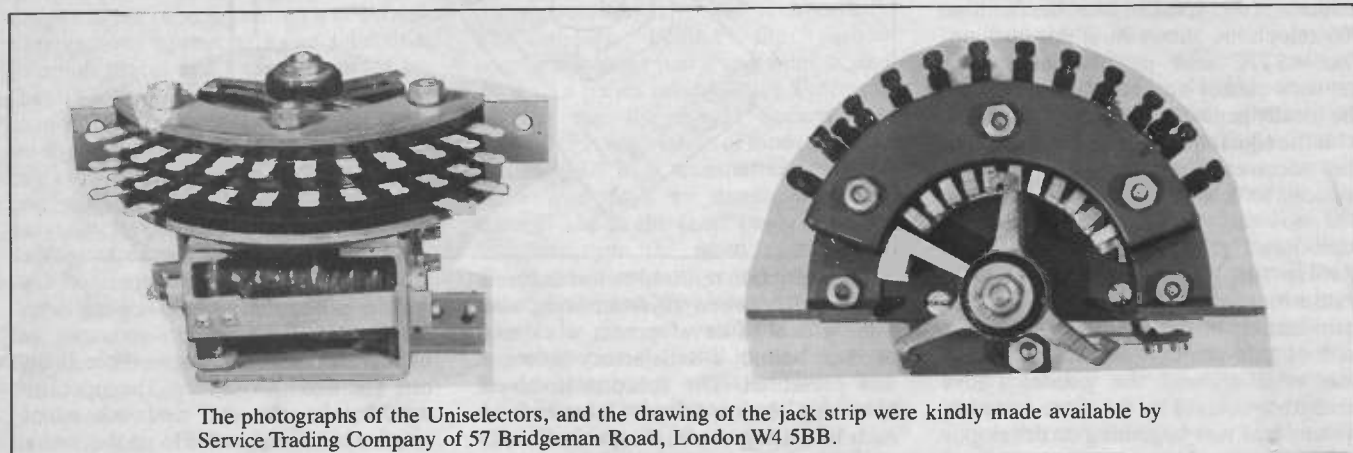
The Strowger system was known as the ‘step-by-step’ system, and used automatic switches which responded to a series of pulses (impulses). This gave rise to the third and final part of the specification still used on the Telecom system today – that of pulsed dialling. The passing of DC through the local telephone signalled the automatic exchange that a call would be made. The familiar “dial tone” was then placed on the line by the exchange equipment signalling that the equipment was ready to receive a dialled number. Use of the dial then caused the DC flowing in the

is operated, some 30 to 50 mA of DC flows which signals the exchange. Thus were established one hundred years ago the specifications for currents, voltages, signalling and dialling pulses that we use today.

## THE STROWGER EXCHANGE

The idea of a method whereby any one of a group of telephones could be connected automatically to any other was one which fascinated Almon B. Strowger. Commencing with the concept of ten telephones, he thought through the concept of a cumbersome number of relays, to a simple electromagnetically actuated ten position selector switch. The ‘minor’ switch, or uniselector as it was later called, was the basis of the first public exchange (photographs 1 and 2).

This required a five-way cable to each telephone; one pair of wires to operate the driving magnet – a solenoid which stepped the switch up one position for each impulse; a pair of wires to operate the release magnet – a second solenoid which returned the selector to the rest position. The fifth wire was the ‘speech’



The photographs of the Uniselectors, and the drawing of the jack strip were kindly made available by Service Trading Company of 57 Bridgeman Road, London W4 5BB.

*Uniselector switch. Left, rear view. Right, top view.*

in series with the bell. Ringing current saw this as a series impedance, and adequate current to operate the bell flowed. A switch was fitted to the receiver hook (Fig. 3) which allowed speech current to flow through the transmitter T, and the primary winding of the transformer.

Some 30mA of DC would flow through the local instrument, the line, and the exchange. This was used to operate a relay at the exchange, with a lamp or other indicator showing to the manual operator that a subscriber was “on the line”. Although for a time, C.B.S. was used together with a locally fitted battery, this system was rapidly overtaken by the central battery system (C.B. operation) in which all the power, both for speech and for signalling, was fed from the exchange. The same signalling method was later used to establish entry to an automatic exchange system.

line to be interrupted 10 times per second according to the number dialled. That is to say one interrupt pulse to dial one, two pulses for two, up to ten pulses for zero.

This system is known as the loop-disconnect system and remains the main system accessible to the subscriber today. The specification, then and now, was that the mark-space ratio should be 1:2, rounded to 33ms make and 67ms break. The maximum permitted variation of speed was 9 to 11 pulses per second.

Prior to the large-scale introduction of automatic exchanges “central battery” working had become the norm, so no power needed to be provided at the subscriber’s instrument. The end result is a line-pair reaching your house which carries about 50V DC when no connection is being made. When the phone is ringing, about 75VAC at 17Hz is superimposed, and when your phone

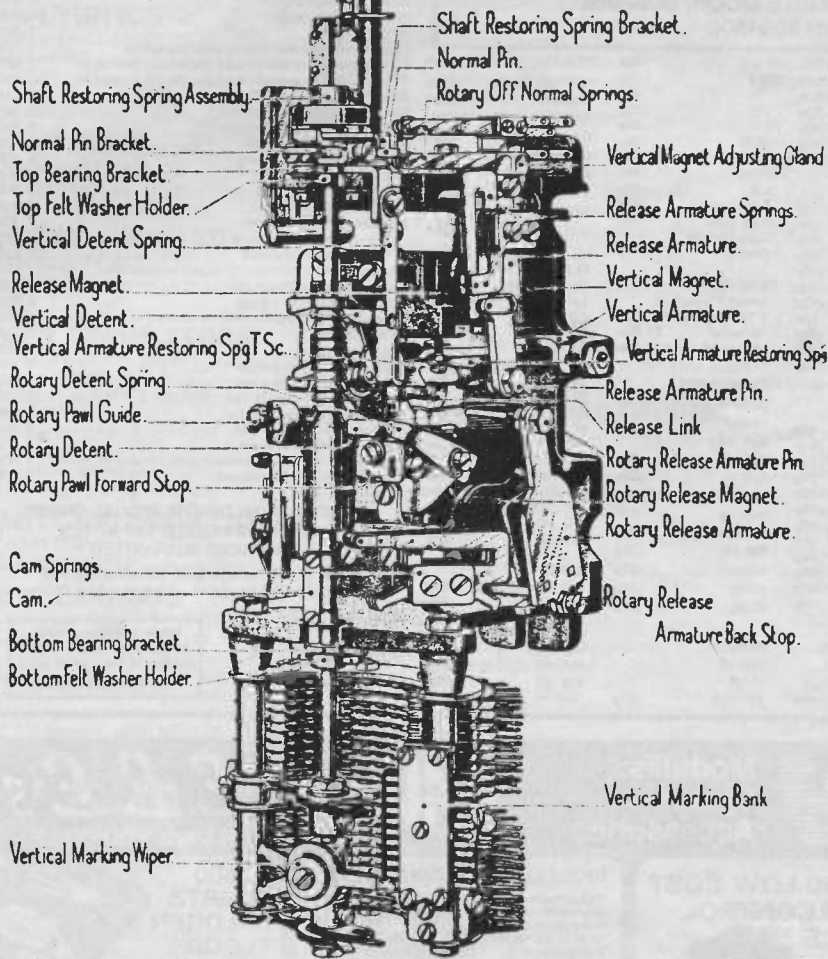
wire, carrying all communications, and using the earth as a return path.

An idea of the sheer quantity of equipment required may be seen by thinking of a single telephone line connected to a single uniselector. This will allow dialling of one digit to select one of ten paths. For a second digit, each of those paths will have to be connected to a further uniselector – eleven uniselectors for a single speech path. In its crude form then, a single one hundred line exchange could comprise as many as one hundred times eleven uniselectors!

Mindful of the complexity of a system built up with uniselectors, Strowger envisaged a development in which one hundred connections might be selected using a single switch. The two-motion selector, or multiselector as it came to be known, was modelled by Strowger using a circular cardboard box (a collar box for those readers who are old

**Fig. 7. Two motion selector mechanism**

The selector mechanism drawing is from the book "Telephony" by T.E. Herbet and W.S. Proctor, published in 1944. We are grateful to Pitman Publishers for the kind permission to reproduce the drawing.



enough to recognise the term!) He cut the box in half lengthwise, and inserted one hundred common pins through the cardboard in a pattern of ten ranks of ten rows. He was then able to show that a centrally fitted contact could reach any single pin by first rising through the required number of levels and then rotating through to the final position. Having established the principle, he built and tested the prototype

multiselector. (Fig. 7 shows the principle). It has contacts rather like those on the uniselector, but stacked in ten banks or levels, and with only one set of wipers for the whole assembly. The operating mechanism is designed to accept two digits consecutively – the first digit selecting the level, and the second causing the rotary motion, just as in the uniselector. The two-motion selector could then respond to two consecutive

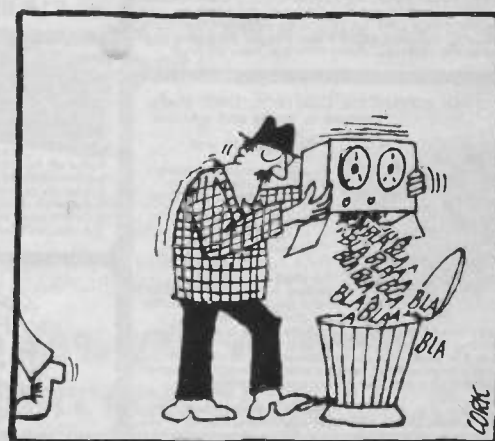
digits, allowing one hundred numbers to be selected, 00,01,02, through to 99.

Later, more complex exchanges would use serial combinations of two-motion selectors to respond to multiples of two digits, and so build up the Strowger exchanges still in use today. This of course presents a much simplified picture.

Imagine a system to cater for one thousand lines, and capable of connecting any one to any other. Firstly, the equipment has to respond to a calling signal (initiated by lifting a receiver), it then has to seek out or "hunt", for a free selector – think about it! All one thousand lines will never be in use at the same time, so the number of selectors is calculated according to a probability formula. (The mathematics, as in all probability work, is fascinating but very complex, and was developed originally by a Danish mathematician named Erlang who gave his name to the unit used to define call-density).

A preselector in connection with each line operates to engage selection equipment when required. When a selector is connected, dial tone is placed on the line. Dial pulses then operate selectors until at the last digit, final selection is made. Having obtained the right line to be called, the equipment then has to test that this line is free, responding to the caller with an engaged tone if not. Assuming that the line to be called is free and the connection can be attempted, the ringing signal has to be placed on the line to be called, together with the ringing tone on the calling line (they are not the same thing). The equipment then has to test for an answer, only making the final connection when this occurs. And that's just one thousand lines; just three digits' worth! How long is your telephone number; not including the trunk dialling code? Even so, the principle remains broadly the same – only the quantity of equipment is multiplied.

**In Part Two next month Barry Drake picks up the story again, from the days of Crossbar**



# BRYANT ACOUSTIX

5 BELLE VUE TERRACE, GILESGATE MOOR, DURHAM  
DH 1-2 HR. TEL (091) 3864500

CMOS.	LS 122	:59p	NE5532	£1:38p	*1 K	:45p	.015/400	:07p	
4000 U	:20p	LS 132	:52p	NE5534	:97p	*4K7	:45p	.022/400	:07p
4001 B	:20p	LS 133	:52p	TLC 272	£1:60p	*10K	:45p	.033/400	:08p
4002 B	:20p	LS 191	:57p	TLO 71C	:70p	*22K	:45p	.047/400	:08p
4007 U	:21p			*A 741	:20p	*47K	:45p	0.1 /250	:09p
4008 B	:66p	<b>TRANSISTORS</b>		*A 747	:68p	*100K	:45p	0.22/100	:10p
4011 U	:23p	BC107B	:19p	ZN 414	£1:05p	*220K	:45p	0.33/100	:13p
4012 B	:30p	*BC108C	:16p			*470K	:45p	0.47/100	:15p
4013 B	:20p	*BC109C	:16p	<b>DIODES</b>		Knop Grub	:40p	0.68/100	:17p
4016 B	:38p	BC182L	:11p	1N 914	:04p	Knob Push	:28p	1 μF/100	
4017 B	:30p	BC184L	:11p	1N 916	:05p	Caps-Red/Blk			
4018 B	:55p	BC204	:20p	1N 4001	:05p	Grn/Blu	:11p		
4020 B	:48p	BC212L	:11p	1N 4002	:06p				
4021 B	:56p	BC214L	:12p	1N 4004	:06p	<b>RESISTORS</b>			
4022 B	:49p	BC239	:10p	*1N 4148	:03p	1/4watt 5% carbon.	:02p	<b>ELECTROLYTIC.</b>	
4023 B	:22p	BC547	:13p	1N 5400	:12p	V 12 range Each	:02p	20% RADIAL	
4027 B	:32p	BC547B	:13p	1N 5401	:18p	100 mixed	£1:60p	Duraplug trailing socket single	:08p
4028 B	:50p	BC547C	:13p	BZY88C3VO	:08p	100 mixed	£1:60p	Duraplug 4-way socket with switch and Neon Rubber Coated.	:09p
4041 U	:60p	BC548	:13p	W 005	:25p	100 mixed	£11:60p	6A terminal block	:09p
4046 B	:55p	BC548C	:12p	W 01	:28p			16A terminal block	:09p
4047 B	:61p	BC549	:13p	W 04	:32p			Mains ext lead 5 metres single	:08p
4049 U	:27p	BC550	:14p			<b>CAPACITORS</b>		Mains ext lead 5 metres 4-way	:08p
4050 B	:21p	BC557	:14p	<b>LED's + OPTO</b>		Ceramic.		*Veroboard 10 stripes x 24 holes	:11p
4051 B	:54p	BC557B	:14p	3mm RED	:12p	value pF		Veroboard 24 stripes x 50 holes	:09p
4056 B	:73p	BC558	:14p	3mm YELL	:14p	10% 100V		DPST toggle switch 250V 12A	:09p
4069 U	:23p	BC558C	:15p	3mm GRN	:14p	2p2/4p7		Miniature pushbutton low volt	:11p
4082 B	:23p	BF244	:55p	5mm RED	:13p	6p8/10p	:06p	Stroke light. Flash rate adjustable in veneered wooden cabinet.	:19p
4093 B	:27p	TIP127	:85p	5mm YELL	:15p	22p/27p	:06p	TDK AD 90 cassette (90 minutes)	:16p
40106 B	:48p			5mm GRN	:15p	33p/47p	:06p		:19p
		<b>LINEAR</b>		8mm RED	:45p	100/220	:07p		:32p
74LS TTL.		CA3130E	:89p	8mm YELL	:46p	330/470	:07p	<b>AXIAL.</b>	
LS 00	:23p	CA3140E	:50p	8mm GRN	:46p	680/820	:07p	1μF /100	:09p
LS 01	:23p	ICM7555	:85p	MOC 3020	:99p	1000p	:06p	4.7 /63	:12p
LS 04	:23p	LF 351	:60p	3mm clip	:04p	4700p	:07p	10 /25	:10p
LS 08	:26p	LF 353	:87p	5mm clip	:04p			47 /16	:11p
LS 10	:26p	LM 324	:49p	8mm clip	:27p			100 /16	:16p
LS 13	:34p	LM 380(14)	£1:30p			Polyester.		100 /63	:31p
LS 20	:23p	LM 381	£2:21p	<b>RESISTANCES</b>		10% toll.		470 /25	:30p
LS 42	:47p	NE544	£2:09p	<b>POTS</b>		μF/Volt.		1000 /16	:31p
LS 47	:69p	*NE555	:18p	Available Lin or Log track.		.01 /400	:07p		
LS 90	:41p	NE556	:65p	*470 R	:45p				

8mm LED's now in stock  
If you do not wish to order anything, just send us a S.A.E. at least 4 x 9 inches for a copy of our free catalogue.

**Items Stocked**  
Electrolytic capacitors by Dubilier. Ceramics and Polyesters by Mullard. Semiconductors by RCA, Texas, Motorola, Toshiba etc. Bernard Babani Books and much more.

<b>ACCESSORIES.</b>		
Audio generator, 20Hz to 20KHz Sine/Square o.p.		£92.90.
Less than 1% distortion.		£ 3.95.
15 watt mains soldering iron		£ 0.75.
10m Solder reel		£ 4.29.
VHS video cleaner		£ 0.46.
20mm Chassis fuseholder		£ 0.78.
PP 3 Battery (blue seal)		£ 0.08.
PP 3 Connector		£ 1.99.
Conductive storage box for static sensitive devices		£ 0.05.
1 x 0.6 single cable available in Blk, Blu, Brn, Grn, Red per M		£ 0.05.
7 x 0.2 single cable available in Blk, Blu, Brn, Grn, Red per M		£ 0.14.
2 core 3A mains oval white pM		£ 0.22.
2 core 6A mains round white pM		£ 0.45.
3 core 13A mains round black pM		£ 0.64.
Mono jack plug red/black Heavy		£ 0.83.
Stereo Jack black only Heavy		£ 0.26.
Jack socket mono plastic		£ 0.30.
Jack socket stereo plastic		£ 1.35.
XL R cable male metal shell		£ 1.35.
XL R cable female metal shell		£ 1.95.
XL R chassis female metal shell		£ 1.27.
XL R chassis male metal shell		
DIL sockets 8 pin 7p/14 pin 11p 16 pin 11p/24 pin 20p		£ 0.65.
Mains plug unbreakable white		£ 1.99.
Duraplug trailing socket single		£ 9.89.
Duraplug 4-way socket with switch and Neon Rubber Coated.		£ 0.38.
6A terminal block		£ 0.54.
16A terminal block		£ 4.99.
Mains ext lead 5 metres single		£12.56.
Mains ext lead 5 metres 4-way		£ 0.30.
*Veroboard 10 stripes x 24 holes		£ 1.69.
Veroboard 24 stripes x 50 holes		£ 0.65.
DPST toggle switch 250V 12A		£ 0.26.
Miniature pushbutton low volt		£19.99.
Stroke light. Flash rate adjustable in veneered wooden cabinet.		£ 1.60.
TDK AD 90 cassette (90 minutes)		

**STARRED ITEMS DENOTE SPECIAL OFFERS**  
**ALL PRICES INCLUDE VAT AT 15%**  
**ALL PRICES GUARANTEED**

add £1.00 carriage to all orders under £50  
add £1.50 carriage to all orders under £50

Catalogue sent with all orders

Prices believed correct, however, all errors will be charged at the correct price. Trade Enquiries welcome

## SECURITY

Modules  
Systems  
Accessories

**SAVE £££££'s**  
BY INSTALLING YOURSELF

### MINIATURE PASSIVE INFRARED SENSOR RP33

ONLY £23.95 Plus VAT

Size only 80x60x40mm. Detects intruders up to 12 metres away.

- 12 metre detection range.
- Size only 80x60x40mm.
- 24 Detection zones.
- Wide 85° coverage.
- Switchable LED indicator.

This advanced new intrusion detector operates by detecting the body heat of an intruder moving within the detection field. The use of a dual element pyroelectric sensor means that changes in ambient temperatures are ignored, thus providing a stable and reliable performance. Easily installed in a room or hallway, the unit will provide effective detection of any intrusion. Operating from a 12V supply and consuming only 15mA, it is ideal for use with the CA 1382, CA 1250 or any equivalent high quality control unit. Supplied with full instructions, its performance compares with detectors costing more than twice the price.

### CA 1382 ADVANCED CONTROL UNIT that's simple to install and operate.

- Fully automatic siren re-set
- Audible entry/exit warning.
- Alarm Sounded memory.
- 2 separate loop inputs
- 24hr circuits.
- Built-in electronic siren.
- Easily installed, full instructions supplied.

The latest control panel provides effective and reliable control for all types of security installations. Its advanced circuitry checks the loop circuits every time it is switched on, preventing incorrect operation. Using a simple 'on/off' key switch, it is easily operated by all members of the family. In addition it provides 24 hr. personal attack protection. Housed in a steel case, it is supplied with full operating instructions.

Available in kit form with fully-built electronics, £39.95 + VAT.

### CA 1250 LOW COST ALARM CONTROL MODULE



This tried and tested control unit represents the finest value for money in control systems, providing the following features:

- Built-in electronic siren drives 2 loud speakers • Provides exit and entrance delays together with fixed alarm time • Battery back-up with trickle charge facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units • Anti-tamper and panic facility • Stabilised output voltage
- 2 operating modes full alarm anti tamper ease of installation • Screw connections for and panic facility • Separate relay contacts for external loads • Test loop facility.

Price £19.95 + VAT

### HW 1250 - ATTRACTIVE HOUSING plus HARDWARE FOR CA 1250

An attractive steel case designed to house the Control Unit CA 1250 together with the appropriate LED indicators and key switch (available separately). Supplied with the necessary pillars, fixings, and punched front panel, the unit is given a professional appearance by the adhesive silk screened label. Size: 200x180x70mm.

Only £9.50 + VAT

COMPLETE SYSTEM FROM £39-95 + VAT

### DP 3570 LIGHTING CONTROLLER

This versatile module provides timed switching of loads up to 3A for pre-set times between 10 secs and 5 mins, the timed period being triggered by the opening or closing of an external loop or switch. The built-in 12V 250mA power supply is available for operating external sensors. Suitable plastic enclosure £2.85 + VAT.



Only £13.95 + VAT

### FL 500 QUARTZ HALOGEN FLOOD LIGHT



Whilst intended for security lighting applications, this unit is suitable for lighting patios, pathways and gardens etc. Supplied complete with 500W lamp, Protective grill, £1.95 + VAT.

Only £14.95 + VAT

### IR 1470 - 50ft. INFRARED BEAM SYSTEM

Consists of a separate transmitter & receiver, the system provides an invisible modulated beam which when broken operates the built-in relay. For use with security systems, but also ideal for photographic purposes and industrial applications. Size: 80x50x35mm.

Only £25.61 + VAT

### US 5063 DIGITAL ULTRASONIC DETECTOR

• 3 levels of discrimination against false alarms • Crystal control for greater stability • Adjustable range up to 25ft

- Built-in delays • 12V operation.

This advanced module uses digital signal processing to provide the highest level of sensitivity whilst discriminating against potential false alarm conditions.

Only £13.95 + VAT

### ULTRASONIC MODULE ENCLOSURE

Suitable steel enclosure for housing the US 5063 supplied with the necessary mounting pillars and fixings.

Only £2.95 + VAT

**RISCOMP LIMITED**  
Dept PE 12  
51 Poppy Road.  
Princes Risborough. BUCKS.  
HP 17 9DB.

**The Security Specialist**

ORDER BY MAIL OR TELEPHONE

VISA

Tel: (084 44) 6326

## ELMASET INSTRUMENT CASE

300x133x217mm deep ..... **£10.00 ea (£2.20)**

## REGULATORS

LM317T Plastic T0220 variable ..... **£1**  
 LM317 Metal ..... **£2.20**  
 7812 Metal 12v 1A ..... **£1.00**  
 7805/12/15/24 plastic ..... **50p 100 + 27p**  
 7905/12/15/24 plastic ..... **50p 100 + 27p**  
 CA3085 T099 Variable regulator ..... **£1**  
 LM338 5A variable ..... **£5**

## COMPUTER ICs

68008 Processor Ex-Equip ..... **£5**  
 27256-30 ex-eqpt ..... **£2.50**  
 2764-30 USED ..... **£2**  
 2716-45 USED ..... **£2 100+£1.50**  
 1702 EPROM ex equip ..... **£5.00**  
 2732-45 USED ..... **£2 100+£1.50**  
 2114 EX EQPT 60p 4116 EX EQPT ..... **70p**  
 6264LP15 8K static ram ..... **£2.80**  
 6116-3 (TC5517AP) ..... **£1.50**  
 4416 RAM ..... **£3.50**

## SURFACE MOUNTED TRANSISTORS

BCW30 BCW31 BCW72 NTAV70 1s2836 min 50/type ..... **100/£2.50**

## POWER TRANSISTORS

2N3055H RCA House numbered ..... **5/£2**  
 2SC1520 sim BF259 ..... **3/£1 100/£22**  
 TIP141, 142, £1 ea, TIP112, 125, 42B ..... **2/£1**  
 TIP35B £1.30 TIP35C ..... **£1.50**  
 SE9302 100V 10A DARL SIM TIP121 ..... **2/£1**  
 2N3055 Ex eqpt tested ..... **4/£1**  
 Plastic 3055 or 2955 equiv 50p ..... **100/£35**  
 2N3773 NPN 25A 160V £1.80 ..... **10/£16**

## QUARTZ HALOGEN LAMPS

A1/216 24v 150w ..... **£2.25**  
 H1 12v 55w (car spot) ..... **£1.50**

## MISCELLANEOUS

D.I.L. Switches 10 Way £1 8 Way **80p** 4/5/6 Way **50p**  
 180 Volt 1 watt ZENERS ALSO 12V ..... **20/£1**  
 Miniature co-axial cable RG316U ..... **£0.50/metre**  
 Olivetti logos calculator keyboard (27) key plus 12 Digit fluorescent display on driver board (ie calculator less case, transformer and printer) ..... **£1.30**  
 Plastic Equipment case 9x6x1.25" with front and rear panels containing PCB with eprom 2764 -30 and ICS 7417 LS30 LS32 LS74 LS367 LM311 7805 Reg, 9 way D plug, push button switch, din socket ..... **£1.90**  
 VNIQLM 60V 1/2 5ohm TO-92 mosfet ..... **4/£1, 100/£20**  
 MIN GLASS NEONS ..... **10/£1**  
 RELAY 5v 2 pole changeover looks like RS 355-741 marked STC 47WB05T ..... **2/£1**  
 OMRON RELAY 3.6volt coil 2p c/o contacts marked G4D-287P-BT2 ..... **2/£1**  
 MINIATURE CO-AX FREE PLUG RS 456-071 ..... **2/£1**  
 MINIATURE CO-AX FREE SKT RS 456-273 ..... **2/£1.50**  
 STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy ..... **£1.50 ea 10+ £1**  
 DIL REED RELAY 2 POLE n/o CONTACTS ..... **£1**

Zettler 24v 2p c/o relay 30x20x12mm sim. RS 348-649 ..... **£1.50 100+ £1**  
 ELECTRET MICROPHONE INSERT ..... **£0.90**  
 Linear Hall effect IC Micro Switch no 613 S4 sim RS 304-267 ..... **£2.50 100+ £1.50**  
 Hall Effect IC UGS3040 + MAGNET ..... **£1.00**  
 OSCILLOSCOPE PROBE SWITCHED X1X10 **£10**  
 CHEAP PHONO PLUGS ..... **100/£2 1000/£18**  
 1 pole 12 way rotary switch ..... **4/£1**  
 AUDIO ICS LM380 LM386 ..... **£1 ea**  
 555 Timer 5/£1 741 Op AMP ..... **5/£1**  
 COAX PLUGS nice ones ..... **4/£1**  
 4 x 4 MEMBRANE KEYBOARD ..... **£1.50**  
 15.00uF 40V SPRAGUE 36D ..... **£2.50 (£1.25)**  
 INDUCTOR 20uH 1.5A ..... **5/£1**  
 NEW BT PLUG + LEAD ..... **£1.50**

1.25" PANEL FUSEHOLDERS ..... **5/£1**  
 CHROMED HINGES 14.5 x 1" OPEN ..... **£1 ea**  
 TOK KEY SWITCH 2 POLE 3 KEYS ideal for car/home alarms ..... **£3**  
 12v 1.2W small wire ended 1 amps fit AUDI VW TR7 SAAB VOLVO ..... **10/£1**  
 12V MES LAMPS ..... **10/£1**  
 STEREO CASSETTE HEAD ..... **£2**  
 MONO CASS. HEAD ..... **£1 ERASE HEAD 50p**  
 THERMAL CUT OUTS 50 77 85 120C ..... **£1 ea**  
 THERMAL FUSE 121C 240V 15A ..... **5/£1**  
 TRANSISTOR MOUNTING PADS TO-5/TO-18 ..... **£3/1000**  
 TO-3 TRANSISTOR COVERS ..... **10/£1**  
 STICK ON CABINET FEET ..... **30/£1**  
 PCB PINS FIT 0.1" VERO ..... **200/£1**  
 TO-220 micas + bushes ..... **10/50p 100/£2**  
 TO-3 micas + bushes ..... **20/£1**  
 Kynar wire wrapping wire ..... **2oz £1**  
 PTFE min screen cable ..... **10m/£1**  
 Large heat shrink sleeving pack ..... **£2**  
 CERAMIC FILTERS 6M/9M/10.7M ..... **50p 100/£20**  
 TOKIN MAINS RFI FILTER 250v 15A ..... **£3**  
 IEC chassis plug rfi filter 10A ..... **£3**  
 Potentiometers short spindles values 2k5 10k 25k 1M 2M5 new value ..... **5/£1**  
 500k iin 500k log ..... **4/£1**  
 40Khz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA ..... **£1/pr**  
 PLESSEY INVERTER TRANSFORMER 11.5-0-11.5V to 240v 200VA ..... **£6 (£3)**  
 Large Qty Available 240 to 115v step down transformers 1kVA ..... **£13 carr £3**

## DIODES & RECTIFIERS

1N4148 ..... **100/£1.50**  
 1N4004/SD4 1A 300V ..... **100/£3**  
 1N5401 3A 100V ..... **10/£1**  
 BA158 1A 400V fast recovery ..... **100/£3**  
 BA159 1A 1000V fast recovery ..... **100/£4**  
 120v 35A stud ..... **65p**  
 12FLO 12A 200V small stud ..... **4/£1.50 100/£25**  
 BY127 1200V 1.2A ..... **10/£1**  
 BY254 800v 3A ..... **8/£1**  
 BY255 1300v 3A ..... **6/£1**  
 6A 100V Similar MR751 ..... **4/£1**  
 VM88 800mA 100VDIL b/REC. ..... **5/£1**  
 1A 800v bridge rectifier ..... **4/£1**  
 4A 100V bridge ..... **3/£1**  
 6A 100v bridge ..... **50p**  
 10A 200v bridge ..... **£1.50**  
 25A 200v bridge £2 ea ..... **10/£18**  
 25A 400v bridge £2.50 ..... **10/£22**

## SCRs

2P4M equiv C106D ..... **3/£1 100/£20**  
 MCR71-6 10A 600v SCR ..... **£1**  
 35A 600v stud ..... **£2**  
 TICV106D .8A 400v SCR 3/£1 ..... **100/£15**  
 MEU21 Prog. unijunction ..... **3/£1**

## TRIACS

NEC Triac ACO8F 600V TO 220 ..... **5/£2 100/£30**  
 NEC Triac 150L Tab TO220 6A 400V ..... **2/£1**  
 ACOV8FGM 800mA 400V T092 TRAC ..... **3/£1**  
 Diacs ..... **4/£1**  
 TXAL225 8A 400V 5mA gate 2/£1 ..... **100/£35**  
 TRAL 2250D 30A 400V isolated stud ..... **£4 each**

## CONNECTORS

Centronics 36way IDC plug ..... **£4 10+ £3.50**  
 Centronics 36way IDC skt ..... **£4**  
 Centronics 36way plug (solder type) ..... **£40**  
 USED Centronics 36W plug & socket ..... **£3**  
 'D' 9-way £1; 15-way £1.50; 25-way ..... **£2**  
 37-way £2; 50-way £3.50; covers 50p ea

## WIRE WOUND RESISTORS

W21 or Sim 2.5W ..... **10 of one value £1**  
 R10 0R15 0R22 2R0 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 36R 47R 56R 62R 91R 100R 120R 180R 390R 430R 560R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0 10K R05 (50 milli-ohm) 1% 3W 4 for £1 ..... **7 of one value £1**  
 W22 or Sim 6W ..... **7 of one value £1**  
 R47 R62 1R0 1R5 1R8 3R3 6R8 9R1 10R 12R 20R 24R 27R 33R 51R 56R 62R 68R 100R 120R 180R 220R 270R 390R 560R 620R 910R 1K0 1K2 1K5 1K8 2K7 3K3 3K9 4K7 8K2 10K 15K

16K 20K  
 W23 or Sim 9W ..... **6 of one value £1**  
 R22 R47 1R0 1R1 15R 56R 62R 68R 100R 120R 180R 220R 300R 390R 680R 1K0 1K5 5K1 10K  
 W24 or Sim 12W ..... **4 of one value £1**  
 R50 1R0 2R0 6R8 9R1 10R 18R 22R 27R 56R 68R 75R 82R 100R 150R 180R 200R 220R 270R 400R 620R 6K8 8K2 1K0 10K 15K

## PHOTO DEVICES

Slotted opto-switch OPCOA OPB815 ..... **£1.30**  
 2N5777 ..... **50p only**  
 TIL81 T018 Photo transistor ..... **£1**  
 TIL38 Infra red LED ..... **5/£1**  
 OPI2252 Opto isolator ..... **50p**  
 Photo diode 50p ..... **6/£2**  
 MEL12 (Photo darlington base n/c) ..... **50p**  
 RPY56A LDR 50p ORP12 LDR ..... **70p**  
 LEDs RED 3mm or 5mm 12/£1 ..... **100/£6**  
 GREEN or YELLOW 3 or 5mm 10/£1 ..... **100/£6.50**  
 FLASHING RED OR GREEN LED 5mm 50p ..... **100/£35**

## SUB MIN PRESETS

**HORIZONTAL**  
 1K 4K7 10K 22K 47K 1M 10M ..... **15/£1 100/£5**

## MULTI

**TURN PRESETS**  
 10R 20R 100R 200R 250R 500R ..... **50p**  
 2K 5K 10K 22K 50K 100K 200K 2K2 2K5 47K 500K 2M2

## IC SOCKETS

6-pin 15/£1 8-pin 12/£1; 14-pin 10/£1.00; 18/20-pin 7/£1; 22/24/28 pin 4/£1 40 pin 30p

## TRIMMER CAPACITORS

**5/50p**  
 Grey 1.5 to 6.5pF Grey larger type 2 to 25pF purple 3pF to 50pF  
 Transistors 2N4427 ..... **60p**  
 Feed Thru Ceramic Caps 1000pF ..... **10/£1**

## SOLID STATE RELAYS NEW 10A 250V AC

Zero voltage switching  
 Control voltage 8-28v DC ..... **£2.50**  
 40A 250V AC Solid State relays ..... **£18**

## POLYESTER/POLYCARB CAPS

1n/3n/5n/8n/2/10n 1% 63v 10mm ..... **100/£6**  
 10n/15n/22n/33/47n/68n 10mm rad ..... **100/£3.50**  
 1uF 250V Mullard/Siemens AX ..... **10/£1 100/£8**  
 100N 250V radial 10mm 100/£3  
 2u2 160v rad 22mm ..... **100/£10**  
 470n 250v AC X rated rad ..... **4/£1**  
 33n/47n 250v AC X rated rad 15mm ..... **10/£1.00**  
 1u 600V Mixed dielectric ..... **50p ea**  
 Paper cap, 1uF 700V ideal for electronic ignition ..... **£1.00**

## BEAD

**THERMISTORS**  
 GLASS BEAD NTC Res @ 20°C ..... **80p**  
 250R 1K2 50K 220K 1M4

## BEAD TANTALUM CAPS

8 25V 47u 3V 12/£1 ..... **100/£6**  
 2u2 20V 8/£1 ..... **100/£8**

## MONOLITHIC CERAMIC CAPS

10n 50V 2.5mm ..... **100/£4.50**  
 100n 50V ..... **2.5mm or 5mm 100/£6**  
 100N 50V axial Shortleads ..... **100/£3**  
 10N 50V ..... **100/£4 1000/£35**  
 100N 50V dil package 0.3" rad ..... **100/£10**  
 10N 50V dil package 0.3" rad. £4/100 ..... **£35/1k**

## STEPPER MOTOR 4 PHASE 2 9v WINDINGS

£3.50 ..... **10/£30**

# KEYTRONICS

MAIL ORDER ONLY

P.o. Box 634

Bishops Stortford, Herts, CM23 2RX

TELEPHONE: 0279 505543

ELECTRONIC COMPONENTS BOUGHT FOR CASH

MIN CASH ORDER £3.00 OFFICIAL ORDERS WELCOME  
 UNIVERSITIES COLLEGES SCHOOLS GOVT DEPARTMENTS  
 MIN. ACCOUNT ORDER £10.00

P&P AS SHOWN IN BRACKETS (HEAVY ITEMS)  
 65p OTHERWISE (LIGHT ITEMS)

ADD 15% VAT TO TOTAL



## HOW TO USE THESE TRACKS

### FIRST MAKE TRANSPARENT COPY

(We regret that we cannot supply transparent copies of PCB track layouts.)

### ISODRAFT METHOD

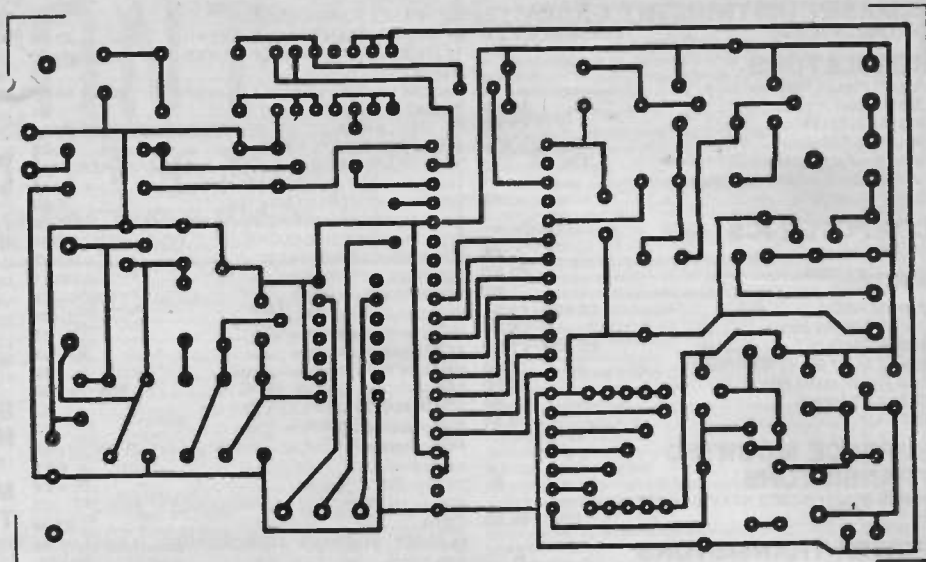
Have a normal photocopy made, ensuring good dense black image. Spray ISODraft Transparentiser onto copy in accordance with supplied instructions. ISODraft is available from Cannon & Wrin, 68 High Street, Chislehurst, Kent. Tel: 01-476 0935.

### PAINSTAKING METHODS

Draw image by hand onto clear film or drafting film using dense black ink. Draw direct onto copper surface of PCB fibreglass, using etch-resist inking pen. Use etch resist PCB tracks and pads, taping direct to copper surface, or onto drafting film.

### NEXT PRINT ONTO PCB

Place positive transparency onto photosensitised copper clad fibre glass, cover with glass to ensure full contact. Expose to Ultraviolet light for several minutes (experiment to find correct time - depends on UV intensity).



PE 160

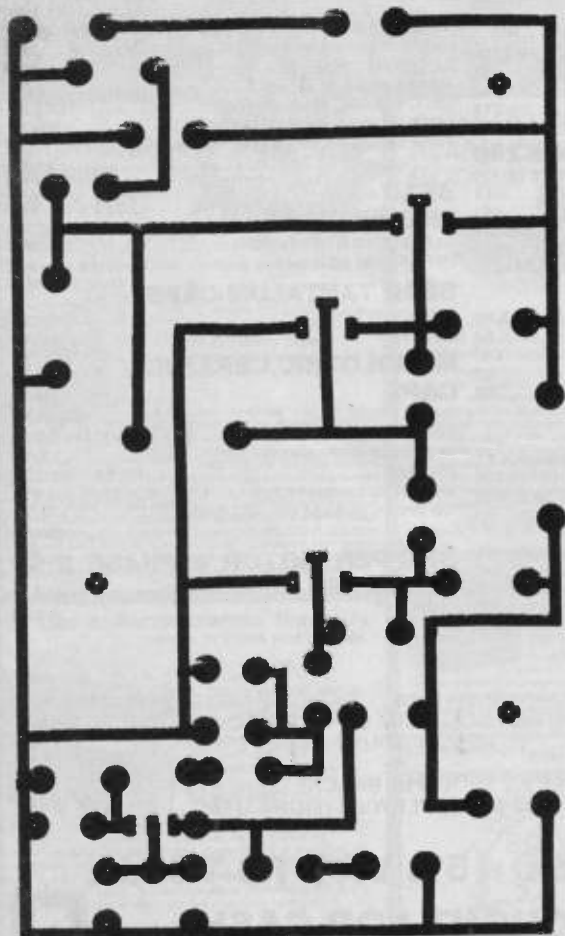
Develop PCB in Sodium Hydroxide (available from chemists) until clean track image is seen, wash in warm running water. Etch in hot Ferric Chloride, frequently withdrawing PCB to allow exposure to air. Wash PCB in running water, dry, and drill holes, normally using a 1mm drill bit.

(PCB materials and chemicals are available from several sources - study advertisements.)

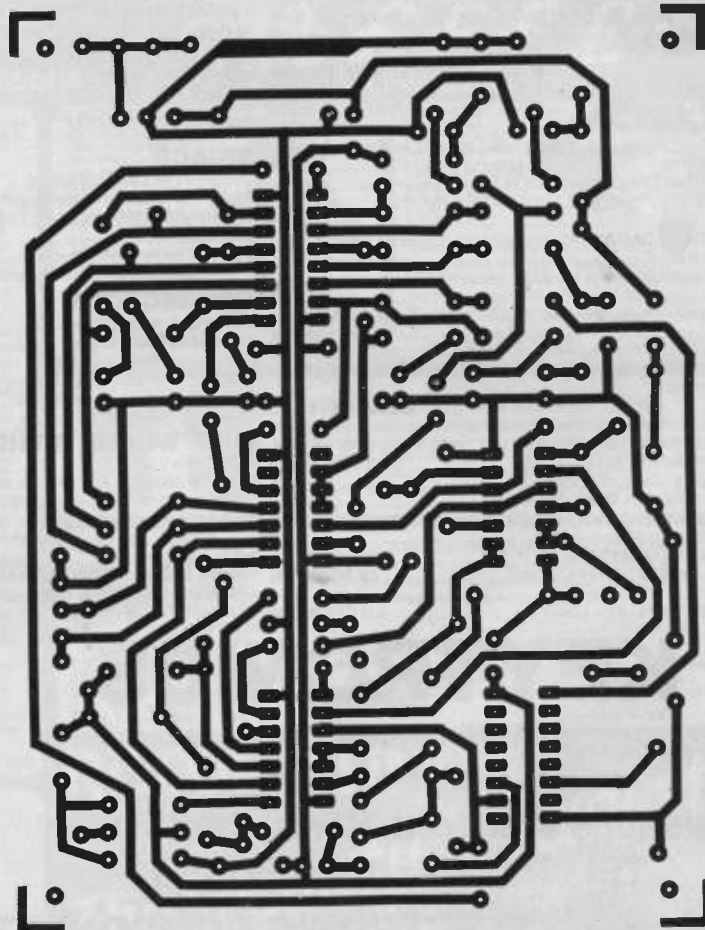
**\* CAUTION - ENSURE THAT UV LIGHT DOES NOT SHINE INTO YOUR EYES. PROTECT HANDS WITH RUBBER GLOVES WHEN USING CHEMICALS.**

### ALTERNATIVE METHOD

Buy your PCB ready made through the PE PCB SERVICE, most are usually available - see page 56.



PE 161



MULTIZONE BURGLAR ALARM





# Zenith Electronics. <sup>©</sup>

## KIT-MODULES-HARDWARE

### CHRISTMAS SPECIAL:

10-Channel variable speed running light Kit, drives LED's or Mains lamps - plus 2-FREE LED display boards and LED lamps. An ideal festive project.



The following are examples of our proven product designs

- ★ High quality touch dimmer 500W R/Built ..... £12.99
- ★ Selectable Tone Generator 9/12 volt ..... £5.50
- ★ 3 Note Electronic Door Chime unit; 9 volt operation, 3 melodious tones; variable frequency. Kit ..... £9.83
- ★ Miniature FM Transmitter; 60-145MHz. Kit ..... £6.95
- ★ R/Built ..... £8.95
- ★ 3 Watt FM Transmitter, 80-108MHz. Kit ..... £13.99
- ★ R/Built ..... £18.99
- ★ 300 Watt Light Dimmer unit for 240 volt mains lights. Kit ..... £6.95
- ★ 4 Code Digital Code unit plus Key Pad—select own code; 9 volt. Kit ..... £15.95
- ★ 5-100 Watt Electronic Loudspeaker Overload Protector, adjustable. Kit ..... £11.11
- ★ VU Meter 10 LED indicator; -5 to +12dB range. Kit ..... £12.59
- ★ Automatic light controller; automatically turns on and off lights at pre-set times and triggered by darkness. Kit ..... £25.08
- ★ Mains Wiring and Metal Detector. R/Built ..... £11.00
- ★ Zenith Speech Processor P-202 R/Built ..... £25.00
- ★ 18-Watt Car/Home Power Amp. 12-V. Kit ..... £13.23
- ★ Amplifier Power Meter; 10 LED indicator from 0.25-100 Watt Input—9 volt operation. Kit ..... £9.52
- ★ Light sensitive relay unit; variable sensitivity trigger control; senses light or dark—selectable. Kit ..... £8.45

ALL KITS CONTAIN FULL INSTRUCTIONS: P.C.B.s AND COMPONENTS.  
ALL PRICES INCLUDE VAT AND POSTAGE & PACKING.  
OVERSEAS ORDERS—ADD 10% TO ABOVE PRICES.  
PLEASE SEND CHEQUE OR POSTAL ORDERS WITH ORDER.

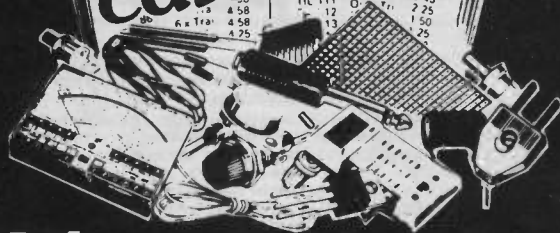
S.A.E. For  
-FREE-  
Data Pack

Zenith Electronics, 14 Cortlandt Business Centre,  
Hailsham, E. Sussex, U.K. BN27 1AE.  
Tel: 0323 847973 Telex: 878334

# CRICKLEWOOD ELECTRONICS LTD

SUMMER EDITION  
HUNDREDS OF LOWER PRICES  
HUNDREDS OF NEW DEVICES

# FREE! catalogue



## It's no secret...

that there is a real difference at Cricklewood Electronics. That's why you should never be without the FREE CRICKLEWOOD ELECTRONICS COMPONENTS CATALOGUE, for sheer variety, competitive prices and service from the U.K.'s number one 100% component shop. No gimmicks, no gadgets or computers, just components, millions of them, all easily available by mail order, calling or credit card telephone orders. Just pick up the phone for a pen! to get your FREE copy now (no SAE required). You have nothing to lose.

## CRICKLEWOOD ELECTRONICS LIMITED

40 Cricklewood Broadway, London NW2 3ET

Tel: 01-450 0995/01-452 0161  
Telex: 91 4977



PE

For KITS & COMPONENTS -  
Choose the easy way - with  
Send 50p\* & SAE  
for CATALOGUE  
\*refundable with first order



ORDERS: RING (01) 567 8910 - 24 HRS.

### ELECTRONIC GUARD DOG KIT

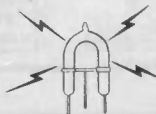


One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would-be intruder think you have a guide dog and try his luck elsewhere. The kit is supplied complete with high quality PCB, mains transformer, all components and instructions. The kit even includes a horn speaker which is essential to produce the loud sound required. The "dog" can be adjusted to produce barks ranging from a Terrier to an Alsatian and contains circuitry to produce a random series of barks giving a more realistic effect. Don't delay, fit one before you go on holiday and let our dog help you guard your home.

XK125 Complete kit of parts ..... £21.95

### POWER STROBE KIT

Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz, this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator.



Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45.

XK124 Stroboscope Kit ..... £12.50

### VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc - details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.

Supply: 240V AC or 15-24V DC at 10mA. Size (excluding transformer) 9 x 4 x 2 cms. The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used.

MK12 IR Receiver (incl. transformer) ..... £14.85  
MK18 Transmitter ..... £7.50  
MK9 4-Way Keyboard ..... £2.00  
MK10 16-Way Keyboard ..... £5.95  
601 133 Box for Transmitter ..... £2.60

### DISCO LIGHTING KITS

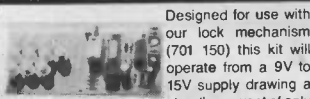
DL1000K This value-for-money 4-way chaser features by-directional sequence and dimming, 1kW per channel. .... £17.50  
DL21000K - A lower cost uni-directional version of the above. Zero switching to reduce interference. .... £9.85  
DLA/1 Optional opto input allowing audio 'beat'/light response ..... 70p  
DL3000K -3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. .... £14.25

The DL8000K



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. And the best thing about it is the price: ONLY £28.50.

### HIGH SECURITY LOCK KIT



Designed for use with our lock mechanism (701 150) this kit will operate from a 9V to 15V supply drawing a standby current of only 50uA. There are over 5000 possible 4-digit combinations and the sequence can be easily changed. To make things even more difficult for an unauthorised user an alarm can be sounded after 3 to 9 incorrect entries - selectable by means of a link. The alarm can sound for a few seconds to over 3 minutes during which time the keyboard is disabled preventing further entries. A latched or momentary output is available making the unit ideal for door locks, burglar alarms, car immobilisers, etc. A membrane keyboard or pushbutton switches may be used and a beep sounds when a key is depressed. Kit includes high quality PCB, all components, connectors, high power piezo buzzer and full assembly and user instructions.

XK121 LOCK KIT ..... £15.95  
350 118 Set of keyboard Switches ..... £4.00  
KB12S 12-Way Membrane Keyboard ..... £9.96  
701 150 Electric Lock Mechanism ..... £16.50

### HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K Remote Control Dimmer ..... £16.45  
MK6 Transmitter for above ..... £4.95  
TD300K Touchdimmer ..... £8.50  
TS300K Touchswitch ..... £8.50  
TDE/K Extension kit for 2-way switching for TD300K ..... £2.70  
LD300K Light dimmer ..... £4.35

TK ELECTRONICS  
13 BOSTON RD.  
LONDON W7 3SJ  
Tel: 01 567 8910

ORDERING INFORMATION:  
ALL PRICES EXCLUDE VAT

FREE P&P on orders over £20 (UK only), otherwise add 75p + VAT. Overseas P&P: Europe £2.75. Elsewhere £6.50. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 529314002.

LOCAL AUTHORITY AND EXPORT ORDERS WELCOME  
GOODS BY RETURN SUBJECT TO AVAILABILITY



# TEACHER RADIO

BY TIM PIKE

The fourth in a series of articles aimed at giving GCSE students of Electronics ideas and guidance with practical projects

*A simple radio requires only some lengths of wire, a pair of headphones, a loo roll to wind the coil on, and two tall trees. Teacher Radio is a little more sophisticated.*

To the young enthusiast, and for that matter the not so young, the ability to create a piece of circuitry which will detect radio signals and reproduce the sounds which are being transmitted, perhaps hundreds of miles away, must rank as one of the most exciting events in his or her experience.

## IN THE BEGINNING

I well remember building my first crystal set with my father's patient help. After some hours of work, which included winding the coil and making a wooden box for the delicate components to reside in, the thrill of connecting a pair of high impedance headphones and turning the dial was unforgettable. I think it received just two stations and the interference was horrendous but nevertheless it worked (and it didn't even need a battery!)

I relived this experience when playing around with a now famous circuit fabrication system some thirteen years ago.

As I built a simple circuit for a radio with single transistor amplification, the laboratory technicians, in whose preparation room I was working, were amazed to hear a strong signal emerge which sounded very much like Radio 1 – and all this in only ten minutes or so! Such is the fascination of radio circuits.

It is not my purpose here to offer the expert any new insight into sophisticated radio circuits. Rather, I intend to start from the same beginnings as I, myself, experienced some twenty-five years ago, with the principle of the crystal set. From here, I will develop some simple solutions to the most obvious problems associated with such a crude receiver. Along the way I will try to give as much background as possible to help the beginner to grapple with the whole notion of radio signals and how they are transmitted, propagated and received.

## THE CRYSTAL SET

Without worrying too much for the moment about the nature of radio signals, if we accept that they exist in



space all around us, all the time, then it is clear that we need to be able to capture some of their energy. An aerial, which may be no more than a long straight piece of wire suspended horizontally between two trees, and connected into the receiver will do to start with.

Having captured some of the energy, we now need to select a particular 'channel', station or transmitter and to reject all others. This is the function of the tuning circuit.

We must now "demodulate" or "detect" the audio signal, by removing it from the radio signal which has carried it through space. All that now remains is to convert the electrical signal into an audio signal using a suitable transducer. This will have to be a device which requires very low current and voltage inputs since the basic circuit has no external power supply. A pair of high impedance headphones is the obvious choice. So we have the minimum four essential elements for our simple receiver (Fig.1.) We must now fill in a little more detail.

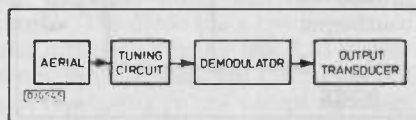


Fig. 1. Minimum features of a radio receiver

## THE TUNING CIRCUIT

The basic tuning circuit consists of a capacitor and an inductor (coil). (Fig.2.) One of these two components must be variable in order to change the station being selected. Except in very 'noisy' environments such as motor cars, it is most convenient to have a fixed inductor and a variable capacitor.

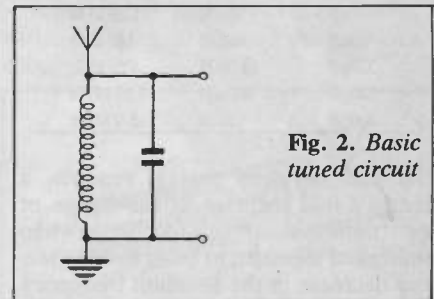


Fig. 2. Basic tuned circuit

The parallel combination of these two components provides a circuit whose frequency response 'peaks' at one particular frequency. The capacitor has reactance which decreases as frequency increases.

$$X_C = 1/2 \pi fC$$

The inductor has a reactance which increases as frequency increases.

$$X_L = 2 \pi fL$$

At one particular frequency (the "resonant" frequency) the two reactances will be equal. Students of GCSE level do not need to concern themselves with the actual phase relationships nor with the complex mathematics required to express them but it is important to understand that the resonant frequency is the one frequency at which the two reactances are equal (and in fact, opposite). This gives rise to the special effects which are observed at this frequency.

To complete the simple mathematical analysis we form an equation by putting  $X_L$  and  $X_C$  equal to each other.

$$\text{If } X_L = X_C \text{ then } 1/2 \pi fC = 2 \pi fL$$

By re-expressing this relationship to make 'f' the subject of the equation,

$$f = 1/2 \pi \sqrt{LC}$$

So, for a given capacitor value (in Farads) and a given inductor value (in Henrys) we can calculate the expected resonant frequency.

There will be many combinations of capacitor and inductor values that give the same resonant frequency (theoretically an infinite number of combinations). In practice we are restricted to a smaller range of values of the two components because they are only available in certain 'preferred' values.

Table 1 gives some examples of values and resonant frequencies.

TABLE 1

CAPACITOR	INDUCTOR	RESONANT FREQUENCY
10pF	10μH	15.9 MHz
47pF	50μH	303 MHz
100pF	500μH	711 kHz
500pF	1 mH	225 kHz
1nF	10μH	1.59 kHz
10nF	100μH	159 kHz
330pF	10 mH	87.6 kHz
220pF	100μH	1.07 MHz
100pF	1μH	15.9 MHz

It can be seen that it requires a hundred-fold increase in the values of the inductor and capacitor, when multiplied together, to bring about a ten-fold decrease in the resonant frequency. This will turn out to be very useful because it means that very fine control of the resonant frequency can be obtained even with a fairly coarse variable component.

## DEMODULATION

Moving onto the demodulator or detector stage, the simplest device that will perform this function is a single diode. The radio frequency (R.F.) signal consists of a high frequency sine wave which has been modulated by the signal that we are trying to detect. If you are uncertain about the whole idea of modulation and demodulation then don't give up now. Later on we will look at this in a little more detail.

Fig.3 shows symbolically the original carrier wave, the original signal (audio) and the combined, modulated signal. The diode is used to remove one half of the modulated wave. (Fig.4.)

We must now filter out the high frequency components which remain by using a suitable capacitor. The headphones connected in parallel with this capacitor must have a higher impedance than the capacitor at radio frequencies but a much lower one at audio frequencies. (Fig.5.)

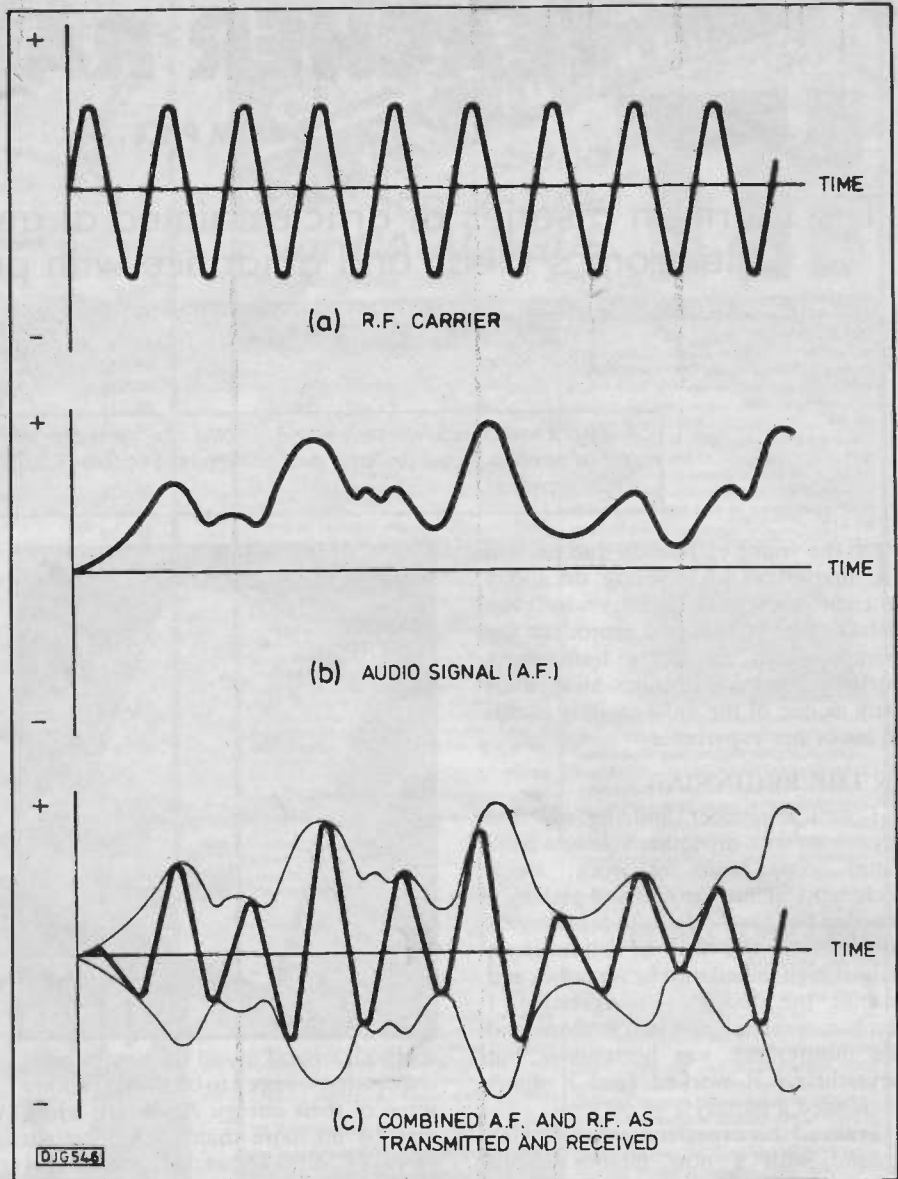


Fig. 3. The amplitude modulation process

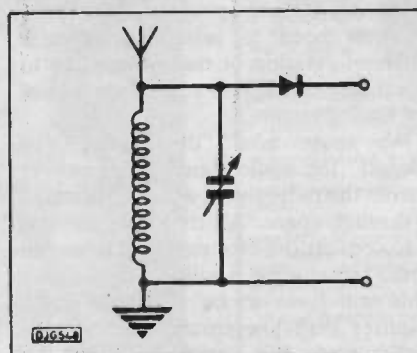


Fig. 4. Diode detector

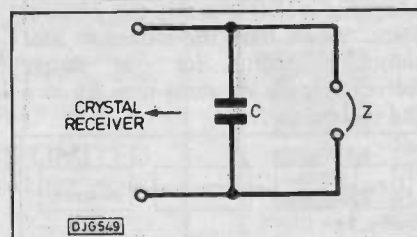


Fig. 5. Simple capacitor filter to by-pass R.F. from headphones

Suppose the radio frequency is 1MHz and the highest audio frequency is 10kHz.

$$\text{At } f = 1\text{MHz } (10^6 \text{ Hz}),$$

$$Z > \frac{1}{2 \pi f C}$$

$$\text{At } f = 10\text{kHz } (10^4 \text{ Hz}),$$

$$Z < \frac{1}{2 \pi f C}$$

So, to satisfy both of these requirements, the headphone impedance will need to be equal to the reactance of the capacitor at, say, 100kHz. If the headphones have an impedance of 2000 ohms, then

$$2000 = \frac{1}{2 \pi \times 10^5 \times C}$$

which gives

$$C = \frac{1}{2 \pi \times 10^5 \times 2000} = 800\text{pF}$$

If we choose our tuning circuit components to be an inductor of  $50\mu\text{H}$  and a variable capacitor with a maximum setting of  $500\text{pF}$  then we can tune to stations in the frequency range  $1\text{MHz}$  to  $7\text{MHz}$  (approx). Many readers will be more familiar with the corresponding wavelengths of these broadcasts.

In order to convert from frequency to wavelength, we use the well known relationship  $v = f \times \lambda$  where  $v$  stands for velocity (in this case the velocity of radio waves which equals the velocity of light),  $f$  is the frequency and  $\lambda$  the wavelength. Rearranging this formula gives  $\lambda = v/f$ .

The velocity of light is approximately equal to  $3 \times 10^8 \text{ m/s}$ . So a station whose carrier frequency is  $1\text{MHz}$  has a wavelength of  $300\text{m}$ . One whose carrier frequency is  $7\text{MHz}$  has a wavelength of  $43\text{m}$ . These wavelengths represent stations in the lower half of the medium wave band and somewhat below this band.

The basic crystal set circuit then is given in Fig.6. Notice the earth connection. This must be a real earth which might be obtained either from the mains earth connection for your house or by connecting a wire to a metal stake and driving this into the ground. The circuit will not function properly unless the earth connection is good.

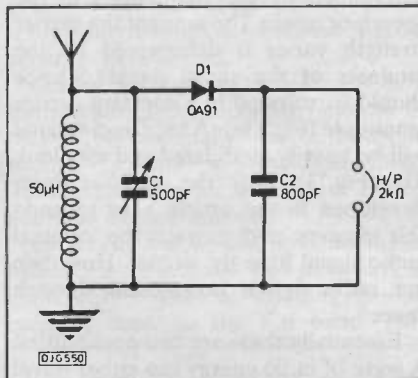


Fig. 6. Basic crystal receiver

## SENSITIVITY AND SELECTIVITY

If you build this circuit you will find that it is very limited in operation and exhibits two main problems which are found in all simple and therefore inexpensive radio circuits.

The first problem is one of poor sensitivity. Sensitivity is a measure of the ability of the receiver to detect the weaker signals which come within its tuning range. With a good aerial and when it is reasonably close to the transmitter, the receiver will work fairly well. 50 to 60 miles is usually considered to be the maximum range for such a receiver.

The second problem is that the crystal set also has poor selectivity. Selectivity is the ability of the receiver to receive just one of two or more closely spaced transmissions. Good selectivity requires that the tuning circuitry has a very sharp response. The ideal response would be

one centred exactly on the carrier frequency and with a frequency spectrum extending by the required signal range on either side of the carrier frequency. Suppose the audio signal includes frequency components up to  $10\text{kHz}$  and the carrier in use is  $1\text{MHz}$ . The ideal tuning circuit will then have a frequency response which looks like that shown in Fig.7a.

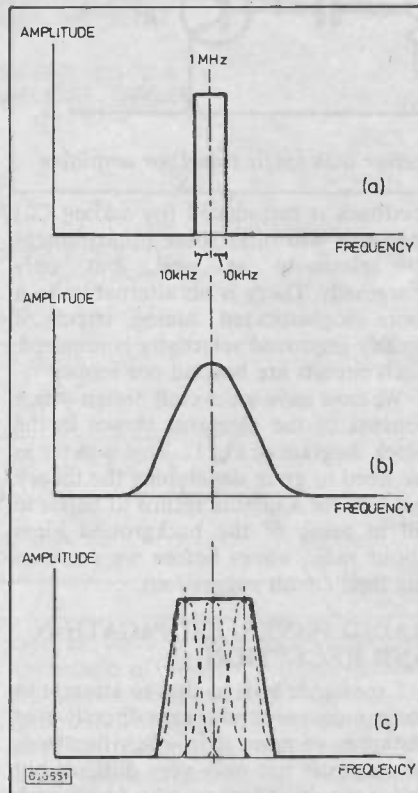


Fig. 7. Tuning responses. (a) Ideal. (b) Typical. (c) Improved.

In practice, even the most sophisticated tuning circuits cannot produce such an ideal response. All real response curves have the familiar 'bell' shape of Fig.7b. By combining two, three or more of these, however, a response not unlike that of the ideal can be obtained. (Fig.7c).

This is the principle employed in more complex radio tuning circuits where a 'ganged' capacitor controls two or three resonant circuits at once. These circuits are beyond the scope of an article aimed at GCSE pupils.

## MATCHING

The first improvement worth considering is to replace the simple coil with either a double-wound coil or a radio frequency transformer. The number of turns on the coil determines its inductance which in turn determines the frequency range that the set will receive. The diode has a low impedance and is therefore better matched to only a few turns of wire, but this would not suit the tuning circuit except for short wave reception.

We can satisfy both requirements if the primary winding forms the tuned

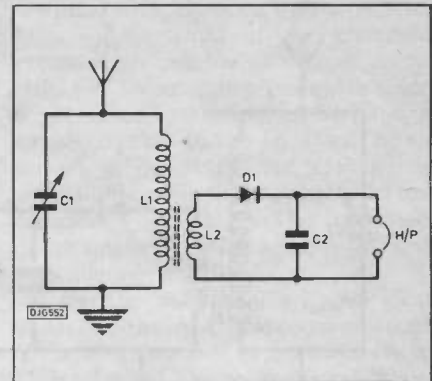


Fig. 8. Use of double-wound coil

circuit and the secondary winding couples the signal into the diode. The circuit of Fig.8 results.

You can learn a great deal about the effect of changing the number of turns of wire both for  $L1$  and  $L2$  if you wind your own coils. You will need a piece of ferrite rod and some enamelled copper wire. The gauge of the wire is also important - try to obtain 24 s.w.g. or close to it.

If you use paper sleeves before you start to wind your coils, you can easily remove them and try other values without having to unwind the previous coils. (Fig.9).

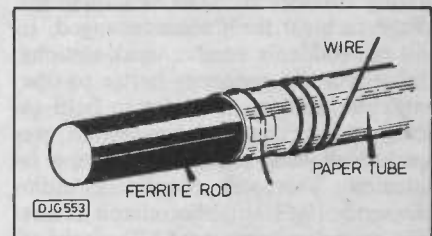


Fig. 9. Coil winding

A few open turns will tune to short wave stations. More turns will tune to the trawler band (shipping) and the amateur bands. Somewhere between 50 and 100 turns should tune to the medium wave band and 150 to 200 turns will bring you into the long wave band.

The use of the double coil should give some improvement in selectivity but the circuit is still self powered and capable of driving only a pair of high impedance headphones.

## AMPLIFICATION

The next level of improvement comes by adding a transistor.

If we continue to use the crystal receiver circuit of Fig.8 but add to it a simple transistor amplifier to give more volume and the possibility of driving a loudspeaker instead of the headphones, then the circuit of Fig.10 results.

Capacitor  $C3$  couples the audio signal into the amplifier but prevents d.c. from the amplifier flowing back into the receiver circuit.  $VR1$  gives some control over the amount of signal presented to the amplifier. It will function as a crude volume control.  $R1$  will bias the transistor into conduction. Any general

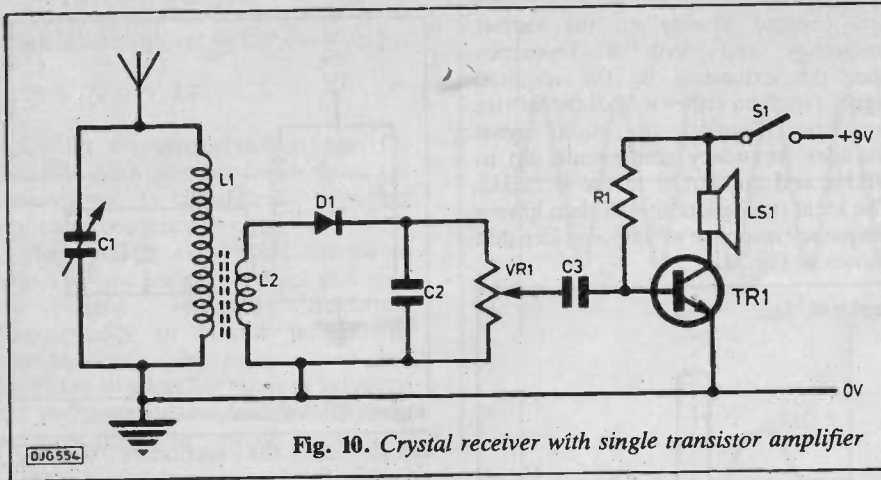


Fig. 10. Crystal receiver with single transistor amplifier

audio amplifier transistor will give good results providing the input signal is adequate. The loudspeaker will need to be of a fairly high impedance (64Ω or 80Ω).

### A COMMON MYTH

It is often thought that the addition of some amplification turns a poor receiver into a better one. This is quite wrong. The transistor has done nothing to improve either the sensitivity or the selectivity of the circuit. It has simply given more volume and the option of driving a loudspeaker. The basic qualities of the receiver itself are unchanged. It will not suddenly receive weak stations and it will not tune any better to one particular station. In order to help to bring about these improvements we need to amplify the signal before it is detected. This will require a radio frequency (RF) amplifier circuit rather than an audio frequency (AF) amplifier as discussed above.

feedback is introduced (by adding C2) then this will offer some improvement to selectivity as well, but only marginally. There is no alternative to a more sophisticated tuning circuit if greatly improved selectivity is required. Such circuits are beyond our scope.

We now have an overall design which consists of the elements shown in the block diagram of Fig.12. This is as far as we need to go in developing the theory, but let's for a minute return to basics to fill in some of the background ideas about radio waves before we come to the final circuit suggestions.

### RADIO WAVES, PROPAGATION AND RECEPTION

Experience tells us that to attempt to communicate sound energy directly over distances of more than a few hundreds of metres is not only very difficult but very annoying to others who do not wish to receive the transmission! Radio waves which form a very small part of the

electromagnetic spectrum are conveniently used as a "carrier". Not only does this give greatly improved range but it also has several other advantages. Firstly, radio waves travel at the speed of light and therefore transmission is very fast. Secondly, the frequencies involved are well outside our audio range and we are therefore oblivious to all the information which is flying around the earth day and night.

The carrier principle can be used in many different ways. The simplest way involves just turning the carrier on and off such as in Morse Code. This is of course limited and relatively slow if complex information is to be transmitted. Modulation of the carrier, which means changing it in some way, offers a much more flexible means of conveying information. GCSE students need to be aware of both Amplitude Modulation (AM) and Frequency Modulation (FM) but more detail is usually required for AM. All the simple radio receivers contained in this article are only suitable for AM reception, so let's look to see how this method of modulation works.

A carrier wave of fixed frequency (e.g. 200kHz for BBC Radio 4) is modulated by varying its amplitude. The rate at which the carrier strength varies is determined by the frequencies of the speech or music. The amount the carrier strength varies is determined by the loudness of the audio signal. Silence should correspond to a constant carrier amplitude (Fig.13a). A loud audio signal will be heavily modulated and may look like Fig.13b. All the radio circuits developed in this article have to undo this process and extract the original audio signal from the carrier. How then are radio signals propagated through space?

Essentially there are two possibilities. A wave of radio energy can either travel to us directly, following a line of sight or it can be directed upwards until it reaches the higher ionized layers in the Earth's atmosphere, which act like mirrors and reflect it back. It is possible to send a radio signal all round the world by reflection from the ionosphere. This explains how the very sophisticated radio transmitters and receivers used by amateur radio enthusiasts enable them to talk to each other from opposite sides of the world.

### FREQUENCY MODULATION

Although GCSE work usually includes very little detail of FM (Frequency Modulation) it is worthy of

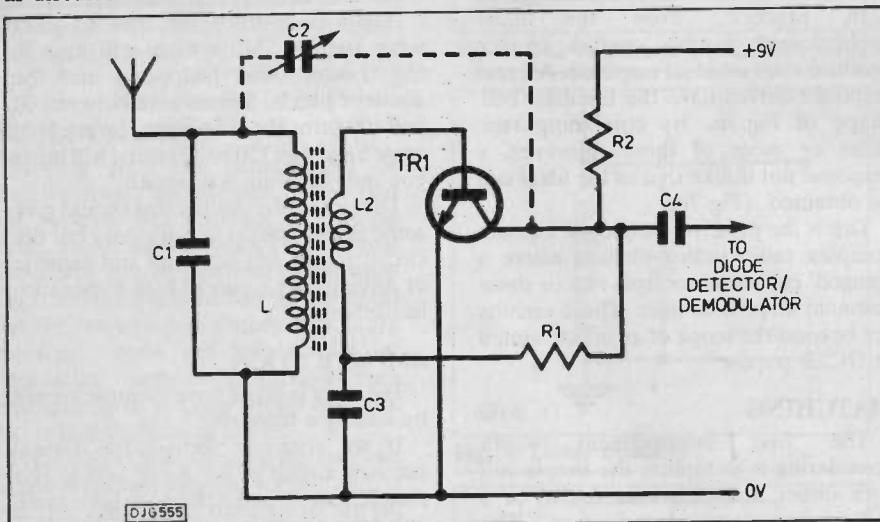


Fig. 11. Typical R.F. transistor amplifier

### SIMPLE RF AMPLIFIER

Fig.11 shows a typical example of an RF transistor amplifier. This will increase the range and sensitivity of the set but since it still only has one tuned circuit, the selectivity will not be markedly different. If an element of positive

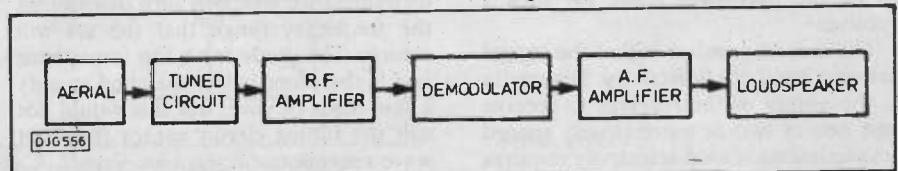


Fig. 12. Features of an improved radio receiver

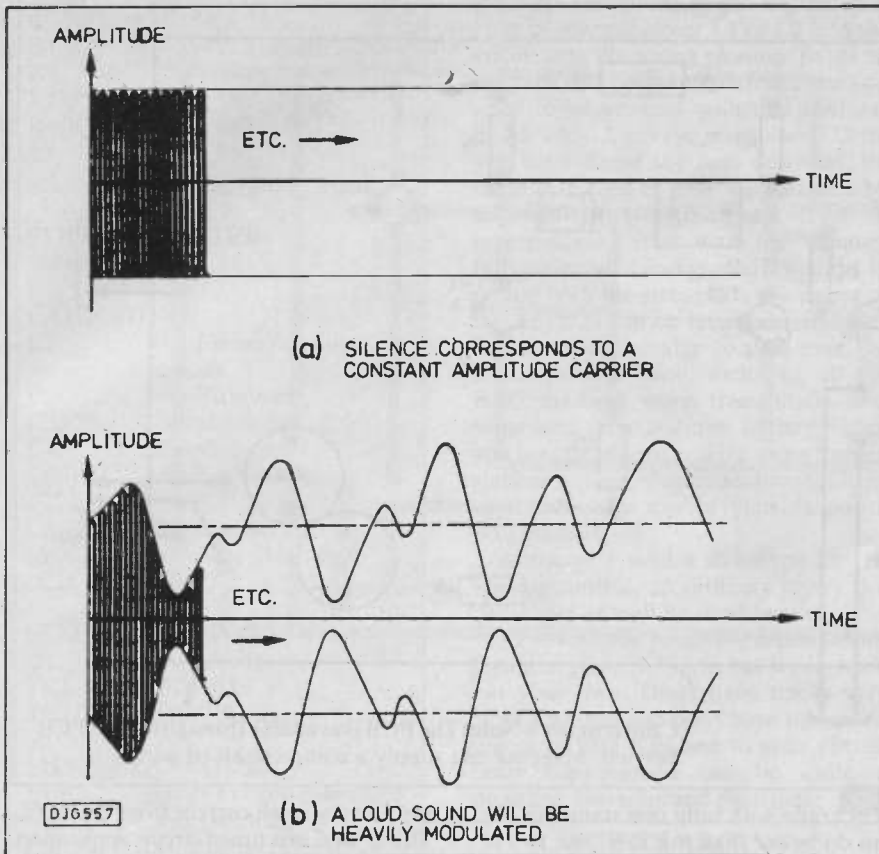


Fig. 13. Amplitude modulation

a brief mention if only because it is so superior to AM.

One of the main advantages of an AM transmission (and reception) system is that it is essentially simple both in technology and in implementation. These factors make the system cheap and thus available to all.

In recent years, FM systems have become more popular and nowadays a great deal of serious listening to the radio is done on the FM band. The

disadvantages of AM systems are the advantages of FM systems. Most of these are concerned with the quality of reception. The very earliest experiments in radio transmitters were conducted using spark transmitters. In fact all sparks propagate in space on a wide range of frequencies. All AM systems are therefore subject to impulsive noise. You will have noticed what happens to your radio reception when a motor vehicle is driven down your road if it is

not fitted with proper suppression on the high voltage parts of the electrical system. Lightning has a similar effect on radio and TV reception. Impulsive noise is generated by electric motors, arcing switch contacts and so on. It can be so serious in its effects that it makes it almost impossible to concentrate on the broadcast signal. The second disadvantage of AM is again concerned with quality.

Referring back to Fig.7, the ideal audio response of a radio receiver would cover all frequencies in the audio range (20Hz-20kHz). Since the modulation process requires that this frequency range appears on either side of the carrier (this is what is meant by the two "sidebands") the channel width would have to be 40kHz.

Broadcasting space is very limited on the AM system because there are so many transmissions and each requires its own 'channel'. In practice it is not possible to separate one channel from the next by 40kHz. In fact, of course, they are sometimes hardly separated at all which is why great demands are put on the receiver if it is to detect one and not the next. The reduced space available means that a reduced 'bandwidth' is allowed for each channel and this effectively reduces the quality of sound by cutting out all the higher frequency components.

FM was developed in an attempt to overcome some of these problems. The transmitter again couples a sinewave to an aerial but this time it is the frequency of the sinewave which varies in sympathy with the audio signal. The amplitude of the transmission is kept constant. The receiver is designed such that the demodulated output is insensitive to impulsive amplitude changes and therefore insensitive to impulsive noise.

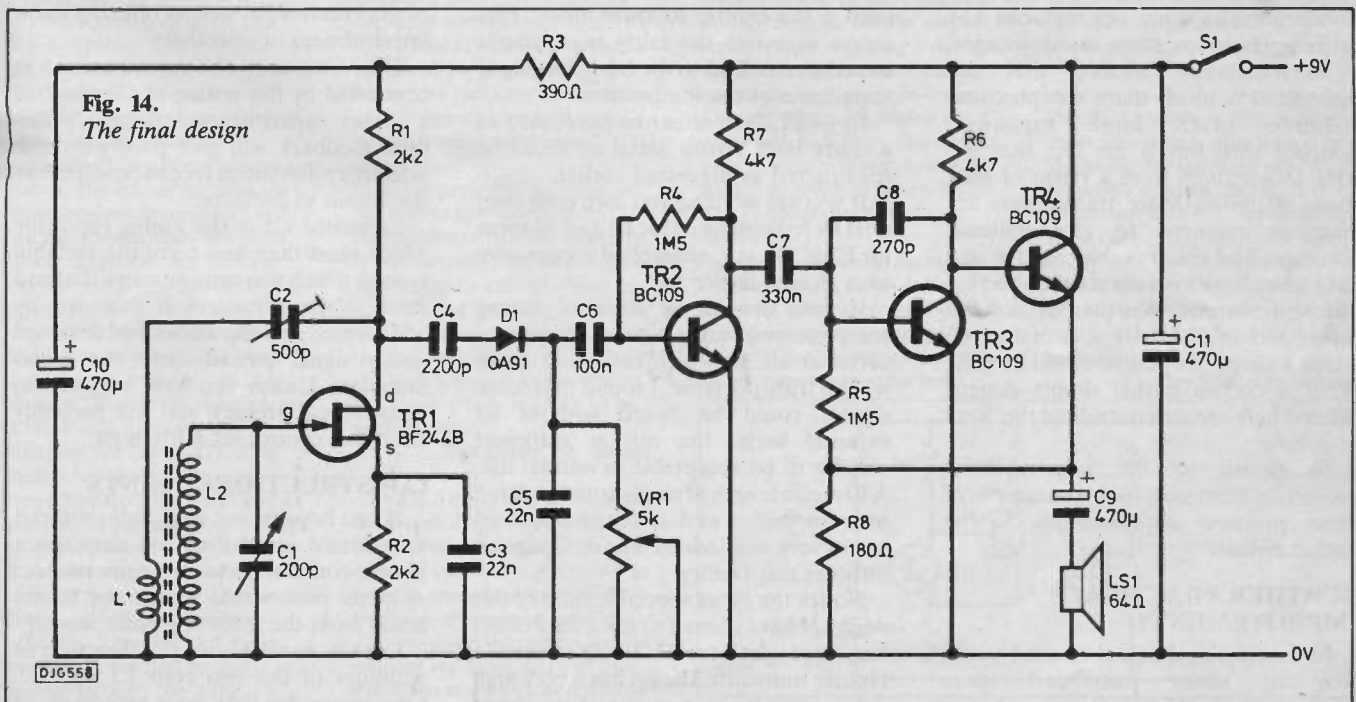
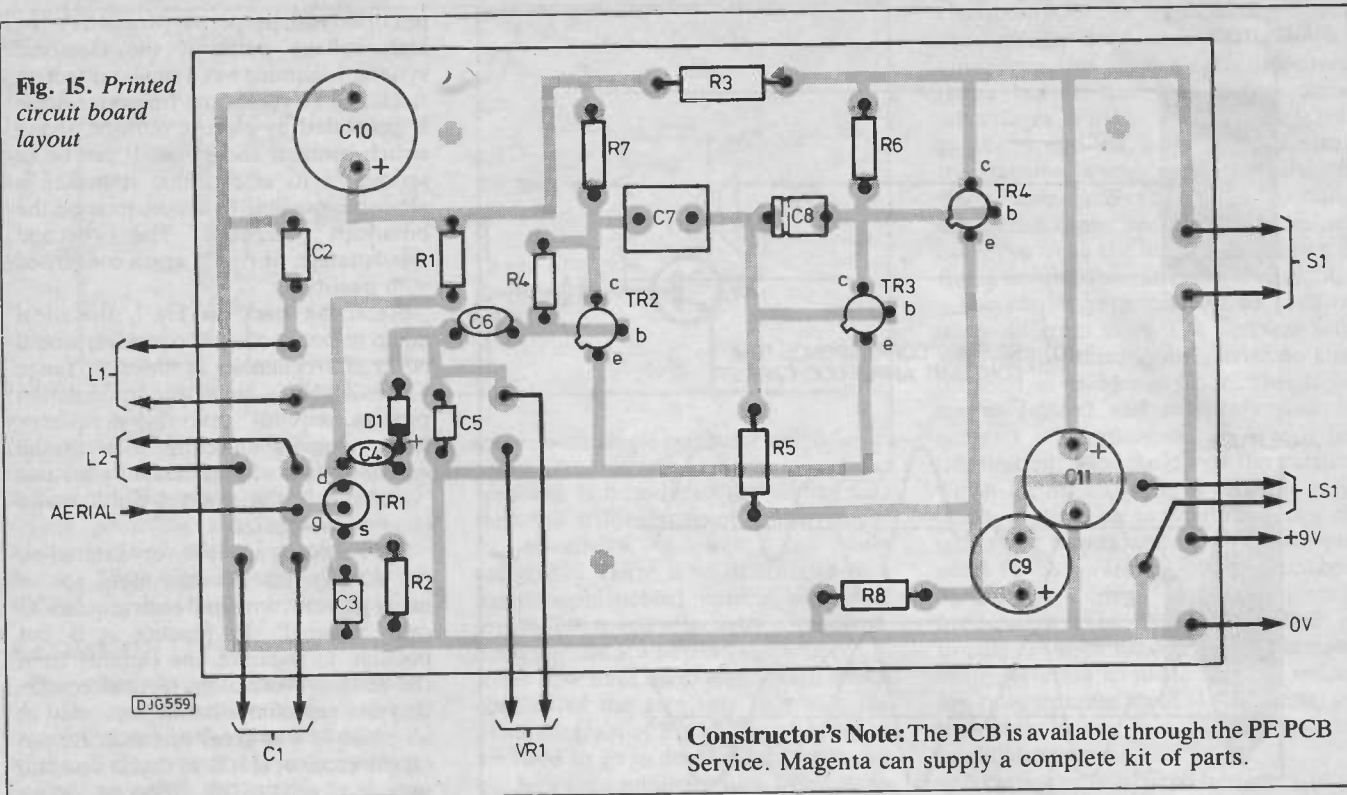


Fig. 15. Printed circuit board layout



The bandwidth required for an FM transmission is higher still than for the ideal AM transmission. An FM bandwidth of 100kHz is typical. This huge amount of broadcasting space can only be accommodated by working with much higher carrier frequencies where the space available is much more plentiful. FM stations are only found on the VHF band. This band stretches from 87 to 108 MHz.

If each channel requires 100kHz bandwidth then it is possible to accommodate 210 channels without any overlap within this range.

FM sounds so good that you might be wondering why it has not replaced AM entirely. There are some disadvantages. I have already implied that the equipment is much more complex and therefore much more expensive. Coupled with this is the fact that the VHF transmitters have a range of only about 50 miles. More transmitters are therefore required to give national coverage. The result is that we live in a time when both systems are required for different reasons. Whether or not the future lies in FM only is a matter on which a range of opinions could be held. What is certain is that simple designs offered here are well outside of this level of debate.

To return to the constructional project, we can now look at a couple of other practical improvements to the earlier circuits.

## FURTHER PRACTICAL IMPROVEMENTS

In developing the final circuit I would like to make just two more improvements. The audio amplifier is

very crude with only one transistor. We can do better than this if we use two or three stages of amplification.

The final design is given in Fig.14. Transistors TR2 and TR3 form two stages of audio amplification to give high gain based on common emitter amplifiers. C7 plays an important part in introducing some high frequency negative feedback which preserves the stability of the circuit. In the presence of RF signals, high gain amplifiers often suffer from "RF breakthrough" and consequent instability. C7 should help to prevent this. The final audio stage is based on another BC109 transistor but this time used in the emitter follower mode. This serves to match the fairly high output impedance of TR3 to the fairly low input impedance of the loudspeaker.

L1 and L2 can either be purchased as a ready built ferrite aerial or could be constructed as suggested earlier.

If you are winding your own coils then start by trying 4 turns for L1 and 60 turns for L2 of 24 s.w.g. enamelled copper wire on a 3/8 inch ferrite rod.

If you live in an area of strong reception you may not need an external aerial at all, in which case your radio will be truly portable. I found that some signals could be heard without an external aerial but not at sufficient volume to be acceptable in normal use. A 10 metre length of single core insulated wire suspended well above ground level works very well indeed. The design given includes this facility.

Notice the other special feature of this design. I have chosen to use a field effect transistor (fet) for TR1 rather than a bipolar transistor. The fet has a very high input impedance and therefore draws

only a very small current from the input. This is vital in a tuned circuit application because there is so little current available from the radio signal. Transistor TR1 forms the RF amplifier; transistors TR2, TR3 and TR4 form the AF amplifier.

## REGENERATION

It is worth pointing out why the output of TR1 (the 'drain' which behaves like the collector of an NPN transistor) is connected back to the coil L1 through C2.

This is an example of positive feedback or "regeneration". The effect is to improve the gain and the sensitivity of the receiver, as well as offering some improvement in selectivity.

The amount of regeneration is controlled by the setting of C2 which is a preset capacitor or "trimmer". Too little feedback will give poor gain and selectivity. Too much feedback will cause the circuit to oscillate.

Capacitor C1 is the tuning capacitor which must therefore be of the variable type to which you can connect a dial and knob. Volume control is provided by VR1 which sets the amount of detected audio signal passed onto the audio amplifier. Unless you have very strong input signal strength you will probably need this control set fairly high.

## CONSTRUCTIONAL HINTS

If you hope to use your radio without an external aerial then you must use a plastic container and not a metal one. A metal case would screen the ferrite aerial from the incoming radio waves!

Care is needed with the direction of windings of the two coils L1 and L2. One reason for very poor reception, or



**RESISTORS**

R1,R2	2k2 (2 off)
R3	390
R4,R5	1M5 (2 off)
R6,R7	4k7 (2 off)
R8	180

All ¼W 5% carbon film

**POTENTIOMETER**

VR1	5k log.
-----	---------

**CAPACITORS**

C1	200 pF max. Variable with spindle
C2	500 pF trimmer
C3,C5	22nF plastic film. (2 off)
C4	2200pF
C6	100 nF
C7	330 nF
C8	270 pF ceramic plate
C9,C10,	10V. 470µ electrolytic
C11	(3 off)

**SEMICONDUCTORS**

D1	OA91 diode
TR1	BF244B f.e.t.
TR2-TR4	BC109 (3 off)

**MISCELLANEOUS**

L1/L2	Ferrite rod and enamelled wire (see text)
LS1	Loudspeaker (see text), 64Ω or 80Ω.
S1	SPST toggle switch.

Plastic box, (150 x 90 x 55mm), knobs (2 off), wire, solder, 9V battery and connector (or 9V d.c. supply), printed circuit board.

even no reception, might be that you have connected either L1 or L2 into the circuit with the wrong phasing. To set up the radio for optimum performance you need to experiment with the positions of L1 and L2 on the ferrite rod. Once you have found the best positions, fix them with tape or glue. C2 can then be adjusted to give the best level of regeneration. Start with the trimmer fully unscrewed and gradually adjust it, noting both the strength and number of stations that can be received.

You should be able to tune over the medium wave band, including all the BBC medium wave transmitters and some local radio stations. In the evening you may be able to receive some foreign stations as well, sometimes broadcasting right over the top of your favourite programme!

Although I used a slider pot for the volume control, an ordinary rotary pot could just as well be used instead.

As usual, one possible printed circuit layout is given in Fig.15 but try to work out your own. Don't have tracks very close together and don't have unwanted pieces of wire attached to your circuit. Stray capacitances can be quite a nuisance. Have fun and good luck! **PF**

**POINTS ARISING****Teacher Power (Nov 87)**

Fig. 15 page 40 (PCB details). Ignore note about IC2 leg swapping. The PCB is correct but the leg labelling should read from left to right as "Out, In, Com".

# TEACHER LETTER

**POINT IN TIME**

Dear Sir

I wish to comment on Tim Pike's 'Teacher Timer' article in the September issue. Though the first and last sections are very suitable, I cannot agree with part of the middle section.

Firstly, Fig.6 will not behave as stated. The transistor turns on after the same delay as for Fig.5, but the current then increases slowly. The capacitor voltage cannot rise above about 5V unless the transistor's gain ( $h_{FE}$ ) is greater than 500. An alternative method is to swap over the led and the 470 ohm resistor, increase the capacitor to 4700µF and decrease the charging resistor to 47k. This method uses the I/V characteristic of the led to give a genuine delay, assuming the use of a small signal NPN silicon transistor with the minimum characteristic of  $h_{FE}$  50,  $I_c$  (max) 20mA, and  $V_{EBO}$  (max) 5V.

In Fig. 7 the Schmitt-trigger action is prevented by the current through the third

transistor, which therefore increases gradually, while the capacitor voltage rises from 2.5V to 7V. True Schmitt action can be produced by placing the led across the collector and emitter of the second transistor, with suitable component value amendments.

If it is preferred to make the Schmitt trigger completely independent of the led drive, the third transistor can be retained, but taking its emitter direct to ground, and inserting a suitable resistor in series with the led in the collector path.

I look forward to the rest of the series which is likely to be very helpful.

Bob Sharp, St. Austell.

In Fig.6 it is of course true that the threshold for the transistor remains at around 0.7V, but the effect of the emitter resistor is to provide some inherent negative feedback around the transistor. The transistor may begin to turn on after the same delay as in Fig.4, but as soon as the collector

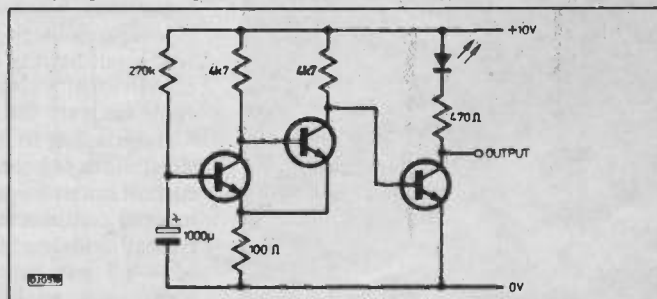
current is flowing, there will be a voltage drop across the emitter resistor, thus requiring a higher voltage on the base (and therefore across the capacitor) in order to keep the transistor biased on. I agree with Bob Sharp that a high gain transistor is required if the base is to reach 5V or more. I don't believe that I implied otherwise.

I agree that to swap the resistor and led gives a better solution in terms of delay achieved, but I would not agree to change the values of the biasing components. In my experience capacitors

greater than 1000µF are relatively difficult to obtain and disproportionately expensive.

With Bob Sharp's point concerning Fig.7, I agree entirely, the third transistor should have been shown as a simple inverter following the standard two-transistor Schmitt circuit. It is important for GCSE students to keep ideas straightforward and therefore I would suggest that Fig.7 becomes the following circuit, which also allows for an output to be taken from the third collector.

Tim Pike, Orpington.

**ilea** Working in EducationPADDINGTON COLLEGE  
25 Paddington Green, W2 1NB**Electrical/  
Computing  
Technician**£9,168-£10,557 inc.  
(Grade 5)

To provide a full technical service in the Electrical/Electronic laboratories and to provide support for the college's computer centre at Saltram Crescent. Duties include preparing and laying out experiments and demonstrations, giving technical advice and assistance to staff and maintaining stock control.

Applicants should have at least ONC, OND, BTEC/TEC Higher Certificate, Advanced City & Guilds or equivalent qualification in appropriate subjects, plus a minimum 8 years relevant experience (including training).

This post is suitable for job share.

For further details and an application form, write to the college or telephone 01-723 8826. Completed forms should be returned to PER/PS5B, Room 336a, The County Hall, London SE1 7PB. Closing date: 27th Nov. 1987.



# SOLAR CELLS

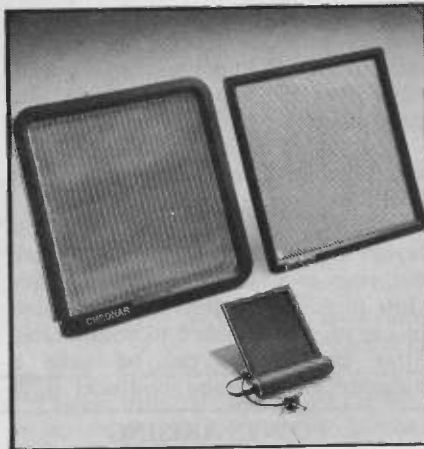
BY IAIN GARNER

## Amorphous silicon takes shape

*The use of different types of photovoltaic cell to turn light into electricity is being constantly extended by OEMs. Here a manufacturer looks at future applications for amorphous silicon cells.*

THE reliability, convenience and present cost of photovoltaic systems have brought solutions to power supply problems in telecommunications, navigation, pipeline protection and railway signalling. Smaller systems are being rapidly adopted in countries such as Spain, Norway and the USA, where remote and holiday homes have no other source of power to charge 12 volt battery supplies. Over many years solar modules have been used in sailing craft to power navigational instruments and are now being installed as original equipment. Similarly with the increasing sophistication of touring caravans and motorcaravans, in some cases extending to built-in air conditioners and microwave ovens, the need for a supplementary solar battery charger has been met by several European and British caravan manufacturers.

At the opposite end of the scale large quantities of small solar modules are being used in calculators, watches and earphone radios, in place of primary batteries. Here the bulk and cost of the power supply, combined with a low power requirement, means that a compact and inexpensive solar module can enhance the product. With the availability of mass produced, low cost amorphous silicon solar modules a sudden, large increase in applications to consumer products will continue these trends. The task for product designers, engineers and specifiers is to examine power requirements in co-operation with photovoltaic manufacturers. The possibility of replicating the success of solar calculators can be achieved by combining different sizes, shapes and colours of amorphous silicon solar modules, either with or without rechargeable battery



storage, in a wide range of small electrical products.

This article discusses some of the possibilities with reference to the size, cost and configuration of typical solar powered products. Emphasising the needs of original equipment manufacturers, design guidelines are established in anticipation of product development requirements.

### MODULE SIZE AND POWER REQUIREMENTS

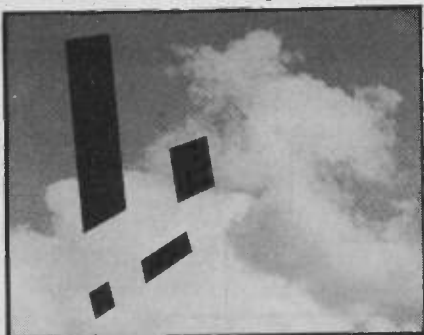
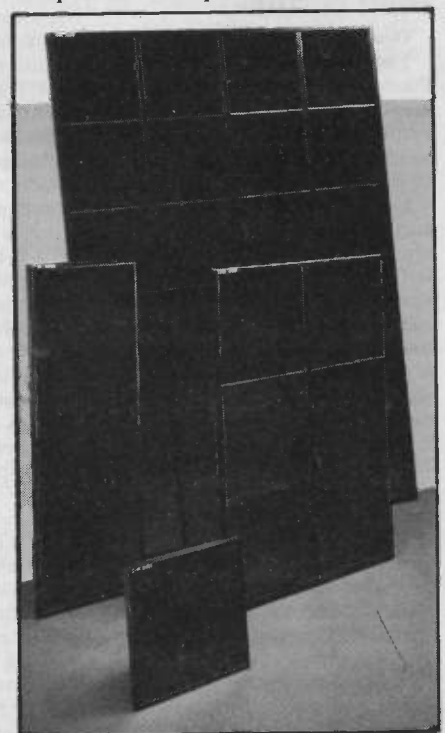
The major advantage of amorphous silicon solar modules is the technique used for interconnection of individual solar cells to produce a useful voltage and current. The p-i-n structure cells are fabricated by deposition onto an electrically conductive, tin-oxide coated glass sheet which is subsequently coated with a metallic back contact. The final module voltage is achieved by a set of stepped laser-scribed divisions which allow rear to front series connections between adjacent cells. Monolithic interconnection in this manner allows a wide variety of configurations without the need for the laborious soldering required with conventional discrete solar cells.

Individual solar cell output is approximately 0.8 volts (open circuit), corresponding to 0.55 volts on load for a cell width of 1 centimetre. The on-load current under bright sunlight is up to 10 mA per centimetre of cell length giving typical module efficiencies in the range of 4-4.5 per cent. Using these basic parameters, minimum module area can

be established for a range of power requirements. Table 1 takes examples of products currently available from Chronar and other photovoltaic product manufacturers.

### MODULE SIZE ANALYSIS

In module sizes up to 100 cm<sup>2</sup>, the competitive advantage of amorphous silicon versus conventional cell materials is entirely dependent on the individual product. Crystalline silicon cells exhibit a greater power density typically 11-13% which, although at a greater cost (perhaps 20-25% more), may be important to a compact, portable product. Several examples of this have recently appeared in the market place notably solar ventilator fans, solar radios, solar key ring torches and a solar powered electric massage device. The problem facing a designer is to make the trade off between solar cell costs and conventional components such as batteries, motor or electronic controls. In many cases amorphous silicon would be cheaper, but would also demand the use of a slightly more highly specified component to keep module area within



**Table 1: Photovoltaic Module Specifications**

Size	Area	Load Volts	Load Amps	Application
10 x 50mm	5 cm <sup>2</sup>	2.5V	10mA	Credit card calculator
20 x 100 mm	20 cm <sup>2</sup>	5.0V	20mA	Desk top calculator
50 x 130 mm	65 cm <sup>2</sup>	6.0V	50mA	Solar torch (4Wbulb with 3 @ AA NiCd rechargeable batteries)
100 x 100mm	100 cm <sup>2</sup>	5.5V	100mA	Battery charger (2 @ AA NiCd rechargeable batteries)
150 x 150mm	225 cm <sup>2</sup>	7.5V	150mA	Garden light (0.5Wbulb with 1.2Ah 6Vsealed battery)
100 x 300mm	300 cm <sup>2</sup>	15.0V	100mA	12Volt trickle charger for battery up to 30Ah capacity
300 x 300mm	900 cm <sup>2</sup>	15.0V	300mA	12Volt trickle charger for battery up to 90Ah capacity
300 x 900mm	2700 cm <sup>2</sup>	15.0V	750mA	Garden light (16Wbulb with 2 Ah 12V NiCd battery pack)

satisfactory dimensions. Of course the response should be to design a better product, but in many cases the use of solar power is seen, particularly by foreign manufacturers, as giving an edge to an otherwise marginal 'gimmick' product.

Above 1000cm<sup>2</sup> amorphous silicon modules are less likely to form an integral part of the product and can compete closely with conventional modules up to power outputs of 20 watts per installation. This category includes most recreational and leisure applications of solar power. However, special requirements for rugged modules in yachting or flexible modules for rough usage at present exclude amorphous silicon. For such special requirements additional lamination in glass is available for environmental protection but is not presently adaptable to military specifications.

Paradoxically, at extremely large scales of power system (over 100kW) amorphous silicon is the market leader, having the potential to compete directly with conventional generating plant in a grid connected system. This is largely due to the high costs of peak generating plant which may be run for short periods to meet high electricity demand, such as for air conditioning. Chronar has built and sold the first such plant, 100kW in size, to a utility company in the United States (Kiss [1]).

## CHARACTERISTICS OF AMORPHOUS SILICON SOLAR MODULES

The physical and electrical differences between amorphous thin-film and crystalline silicon photovoltaic modules arise directly from their fundamentally different methods of fabrication. The following comparison in Table 2 deals strictly with mass produced cells and panels currently available following a previously published analysis by Hart [2].

While increased active area may be required to produce a given current, since monolithic series connections are more compact, amorphous silicon can compete directly with conventional materials. Where indoor usage is envisaged, or where high temperatures may be involved, the performance of amorphous silicon may be significantly better. In larger systems requiring in the region of 3.0A at 12V nominal, the additional area related costs for amorphous silicon modules may also be offset by the reduced high temperature performance of crystalline modules. Specifically, it is questionable whether closely packed cells can perform adequately in high temperatures, at least for battery charging applications. Packing density problems do not affect amorphous silicon modules due to the very small amounts of active material present.

## PHYSICAL CHARACTERISTICS

A wide variety of substrates can be used for deposition of amorphous silicon. Several commercial products are now available using glass but it is equally practicable to use stainless steel or even

certain plastics. The problem in all cases is to keep costs sufficiently low to maintain viability in the product.

The lowest cost material is glass, which is used widely for all sizes of modules. Above 900cm<sup>2</sup> the best policy is to adopt a second layer of glass in a laminated form for strength and environmental protection. Encapsulation is less critical in products primarily designed for interior use and typically a painted finish only is required to prevent damage to the back contacts during assembly. Various forms of vinyl encapsulation can also be used to provide easily adaptable sizes and shapes of module, suitable for exterior use.

Glass thickness is normally 3mm for the superstrate, with 1mm for a back cover on large area, laminated modules. However in small area modules up to 20cm<sup>2</sup> it is more practical to use a single layer of 1mm glass for ease of cutting. In products such as a battery charger or solar torch, the additional strength of 3mm glass is probably of greater benefit than the reduced weight. Some manufacturers have adopted various textured plastic covers to protect the glass surface on a thin module. However, this tends to reduce energy conversion efficiency in all but bright sunlight and is an additional major cost.

## AMORPHOUS SILICON MODULE COSTS

While the whole photovoltaic industry is dependent upon volume, prices for specific applications cannot be anything more than guidelines. For typical systems a price of £4.00 being the module cost. This relates only to large systems serving professional applications, where the largest possible module units are employed, typically 40-50 watts each. Since most such applications are procured through competitive bidding, price and market share are often traded. Rarely, if ever will any company make a profit unless they supply the entire system, since engineering time is rarely costed-in.

**Table 2: Comparison of Amorphous and Crystalline Solar Modules**

Characteristic	Amorphous Silicon	Crystalline Silicon	Comment
Efficiency	4-5%	9-13%	Amorphous anticipated at 5-5.5 over 2700 cm <sup>2</sup> end 1987; target 10-11% by 1990
Stability	10% loss over 10-15 years	10% loss over 20 years	Amorphous instability now largely solved.
Spectral Response	70-80% at 440-650nm	75-85% at 550-700nm	Amorphous better under fluorescent light
I-V Curve	Fill factor low (50-60%)	Fill factor high (80%)	Low fill factor gives light level dependent output
Cell	Low losses with temperature rise	High losses with temperature rise	Temperature can seriously reduce output of crystalline modules
Interconnects	Monolithic	Discrete	Amorphous costs unrelated to area.



In applications requiring module sizes up to 20 watts prices reflect more closely the actual costs. There are more opportunities to design systems which can become standard products and prices of up to £13.00 per watt for the module alone are common for crystalline silicon. Amorphous modules would typically cost in the region of £10 per watt in the size range from 3 to 20 watts. Below 5 watts there is no competition; amorphous modules are now being sold at retail prices of £13 per watt.

Below 1 watt, or when module sizes are below 300 cm<sup>2</sup>, the quantity for a given application will influence the selling price directly. In solar calculators retail prices from £50-100 per watt are common for a module of 5 cm<sup>2</sup>. In battery chargers for two NiCd batteries the module components are sold at a retail price equivalent to £60 per watt and £45 per watt in a solar powered garden light.

In the above categories many individual products can be identified which would benefit from having no wiring, avoiding the necessity of replacing batteries, and operating whenever the sun shines without additional cost. Many examples have appeared in the last few years, but several are worthy of examination in more detail.

## AUTOMOTIVE APPLICATIONS

In the accessory "aftermarket" several suppliers are beginning trials with simple solar battery trickle chargers with the obvious intention that manufacturers should eventually include the idea as standard equipment. The need is due to pressure from two directions. First more electronic equipment is increasing "key-off" loads in modern cars, which when parked for several days can bring the

vehicle battery down to a low state of charge. Second, batteries must become lighter to save fuel while retaining strength through the addition of calcium or antimony, unfortunately promoting battery self-discharge.

The addition of a solar panel in the vehicle roof or parcel shelf can alleviate these problems and add value to the product. For example, it may be possible to drive a ventilating fan during hot weather while the car is parked.

## POTENTIAL APPLICATIONS

Although the number of potential applications of photovoltaic power is unlimited, and the list of existing applications growing rapidly, most photovoltaic consumer products can be grouped into one of three categories, relating to electrical storage (Garner, [3]).

Direct Solar Power products cannot store power, and so run only when light is available. Into this category fall solar powered calculators, digital thermometers and various kinds of fan. Of these, solar-powered fans are perhaps the most obviously appealing, as the need for ventilation is generally greatest when sunlight is at its most intense.



The second category consists of solar-powered devices which use a capacitor as the means of electrical storage, generally having an average power consumption of up to 1 milliwatt continuous, such as solar-powered clocks, smoke detectors, and micro-computer and calculator memories.

The third category combines a photovoltaic module with a battery. During daylight hours, solar cells operate both as a direct power supply and to charge small batteries, which then provide the load during night-time and extended periods of low light. In the

consumer sphere, the most appropriate applications are for devices requiring a load greater than 1 milliwatt continuous, where extended night-time use is likely. Examples of such products include solar powered radios, televisions and lights.

## DOMESTIC APPLICATIONS

This is potentially the largest market segment, but is dependent upon providing the right benefits to enhance a product. Garden lights without wiring, switching on automatically after sunset are a good example which can be extended into other areas of the home where power may be inaccessible. Other examples such as a solar powered air freshener may require careful design to optimise motor power, solar module size and cost.

The solar powered electronic scale very nearly duplicates the concept of calculators, while replacing batteries in hearing aids or clocks and watches can certainly provide improved convenience if not direct economic benefits.

There seems little doubt that the trend towards expansion in the number of battery powered products and the popularisation of rechargeable cells will continue. This trend can employ many of the advantages of amorphous silicon solar modules to provide a steady maintainance charge for nickel-cadmium or lead-acid batteries.

## CONCLUSIONS

Photovoltaics, after a long gestation period, are here to stay and expansion into a broad range of applications is concomitant on the continuing reduction in prices. This is likely to depend largely on the successful large scale commercialisation of amorphous silicon solar modules and products. At present 20% of the world photovoltaic industry is dependent upon a single product: the solar calculator. If the industry is to survive and expand more innovative ideas must be found and developed. The potential is available in amorphous silicon to produce time-saving, convenience products at sufficiently low cost to generate an enormous solar powered consumer product market. PI



For further information contact Iain Garner, Chronar Ltd, Unit 1, Waterton Industrial Estate, Bridgend, Mid Glamorgan, CF31 3YN

## REFERENCES

1. Kiss, Z. Chronar Corp. Annual Report 1985, Princeton, NJ 08542, USA.
2. Hart, P.R. "Crystalline vs. Amorphous Silicon in Photovoltaic Applications", presented at 7th European Photovoltaic
3. Garner, I.F. "The Increasing Range of Photovoltaic Applications", presented at Power Europa '86, Weisbaden, West Germany, 3-5 June 1986.

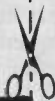
**DON'T MISS A VITAL COPY!**

Ever been in the middle of a project only to find the next issue sold out? An annual subscription to **PRACTICAL ELECTRONICS** solves the problem.

Wherever you live you'll receive a copy regularly each month. It's the quick, practical way to solve the delivery problems.

**COMPLETE AND POST THIS ORDER FORM TODAY!**

You may send a photocopy of this form.



**PRACTICAL ELECTRONICS**

**SUBSCRIPTION ORDER FORM**

Annual Subscription Rates	
U.K.	£15.00
Overseas	£18.00
Students: Deduct £1 and quote Student Number	

Complete this form and post it, with payment to: **Practical Electronics Subscriptions Dept.**  
PO Box 500  
Leicester LE99 0AA

POST COPIES TO

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

POST CODE \_\_\_\_\_

I enclose my cheque/PO payable to Intra Press for £.....

Please Note: Subscriptions cannot be ordered by phone

Signature \_\_\_\_\_

**BOOKMARK**

The following books have recently been received:

**Electronics — a Self-teaching Guide, 2nd Edition.** Harry Kybett. Wiley Press. ISBN 0-47-00916-4. Teaches the basics of electricity and electronic components in a self-paced, self-instructional format. You do not need previous electronics experience to use and understand this learn-by-doing guide, though an appreciation of mathematical formulae would be desirable.

**Computer Circuit Concepts.** Saul Ritterman. McGraw-Hill. ISBN 0-07-052952-3. £12.95. Aims within over 400 pages to give a balanced approach to explaining what a computer does and how it does it. Nine chapters cover subjects from logic, gates, counters, mathematical operations, to memory and peripheral devices, concluding with a description of a complete computer from its architecture to programming techniques.

**Chip Talk — Projects in Speech Synthesis.** Dave Prochnow. Tab Books. ISBN 08306-2812-6. £12.00. A practical introduction to speech synthesis that shows you how to build your own low cost stand alone or computer interface synthesiser units. Interestingly, it also devotes ten pages to the SSI263A chip as used in the PE Micro-Chat (Aug 87).

**Build Your Own Working Robot — The Second Generation.** David L. Heiserman. Tab Books. ISBN 0-8306-2781-2. £10.35. Uses a step by step approach to break down the construction of a complex personal robot system into easy and logical sub-systems. Has more emphasis on electronics and control than on mechanics.

**Op-Amps — Their Principles and Applications — 2nd Edition (1986).** J. Brian Dance. Newnes. £4.95. Intended both for technicians and home constructors who require enough information about op-amps to use them in conventional circuits without in-depth study. Its practical approach is written in a simple non-mathematical style and is specifically aimed at the non-academic reader.

**Practical Techniques of Electronic Circuit Design — 2nd Edition.** Robert I. Bonebreak. Wiley. ISBN 0-471-85244-9. £42.65. Some familiarity and experience with electronic circuits are assumed. Although not a beginner's text, it is however, directed towards the straightforward design of electronic circuits by those who lack a strong background experience. It is more concerned with facts than formulae.

**LEADING EDGE**

*Continued from page 8*

America the wretched system has been referred to the National Bureau of Standards. In Brussels, two different departments of the Eurocracy are squabbling about it.

The new Philips system allows one copy of a recording to be made, but no more. This allays the record industry's worst fears about DAT, namely that once a digital copy of a compact disc or LP record has been made, any number of further digital copies can be made without any loss of quality. The Philips one-copy system is preferable to the CBS Copycode system because it does nothing to spoil the sound of the original recording.

Apparently oblivious to the political implications, Philips unveiled "one-copy" in London, on 29 April, when their lawyer Peter Plompen spoke at a seminar organised by the Copyright Unit

of the European Economic Community. Ironically there was space in the timetable only because CBS had declined an invitation to talk about Copycode.

All DAT recorders are able to store extra digital information on tape along with the music. This can identify the recording by title or date. There is also room in the digital bit stream for "flags" which have no effect on the music, but can be sensed by any other piece of digital equipment.

The Philips idea is for DAT recorders to incorporate a simple circuit which adds an anti-copy flag to the bit stream whenever the recorder is used to copy music through its input sockets. The recorder also has a circuit which switches it off whenever it senses the presence of a flag. So when a DAT recorder copies music for the first time, the recording is perfect. But thereafter any attempt at copying the copy fails because the recorder switches itself off.

Already DAT recorders cannot dub in

digital domain from CD because of deliberate mis-match of the sampling frequencies (44.1 kHz for CD and 48 kHz or 32 kHz for domestic DAT). The CD data stream has room for a copy-inhibit flag which does the same trick.

The Philips one-copy scheme overcomes the record industry's main objection to DAT, summed up succinctly by George Martin, ex-Beatles producer.

"The awesome thing about digital taping is that it isn't just taping, it's cloning" says Martin. "However many copies you make the product is just as good as you get in the studio".

Polygram, who back Copycode to the hilt, were angered by Plompen's lecture. Although the EEC seminar was open to anyone who was willing to pay £110 to attend and those who did were promised a written copy of Plompen's text, Philips said lamely the "English was not good enough to release". Now, several months later, Philips just pretends Plompen and his lecture never happened.

PI

# SPACEWATCH

BY DR PATRICK MOORE OBE



The furthest object which we can detect from our solar system is outrunning us. Back here at home, Voyager 2 draws closer to Neptune.

Discoveries are made nowadays in rapid succession — and one has come from research carried out with the UK Schmidt telescope at the Siding Spring Observatory, New South Wales. Dr Cyril Hazard has located the most remote object so far known; it was recorded on a UKS plate. It is a quasar, with an estimated distance of around 13,000 million light-years. This means that it must be receding at well over 90 per cent of the velocity of light.

Hubble's Law states that "the further, the faster". If this Law remains valid,

then we must eventually reach a distance at which an object will be receding at the full velocity of light, so that we will be unable to see it at all, and will have come to the boundary of the observable universe. It is generally thought that this critical distance must be between 15,000 and 20,000 million light-years, with a slight preference for the lower figure. It looks, therefore, as though the new quasar is well out toward the limit. Searches are continuing — probably the "distance record" will be broken again before long.

Discussions continue about the supernova in the Large Cloud of Magellan. It has now faded, but will probably be followed for many months yet, and perhaps even years, before it becomes too dim to be made out. It is certainly unusual; the blue giant star Sanduleak -69°202 certainly seems to have been the progenitor, and since it had always been thought that supernovæ were caused by the deaths of red supergiants it looks as if some of our cherished theories will have to be revised.

## The Sky This Month

Both the inner planets are on view during November. Venus has started to emerge into the evening sky, though it is still more than 90 per cent illuminated by the Sun and it is not likely that any surface markings will be seen on it — bearing in mind that a telescope will never show more than vague, cloudy features which are well nigh impossible to define. Mercury is at its best as a morning object, reaching its greatest western elongation from the Sun (19 degrees) on the 13th of the month. The phase increases from 25 per cent at the beginning of the month to 90 per cent at the end. There should be little difficulty in finding Mercury with the naked eye before dawn for the second and third weeks of November, provided that the skies are clear. The magnitude rises to  $-0.6$ , so that Mercury is actually brighter than any star visible from Britain apart from Sirius — though this is difficult to appreciate, because the planet is never seen against a dark background.

Mars is a morning object in Virgo, but is still a long way away, and not much brighter than the Pole Star. On November 12 it passes three degrees south of Spica. Jupiter, which was at opposition last month, is still visible for most of the night; it is in Pisces, and is a splendid sight in a telescope, though the famous Great Red Spot is obscure at the moment. Saturn has been more or less lost in the evening twilight, though it is worth noting that on November 20 Saturn and Venus are only two degrees apart.

There are two comets which may be worth looking for during November. One is Bradfield's Comet, 1987s, found by the famous Australian amateur; this is his thirteenth discovery, a record for our own century. It is expected to reach the 6th magnitude, in which case it will be on the fringe of naked-eye visibility, and there may be an appreciable tail. It will move in the general area of Serpens, Scutum and Aquila. The position on November 11, around the time of peak brightness, has been estimated as RA 18h 10m and declination  $-4^{\circ}51'$ . The other comet, Rudenko's (1987u) is not expected to

become brighter than magnitude 7 at best. In this case it should be fairly easy to locate, but it is passing through a region near the Virgo/Crater border which abounds in faint galaxies, and this may make identification difficult. Moreover, the comet travels rapidly south during November, and is not likely to be accessible after the end of the first week of the month.

Of course, November is the month of the Loenid meteors, which can provide the most spectacular of all "meteor storms" — as they did in 1833, 1866 and 1966. The maximum is on the night of the 17th/18th — but do not expect much this year. The Leonids will probably be sparse, and we are unlikely to have another major display from them until 1999. The Taurid shower is active from mid-October to the end of November, but it too is not likely to be striking. It reaches its maximum on the 3rd, but moonlight will interfere badly; the Moon is full on November 5 and new on the 21st.

There are no eclipses this month.

Orion is now starting to come into view in the late evening, reminding us that winter has arrived. Preceding it is the lovely cluster of the Pleiades; look at it with the naked eye on a clear night and see how many separate stars you can count (if you can make out a dozen you are doing very well indeed). The W of Cassiopeia is almost at the zenith, with Ursa Major, the Great Bear, at its lowest in the north — though of course it never sets over any part of the British Isles. We are losing part of the "Summer Triangle" well before midnight, though two of its members, Vega and Deneb, do not actually drop below the horizon. In the south there is the large, rather faint Cetus, the Whale; look for the famous long-period variable Mira, which can equal the Pole Star, but at minimum becomes so faint that even binoculars will not show it. It is due to reach maximum in January next year, but it may become visible with the naked eye during November. The Square of Pegasus is still conspicuous high in the south-west all through the evenings.

## FIRST VOYAGER 2 VIEWS OF NEPTUNE

Neptune is the outermost of the known planets — at the present time, further away even than Pluto (though whether Pluto should be ranked as a true planet seems to be becoming more and more dubious). At its mean opposition distance, Neptune is more than 2,700 million miles from the Earth, and surface details are almost impossible to make out visually even with large telescopes, but it does look as though Neptune has more cloud activity than Uranus, and from Mauna Kea, at almost 14,000 feet above sea-level, Heidi Hammel has used the 88-inch reflector to take new pictures. The cloud features in the planet's southern hemisphere are well seen, and yield a rotation period of 17.9 hours. No bright clouds were seen in the northern hemisphere, though they had been recorded earlier, so it does seem as

though there are marked variations. Neptune, of course, is a giant world 30,000 miles in diameter; it is slightly smaller but appreciably denser than Uranus, and does not share in Uranus' extraordinary axial inclination. Neptune takes over 164 years to complete one journey round the Sun.

Voyager 2 has already by-passed Jupiter, Saturn and Uranus, sending back close-range pictures of each. It is now en route to Neptune, and will make its pass in August 1989. The first pictures of the planet taken from Voyager have now been received. Naturally, they show no details; Neptune is nothing more than a tiny, blurred patch, and its larger satellite, Triton, is a dot of light — but we know that Voyager is in good health, and there is no reason to doubt that it will be successful in this, its final mission target.

At the moment we do not know a great

deal about Neptune, and we do not know whether it has a ring; "ring arcs" have been suspected, but not with any certainty. We may expect a magnetic field and radiation zones, as with the other giant planets. Of special interest are the two Neptunian satellites; Triton, which is rather larger than our Moon and may have an appreciable atmosphere, and the tiny Nereid. Triton moves in a wrong-way or retrograde sense, and is the only large planetary satellite to do so (all the other retrograde satellites are asteroidal), while Nereid has direct motion, but an eccentric orbit resembling that of a comet.

What Voyager 2 will tell us remains to be seen, but great hopes are placed on it. If it should fail, then we may have to wait for many years before we learn much more about the outermost giant.

PE

# Astronomy Now

Number 5

Articles in an advanced state of preparation:

**SUPERNOVA 1987A UPDATE**  
by Dr. Paul Murdin

**PLANETARY ATMOSPHERES**  
by Dr. Garry Hunt

**A HOME-MADE 20-INCH DOBSONIAN TELESCOPE**  
by Richard Fleet

**AMPHITRITE AND THE REGENT'S PARK OBSERVATORY**  
by Andrew Wilson

**COLOUR PHOTOGRAPHY WITH A SCHMIDT CAMERA**  
by Terence Tempest

plus a host of regular features including:

News Update Exclusive – Interview with Bill Bradfield, Australian comet discoverer extraordinaire

The Night Sky This Month  
Sky Watch Down Under  
Foreign News

Society News  
Letters to the Editor  
Book Reviews

Newcomer's Guide this issue covers "Spectroscopy – The Analysis of Starlight"

**ON SALE at all good newsagents — Price £1.25**

**ISSUE NUMBER 5 ON SALE TUESDAY NOVEMBER 17th**

## KLANG!

There are several locks on a building for which I have recently been made responsible, and the keys were specially cut for me.

The first time I needed to enter I began the unlocking procedure, starting with the burglar alarm entry timer. All

went well until the final lock — the key wouldn't fit!

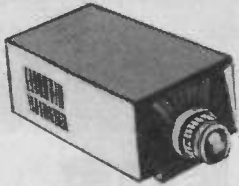
With the timer remorselessly counting down, I struggled to turn the key like a desperate James Bond trying to defuse a ticking atomic bomb. But unlike 007, I failed — the time expired and clanging alarm bells ripped the night air.

Try as I might, I could not get in to stop the racket. There was no option but to go for help from another keyholder; who lived all of two miles off. That's an awful long way when you haven't brought the car.

The resounding moral — don't just assume a system works — check it! **ED.**







## CCTV CAMERAS FROM ONLY £69.50 EACH PLUS CARRIAGE & VAT

Crofton Electronics are now able to offer C.C.T.V. cameras from as little as £69.50 + VAT & carriage. These cameras have been refurbished to a high standard. The output is 1volt p-p. and will work with most video equipment. These cameras are powered from 240volt mains, and have a vidicon rack giving a focusing range from an inch or two to infinity. A standard 16mm lens is also supplied. The sensitivity is in the order of 10 lux which allows their use in the domestic environment. Pictures can be produced with only 2.5 lux but with a worse signal to noise ratio. Low light versions are available having sensitivities of 0.1 lux (half moonlight) at £350 + VAT and carriage. Many other lens are available from stock. A Mounting bush is standard. Many other cameras are available from stock both reconditioned and new, i.e. brand new mini 12volt camera at only £80 plus VAT and carriage, lens extra. Many other items of CCTV equipment such as monitors (both new and refurbished) switchers, panning units, housings, time and date generators are available from stock. We also supply camera and monitor tubes, as well as scanning yokes for a wide range of equipment.

### SPECIAL SPECIAL SPECIAL SPECIAL

Currently on offer is a professional drive board and tube to make a superb 12" professional green panelled tube monitor at £23.50 inclusive. Would normally cost well over £200 +. Buy 10 off and they will only cost you £180.00 inclusive. Be sure to ask us to quote for any of your camera/monitor requirements - we will never be beaten on price.

### HURRY HURRY HURRY

(Not many left. First come first served.)

Brand New Time Date generators at a fraction of their original price. Only £132 inclusive. Normal price £477. These generators are mains driven and accept normal composite video in. They produce video out with time/date/day/month/year added to the signal in normal or reverse video. Adjustable positioning anywhere on the screen. Switchable character size also provided. A REAL MUST FOR SECURITY APPLICATIONS WHEN RECORDING.

We also have a host of used items such as cooling fans power supplies at give away prices, so why not ask for a list?

Send a 40p SAE for our complete range of catalogues.

MOST MAJOR CREDIT CARDS ACCEPTED.

**CROFTON ELECTRONICS** 05448 557  
'KINGSHILL', NEXTEND, LYONSHALL, HEREFORDSHIRE HR5 3HZ.

## JUST LOOK AT THESE SPECIAL LOW PRICES!!

### STRIPBOARD

Fully pierced copper clad boards, .1" pitch

Tracks	Holes	Part No	1+	10+	100+
10	24	16.0100	.14	.13	.11
24	37	16.0101	.45	.35	.33
36	50	16.0102	.85	.60	.57
36	170	16.0103	3.20	2.30	2.00
36	175	16.0104	3.80	2.90	2.70

### SOLDER

Item	Part No	1+	10+	100+
60/40 W/Kg Reel	23.0100	4.70	3.50	3.00

### NICAD BATTERIES

Item	Part No	1+	10+	100+
AA (1.25v/500mAh)	17.0100	90	80	72
C (1.25v/1200mAh)	17.0101	2.00	1.70	1.50
D (1.25v/1200mAh)	17.0102	2.20	1.75	1.60
Universal Charger	17.0103	5.00	4.00	3.70

### RIBBON CABLE

Grey ribbon cable .05 pitch awg.

Part No	1'	100'	1000'
10-way	19.0103	.10	.04
16-way	19.0104	.20	.09
20-way	19.0105	.24	.10
26-way	19.0106	.32	.11
34-way	19.0107	.44	.16
40-way	19.0108	.52	.18

### DIL SOCKETS

Low profile, dual wipe contacts; black polyester bodies

Part No	100+	1000+
8 pin	20.0100	.032
14 pin	20.0101	.048
16 pin	20.0103	.056
18 pin	20.0104	.062
20 pin	20.0105	.078
24 pin	20.0106	.082
28 pin	20.0107	.096
40 pin	20.0108	.14

### D CONNECTORS

Item	Part No	1+	100+	1000+
9-way Plug	18.0100	.38	<25	.17
9-way Socket	18.0101	.44	30	.21
15-way Plug	18.0102	.39	25	.21
15-way Socket	18.0103	.49	40	.24
25-way Plug	18.0104	54	33	.21
25-way Socket	18.0105	.63	40	.26
9-way Covers	18.0200	.60	40	.26
15-way Covers	18.0201	.65	41	.29
25-way Covers	18.0202	.69	50	.33

### CABLE TIES

Nylon cable ties with a non-releasable ratchet lock

Part No	100+	1000+
100mm	21.0100	.009
142mm	21.0101	.011
203mm	21.0102	.015

All prices exclude VAT  
Please add 80p postage and packing to any order  
Credit cards accepted on telephone orders, otherwise cheque,  
postal order or cash with order.  
Please allow up to 14 days for delivery,  
although we aim to despatch by return.

**SCS COMPONENTS**  
218 PORTLAND ROAD, HOVE, SUSSEX BN3 5QT  
Telephone: 0273 770191

# TECHNICIANS

Looking for a brighter future?  
Join the fast moving and lucrative  
computer servicing industry.

## Vacancies are now available on our MICROPROCESSOR SYSTEMS TECHNICIANS COURSE

A 16 week full time course designed for  
Electronics Technicians wishing to retrain in:  
**MICROPROCESSOR TECHNOLOGY**

The course concentrates on realistic  
hands on practical work.

Start dates: **November 87 & March 88**

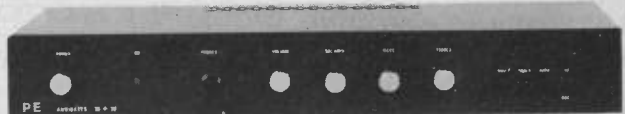
Apply with full CV to:  
**Milton Keynes Skillcentre**  
Chesney Wold, Bleak Hall, Milton Keynes.  
Tel: (0908) 670001

OR

**Swindon Skillcentre**  
Faraday Road, Dorcan Industrial Estate,  
Swindon, Wiltshire SN3 5HB  
Tel: (0793) 641671

A training allowance and lodging/travel  
allowance will be paid.  
This is an M.S.C. funded Equal Opportunities Training Course

## AUDIOKITS Precision Components



### The new PE 30 + 30 integrated Amplifier (featured Practical Electronics Feb-April 87)

The PE 30 + 30 integrated amplifier is the first to benefit from Graham Nalty's research into Temperature Generated Distortion in transistors. As a result it exhibits a smoothness and musicality normally only expected from expensive valve amplifiers. Advanced power supply electronics and the use of Holco precision resistors in critical positions reaffirm its ability to give greater musical pleasure from your records, CDs and tapes. Yet you can buy the complete kit from AUDIOKITS for under £170 to build it yourself.

#### Complete Kits

PE 30 + 30 standard 30W £172.00  
PE 30 + 30 standard with Extra  
Output Transistors for 40W £185.00  
PE 30 + 30 Audiophile improved version  
40W Output £380

VISIT AUDIOKITS STAND AT THE  
FESTIVAL OF SOUND & VISION 1987  
AT THE SHERATON HOTEL,  
EDINBURGH, 6th-8th NOVEMBER

All parts for PE 30 + 30 are available separately.

Semi Conductors	Resistors	Hardware
MC7818CT 70p	100R, 2K2, 4K7 Bulk Foil £5.00	IN4148 4p
BC184C 12p	68K, 220K Bulk Foil £10	IN4002 5p
BC214C 12p	1R, 1W, Holco H2 £1.15	IN5401 15p
BC547C 12p	10R, Holco H8 70p	25A 200V Bridge £3.50
2SB737 75p	15R Holco H8 55p	35A 200V Bridge
2SD786 75p	22R1-442K Holco H8 35p	Motorola BYW62 £7
BD243C 80p	681R 1W Holco H2 40p	
BD244C 80p	15R-470K ¼W Metal Film 4p	Push Button Switch
	1R-470K ½W Metal Film 7p	Silver Plated
MJ11015 £6		2 pole c/o £1.00
MJ11016 £5.50		4 pole c/o £1.50
2N4401 25p		Button (Black) 20p
2N4403 25p		Gold Plated Phono
MPSA06 25p		Chassis socket £2
MPSA56 25p		TO3 Silicone
OP2767 £8.25		Insulators 15p
MAT02FH £8		TO-220 Silicone
		Insulators 10p

For details please send : 9" x 4" SAE to  
AUDIOKITS, 6 MILL CLOSE, BORROWASH,  
DERBY DE7 3GU. TEL: 0332-674929.

*Multizone detection keeps you safer and helps you save your sorrow as well as your property. Be alarmed before the goods have gone!*

# INTRUDER ALARM CONTROLLERS

PART TWO BY BILL KENT

Detectors deter delinquents

Part one of this article looked at some of the motivations for installing a burglar alarm, and described the principles and construction of simple control unit that activates a timed bell in the event of a detection circuit being broken. This month in part two, a more complex system is described that offers several levels of detection. (Fig.8).

It includes monitoring of two detection zones, an anti-tamper detector, a 24 hour detector (or 'granny-bashing!' alarm), latched intrusion indicators, timed bell duration, optional automatic alarm resetting, timed entry-exit control, and a latched strobe light control driver. It is principally for use with pressure pads, and magnetic contact switches, but could also be used with a variety of other detectors, such as infrared and ultrasonic devices. The use of the switches was described in detail in part one.

## MULTIZONE MONITORING

For any premises larger than just a room or two, it is a considerable advantage to know roughly which area has been subjected to unauthorised entry. For example, the front and the back of a house can be monitored separately, or the upstairs and downstairs treated as separate zones. On large premises there may be many zones, each of which are treated as independent regions. Not only does this help to locate the forced entry point, but also should any of the detectors fail, their location can more readily be determined. Each of the detection zones is monitored by a single master control unit that initiates the necessary action depending on the type of incident detected.

For an average sized domestic house the two zone system is probably adequate, the choice of zone separation being assessed by expediency. Detection within these zones will follow similar principles, that if the circuit status is disrupted, an alarm will be activated by the controller.

The simplest detection device is the magnetically activated contact switch, as discussed in part one. Under normal conditions this maintains continuity of an electrical loop. If the loop is broken, either by the opening of the switch, or the cutting of the connecting wires, a

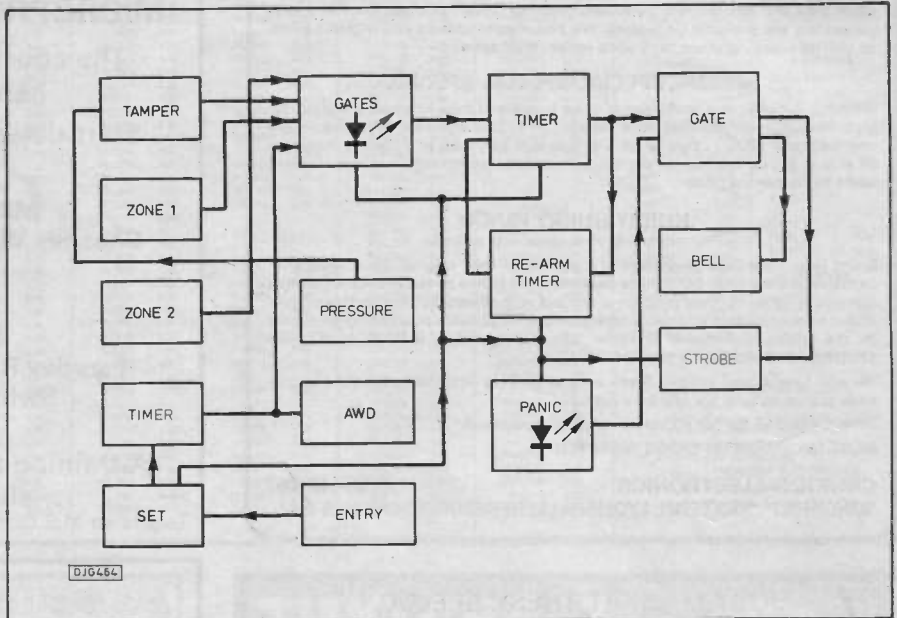


Fig. 8. Block Diagram of Multizone controller

voltage change will take place, triggering the controller.

For the most part, in the system described here, the controller will see a zero voltage when the loop is closed. If the circuit opens, the controller then sees a positive voltage at its input. Looking at Fig.9, it will be seen that zones one and two have identical circuitry around IC1a and IC1b.

## ZONE ONE

Taking zone one, IC1b is a latching gate, the input of which is supplied by a positive voltage via R4 and R5. The detector loop is connected between the junction of R4 and R5, a series of normally closed contact switches, and ground. When all the switches are closed, the resistor junction is held low, but if the circuit opens it will revert to its stable high state. Pin 4 of IC1b also goes high via R5. A clocking pulse is constantly being fed from the oscillator around IC3a and IC3b, to a common control input at IC1 pin 9. This signal triggers the gate to open, causing the output to take on the same state as its input. Here the output is fed back to the voltage input at pin 4, via diode D2. Because of the presence of R5, even if the loop circuit is reclosed, the input and the output will remain high until the chip

is reset by a separate control signal. The latched output provides the voltage to turn on the led D12. This shows that at some time the circuit has been disrupted, however briefly.

Note that the LEDs for both zones and the tamper loop can be triggered even if the system is not set by S2, though the bell will remain silent.

## TRIGGERING

At first sight it may appear that the output of IC1b should be the trigger source for the alarm activating circuit. This though, would not allow for the situation where the circuit was briefly opened, and then reclosed. Obviously it is undesirable for a burglar to trigger the bell circuit, disappear until the bell has stopped automatically, and then reappear knowing that his entry would not retrigger the bell. Consequently, the output of IC1b is only used to give a visual indication that the circuit has at some time been broken, in due course informing the rightful owner of the alarm status.

The bell triggering is carried out by taking the voltage at the junction of R4 and R5, feeding it via the OR gate IC2a, the inverter IC3f and then to IC4a. When the loop circuit is broken the resulting negative going pulse, generated by IC3f

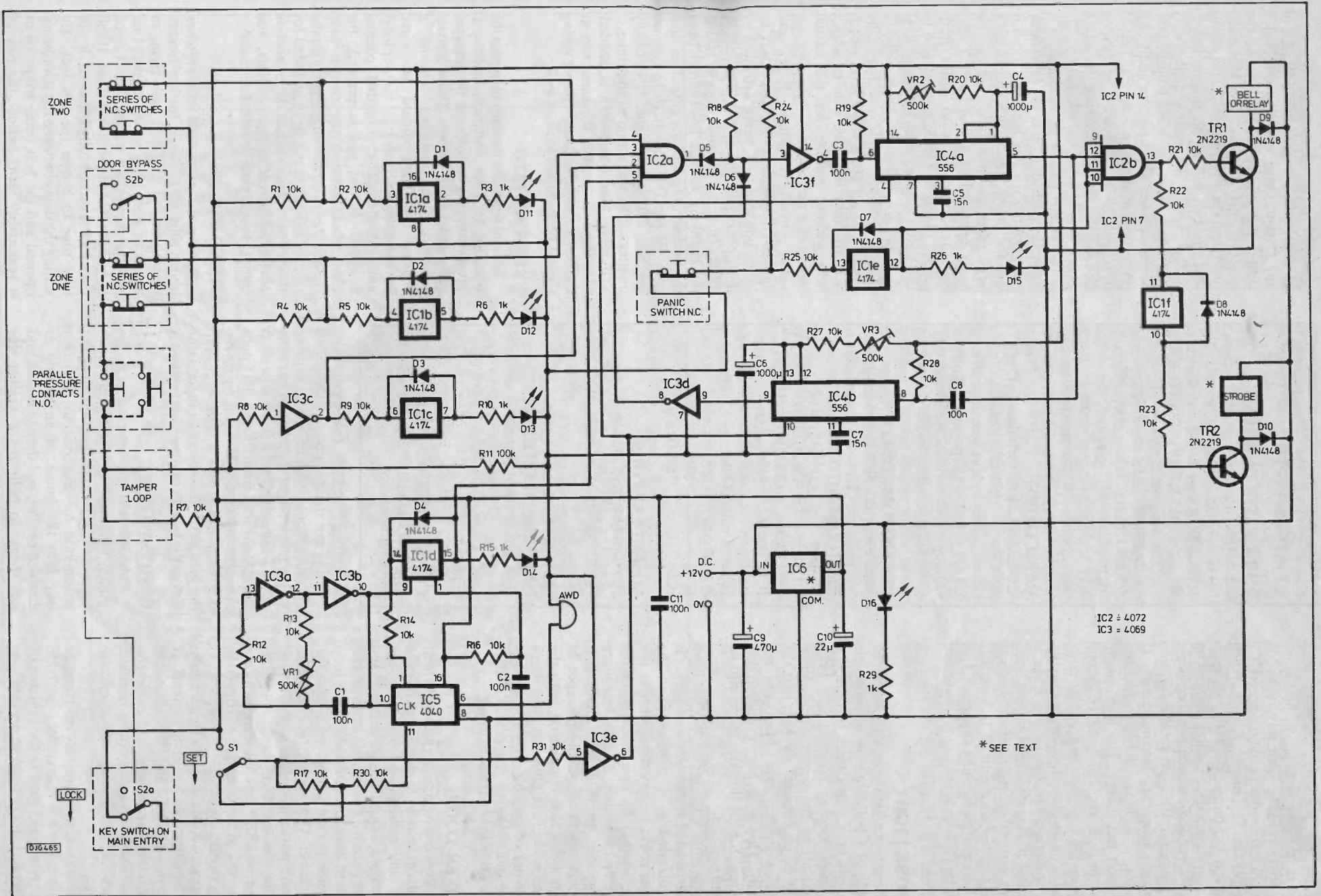


Fig. 9. Circuit diagram of Multizone intruder alarm controller

via the differentiator C3 and R19, triggers the monostable within IC4a. This operates in the same way as the 555 timer in last month's article, indeed IC4 is simply two 555s in one package. When triggered the output of IC4a goes high and remains so until C4 has charged up via VR2 and R20, whereupon the output will fall again. VR2 can set the duration between about 17 seconds and 15 minutes, within the restrictions discussed last month. The high output goes through the OR gate IC2b and turns on TR1, activating a bell or relay, with D9 quenching inductive transients. The operation and use of this stage is identical to that described in part one.

The output of IC2b simultaneously feeds another latch gate, IC1f, with R22 and D8 ensuring latching until reset. This turns on TR2, to which can be connected another relay, or a strobe light.

## STROBE LIGHT

The use of a high power strobe on the outside of a building is of considerable value. If only a bell were to be relied on, once this had automatically been turned off by the timing circuit, there would be no external warning that the premises might have been entered illegally. This is a highly undesirable situation, for the intruder might still be around.

Additionally, the police may not have yet responded to the alarm call. This is not intended as a criticism, and the reasons could be any thing such as not being advised by neighbours that the alarm had sounded, or they had more emergencies to deal with than their numbers would allow. The presence of the strobe, which remains on until the system is deliberately reset, forewarns the owner of possible trouble, and is a visual indication to the police if they arrive after the bell has shut off.

## TAMPER LOOP

Thieves can be cunning and try to beat any alarm system. System users have to make any attempts at bypassing the protections as difficult as expense and reason permits. One simple extra protection is to have an additional circuit loop alongside the entry loop, and within the same cable. This should be held at an opposite potential to the entry loop so that anyone interfering with the wires cannot readily determine which are which and so be in danger of triggering either circuit.

In practise, the use of a tamper loop may be debatable for some systems. If the wiring between units is inaccessible to intruders, the expense and inconvenience of extra wires may not be justified. The choice should depend on circumstances.

If required, the positively held tamper loop is taken via R7, around the complete system and back to the junction of R8 and R11. R7 is there to prevent any-

## COMPONENTS

### MULTIZONE BURGLAR ALARM

#### RESISTORS

R1,R2,R4,R5,R7-R9	10k (24 off)
R12-R14,R16-R25, R27-R28,R30-R31	
R3,R6,R10,R15,R26	1k (6 off)
R29	
R11	100k
All resistors 1/4W 5% carbon film	

#### CAPACITORS

C1-C3,C8,C11	100n polyester (5 off)
C4,C6	1000µ 10V electrolytic (2 off)
C5,C7	15n polyester (2 off)
C9	470µ 25V electrolytic
C10	22µ 16V electrolytic

#### POTENTIOMETERS

VR1-VR3	500k skeleton (3 off)
---------	-----------------------

#### SEMICONDUCTORS

D1-D10	1N4148 (10 off)
D11-D16	LED (6 off)
TR1,TR2	2N2219 (2 off)
IC1	4174
IC2	4072
IC3	4069
IC4	556
IC5	4040
IC6	7808 (see text)

#### MISCELLANEOUS

Pcb clips (4 off), PCB280A, 14-pin i.c. socket (3 off). 16-pin i.c. socket (2 off).

#### SECURITY PRODUCTS NEEDED: (SEE TEXT):

Bell, strobe light, magnetic contact switches, SP key operated switch, DPCO key operated switch, 4-core cable.

#### CONSTRUCTOR'S NOTE:

The PCB and a kit of parts is available from Phonosonics.

one cutting through the wires from shorting out the full power supply. This of course would stop the system entirely. R11 is much larger than R7, so has little affect on the high voltage level seen at IC3a. If the lead is cut though, R11 pulls down the input of IC3c which, by inverting the polarity, puts a high level onto the gate IC1c. This responds in the same way as the latches of zones one and two.

## PANIC SWITCH

Although jokingly referred to as the 'granny bashing!' alarm, the panic switch has a deadly serious function. It is not uncommon for someone to talk their way into the house of an elderly or disabled person, and then to assault and rob them. To help guard against this

situation it is recommended that a personal attack switch should be part of any system. Once activated this switch causes the bell to ring, but unlike the other trigger systems, the automatic timed bell cut off is bypassed. This means that the bell will go on ringing indefinitely until someone deliberately switches it off at the main control box. Some switches also have the additional protection of needing a special key to deactivate them. If granny, or anyone else feels in danger, pressing the attack switch should bring outside help.

The switch should be mounted in a convenient position, near the front door say, preferably a few feet back from it into the house. The switch should be a large press to open type that can be easily operated by a frail hand. I also feel that those likely to suffer from sudden illness would be well advised to also have a similar switch near floor level in a readily accessible place. Should anyone collapse and not have the strength to get up, if a low level switch is handy they might be able to attract help without waiting for the casual calling of a neighbour.

The circuit is around IC1e, and basically responds in the same way as zones one and two, being activated by the opening of the circuit. The circuit differs from the previous ones by taking the changing voltage level direct from the latched output of the gate. This then goes via the OR gate IC2b to turn on the bell and strobe light. It is totally unaffected by the action of the timer.

If more than one switch is needed, wire them in series in the same way as the contact switches. Anti-tamper wiring should be included here as well.

## PRESSURE PADS

Should someone manage to bypass the window or door switches, additional protection can be offered by pressure pads underneath carpets. These contain normally open switches, closing if walked on. They should be wired between the positively held tamper loop, and the normally grounded contact switches. If the pad is pressed, the contact will activate the tamper loop trigger. Zonal monitoring display on the control panel has not been included for this circuit. However, a later section covers additional trigger circuits, and tamper loops could be zoned if needed.

## TIMED PASSING

Putting the entry and exit switches under time control is a further hindrance to anyone who is illegally trying to get in or out. Keys to the control box and the main door trigger circuit need to be operated for authorised use. If the door lock is successfully bypassed, it will take time to bypass the box lock. By setting the delay between the door being opened and the bell being triggered to a reasonably short period, the risk of

successful dual lock picking can be reduced.

Prior to exit, the control box switch S1 is turned on. This sends a negative going pulse via C2 to the reset pin of IC1. If all the security switches are in the correct state, all LEDs D11 to D15 will go out. If a switch is in the wrong state, the light will be retriggered straight on again.

Before S1 is turned on, the counter IC5 is held at reset by the positive voltage via S1 and R30. Switching S1 on allows IC5 to start counting pulses from the oscillator around IC3a and IC3b. If S2a is not also switched on before the counter has reached half the maximum count, pin 1 of IC5 will go high, triggering the latch IC1d. The bell triggering line is taken from the latch output and will remain high until the system is reset again. If, however, S2a is correctly closed before the time out period, IC5 will be reset by the positive level via S2a. While the door is open, the door contact switch is bypassed by S2b.

## RE-ENTRY

Before opening the door for entry, S2 is switched off first, enabling IC5 to start counting. If S1 is then switched off in time, IC5 will not reach its maximum, and so the system will not be triggered.

If it is triggered, it will stay so until S1 is turned off.

The action of turning off S1 also resets the timer circuits IC4a and IC4b. The panic switch circuit though, will stay on with the bell ringing until S1 is briefly switched on and off again, resetting all of IC1.

The delay time can be set from anything between about 5 seconds and three minutes, and is controlled by the oscillator frequency. The oscillator is a standard twin inverting gate CMOS circuit, the frequency of which is set by the values of C1 and the total resistance of R13 and VR1.

Throughout the time that IC5 is counting, one of its early output stages is driving a low power active audible warning device mounted inside the box. This turns on each time the counter pin goes high, but becomes silent once the counter is reset. Some units use an internal AWD to indicate any triggered condition, but in this unit the external strobe and D11 and D15 are considered to be sufficient warning.

## AUTOMATIC REPEAT

The desirability of an automatic re-arming circuit is open to discussion. On the one hand is the desire to give maximum protection against intruders. On the other hand is consideration for

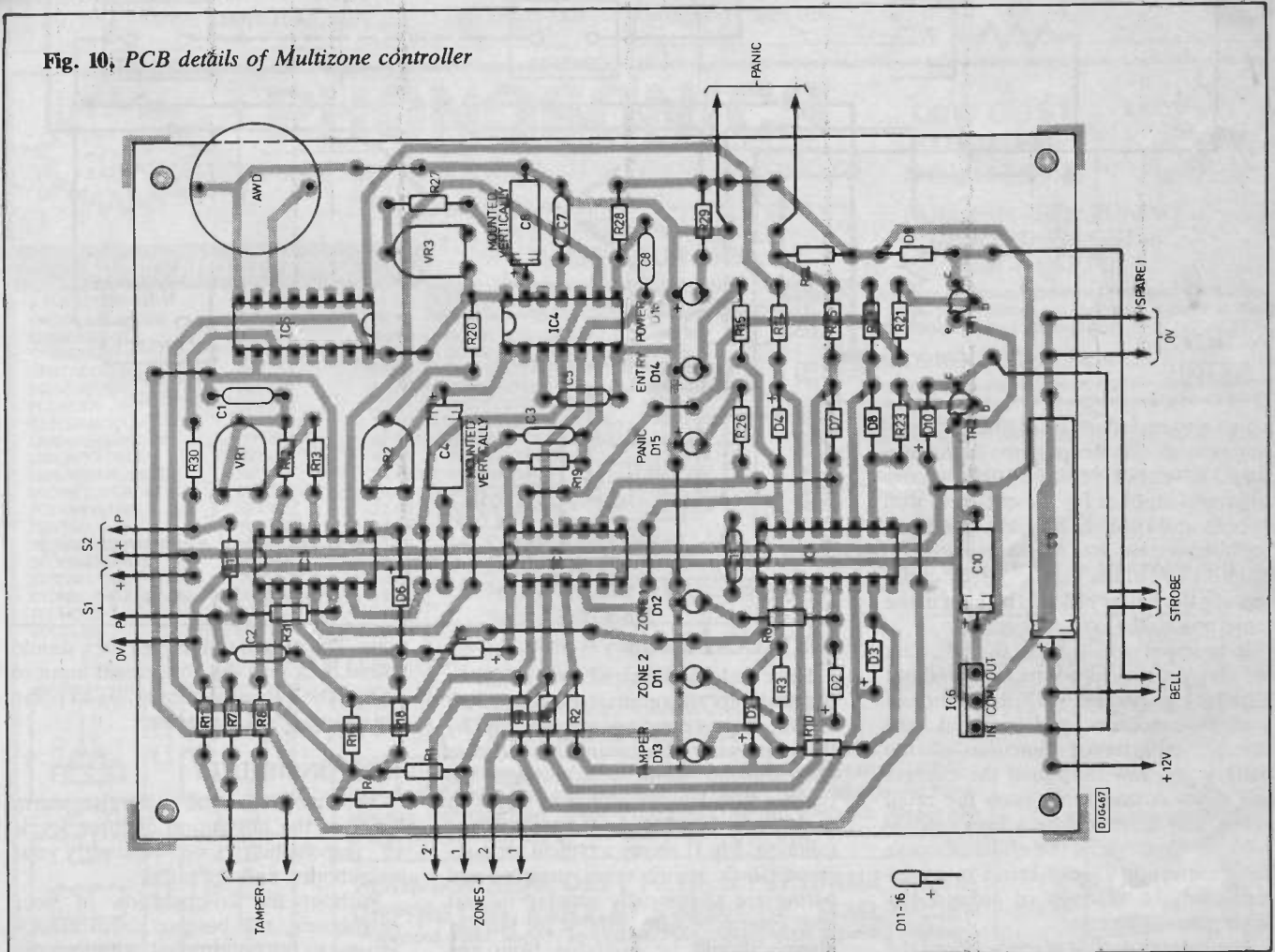
neighbours if the system should develop a switch or wiring fault causing triggering to occur. I can only say that the choice must be yours - the facility is included should you want it.

At the end of the bell on-time set by IC4a, the timer output pulse falls, and via C8 this triggers a second timer around IC4b. It is identical in operation to IC4a and has a similar timing range as set by VR3. At the end of its cycle, the negative going output level is inverted by IC3d and goes to D6. Between them D5, D6 and R18 form an AND gate. If any of the lines into IC2a are still high, the AND gate allows IC3f to retrigger IC4a. This cycle will go on indefinitely until either the system is reset, or the inputs of IC2a revert to their normal state. If they revert, the AND gate will not allow a pulse to be generated at C3. If the re-arm facility is not needed, omit C8.

## POWER SUPPLY

Reading the British Standards recommendations for burglar alarms, there appears to be no standardisation on power supply voltages, though +12V seems to be common. However, the circuit here can be operated from any power supply between +5V and +12V. If the LED resistor values are increased, even +15V should be acceptable. Bells

Fig. 10, PCB details of Multizone controller



# INTRUDER ALARM

and strobes though appear to be more common for +12V supplies.

One intention of this unit is that it should be inexpensive, consequently, rather than recommend a fully stabilised mains PSU, with all its attendant mains safety factors, a normal 12 volt car battery charger is suggested as the PSU.

The output voltage should not be used directly to supply the circuit, but should be used with a 12 volt battery in parallel, of at least 3 amp hours capacity. A good heavy duty battery is essential for a reliable alarm system since it can supply power for prolonged periods during

bell and strobe direct, but the circuit uses a voltage stabiliser, IC6 to regulate the controller voltage at +8V. A +5V regulator such as a 7805 could be substituted if a 7808 is not available.

If the unit is to be used with ancillary detection equipment that puts out a trigger signal in excess of the stabilised PSU level, a voltage dropping attenuator should be included in the feed line.

Alternatively, the circuit could be driven by a more sophisticated mains and battery circuit, though at greater expense. In this case IC6 should be omitted.

supplier of security system parts. Note that the bell should also be included in the tamper wire.

Checking of the assembled control board (Fig.10) can be carried out systematically during the installation process. If any of the detector circuits are not used, the switch wiring should be replaced by a short link wire on the pcb.

Check out the response for each new switch or zone completed. During the early testing stages though, leave the bell cover off to avoid disturbing neighbours. The buzzing sound of the uncovered bell will be sufficient advice that things are working. The timing controls should all be set for minimum delay during testing. Once the system is otherwise fully working, then set the delays to the desired duration.

## EXTRA ZONES

Any of circuits around IC1 can be repeated on a piece of veroboard or similar, feeding the control lines into a second OR gate. This could have two, four or eight inputs as required. One of the existing inputs to IC2a should be rerouted to one input of the second OR

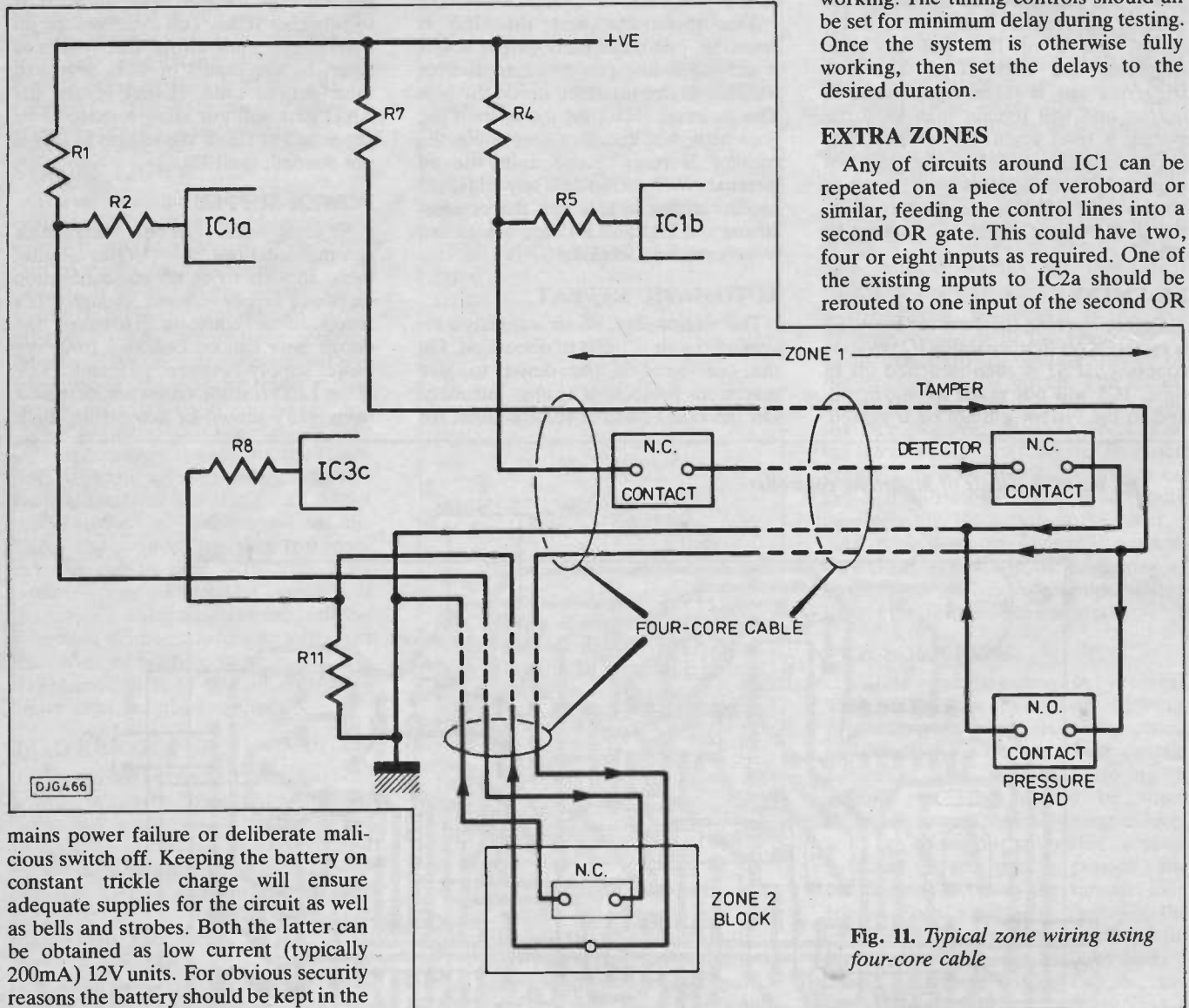


Fig. 11. Typical zone wiring using four-core cable

mains power failure or deliberate malicious switch off. Keeping the battery on constant trickle charge will ensure adequate supplies for the circuit as well as bells and strobes. Both the latter can be obtained as low current (typically 200mA) 12V units. For obvious security reasons the battery should be kept in the same box as the control board.

It is important to note though, that the charger should not be used without a battery in parallel with it. In the unloaded condition and without the storage capacitance function of the battery, the raw output of the charger can differ considerably from the rated value, and there will be a heavy ripple voltage. Conversely, the effect of smoothing capacitor C9 can result in an unregulated d.c. voltage of around 18V from some chargers.

The battery output is used to feed the

## INSTALLATION

Since only one tamper loop circuit is included, its wiring must be connected so that all protected zones are served by the same wire. This means that all joins between the zones should keep the tamper wire lengths joined in series. If they are in parallel the trigger will not function. Fig.11 shows a typical arrangement. Basic switch types, routing and wiring are additionally covered in part one. Four core wire suitable for burglar alarms should be available from any

gate. The output of this gate then should come back into the now vacant input of IC2a. The gate is non-inverting so polarity changes will not occur.

## RESPONSIBILITY

The installation of a burglar alarm involves the imposition of three levels of responsibility: on yourself, your neighbours, and the police.

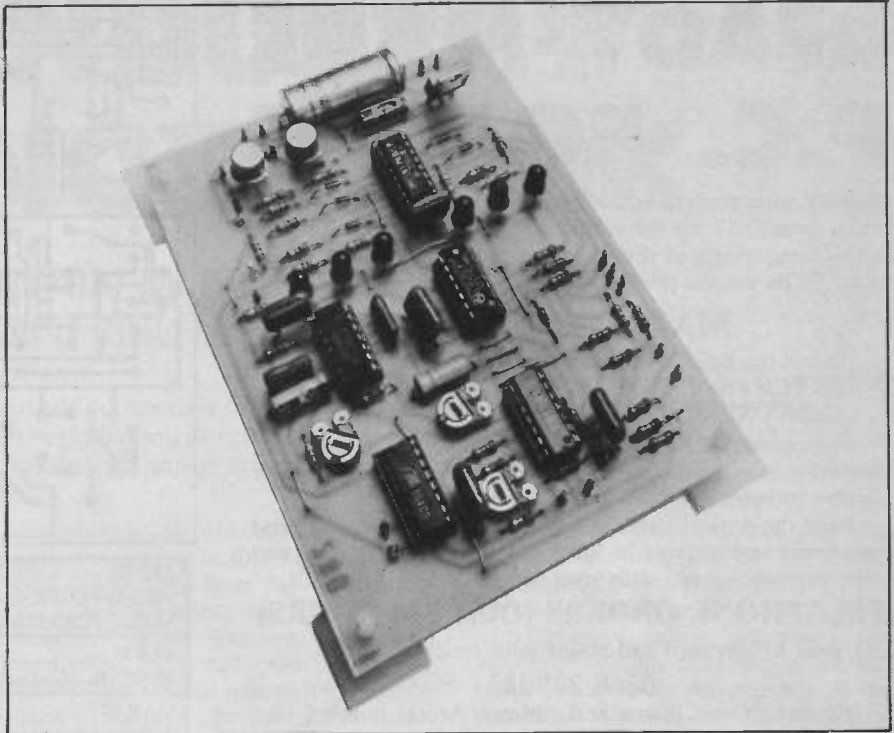
Without the co-operation of your neighbours, the burglar alarm cannot assume its full potential. Although the

sound of an alarm bell ringing is likely to scare off most intruders, you still need someone to advise the police that the system has been triggered. Someone should also hold entry keys in case of problems during your absence.

If you are on good terms with your neighbours there should be no embarrassment about asking them to act on your behalf. If you are part of a neighbourhood watch scheme, you probably have a co-ordinative arrangement anyway. Even if you are not in a scheme, at least one neighbour should be pleased to act – they may need a similar gesture from you in the future. So, pass a spare set of keys to a neighbour, and keep them informed about where you can be contacted in case of emergency.

Additionally, advise the police that you have installed an alarm, and who the keyholders are. This is part of their normal procedure and you need feel no reticence about informing them. The responsibility you place on them will be to their assistance, and they will be pleased to advise you on any security matter. They would sooner prevent crime than solve it, and an alarm system is a good crime deterrent. Certainly it will not prevent a persistent thief, but it will make most think twice before attacking your property.

The final responsibility is yours, firstly in carrying out the above, and, just as



important, keeping your alarm system in good working order. Nothing brings them into greater disrepute than repeated false alarms. Try to ensure that the alarm never rings except in anger.

Surprisingly, the misinformed opinion still exists that an alarm advertises that

you have something worth pinching. If you have, thieves may discover it anyway at any time. Deterrence is the better part of discretion, and in this case advertising your intention to keep thieves out is advantageous. So install an alarm, and use it. **PE**



## PHONOSONICS

THROUGH ELECTRONICS UNDERSTAND ESSENTIAL TECHNOLOGY

### MUSIC AND EFFECTS

A-D-A INTERFACE*	SET 251	61.00
CHORUS FLANGER	SET 235	59.99
COMPANDER	SET 238	22.99
CYBERVOX	SET 228	44.76
DIGITAL DELAY	SET 234	198.50
ECHO-REVERB	SET 218	57.66
FLANGER	SET 153	28.45
GUITAR MODULO	SET 196	23.56
LINKAFEX CHORUS	SET 204	42.96
LINKAFEX DELAY	SET 206	42.09
LINKAFEX FLANGE	SET 207	34.92
MICRO TUNER*	SET 257	55.32
POLYWHATSI!	SET 252	122.69
REVERB	SET 232	27.35
RING MODULATOR	SET 231	45.58
STORM (SIMPLE)	SET 154	23.60
STORM - THUNDER	SET 250T	29.50
STORM - WIND & RAIN	SET 250W	29.50
TREMOLO	SET 136	15.62
VODALEK	SET 155	18.31

- ★ BE KIT CREATIVE
- ★ RAISE YOUR SKILLS

### OTHER FINE DESIGNS

BURGLAR ALARM MULTI	SET 280	22.77
BURGLAR ALARM SIMPLE	SET 279	9.32
CHIP TESTER 16-PIN*	SET 258S	32.50
CHIP TESTER 24-PIN*	SET 258F	39.30
CHIP TESTER SIMPLE*	SET 262	28.50
DISCO LIGHT CONTROL	SET 245F	62.50
EPROM PROGRAMMER*	SET 277	25.25
EVENT COUNTER	SET 278	31.50
MICRO CHAT*	SET 276	64.50
MICRO SCOPE*	SET 247	44.50
MORSE DECODER*	SET 269	22.16

- ★ COMPUTER CONTROLLED (BBC, C64, PET)
- ★ MOST PCBs AVAILABLE SEPARATELY
- ★ LEARN BY BUILDING
- ★ ENJOY BY USING
- ★ POPULAR PROJECTS FROM A LEADING AUTHOR

### LOW COST GEIGER COUNTERS



### NUCLEAR FREE ZONES? CHECK THEM OUT - GET A GEIGER

Detectors for environmental and geological monitoring – know your background! You'd be amazed at the quantities sold since Chernobyl.

### METERED GEIGER (PE MK2)

Built-in probe, speaker, meter, digital output. Detector tube options – ZP1310 for normal sensitivity. ZP1320 for extrasensitivity.

Kit-form – SET 264 – (ZP1310) £59.50, (ZP1320) £79.50

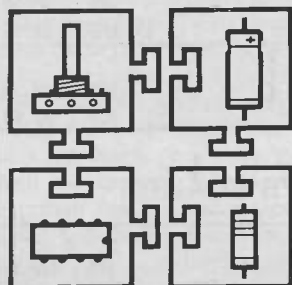
Ready-built = TZ272 – (ZP1310) £75.50, (ZP1320) £95.50

### GEIGER-MITE SET 271 £39.50

Miniature geiger with ZP 1310 tube, LED displays radiation impacts. Socket for headphones or digital monitoring. Kit-form only.

THE PE GEIGER WAS SHOWN ON BBC TV "TAKE NOBODY'S WORD FOR IT" PROGRAM

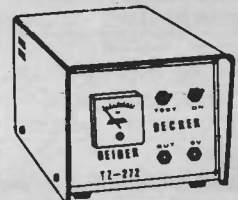
### KITS THAT FIT



Send SAE for detailed catalogue, and with all enquiries (overseas send £1.00 or 51.R.C.'s). Add 15% VAT. Add P&P – Sets over £50 add £2.50. Others add £1.50. Overseas P&P in catalogue. Text photocopies – Geiger & DDL Texts £1.50 each, others 50p, plus 50p post or large SAE. Insurance 50p per £50. MAIL ORDER, CWO, CHQ, PO, ACCESS VISA.

**PHONOSONICS, DEPT PE7D, 8 FINUCANE DRIVE, ORPINGTON, KENT, BR5 4ED. MAIL ORDER**

Telephone orders: Mon-Fri, 9am – 6 pm. 0689 37821. (Usually answering machine).



# READY-MADE P.C. BOARDS

Simplify your project assembly – use a ready-made printed circuit board. All are fully drilled and roller tinned. Just slot in the components as shown in the project texts, and solder them. PCBs are the professional route to project perfection.

## MAIL ORDERING

Select the boards you want, and send your order to  
PE PCB SERVICE, PRACTICAL ELECTRONICS,  
193 UXBRIDGE ROAD, LONDON W12 9RA.

Prices include VAT and postage and packing. Add £2 per board for overseas airmail. Cheques should be crossed and made payable to **Intra Press**.

Quote the project name and PCB Code Number, and print your name and address in **Block Capitals**. Do not send any other correspondence with your order.

## TELEPHONE ORDERS (OPEN 24 HOURS)

Use your Access card and phone your order to

**0268 289923**

clearly stating your name and address, Access number, and order details.

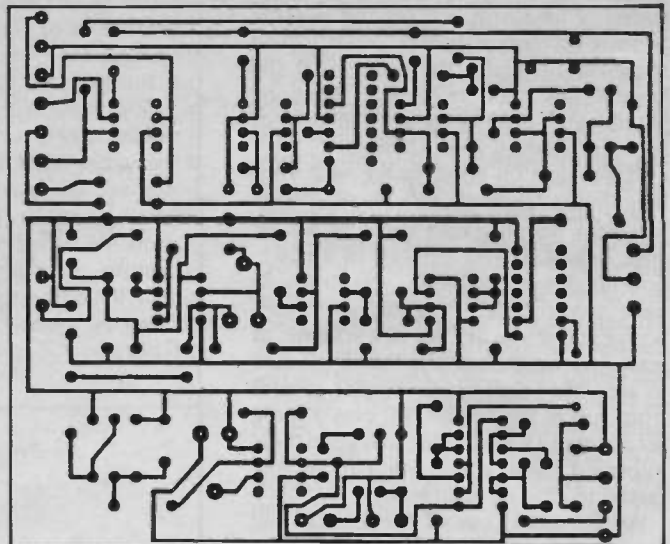
All orders receive priority attention, but allow 28 days for delivery in case a PCB is temporarily out of stock.

**WE CAN ONLY SUPPLY THE PCBs LISTED HERE**

**CHECK LATEST ISSUE FOR  
PRICES BEFORE ORDERING**

PHOTOCOPIES OF THE TEXTS MAY BE BOUGHT FROM THE EDITORIAL OFFICE AT £1.00 EACH PART (£1.50 OVERSEAS), P&P INCLUSIVE.

COMPONENTS ARE AVAILABLE FROM ADVERTISERS.



<b>MAY 86</b>		
NOTCHER EFFECTS – unusual harmonics.	107	£5.99
TTL LOGIC CHECKER – for 14 and 16 pin chips	108	£4.59
DF BEACON TIMER – accurate navigation aid.	109	£6.18
STE-BUS BACKPLANE – data and PSU routing socket board.	110	£14.97
<b>JUN 86</b>		
GUITAR TRACKER – transforms a guitar for sound synthesis.	111	£6.98
THERMOCOUPLE INTERFACE – transforms a DVM into a thermometer.	112	£3.90
PE HOBBY BUS – universal computer interface	113	£29.00
BBC LIGHT PEN – inhibiting, enhancing and visual feedback.	114	£3.90
<b>JULY 86</b>		
PASSIVE IR DETECTOR – burglar detection	115	£3.90
200MHZ COUNTER – professional specification	00D	£30.88
<b>SEP 86</b>		
FIBRE-OPTIC LINK – computer comms.	ODE	£10.14
PE HOBBY BUS – universal D-A and A-D unit.	120	£7.25
<b>OCT 86</b>		
DRUM SYNTHESISER – variable dynamic sound triggered effects.	121	£7.67
MAINS DELAY TIMER – selectable 15 to 120 mins. Set of 2 PCBs.	122	£7.92
MAINS DIMMER – touch control up to 400W.	123	£3.90
<b>NOV 86</b>		
REMOTE JOYSTICK – infrared computer controller. Set of 2 PCBs.	124	£10.86
BABY ALARM – through-the-mains transceiver.	125	£10.71
<b>DEC 86</b>		
VIDEO ENHANCER – manually adjustable video improvement.	126	£8.76

<b>JAN 87</b>		
VIDEO FADER – simple inexpensive video mixer	127	£4.50
VOICE SCRAMBLER – confidential trans.	128	£8.06
<b>FEB 87</b>		
HI STAB – good variable workshop PSU	132	£8.79
<b>MAR 87</b>		
4 CHANNEL ENHANCER – adapts stereo to 4 channels	135	£4.60
LIGHT PEN – uses fibre optics for high accuracy	136	£4.10
PHONE REPEATER – extra bell interface	137	£3.90
ULTRASONIC TAPE MEASURE – resolution to one centimetre	138	£9.50
<b>APR 87</b>		
VIGILANTE CAR ALARM – keeps cars alert to intruders	139	£5.90
INDUCTIVE LOOP TRANSCEIVER – remote control for models:		
... Transmitter	143	£3.90
... Receiver	144	£3.90
<b>MAY 87</b>		
BRIGHT FUZZ – Foot operated overdrive	145	£3.90
<b>JUN 87</b>		
AUDIO SIGNAL GENERATOR – uses frequency synthesising techniques	146	£10.20
<b>JUL 87</b>		
WORD GENERATOR – produces binary words of up to 16 bits	147	£13.42
SCOPE STORE oscilloscope add-on data storage	148	£11.94
<b>AUG 87</b>		
PSEUDO STEREO – mono to simulated stereo	149	£7.37
<b>SEP 87</b>		
SPEECH PROCESSOR – clarifies transmitted speech quality	150	£5.86
GCSE TIMER UNIT – versatile variable delay AWD and switching	151	£5.18
FUNGEN – triple waveform signal generator	152/153	£9.69
LIGHT CONTROLLER – delayed switching	154	£4.64
<b>OCT 87</b>		
TEACHER LOCKER – digital lock control	155	£7.50
POWER SUPPLY – stabilised ±15V	156	£7.50
GUITAR TO SYNTH – music interface	157A/B	£9.95
<b>NOV 87</b>		
DUAL POWER SUPPLY – GCSE	158	£6.20
MIDI EXPANDER – Music Interface	159	£5.04

## THIS MONTH'S BOARDS

<b>DEC 87</b>		
RS 232C TO MIDI	160	£6.43
TEACHER RADIO – GCSE	161	£5.58





**REPORT BY  
TOM IVALL**

# INDUSTRY NOTEBOOK

## BRITAIN MUST CONTINUE TO CONTRIBUTE, TO BE HEALTHY

*Overseas companies bring work into the UK, adding to our prosperity and strengthening our role in electronics worldwide. But the UK must not neglect its native industry for quicker rewards from elsewhere.*

Good news for the end of the year: the indigenous UK electronics industry is doing reasonably well. By indigenous I mean companies founded in the UK, which are predominantly British-owned and whose fortunes are strongly linked to the economic health of this country. This category includes the big concerns like British Telecom, Ferranti, GEC, Plessey, Racal, STC, Thorn-EMI and a host of smaller firms too numerous to list here.

During 1986 I was reporting a whole series of poor financial results such as Racal's pre-tax profits plunging by over 30%, Ferranti's falling by 11% and — probably the nadir — the hitherto very successful company STC going into the red with a first-half loss of £8.7 million. But now these indigenous firms have largely pulled themselves out of their troubles.

STC, for example, has increased its pre-tax profit by as much as 46%, Ferranti by 22%, while Racal has pulled itself back by more than 11%. Even the temporarily loss-making Computer and Systems Engineering data communications company has reduced its previous year's loss of £14 million to £5 million (and is now predicting a profit).

It was sad, though, that Thorn-EMI had to resort to selling off its Ferguson business — a once-great name in radio and TV sets — to the French firm Thomson Grand Public. But there wasn't much hope of turning round the Ferguson losses of some £12 million in the face of the massive Far Eastern competition in electronic consumer goods.

You may well ask what is so important about these indigenous companies? Why follow their financial ups and downs with such concern? After all, it's often said that when the USA sneezes Britain catches a cold, and economically this is surely more significant than the affairs of a few home-grown electronics firms. And we do have subsidiaries of some excellent foreign electronics companies in the UK, bringing in advanced technology, providing employment and generally contributing to economic activity.

For example, to take three major competitor countries in this field, we have NEC Electronics from Japan, Siemens from West Germany and IBM United Kingdom from America. The last-mentioned alone has generated about 5000 jobs in UK manufacturing industry. Such foreign, often multi-national, companies also provide a useful spin-off in the form of business (and hence employment) for their multitude of suppliers in the UK.

This presence of foreign companies manufacturing in Britain is known as 'inward investment' and is often encouraged by the government through various incentives. It is genuine investment in that the foreign firms have to spend and risk money on their overseas ventures. But the point of an investment is to produce returns, and here's the rub as far as the host country is concerned. The benefits of larger markets (for Japanese companies the whole EEC), greater sales, higher volume production and hence economies of scale all go to the foreign firm. These benefits, and the 'repatriated' profits, help to boost the prosperity of some other country, not the UK.

But perhaps rather more negative is the fact that these chunks of the UK economy are controlled from outside Britain. A board of management in some foreign country can, at the stroke of a pen, simply close down a plant or shift it elsewhere, purely in the interests of that company. It does in fact happen, as we have seen recently during the world recession in semiconductors.

This kind of thing, although it may produce immediate job losses, does not shake the total economy too badly as long as it remains on a small scale. A good insurance against its effects is to maintain a strong indigenous electronics industry. Then, although we may be dependent on other countries for some products — as we are on the USA and Japan for standard integrated circuits — we are not dependent on them for everything. It's a matter of maintaining a workable balance.

There is no sure way to guarantee the existence and health of the indigenous electronics industry in Britain. The government can do a certain amount with financial grants, overseas trade assistance, placing of contracts etc. but in the end the outcome depends on the companies themselves. They have to stand up to world competition both in home and export markets, in order to keep their share of whatever business is going. That is why it is good news when we hear that the indigenous companies are doing better financially. While they are financially sound and producing adequate returns for their shareholders they are more likely to stay in the game.

What I have said could, of course, apply to any sector of British industry. But the situation is particularly crucial in electronics because this technology, and the production of goods and services resulting from it, is one of the industries of the future. Though not in its infancy like biotechnology, it obviously still has a long way to go. It is still an expanding part of the total world economy, and the current global rate of investment in research, development and new production techniques is an indication of what is to come. For the UK to drop out of the business through neglect, or be forced out by superior competition, would be extremely irresponsible.

However, I am not a nationalist, nor am I a techno-fetishist — a worshipper of technology for its own sake. Both of these aberrations have had unhappy effects on human life. There is now a much greater need for innovation and development in the social/personal sphere than in technology. The historian R.H. Tawney has written: "As long as men are men, a poor society cannot be too poor to find a right order of life, nor a rich society too rich to have need to seek it." We have to find a civilised balance between the material basis and the social consequences. Coming to terms with the realities of competition in today's world is just one aspect of good housekeeping.

**PE**

## PE BAZAAR

**Switch mode power supplies.** All 120V-240V (5V 20A,  $\pm 15V$  4A), 5 @ £35. (5V 20A,  $\pm 12V$  1.5A) £30. £3V-17V 12A, 6 @ £15. P. Lacey, Portsmouth 0705 266856.

**Telequipment D67 oscilloscope** £125. Evenings 01-360-4499. M. Applebaum, 36 Houndsden Road, Winchmore Hill, London N21.

**Wayne Kerr** multimeter, oscillator, peak meas. 10 valves 240V. Instr book, full diagrams. 80 lbs. Not used. £70. P. Sharp. Tel: 01-278-4393.

**For sale.** 741 12p, 555 14p, BC109 8p, 7400 14p. 100s more. SAE for list. 38 Dovedale Road, Nottingham, NG2 6JA. 0602-231395.

**Wanted.** Nelson-Jones tuner Mk2, working, non-working, parts, especially PCBs, tunerhead. Pay or exchange capacitance meter. 0248-722697.

**Silver Reed** four colour typewriter with six fonts, graphical mode and Centronics input. £75 o.n.o. R.T. Lovelock, 14 Knightley Road, Exeter, EX2 4SR. 0392-75896.

**Two parcels,** 400 new components (well assorted) plus large copper clad board £6.50 each (post free). K. Bailey, 40 Seymour Close, Selly Park, Birmingham. B29 7JD.

**Intracapt** colour bar generator £45. Sabatronics DMM £29. Tech G.D.O. £27. Phonosonics reverb unit £22.

R. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk. 0502-66026.

**Memotech MTX500 computer.** 32K RAM, assembler. Complete with all leads, manual and power supply. £50 o.n.o. M.W. Divall, 75 Panters, Hextable, Swanley, Kent, BR8 7RW. 0322-614459 (eve).

**Iriioms Tsusmin** switch mode power supply PCB  $\pm 5V$ , +12V, working. £10 o.n.o. 061-368-2168.

**UK101 computer,** 16 K memory, full colour, u-defined graphics, sound, numeric keypad, joystick. £50. Buyer must collect. D. Hunt, 1 Love Street, Kilwinning, Ayrshire. 0294-52250 (pm).

**Wanted.** Philips G8 TV service manual to exchange with Sony D-55T discman service manual. A. Dhada, 112 Headfield Road, Dewsbury, W. Yorks, WF12 9JG.

**Ex. Govt inverter** CLA-2500VA, input 27.5Vdc 150 amps. Output 1 Ph. 115V 400cy, 2500VA 0.90 P.F. Offers wanted. E.G. Priestley, 6 Lynden Avenue, Windhill, Shirley, BD18 1HF, W. Yorks. 0274-593382.

**U.V. exposure** unit for producing PCBs, 250 x 150mm max. Includes full instructions, hardly used. £35 + postage. A.L. Moulson, 0535-44325.

## PESE Semiconductor

Est. over 20 years

Obsolete, unusual transistors

1. We can source for you

OR

2. We can deliver from our own manufacturing

24 hour delivery

Full details available

Saarstr 66-D5500 Trier Germany

Tel: (49) 651-73270

Telex: 47260

### QUALITY COMPONENTS AND ACCESSORIES

Wide range of Multimeters from £8.00  
Altai ETC5000 Multimeter 50K $\Omega$ /V £28.60  
Altai Solder Pump £4.50 post free  
12" 150 watt 8ohm Guitar Power Speaker only £25 + £2.50 P&P  
SEND FOR FREE LISTS  
STRACHAN ELECTRONICS  
9 CROALL PLACE  
EDINBURGH EH7 4LT  
Tel. 031-556 9549

### DESIGN YOUR OWN PCBs

With our powerful drafting utility Available for Amstrad CPC464/664/6128  
Double sided boards up to 25x25 inch  
Powerful screen editing facilities  
Various track widths and pad sizes  
£17.99-Tape £19.99-Disc  
CADsoft system, 18 Ley Crescent, Astley, Tyldesley, Manchester M27 7BD

## PE BAZAAR

A free readers' advertising service

Name & Address:			

Please publish the following small ad. FREE in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules.

Signature ..... Date .....

**RULES** Maximum of 16 words plus address and/or phone no. Private advertisers only (trade or business ads. can be placed in our classified columns). Items related to electronics only. No computer software. PE cannot accept responsibility for the accuracy of ads. or for any transaction arising between readers as a result of a free ad. We reserve the right to refuse advertisements. Each ad. must be posted within one month of cover date. (One month later for overseas readers).

Send this form (or a photocopy of it) to  
PE Bazaar, Practical Electronics, 193 Uxbridge Road, London W12 9RA.

Microkit Ltd



0536 744664  
24-HR 7 DAYS/WEEK

CMOS	74LS	74HC
00	20	25
02	20	25
04	20	25
08	20	25
10	20	25
14	20	29
20	20	29
32	20	35
74	20	38
86	20	48
		47
		49
		49
138	40	49
139	40	49
157	40	55
158	40	55
163	55	55
166	60	60
175	55	55
193	60	75

**SAVE OVER 40% ON OUR EX EQUIPMENT MEMORIES AND EPROMS**  
1000's of delighted customers  
**GUARANTEED UV ERASED AND TESTED**  
4116 16K x 8 £0.75  
**EPROMS**  
2716 2K x 8 £1.50  
2732 4K x 8 £1.20  
2764 8K x 8 £1.50  
27128 16K x 8 £1.75  
All taken from working boards. Try some. You will SAVE POUNDS!!!!

MEMORIES		
DRAM 5V NMOS		
4164	64K x 1	£0.88
41256	256K x 1	£2.39
4416	16K x 1	£2.80
41464	64K x 1	£2.40
SRAM 5V NMOS		
2114LP	1K x 4	£1.50
2128LP	2K x 8	£2.50
SRAM 5V CMOS		
6116LP	2K x 8	£1.30
6264LP	8K x 8	£2.40
62256LP	32K x 8	£14.50
EPROM 5V NMOS		
2716	2K x 8	£2.70
2732	4K x 8	£2.65
2764	8K x 8	£2.45
27128A	16K x 8	£2.70
27256	32K x 8	£3.75
27512	512K x 8	£8.20

ADD VAT AT 15%. ORDERS UNDER £25 P&P £1. OVER £25 POSTAGE FREE.  
ORDERS DISPATCHED SAME DAY BEFORE 3.30 PM.

DEPT (P6), 18A COLDERMEADOW AV., CORBY, NORTHANTS NN18 9AJ.

### AFFORDABLE, EASY AND SIMPLE.

Complete SATELLITE T.V. receiving system for £339.00 + VAT.		
1.2 metre system .....	£439.00 + VAT.	
Dishes: complete with stand & mount.		
0.9 m Spun aluminium .....	£55.00	£45.00
1.2 m Spun aluminium .....	£85.00	£65.00
LNB Converter .....	1 of	10 of
Swedish Microwave (NF 2.1 dB) .....	£129.00	£99.00
SATELLITE Stereo Receiver .....	1 of	10 of
model Rockdale - TR12E .....	£145.00	£129.00
Polarotors unit .....	1 of	10 of
Feed Horn ariel .....	£40.00	£30.00
	1 of	10 of
	£15.00	£12.00

All prices exclusive of VAT & carriage.

Please phone for a catalogue or visit our showroom for a demo.  
ROCKFORT PRODUCTS, 81 CHURCH ROAD, LONDON NW4 4DP.  
Tel: 01-203 0191. (Trading division of Vignesh Ltd.).

# FULL-TIME TRAINING COURSES

**2 YEAR**  
**BTEC National Diploma (OND)**  
**ELECTRONICS AND COMMUNICATIONS ENGINEERING**  
*(TV, Computers, Programming, IT)*

**1 YEAR**  
**BTEC National Certificate (ONC)**  
**ELECTRONIC EQUIPMENT SERVICING**  
*(TV, Video, CCTV)*

**COMPUTING TECHNOLOGY**  
*(Microprocessors, DataComms, Interfacing)*

**INFORMATION TECHNOLOGY**  
*(Telecomms, Satellite TV, CD, Networks)*

**SOFTWARE ENGINEERING**  
*(Assembler, BASIC, PASCAL, CAD/CAM)*

COURSES COMMENCE  
 11th January & 25th April 1988

## LONDON ELECTRONICS COLLEGE

Dept: AA, 20 Penywern Road,  
 London SW5 9SU. Tel: 01-373 8721

MANUFACTURERS OF METAL CASES  
 Front panels professionally silk screen printed to your own design.  
 Positive transparencies available for PCB track layout from April 87 Issue.  
 Please enclose £5.75 per Track for 2/3 day service.  
 Send details of your requirements for a quotation.

**PAYNE ELECTROPRINT LTD**  
 Marcus Road, Dunkeswell,  
 Honiton, Devon EX14 0RA.

**THE SCIENTIFIC WIRE COMPANY**  
 811 Forest Road, London E17. Telephone 01-531 1568

ENAMELLED COPPER WIRE			
SWG	1 lb	8 oz	4 oz
8 to 34	3.63	2.09	1.10
35 to 39	3.82	2.31	1.27
40 to 43	6.00	3.20	2.25
44 to 47	8.67	5.80	3.49
48	15.96	9.58	6.38

SILVER PLATED COPPER WIRE			
	1 lb	8 oz	4 oz
14 to 30	10.10	5.20	2.93

TINNED COPPER WIRE			
	1 lb	8 oz	4 oz
14 to 30	3.97	2.41	1.39

Fluxcore Solder 5.90 3.25 1.82 0.94  
 Post Free. Please add V.A.T. at 15%. Orders under £3.00 add 50p SAE for list of copper and resistance wire.  
 Dealer enquiries welcome.

## OMNI ELECTRONICS

stock a wide range of electronic components at  
**174 Dalkeith Road**  
**Edinburgh EH16 5DX**  
**Tel: 031 667 2611**  
 situated midway between  
 Commonwealth Pool  
 and Cameron Toll

Carbon Film Resistors 1/4W E24 series 0.51R to 10MΩ - 1p  
 100 off per value - 75p 1000 off in even hundreds per value - £7  
 Metal Film 1/4W 10R0 to 1MΩ 5% E12 series - 2p 1% E24 series - 3p  
 1/2Watt metal/carbon film E24 series 1R0 to 10MΩ - 11p  
 1 Watt metal/carbon film E12 series 4R7 to 10MΩ - 5p  
 BC107/8/9 - 12p BC547/8/9 - 8p BC182L 184L - 10p  
 BFY50/51/52 - 20p 2N3055 - 50p TIP31A, 32A - 25p TIP41, 42 - 40p

Tantalum head subminiature electrolytics (Mids/Volts)  
 0.1/35, 0.2/35, 0.4/35, 0.7/35, 3.3/16, 4.7/16 - 14p 4.7/35 - 15p  
 2.2/35, 4.7/25, 10/5 - 15p 4.7/35, 6.8/16 - 16p 10/16, 22/6 - 20p  
 22/16 - 30p 33/10 - 30p 47/10 - 35p 100/6 - 40p

Aluminium Electrolytics (Mids/Volts)  
 1/50, 2.2/50, 4.7/25, 4.7/50, 10/16, 10/25, 10/50 - 5p 22/16, 22/25 - 6p  
 22/50, 47/16, 47/25, 47/50 - 6p 100/16, 100/25 - 7p 100/50 - 12p  
 100/100 - 14p 220/16 - 18p 220/25, 220/50 - 10p 470/16, 470/25 - 11p  
 1000/25 - 18p 1000/35, 220/25 - 22p 4700/25 - 70p

Miniature Polyester Capacitors 250V Wkg. Vertical Mounting  
 .01, .015, .022, .033, .047, .068 - 4p 0.1 - 5p 0.15, .22 - 6p 0.47 - 8p

Mylar Capacitors 100V Wkg. Vertical Mounting E12 Series  
 1000p to 8200p - 3p .01 to .068 - 4p 0.15p 0.15, 0.22 - 6p

Subminiature Ceramic Plate 100V Wkg. E12 Series Vertical Mounting  
 2% 1P8 to 47P - 3p 56P to 330P - 4p 10% 390P to 4700P - 4p  
 Ceramic plate/disc E6 Series 50V 22P to .047 - 2p

Polystyrene Capacitors 63V Wkg. E12 Series Axial Mounting  
 10P to 820P - 3p 1000P to 10,000 - 4p 12,000P - 5p  
 1N4148 - 2p 1N4002 - 4p 1N5404 - 14p W01 bridge - 25p  
 0A91 - 6p AA143 - 8p W005 - 20p 1N4006 - 6p  
 Zener diodes E24 series 3V3 to 33V 400mW - 8p 1 watt - 12p  
 L.E.D's Red, Green & Yellow 3mm & 5mm - 10p 8mm - 35p  
 20mm fuse 0.1A to 5A quick blow - 5p Anti Surge - 8p  
 High Speed drills 0.8mm, 1.0mm, 1.3mm, 1.5mm, 2mm - 25p  
 Expo Reliant drilling machines 12V d.c. with improved 3-jaw chuck 6.50  
 Nicads AA - 80p HP11 - £2 PP3 - £4.20 Universal Chargers - £6.50  
 Glass reed switches single pole make contacts - 8p Magnets - 12p

VAT inclusive. Return postage 20p (free over £5). Lists free.

**THE C.R. SUPPLY CO.,**  
 127 Chesterfield Road,  
 Sheffield S8 0RN. Tel. 557771.

## TURN YOUR SURPLUS

ICS transistors etc into cash, immediate settlement. WE also welcome the opportunity to quote for complete factory clearance.  
 Contact **COLES-HARDING & Co,**  
 103 South Brink, Wisbech, Cambs.  
**ESTABLISHED 15 YEARS**  
 Tel: 0945 584188

## ESR ELECTRONIC COMPONENTS

- Velleman Electronic Kits
- Test Equipment & Tools
- Instrument Cases

(Mon-Sat. 9.30-5.30 Closed Thurs)

13A Station Rd, Cullercoats, North Shields,  
 Tyne & Wear NE30 4PQ. Tel. 091 251 4363

## SURPLUS/REDUNDANT ELECTRONIC COMPONENTS WANTED

I/CS - Tuners - Transistors - Valves - Diodes etc. any quantity considered - immediate payment.

**ADM ELECTRONIC SUPPLIES**  
**Tel: 0827 873311**

## NEW ZERO INSERTION FORCE CONNECTORS

24, 28 or 40 way. Tin or gold plate.  
 eg. 1 x 24T £4.25 ea.  
 10 x 24T £3.54 ea.

## AUDIBLE/VISUAL CONTINUITY TESTER

(probe current 0.1 ma) at £9.85.  
 Resist coated PCB's, 12v dc drills + accessories, meters, elapsed timers, tools + many other items.  
 Indicate area of interest + S.A.E. to **JASP INTERNATIONAL**  
 14 Tudor Close, Wokingham,  
 Berks RG11 2LP  
 Tlx 849021

(Trade enquiries welcome)  
 Agents req. UK, Canada, Australia & New Zealand.

## d.c. electronics

THE Source For All Your Component Requirements.

ALL components are professional grade, brand new with manufacturers marking and guarantee.

**SPECIAL BARGAINS - ONLY £1 EACH**

- 200 0.25W resistors, mixed values (max 5 your choice)
- 50 0.4W resistors, mixed values max 5 your choice)
- 40 1N4148 computer diodes
- 30 1N4001 1A power diodes
- 15 BC182L NPN transistors
- 15 BC212L PNP transistors
- 30 Ceramic plate caps - you specify value
- 10 Electrolytic caps 47-470uF - you specify value

Only our catalogue can tell the full story - send SAE (9x6) for your FREE copy now.

**Dept. P, 34 The Platters, Rainham, Kent, ME8 0DJ.**

Mail order only, cash, PO or cheque with order.  
 60p P&P. Prices incl VAT.

**Panel Meters, Multimeters, Microphones Transformers Computer Leads, Ni-Cad Batteries.**

Send £1 for illustrated Colour Catalogue.  
 M. Dziubas  
 158 Bradshawgate  
 Bolton  
 Lancs.

Free Membership to a new national electronics club. For details and a free pack of components worth over £10 send only £1 p&p to Dept PE Woodside, Dowsett Lane, Ramsden Heath, Billericay, Essex CM11.

## KAYCOMP EXPANSION BOARD

provides fully buffered buses to allow off-board memory expansion to 14 megabytes. Complete kit £45.00.  
 Motorola I.C's, 6881 Maths Chip & Skt £195.00; 68000P8 8Mhz Processor £19.00; 68000L12 12Mhz Processor £50.00; 68230 P.I.T. £6.95; 68681 Duart £6.95; Data £2.00. **Havant Micro's, 36 Chalton Crescent, Leigh Park, Havant, Hants PO9 4PT.**

## UNIQUE REPAIR DATA with CIRC'S Video or Mono TV £10.50: CTV £12.95

Sinclair Spectrum Repair/Service £5  
**SERVICE SHEETS - Radios, Mono TV., Rec PL, Cas.R. £2.50 +/sac.**  
 CTV or any combi £3.50 +/sac  
 Worlds largest stockist any equipment data/sac brings quotes/price list - or £3 for set of catalogues with £4 worth of vouchers  
**PHONE 0698 884585 FOR FAST QUOTES**  
**TISPE 76 CHURCH ST, LARKHALL ML9 1HE LANARKSHIRE.**

## SERVICES

PCB's. Cheap quotes for fine quality boards. Fast service. Send track layout, photocopy, or enquiry to: **PCS, 290 Stanstead Road, Hoddesdon, EN11 0RX.**

**HEATHKIT U.K. SPARES AND SERVICE CENTRE.** Cedar Electronics, Unit 12, Station Drive, Bredon, Tewkesbury, Glos. Tel. (0684) 73127.

## MISCELLANEOUS

**CLEARING LABORATORY,** scopes, generators, P.S.U.'s, bridge analysers, meters, recorders etc. Tel. 0403-76236.

**DELUXE WALKIE TALKIES** 49Mhz, long range, satisfaction or refund. £24.99/pair (normally £31.49), 48hrs delivery. Xenon (Dept PE9) 24 Wharnclyffe Street, Barnsley, Yorkshire.

# INDEX

## JANUARY 1987 TO DECEMBER 1987

# VOLUME 23

# Constructional Projects

**Analogue to Digital to Analogue** by J Becker. General purpose audio ADA converter and part 1 of the POLYWHATSIT effects unit.

May

**Bio-Feedback** by the Prof. Experimental brain wave control circuit.

May

**Bright Fuzz** by R Rockett. Foot operated guitar overdrive distortion unit.

May

**Car Alarm - Vigilante** by M Delaney. Keep your car alert to intruders - build a box to fox them.

April

**Corridor Light Control** by G Read. Preset automatic lamp cutoff controller.

September

**Deaf Alarm** by T Pinnell. Novel alarm system for deaf or heavy sleepers.

January

**Eprom Programmer** by M Harvey. Computer controlled unit for 4K Eproms.

October

**Event Counter** by J Becker. Plug in counter with 4-digit display for the PE Geiger radiation monitor, and other pulse generating units.

July

**Fibre Optic Light Pen** by R Penfold. Using fibre optic cable to concentrate target area for greater precision.

March

**Fungen** by A Armstrong and R Keely. Fundamental three waveform signal generator.

September

**Guitar to Synth Interface** by R Penfold. Interface for controlling a synth from a guitar.

October

**Inductive Loop Control** by the Prof. Experimental remote control for models via a cable loop.

April

**Infra-red Transceivers** by the Prof. Experimental cordless headphone transceiving circuits.

June

**Ingenuity Unlimited - Lecture Talker Timer** by P Thompson.

January

**Ingenuity Unlimited - Logic Monitor** by J Hester.

June

**Ingenuity Unlimited - Luxmeter** by P Thompson.

January

**Ingenuity Unlimited - Tachometer** by K Wevill.

June

**Interrupting the BEEB** by D Berry. Practical diagrams and programs for external control of BBC interrupt routines.

July

**Intruder Alarm Controllers** by B Kent. A choice of simple or multizone intruder deterrents.

November-December

**Micro-Chat** by M Harvey. Computer driven speech synthesiser.

September

**Microforum - Amstrad RS232 Interface** by S Dean.

January

**Microforum - BEEB Brake** by J Nolan. A slow down device for the BBC.

February

**Microforum - Eprom Programmers** by S Burkitt. Two interfaces for the Amstrad.

April

**Microforum - RAM Driver** by S Winder. Offering low cost memory expansion for the BBC B.

March

**Microforum - ZX Spectrum** by P Small. Two extra ports.

June

**Micro-tuner** by J Becker. Accurate computer controlled (BBC, PET, C64) musical tuning aid and frequency counter.

March

**Editorial** monthly views and comments from the Editor.

**Industry Notebook** by T Ivall. Monthly series looking at the electronics industry.

**Leading Edge** by B Fox. Monthly series looking at technology behind the news.

**Spacewatch** by Dr Patrick Moore OBE. Monthly series of astronomy reports.

**Bazaar** Regular readers' free advertising service.

**Bookmark** Reviews of books received. January, then monthly series from July

**MIDI Converter** by R Penfold. Converts RS232C data to a MIDI format.

December

**MIDI Expander** by R Penfold. A digital distributor for MIDI control of multiple instruments.

November

**Motor Controller** by M Stuart. Controls d.c. motors from a computer 8-bit output port.

November

**Polywhatsit! Part 1** by J Becker. General purpose analogue to digital to analogue converter.

May

**Polywhatsit! Part 2** by J Becker. Remarkable digital music effects controller for use with the ADA in part one.

June

**Power Supply (Dual)** by D Silvester.  $\pm 15V$  up to 1.5A.

October

**Power Supply - Hi-Stab** by M Delaney. A superb workshop PSU.

February

**Promenader-Parts 2 and 3** by M Delaney. Multichannel programmable display controller.

January-February

**Pseudo Stereo** by the Prof. Splits mono into simulated stereo channels.

August

**Scope Store** by R Penfold. Compact self-contained digital storage for an oscilloscope.

July

**Speech Processor** by the Prof. Clarifies transmitted speech signals.

September

**Surround Sound** by the Prof. Experimental stereo to four channel separation adapter and enhancer.

March

**Switch Mode PSUs** by R Penfold. Three practical circuits illustrating SMPSU principles.

April

**Switch Mode PSU** by A Armstrong. More merits of SMPSUs, plus example of a flyback converter.

August

**Synthesised AF Signal Generator** by R Penfold. A superb constructional project complementary to the Frequency Synths design feature.

June

**Teacher Locker** by T Pike. GCSE theory and project - Digitally coded locks.

October

**Teacher Power** by T Pike. GCSE theory and project - Power supplies.

November

**Teacher Radio** by T Pike. GCSE theory and project - Radio reception.

December

**Teacher Timer** by T Pike. GCSE theory and project - Timing circuits.

September

**Telephone Bell Repeater** by G Read. Relays the sound of the phone to where you want it.

March

**Ultrasonic tape measure** by the Prof. Experimental medium range measurement project with 1 centimetre resolution.

March

**Video Fader** by R Penfold. Allows simple signal modification and video mixing.

January

**Word Generator** by J Chamberlain. A highly versatile item of test equipment for generating a binary word of up to 16 bits

July-August

**Voice Scrambler** by the Prof. Experimental project for telephone systems or recording using frequency inversion techniques.

January

**30+30 Amplifier** by G Nalty. High quality stereo hi-fi amplifier.

February-April

## Regular Features

**Catalogue Casebook** Monthly list of catalogues received.

**Chip Count** Monthly list of new chip details received.

**Countdown** Monthly list of forthcoming exhibitions.

**Logic Puzzles** Monthly series of brain testers, from April.

**News and Marketplace** Monthly series detailing new products and services.

**Readers' Letters** Expressing your views, and a few replies. Regular series from August.

# Special Features

**Autobutler** by R Mishra. Unweaves a delightfully told predictive tale showing how technologically aided humanity might someday be free to enjoy living. **July**

**Battery Update** by R Cooper. A follow-up to the 1986 series of articles on batteries. **May**

**Click Eliminators** by the Prof. The design theory behind pulse blankers. **October**

**Component Technology** by G Nalty. Merits of high quality components for Hi-Fi. **August-September**

**DC Motors** by B Brooks. Their principles, characteristics and applications. **March-April**

**Electrical Safety** by R Stuart. Vital points relating to mains safety make essential reading. **May**

**Flight 68K - Review** by R Penfold. Independent examination of a comprehensive commercial microprocessor development and teaching system. **July**

**Frequency Synthesizers** by the Prof. What they are and how they are used in numerous applications. **June**

**Hi-Fi Design** by G Nalty. Circuit ideas and considerations for true hi-fi enthusiasts. **January**

**Lasers and Optic Fibres** by B Fox. A look at the history and present day techniques of communications by light. **November**

**Liquid Crystal Displays** by R Penfold. Applications of LCD technology. **February**

**Microwaves** by A Armstrong. The use and nature of microwaves - two technology applications reports. **January-February**

**Midi Interfacing** by the Prof. Musical instrument control via dedicated data links is simpler than you might think. **September**

**Oscillators** by A Armstrong. A technical discussion about various types of oscillator, with circuits. **May**

**Power Supplies - Low Drop Out** by B J Frost. Designing battery powered PSUs for test and development use. **February**

**Printing PE** by J Becker. The Editor's discovery browse around look behind the scenes at the printing presses. **June**

**Programmable Logic Devices** An explanatory series of articles. **October - November**

**Red Boxes - Review** by R Stuart. Computer add-ons for various home control applications, particularly security. **February**

**Robotics in Classrooms** by L Hamburg. A tutor's experience of teaching analysis techniques through robot control. **November**

**Semiconductors** by A Armstrong. A series of articles demystifying the business of choosing and using semiconductors. **November-December**

**Sensors - Part 1.** by the Prof. Hall effect, gas, light and strain sensing devices. **April**

**Sensors - Part 2.** by the Prof. Thermocouples, pH probes, and pyro sensors are looked at in detail. **May**

**Signal Processing - Part 1** by the Prof. Analogue signal handling, with special regard to Dolby, companding, noise gates and delay lines. **July**

**Signal Processing - Part 2** by the Prof. Digital sampling. **August**

**Solar Cells** by I Garner. Practical devices and techniques for harnessing solar energy in consumer applications. **December**

**Stebus Specs** by R Whitlock. Part Two. Read and Write timing details. Part Three, final details. **January-February**

**Surface Acoustic Wave Devices** by A Armstrong. Examines the technology and various applications of SAW devices. **March**

**Switch Mode Power Supplies** by R Penfold. Explains the design principles involved in SMPUs. **April**

**Telephones** by B Drake. A historical look at how telephone networks came about, and how they may develop. **December**

**TV Receivers** by M Sanders. An inside look at the processing techniques used within The Box. **June**

**Ultrasonics in Measurement** by the Prof. Discussion of experimental considerations. **February**

**Woodpecker** Further information on Russian high power transmissions. **August**

**30+30 Amplifier-Review** by R Penfold. An independent critique substantiating performance claims. **February**

## Summary Points 1987

### AMSTRAD EPROM PROGRAMMER (Apr 87)

Fig 1. IC1 pin 12 links to IC1 pin 11. On IC2 CF should read FF, CX should read EX. On IC3 pin 26 is Vcc. FBXX-FBXX should read F8XX-FBXX. Point FX on IC2 pin 9 is not normally connected, but is a decoded port address for FO-FF hex which can be used in place of the EX address (IC2 pin 11) if this clashes with other equipment. Expansion port WR pin 36 should read pin 33.

Fig 2. A11, A12 A13, CSEL, PULSE are pins 17, 13, 12, 11, 10 respectively of Port C. ZIF socket +5V is pin 28, GND is pin 14.

### CORRIDOR LIGHT CONTROL (Sept 87)

It is essential to ensure that correct mains wiring polarity is observed, and that the unit is preceded by a switch that can isolate it from the mains.

### FIBRE-OPTIC LIGHT PEN (Mar 87)

Fig 2. TR1 and TR2 labels should be exchanged.

### FIBRE-OPTIC LINK (Oct 86)

The opening line should read 'TR3 is the phototransistor, and it is given a small forward bias by R9'.

### FUNGEN (Sept 87)

The correct component values are those on the circuit diagram Fig 3 page 36. In Fig 4 all transistor pins should read CBE when viewed from top, flat facing left, clockwise from top.

### INFRARED TRANSCIEVERS (Jun 87)

Fig 3. R7 goes to IC2 pin 11.

### MICRO-CHAT (Aug to Sept 87)

Fig 4 page 16 (PCB details). Orientation of IC2 and LP1 should be reversed. TR1 goes in holes above R3, pins reading CBE.

### POLYWHATSIT (June 87)

Fig 2. IC18 pin 1 goes to 0V. IC18 pin 9 goes to pins 9 of IC10-IC12. The PCB is correct. There are minor apparent differences between the switch wiring in Fig 2 and Fig 5; Fig 5 is correct. These corrections do not affect the correct functioning of the unit.

### PROMENADER (Dec 86 to Feb 87)

The capacitor across R9 on the PCB is C19 at 10 $\mu$  16V. C10 is 10 $\mu$  16V. R21 is 4k7. R26 is 10k.

### SCOPE STORE (Jul 87)

Fig 3. Polarity of D3 and D4 should be reversed. C12 should go to junction of D1 and D2 (cut track from C12 to D1, then hardwire it to correct point). Parts list, C9 and C10 should be 100 $\mu$ F 16V electrolytic, and omitted C11 is 100p ceramic plate.

### SWITCH MODE PSU (Apr 87)

Pages 28 and 29: diagrams for Figs 5 and 7 should be transposed. Pages 35 and 37: Figs 2 and 7 should be transposed.

### TEACHER POWER (Nov 87)

Fig 15 page 40 (PCB details). Ignore note about IC2 leg swapping. The PCB is correct but the leg labelling should read from left to right as "Out, In, Com".

### TELEPHONE BELL REPEATER (Mar 87)

Fig 3. Bridge rectifier BR1, top RHS pin should be a.c., bottom RHS pin should be negative. C2 LHS pin is positive.

### VIDEO FADER (Jan 87)

Fig 5. The polarity of C2 should be reversed.

### VIGILANTE CAR ALARM (Apr 87)

Gremlins crept in overnight on pages 24 and 25! Anybody who is puzzled about the wording continuity should send a stamped addressed envelope for a copy of the pages as they should have been.

### ZX SPECTRUM PORT (Jun 87)

IC3a and IC3b symbols should be OR gate symbols.

### 30+30 AMPLIFIER (Mar 87)

Fig 1. 'Right -VE from C35' should read 'Right -VE from C36'. 'Left +VE from C36' should read 'Left +VE from C35'. R124 (middle LHS) should be R144. C32 and C132 go into spare holes by IC2 and IC102 respectively. R15 goes into spare holes below C5, C8 then goes where R15 is marked.

# TRANSFORMERS EX-STOCK

MAINS ISOLATORS				60/30V or 30-0-30V				AUTOS					
Pri/Sec 120Vx2 OR				2x30V Tapped Secs				105, 115, 220, 230, 240V					
220/240V OR 415/440V								For step-up or down					
(SEC 440V OR 240V OR 110V C. Tap)													
20VA	£7.60	P 2.18		60V	30V	£	P&P	80VA	£5.86	1.70			
60	11.51	& 2.31		1	2	8.67	1.91	150	8.49	1.85			
100	13.43	P 2.59		2	4	11.15	2.20	250	10.34	2.98			
200	19.03	3.10		3	A	6	16.12	2.34	500	16.12	1.96		
250	23.01	3.24		4	M	8	18.38	2.55	1000	28.79	P 3.25		
500	35.45	3.66		5	P	10	23.23	2.78	1500	34.17	& 3.68		
1000	64.28	4.62		6	S	12	26.50	3.02	2000	51.09	P 4.62		
1500	82.92	5.95		8		16	37.25	3.65	3000	86.88	5.72		
2000	99.76	6.36		10		20	43.37	3.99	4000	112.78	OA		
3000	139.39	OA		12		24	49.98	4.65	5000	131.33	OA		
6000	296.89	OA							7500	202.71	OA		
									10KVA	239.53	OA		

50/25V or 25-0-25V				12V				24V				CASED AUTOS			
2x25V Tapped Secs				2x12V Secs. Pri. 240V				240V Cable Input				115V USA socket outlets			
50V	25V	£	P&P	12V	24V	£	P&P	20VA	£8.34	1.76					
0.5	1	5.01	1.76	0.3	0.15	2.92	1.10	80	11.33	1.87					
1	2	6.09	1.90	0.5	0.25	3.06	1.60	150	14.67	P 2.20					
2	A	4	10.84	1	0.5	3.70	1.60	250	17.87	& 3.02					
3	M	6	12.54	2	1	5.15	1.70	500	29.32	P 3.19					
4	P	8	17.16	2	2	5.94	1.90	1000	41.85	4.34					
6	S	12	21.84	2	4	10.89	2.10	2000	73.33	5.28					
8		16	30.89	2	8	15.73	2.80	3000	105.26	OA					
10		20	36.66	3	10	21.17	3.04								
12		24	43.87	3	15	26.31	3.10								
				3	20	37.56	3.75								
				3	30	53.92	4.90								
				3	40	62.09	5.65								

30/15V or 15-0-15V				INVERTERS				110V to 240V Cased Transformers					
2x15V Tap Secs				12/24V DC to 240V AC				Now Available					
30V	15V	£	P&P	100W to 4kW				Full range AVOs MEGGERS					
0.5	1	3.86	1.41	CONSTANT VOLTAGE TRANSFORMERS FOR Spike-free stable mains				TOROIDALS Wound to Order					
1	2	5.24	1.70	ALSO VALVE MAINS OUTPUT & MATCHING TRANSFORMERS				PLEASE ADD 15% VAT TO ALL ITEMS AFTER P&P					
2	4	8.47	1.92	WINDING SERVICE 3VA TO 18KVA									
3	6	9.82	2.10	Stock items by return									
4	A	8	11.72										
5	M	10	14.49										
6	P	12	18.40										
8	S	16	21.95										
10		20	25.32										
12		24	28.07										
15		20	31.66										
20		40	43.22										

Unit 211, Stratford Workshops, Burford Road, London E15 2SP  
**BARRIE ELECTRONICS LTD**  
 Tel: 01-555 0228 (3 lines)

VISA
Xen-Electronics
0983 292847

I.C.S.					
4001UB	12	+8 1.5A	68	18 Way	36
4011UB	12	+12 1.5A	39	20 Way	40
4011UB	12	+15 1A	36	22 Way	44
4011	12	+24 1A	58	24 Way	48
4017	31	-5 1A	39	28 Way	56
4028	29	-12 1A	2.10	40 Way	80
4040	38	-15 1A	39		
4053	37	-24 1A	39		
4066	19	+5 0.1A	28		
4081	12	+8 0.1A	28		
Z80ACPU	1.85	+12 0.1A	28		
Z80APIO	1.68	+15 0.1A	35		
7217PI	4.00	-5 0.1A	30		
8402PL	7.30	-12 0.1A	30		
555	41	-15 0.1A	30		
558	3.30				
741	25				
LM380N	1.87				
TL074CP	51				
SG3526N	3.69				
SG3562J	4.92				
SL485DP	2.20				
SL490DP	2.13				
ML926DP	3.04				

Diodes					
1N4001	05	BC107	16	100µF 25V	.18
1N4003	05	BC108	21	470µF 10V	.22
1N4005	05	BC109C	19	100µF 63V	.31
1N4007	06	BC182	05	0.022µF 63V	.08
1N5401	12	BC212	05	0.047µF 100V	.08
		BC546B	04	0.1µF 63V	.08
		BC556A	04	0.15µF 63V	.17
		BD233	42	0.33µF 63V	.33
		BF515	54	0.47µF 63V	.17
		BF259	58		
		BSR50	49		
		IRF840	1.61		
		IRF840	4.10		
		J112	57		
		MTP8N10	1.44		
		TIP121	34		
		TIP126	34		
		TIP31C	30		
		TIP32C	30		
		2N2646	1.18		
		2N3055	47		

Zener Diodes					
2V7	4W	05			
5V1	4W	05			
7V5	4W	06			
9V1	4W	06			
10V	4W	05			
11V	4W	05			

I.C. Sockets					
6 Way	05				
9 Way	07				
14 Way	11				
16 Way	13				
18 Way	15				
20 Way	16				
22 Way	18				
24 Way	20				
28 Way	23				
40 Way	32				
Turned Pin					
6 Way	13				
8 Way	16				
14 Way	28				
16 Way	32				

LED's					
3mm Dia					
Red	13				
Green	12				
Orange	21				
Yellow	15				
3mm Dia.					
Red	13				
Green	13				
Orange	21				
Yellow	13				

Fixed Voltage Regulators					
+5 1A	36				
+5 1A	36				

Connectors					
D type Solder					
9W Skt	43				
9W Plug	38				
9W Cover	98				
15W Skt	60				
15W Plug	53				
15W Cover	107				
25W Skt	60				
25W Plug	53				
25W Cover	116				

PCB Mount					
15W Skt	1.02				
15W Plug	.39				
25W Plug	2.15				

Capacitors					
Radial Lead					
2.2µF 50V	06				
2.2µF 63V	11				
4.7µF 63V	06				
33µF 16V	04				
47µF 10V	06				
47µF 25V	06				
47µF 63V	08				
47µF 100V	17				
10µF 35V	06				
10µF 63V	06				
22µF 10V	21				
470µF 16V	25				
470µF 50V	40				
470µF 63V	63				
1000µF 10V	23				
1000µF 16V	27				
2200µF 16V	45				
AXIAL LEAD					
4.7µF 63V	06				
10µF 35V	11				
47µF 25V	10				

Resistors					
Carbon Film					
0.25 Watt 5%					
1Ω To 10MΩ					
0.5 Watt 5%					
10Ω To 10MΩ					
each 04					

Transistors					
BCD (N/C)					
GM472W					1.95
(4.7KΩ)					

Photoresistors					
PLH Mount					
Corner Top Adj					
100Ω	.30				
1KΩ	.30				
5KΩ	.30				
10KΩ	.50				
20KΩ	.50				
100KΩ	.50				
200KΩ	.50				

Project Kits					
RS232 to Centronics Converter					
KIT Only	18.40				
Z80 Based Controller Board 4MHz					
KIT Only	20.45				
Ultrasonic Tape-measure (Display-Module Extra)					
KIT Only	23.52				
Four Digit LCD-Module for above					
KIT Only	14.30				

Who says we never give anything away?  
 An offer which can only last until stocks are exhausted  
**The Electronic Industry Telephone**  
**Code Book and Diary 1988**  
 Yours absolutely free when you next place an order worth £25 or more.  
 Alternatively you can order the diary on its own at a price of £7.25. Zero rated  
 Order now and Don't be caught without!!!!

Mail or Telephone Orders Only Please To: Samuel Whites Estate, Bridge Road, Cowes, Isle of Wight, PO31 7LP  
 Please Add £1 For 1st class Post and Packaging, and 15% VAT to Total Stock Listing available soon. Please send  
 SAE to be put on the mail list.

## INDEX TO ADVERTISERS

A.D.M. Electronic Supplies	59	Keytronics	31
Astronomy Now	47	London Electronics	
Airlink Transformers	33	College	59
Audiokits	49	Magenta Electronics	IFC
Barrie Electronics	62	Maplin Electronics	OBC
BiPak Components	24	Microkit	58
B.K. Electronics	IBC	M.S.C.	49
Bryants Acoustix	30	Omni	59
Bull J.	7	Payne Electroprint Ltd	59
Cadsoft Systems	58	Phonosonic	55
Classified Ads	59	Riscomp	30
Coles Harding	59	Rockfort	58
Cricklewood Electronics	34	Scientific Wire Co.	59
Crofton Electronics	49	S.C.S.	49
C.R. Supply Co.	59	Service Trading Co.	62
C-Scope	48	Sherwood	24
D.C. Electronics	59	Smith Electronics	33
Display Electronics	23	Specialist Semiconductors	18
Electronize Design	33	Strachan	58
E.S.R.	59</		

# OMP POWER AMPLIFIER MODULES

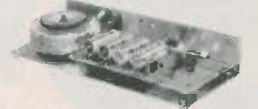
## OMP POWER AMPLIFIER MODULES

Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi, etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof.

Supplied ready built and tested.



**OMP 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz -3dB, T.H.D. 0.01%, S.N.R. -118dB, Sens for Max output 500mV at 10K, Size 355 x 115 x 65mm. PRICE £33.99 + £3.00 P&P.**



**OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. -125dB, Size 300 x 123 x 60mm. PRICE £39.99 + £3.00 P&P.**

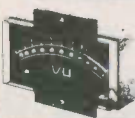


**OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. -130dB, Size 300 x 150 x 100mm. PRICE £62.99 + £3.50 P&P.**



**OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz -3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. -130dB, Size 330 x 147 x 102mm. PRICE £79.99 + £4.50 P&P.**

NOTE: Mos Fet's are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV) If required P.A. version (50KHz bandwidth & Input Sensitivity 775mV) Order - Standard or P.A.



**Vu METER** Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.F.D. diodes (7 green 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 x 27 x 45mm. PRICE £8.50 + 50p P&P.

**LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.** Cabinet Fixing in stock. Huge selection of McKenzie Loudspeakers available including Cabinet Plans. Large S.A.E. (28p) for free details.



**POWER RANGE**  
8" 50 WATT R.M.S. Hi-Fi/Disco.  
20 oz magnet. 1 1/2" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.  
12" 100 WATT R.M.S. Hi-Fi/Disco.  
50 oz magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

**McKENZIE**  
12" 85 WATT R.M.S. C1285GP Lead Guitar/Keyboard/Disco.  
2" ally voice coil. Res. Freq. 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £29.99 + £3.00 P&P ea.  
12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.  
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £31.49 + £3.00 P&P ea.  
15" 150 WATT R.M.S. C15 Bass Guitar/Disco.  
3" ally voice coil. Die cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £57.87 + £4.00 P&P ea.  
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.  
2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7.5KHz. Sens. 99dB. PRICE £19.99 + £2.00 P&P.  
10" 200 WATT R.M.S. C10200GP Guitar/Keyboard/Disco.  
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £44.76 + £3.00 P&P.  
15" 200 WATT R.M.S. C15200 High Power Bass.  
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £62.41 + £4.00 P&P.  
15" 400 WATT R.M.S. C15400 High Power Bass.  
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £89.52 + £4.00 P&P.

**WEM**  
5" 70 WATT R.M.S. Multiple Array Disco etc.  
1 1/2" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £22.00 + £1.50 P&P. ea.  
8" 150 WATT R.M.S. Multiple Array Disco etc.  
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £32.00 + £1.50 P&P. ea.  
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.  
1 1/2" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £36.00 + £2.00 P&P. ea.  
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.  
1 1/2" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £47.00 + £3.00 P&P. ea.

**SOUNDLAB (Full Range Twin Cone)**  
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.  
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 + £1.00 P&P. ea.  
6" 70 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.  
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P. ea.  
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.  
1 1/2" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P. ea.  
10" 60 WATT R.M.S. Hi-Fi/Disco etc.  
1 1/2" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P.

**PANTEC HOBBY KITS.** Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

**FM MICROTRANSMITTER (BUG)** 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 x 46 x 14mm (9 volt). Price: £8.62 + 75p P&P.  
**3 WATT FM TRANSMITTER** 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 x 84 x 12mm (12 volt) Price: £14.49 + 75p P&P.  
**SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER** 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22mm (9/12 volt). Price: £17.82 Transmitter 90 x 50 x 15mm (9/12 volt). Price: £11.29 P&P + 75p each. S.A.E. for complete list.



3 Watt FM Transmitter

\* PRICES INCLUDE V.A.T. \* PROMPT DELIVERIES \* FRIENDLY SERVICE \* LARGE S.A.E. 28p STAMP FOR CURRENT LIST

## BURGLAR ALARM

Better to be 'Alarmed' than terrified. Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. FULLY GUARANTEED.

**Control Unit** - Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated fascia switch - off - test - armed. 30 second exit and entry delay.

**Indoor alarm** - Electronic swept freq siren 104dB output.

**Outdoor Alarm** - Electronic swept freq siren 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £138.00 Usual Price £228.85

BKE's PRICE £89.99 + £4.00 P&P

Why buy a collection of self-assembly boards!

IDEAL for Work-shops, Factories, Offices, Home, etc. Supplied ready built.



## OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit today's need for compactness with high sound output levels. Finished in hard wearing black vinylite with protective corners, grille and carry handle. All models B ohms. Full range 45Hz - 20KHz. Size 20" x 15" x 12". Watts R.M.S. per cabinet. Sensitivity 1W 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.

OMP 12-200 Watts 102dB. Price £199.99 per pair.

Delivery Securicor £8.00 per pair



## OMP 19" STEREO RACK AMPS



Professional 19" cased Mos-Fet stereo amps. Used the World over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. Three models (Ratings R.M.S. into 4 ohms). Input Sensitivity 775mV

MF200 (100 + 100)W. £169.00 Securicor Delivery

MF400 (200 + 200)W. £228.85

MF600 (300 + 300)W. £322.00 £10.00

## 1 K-WATT SLIDE DIMMER

- \* Control loads up to 1Kw
- \* Compact Size 4 1/2" x 1" x 2 1/2"
- \* Easy snap in fixing through panel/cabinet cut out
- \* Insulated plastic case
- \* Full wave control using B amp triac
- \* Conforms to BS800

\* Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc. PRICE £13.99 + 75p P&P

## BSR P295 ELECTRONIC TURNTABLE

\* Electronic speed control 45 & 33 1/3 r.p.m. \* Plus Minus variable pitch control \* Belt driven \* Aluminium platter with strobed rim \* Cue lever \* Anti skate (bias device) \* Adjustable counter balance \* Manual arm \* Standard 1/2" cartridge fixings \* Supplied complete with cut out template \* D.C. Operation 9-14V D.C. 65mA

Price £36.99 - £3.00 P&P.



ADC Q4 mag. cartridge for above. Price £4.99 ea. P&P 50p

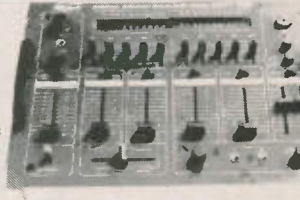
## PIEZO ELECTRIC TWEETERS MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER

- TYPE 'A' (KSN2036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 each + 40p P&P
  - TYPE 'B' (KSN1005A) 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £5.99 each + 40p P&P
  - TYPE 'C' (KSN6016A) 2" x 5" wide dispersion horn. For quality Hi-Fi systems and quality discos etc. Price £6.99 each + 40p P&P
  - TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 each + 40p P&P
  - TYPE 'E' (KSN1038A) 3 1/2" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 each + 40p P&P
- LEVEL CONTROL** Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 x 85 mm. Price £3.99 + 40p P&P

## STEREO DISCO MIXER

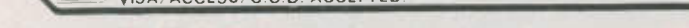
STEREO DISCO MIXER with 2 x 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features. 5 inputs with individual faders providing a useful combination of the following - 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L & R Master Output controls. Output 775mV. Size 360 x 280 x 90mm. Price £134.99 - £3.00 P&P



# B. K. ELECTRONICS Dept PE

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR TEL: 0702-527572

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME. SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED



1988 BUYER'S GUIDE TO ELECTRONIC COMPONENTS

# Maplin

**GET YOUR COPY OF THE NEW MAPLIN CATALOGUE ON SALE FROM 13<sup>th</sup> NOVEMBER 1987**

Pick up a copy from any W.H. Smith for just £1.60 or post this coupon now to receive your copy by post for just £1.60 + 40p p & p. If you live outside the U.K. send £2.75 or 12 International Reply Coupons. I enclose £2.00.

Name \_\_\_\_\_  
Address \_\_\_\_\_

Send to Maplin Electronic Supplies Ltd, P.O. Box 3, Rayleigh, Essex, SS6 8JF. Post Code \_\_\_\_\_

**AVAILABLE SOON IN ALL W.H. SMITH STORES ORDER YOUR COPY NOW!**

**VISIT OUR NEW SHOP IN BRISTOL NOW OPEN AT 302 GLOUCESTER ROAD Tel: (0272) 232014**



**UNIQUE**

Make your own **DIGITAL WATCH KIT**

**1/2 PRICE OFFER ONLY £1**

SEE INSIDE COVER. NO SOLDERING. SUITABLE FOR AGES 10+



**NEW! RADIO CONTROL MODELS 100'S OF NEW PRODUCTS AT LOW, LOW PRICES £1.60**

