FREE!
in this issue...

TRANSISTOR IDENTICART

AUDIO LEAD TESTER

SPECIAL Turntable OFFER

CINE FRAME COUNTER
**EUROPE’S FASTEST SELLING ONE BOARD COMPUTER**

**COMPKIT UK101**

- 8K2O based system — best value for money on the market.
- Powerful 8K BASIC — Fasest around.
- Full Quality Keyboard.
- 4K RAM Expandable to 8K on board.
- Power supply and RF Modulator on board.
- No Extras needed — Plug in and go.
- Kansas City Tape Interface on board.
- Free Sampler Tape including powerful Disassembler and Monitor with each Kit.
- If you want to learn about Micros, but didn’t know which machine to buy then this is the machine for you.

4 pin Expansion Jumper Cable for Compkit expansion £5.50 + VAT

**NEW MONITOR FOR COMPKIT UK101**

- In 2K Eeprom 2716
- Allows screen editing
- Saves data on tape
- Flashing cursor
- Text scrolls down £22.00 + VAT

**FOR THE COMPKIT**

<table>
<thead>
<tr>
<th>Game Packs</th>
<th>Space Invaders</th>
<th>£5.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembler/Editor</td>
<td>1. Four Games</td>
<td>£5.00</td>
</tr>
<tr>
<td>Screen Editor Tape</td>
<td>2. Four Games</td>
<td>£5.00</td>
</tr>
<tr>
<td>All Prices exclusive VAT</td>
<td>3. Three Games 8K only</td>
<td>£5.00</td>
</tr>
</tbody>
</table>

**NEW TV GAME BREAK OUT**

- Has got to be one of the world’s greatest TV games. You really get hooked. As featured in ETI. Has also 4 other pinball games and lots of options. Good kit for up-grading old amusement machines.

MINI KIT — PCB, sound & vision modulator, memory chip and de code chip. Very simple to construct. £14.90 + VAT

OR PCB £2.90 MAIN LSI £8.90 Both plus VAT

**VISTA V200**

**SORCERER DUAL DISC DRIVE**

Includes two 40 track drive, power supply and CP/M DOS, including basic /E compiler

£850 plus VAT

**SPECIAL—ONCE IN A LIFETIME OFFER!**

- 16K £399
- 32K £449
- 48K £499 + VAT

**EXIDY SORCERER**

- For Personal or Business Use.
- 32K or 48K memory, 8K Microsoft BASIC in ROM.
- Dual Cassette I/O, RS232 I/O, Parallel I/O (Centronics). Expansion available through optional extra £100.

- Motherboard, 69 Key Keyboard including 16 key numeric pad.

**SUPER PET 32K**

- 40/80: EX STOCK
- £825 PLUS VAT

**NASCOM 2 DISC DRIVES**

- Add a powerful, double density, mini floppy disc to your Nascom system.
- Disc Controller Card (include)
- 8K memory, 8K disk controller card.
- Will control 4 drives
- DPM operating system.
- Extended Disc Basic Compiler.
- Power supply included

One Disc System — £499 + VAT
Additional Disc Unit — £299 + VAT

**MINI PET RESOMER**

We give a full one year’s warranty on all our products.

We now have in stock demonstration models of the Atari 800 and Texas 95/4. Come and see them.

Please add VAT to all prices — including delivery. Please make cheques and postal orders payable to COMPSHOP LTD., or phone your order quoting BARCLAYCARD, ACCESS, DINERS CLUB or AMERICAN EXPRESS number. CREDIT FACILITIES ARRANGED — send S.A.E. for application form.

14 Station Road, New Barnet, Hertfordshire, EN5 1OQ Telex: 298755 TELECOM G
Telephone: 01-441 2922 (Sales) 01-449 6596 OPEN — Monday to Saturday
Close to New Barnet BR Station — Moorgate Line.

**NEW SALES SHOP**

311, EDGWARE ROAD, LONDON, W2
CONSTRUCTIONAL PROJECTS

CINE FRAME COUNTER by Stephen Ibbis
Battery Powered Unit with 7-segment display

LEAD TESTER by Chris Lane
Provides rigorous analyses of signal lead

125W AMPLIFIER
High power mono design

PE TELETEXT Part 3 by David Shortland
Video Summer Board and P.S.U.

DISCO DESK Part 2 by Ben J. Duncan
Card 2 and more circuits

GENERAL FEATURES

MICROBUS by D.J.D.
Acorn teletext VDU—Nine problems revisited

SEMI CONDUCTOR UPDATE by R. W. Coles
LM1871 LM1872 HM6564 TO237 TDA1085A

INGENUITY UNLIMITED
Roulette Wheel—Car Anti-Theft Device—Shoot Game

THE SHAPE OF SPACECRAFT by C. R. Francis B.Sc., Ph.D.
Technical details behind the weird shapes

NEWS & COMMENT

EDITORIAL
MARKET PLACE
New Products

INDUSTRY NOTEBOOK by Nexus
What's happening inside Industry

SPACEWATCH by Frank W. Hyde
Leasat, Landsat 2, Comet Chaser Giotto, and the Solar Maximum Mission

TURNTABLE OFFER
For Disco and general audio applications

NEWS BRIEFS
PATENTS REVIEW
Hi-Fi Filming

POINTS ARISING
Micro Prompt

COUNTDOWN
The Personal Computer Book

BOOK REVIEW

OUR NOVEMBER ISSUE WILL BE ON SALE FRIDAY, 10 OCTOBER 1980
(for details of contents see page 43)
NEW! LERNA-KITS!

- HIGH QUALITY EDUCATIONAL KITS
- LATEST SOLID STATE TECHNOLOGY - DESIGNED & MADE IN THE U.K.
- DETAILED STAGE BY STAGE BUILDING INSTRUCTIONS
- FREE ADVISORY SERVICE THROUGHOUT THE BUILDING

To:- LERNA-KITS, 4 Cleveland Road, Jersey, Channel Islands, (Est. 40 years)

Please supply us either Kit at £ (add 2% postage U.K. only)
E10 postage overseas Air Mail

BLOCK CAPS PLEASE

NAME

ADDRESS

(Dispatch is normally within 1 week of receipt of order)

SOLDERING EQUIPMENT

IRON-ANTEX

15 watt C15 £3.95
15 watt CCN £4.20
17 watt CX7 £4.20
25 watt CX5 £4.20
Stand £1.50
DESDOLING TOOL
Soldier £6.50

SINCLAIR INSTRUMENTS

Digital Multimeter

PD25 £3.50
DM25 £5.25
DM55 £7.50
DM50 £9.00

Digital Frequency Meter

PFM200 £49.90

Low Power Oscilloscope

SC110 £139.00

CRIMSON ELEKTRIK HI FI MODULES

CE608 Power Amp £18.25
CE1004 " £21.30
CE1008 " £23.91
CE1704 " £30.43
CE1708 " £30.43
 CPS1 Power Unit £16.96
CPS6 " £26.09
CPR1 Pre Amp £29.57
CPR15 Pre Amp £38.70
All prices + VAT + postage/packaging

L10 LOGIC DEMONSTRATION PANEL

Base unit contains different technology, AND or OR gate, NOR and NAND. Scale type meter, Truth tables, AND and OR gates, Half adder, decoder circuit, RS flip flop. Battery operated. 2 hours operation. £23.91

L10f SHORT WAVE RECEIVER

A simple 3 stage short wave only radio receiver for the amateur. Very good selectivity and sensitivity and gives hours of enjoyment. Simple to construct by people of any age. £11.60

L1E AUDIO GENERATOR

Covers 100Hz to 10kHz in two switched stages. Variable voltage output. £40.00

L1E MORE COMPUTER

Ideal source oscillation for beginners. Motor-driven, 10 bit data bus and 13 bit address bus. Ready assembled. ROM 16 kbits, RAM 8 kbits, 5.5 V ± 5% fully reflective. 8 digit LED display, Hexadecimal keypad. Battery and external power source included. Provision for remote and serial operation. £160.00

L1E ELECTRONIC TECHNIQUES

Experiment stand mounted on a PVC board. 100V, 10mV selector switch, D.E.C. and SELECT switch, 200kHz Oscillator. 3 types. 500kHz, 1kV, 10MHz. Power Supply. £23.91

L1K ANALOGUE TESTER

Solid state range test meter kit. Kit includes 20,000 ohm range sensitivity. Range: D.C. and A.C. ranges 0%, 2%, 10% 25% 250V, D.C. 100V, 630V, D.C. 20A Resistance 0-100, 0-50, 0-250, 0-5000. £29.60

L1K LOGIC TESTER

Solid state radio test meter kit. Kit includes 20,000 ohm sensitivity. Range: D.C. and A.C. ranges 0%, 2%, 10% 25% 250V, D.C. 100V, 630V, D.C. 20A Resistance 0-100, 0-50, 0-250, 0-5000. £29.60

L1K DIGITAL MULTIMETER

Solid state instrument with digital display. Ranges are up to 100%. D.C. end A.C. and current D.C. to 50mA. Resistance range are 100, 1000, 10k, 100k, 1M, 10M, 100M & 1G. £27.65

L1K DIGITAL OSCILLOSCOPE

Solid state instrument suitable for digital display. Ranges are up to 100%. D.C. end A.C. and current D.C. to 50mA. Resistance range are 100, 1000, 10k, 100k, 1M, 10M, 100M & 1G. £27.65

L1F BUTTONS & SWITCHES

All ranges. £1.50

SN7492N £3.65
SN7495N £2.00
SN7414N £2.00
SN7408N £2.00
SN7404N £2.00
SN7406N £2.00
SN7413N £2.75
SN7410N £2.00
SN7417N £2.00
SN7412N £2.00
SN7414N £2.00
SN7416N £2.00
SN7415N £2.00
SN7419N £2.00
SN7420N £2.00
SN7421N £2.00
SN7422N £2.00
SN7432N £2.00
SN7433N £2.00
SN7436N £2.00
SN7447N £2.00
SN7453N £2.00
SN7454N £2.00
SN7474N £2.00
SN7485N £2.00

Prices include VAT and postage/packaging.

LERNA-KITS, 4 Cleveland Road, Jersey, Channel Islands, (Est. 40 years)

Mail Order: 01-624 9582

Mail order: 01-624 8582

Credit cards accepted on receipt 12p stamp.

SERIES Ceramic 63v range

1pF to 10,000pF E 24 range

all at £0.06 each

Siemens Ceramic 63v 837448/9

01.022.0.033.0.047mF £0.06

0.068.1mF £0.08 0.22mF £0.11

DCS high Voltage Ceramic Discs

Prices £0.07 to £0.18 Range

100pF to 10,000pF

Voltage range up to 6kV.

See catalogue for details.

Comprehensive range Siemens

Layer Polyster Caps. 001 to 3.3mF

Prices £0.07 to £0.63.

See catalogue for details.

Large range of Mullard/Siemens

Electrolytic Axial/Radial

Capacitance values 1.0mF to

10,000mF

Voltage ranges 25v: 40v: 63v:

100v:

Prices and types as catalogue

Also Mullard C280; Siemens

B32231/4 and B32110. All prices

net + VAT and postage/packaging.

TOOLS BAHCO

Side Cutter with Bezel.

Side Cutter without Bezel.

End Cutter without Bezel.

Vero Metal Shears.

Other items as catalogue.
Aura Sounds are the first company to successfully market Wersi Organs and Kits in the United Kingdom. Operating from modern Showrooms, we offer a complete, unique evening and weekend telephone support advice. We pride ourselves on our friendly and individual service. We market Wersi products because we feel they are simply the best, both in terms of quality and reliability. These factors, together with a fresh approach, are what have made Wersi one of the leading organ manufacturers in the world today. AURA SOUNDS AND WERSI — THE WINNING COMBINATION. Illustrated below are just a few of the wide range of organs in stock.

**The SATURN W3T.**
The ultimate transportable organ, featuring sophisticated rhythm unit and built-in WERSI Voice. 30 or 61 note Keyboards and 30 pedals.

**The COSMOS W5S**
The baby of the range, a great instrument at a great price. There are many optional extras and Cosmos can be easily assembled at home by the average handyman.

**The HELIOS.** For home or professional use. Available as a transportable model with various options including 25 pedal clavier.

**The GALAXY.**
The top model of the range with 3 full manuals and a 30 note pedalboard. For looks and sound, the effects are first class.

---

**IMPORTANT**
AURA SOUNDS have just been appointed marketing agents for the range of Heath Electronic Kits in the U.K. This exciting range of ‘up-market’ Kits makes AURA SOUNDS more than ever before, the company to come to for advice and product choice.

**AURA SOUNDS 14-15 Royal Oak Centre, Brighton Road, Purley, Surrey. Telephone 01-668 9733 and at 17 Upper Charter Arcade, Barnsley, West Yorks. Telephone (0226) 5248**

THE PROFESSIONALS

---

Please send me the 104 page colour WERSI catalogue plus the NEW HEATHKIT BROCHURE & price lists. I enclose a cheque/P.O. for £1.00

Name ________________________________

Address ____________________________________________

Send to Aura Sounds Ltd. 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey.
P.E. MINISONIC MK2 SYNTHESISER

A portable mains operated miniature sound synthesiser with keyboards and effects built around high quality ICs and having slightly fewer facilities than the large Minisonic and P.E. synthesizers the functions offered by this design give a great scope and versatility. Set of basic component kits (i.e. KBD R’s & testing parts - see list for options available) and PCBs (i.e. layout charts)

"Sound Design" booklet KIT 38-2 £80.12 £1.00

P.E. 128-NOTE SEQUENCER

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythm patterns are externally variable. Set of basic components, PCBs and charts

Set of text photocopies KIT 77-5 £28.80 £1.38

P.E. 16-NOTE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synths. Set of basic components, PCBs and charts

Set test photocopies KIT 66-5 £32.60 £1.94

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser. Set of basic components, PCBs & charts

KIT 77-8 £107.96

ELEKTOR ELECTRONIC PIANO

A touch-sensitive multi-level piano using the latest integrated circuit techniques for the keying and envelope shaping, and virtually eliminating "burnout" noise liable to occur in electronic pianos. 5-octave set of basic components and PCBs (as published)

KIT 60-9 £146.86

Additional 3-octave extension and basic parts and PCBs (as published)

KIT 60-10 £36.60 Set of text photocopies £1.81

ELEKTOR FORMANT SYNTHESISER

A very sophisticated synthesiser for the advanced constructor who puts performance before price. Set of basic components, PCBs (as published)

KIT 66-14 £225.49 Set of text photocopies £7.83

ELEKTOR DIGITAL REVERB UNIT

A very advanced unit using sophisticated ICs techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 480mS using the extension unit. Further delays can be achieved using more extensions. Main unit basic components and PCB (as published)

KIT 78-3 £63.40

Extension unit basic components and PCB (as published)

KIT 78-4 £82.78 Text photocopy

ELEKTOR ANALOGUE REVERB

Using IC’s instead of springs the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 2.5 sec. May be used with either monaural or stereo equipment.

Main unit basic component set KIT 82-1 £29.49

Additional delay basic components KIT 82-2 £20.07

PCB (as published) to hold both kits PCB9973 £4.52

Text photocopy £0.79

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesizers. Set of basic components & PCB (as published)

KIT 87-2 £6.84 Text photocopy £3.90

ADD: POST & HANDLING UK.R. orders: Keyboards and £2.70 each. Other goods: Under £5 add 50p. Under £20 add 75p. Over £20 add £1. Recommended insurance against postal mishaps: add £50 for cover up to £50, £110 for £100 cover, etc. Insurance must be added for credit card orders.

N.B.: Electric C I, B.P.O. & other countries are subject to higher export postage rates. ADD: 10% VAT (for current rate if changed). Must be added to full total of kits, discount cost & handling on all U.K., orders. Discount cannot apply to Exports, or photocopies.

10% DISCOUNT VOUCHER (PE 83)

TERMS: Goods in current address & lists over £50 goods value (not P&T & VAT). Correct, correctly C.O.D., U.K. orders only. This voucher must accompany order. Valid until 1st January. Not exchangeable on orders. Mailing address must apply to credit card orders.

PHONOSONICS \ DEPT PE88 \ 22 HIGH STREET \ SIDCUP \ KENT DA14 6EH

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

P.E. MINISONIC SFX SYNTHESIZER

Set of basic components, PCBs & charts

KIT 42-3 £30.36

ELEKTOR RESONANCE FILTER

A very advanced unit using sophisticated ICs techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 480mS using the extension unit. Further delays can be achieved using more extensions. Main unit basic components and PCB (as published)

KIT 78-3 £63.40

Extension unit basic components and PCB (as published)

KIT 78-4 £82.78 Text photocopy

ELEKTOR ANALOGUE REVERB

Using IC’s instead of springs the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 2.5 sec. May be used with either monaural or stereo equipment.

Main unit basic component set KIT 82-1 £29.49

Additional delay basic components KIT 82-2 £20.07

PCB (as published) to hold both kits PCB9973 £4.52

Text photocopy £0.79

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesizers. Set of basic components & PCB (as published)

KIT 87-2 £6.84 Text photocopy £3.90

ADD: POST & HANDLING UK.R. orders: Keyboards and £2.70 each. Other goods: Under £5 add 50p. Under £20 add 75p. Over £20 add £1. Recommended insurance against postal mishaps: add £50 for cover up to £50, £110 for £100 cover, etc. Insurance must be added for credit card orders.

N.B.: Electric C I, B.P.O. & other countries are subject to higher export postage rates. ADD: 10% VAT (for current rate if changed). Must be added to full total of kits, discount cost & handling on all U.K., orders. Discount cannot apply to Exports, or photocopies.

10% DISCOUNT VOUCHER (PE 83)

TERMS: Goods in current address & lists over £50 goods value (not P&T & VAT). Correct, correctly C.O.D., U.K. orders only. This voucher must accompany order. Valid until 1st January. Not exchangeable on orders. Mailing address must apply to credit card orders.
**P.E. V.C.F.**
A voltage controlled filter extracted from the P.E. Minisonic project.

**Basic components, PCB & chart KIT 65-1**
£8.45

**P.E. RING MODULATOR**
Extracted from the P.E. Minisonic project.

**Basic components, PCB & chart KIT 59-1**
£6.35

**WIND & RAIN EFFECTS UNIT**
A slightly modified version of the original P.E. unit.

**Basic components, PCB & chart KIT 28-1**
£4.84

**P.E. ENVELOPE SHAPER**
Provided full manual control over attack, decay, sustain and release functions, and is for use with existing VCA.

**Basic components, PCB & chart KIT 44-1**
£5.73

**P.E. TRANSIENT GENERATOR**
An ADDER envelope shaper without VCA, and additionally providing a trigger for starting and stopping a synthesiser.

**Basic components, PCB & chart KIT 41-4**
£7.62

**P.E. EXTERNAL INPUT SYNTHESER INTERFACE**
Allows external inputs such as guitar, microphone etc., to be processed by synthesiser circuits.

**Basic components, PCB & chart KIT 81-1**
£3.90

**P.E. TUNING FORK**
Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying the actual note.

**Set of components, incl. power supply, PCBs & charts KIT 46-3**
£23.32

**P.E. TUNING INDICATOR**
A simple 4-octave frequency comparator for use with synthesiser and other instruments where the full versatility of kit 46 is not required.

**Basic components, PCB & chart, incl. LED's, SW KIT 69-1**
£8.19

**P.E. DYNAMIC RANGE LIMITER**
Provides automatic control over output levels.

**Basic components, PCB & chart KIT 62-1**
£5.31

**PHONOSONICS**
Photographs in this advertisement show two of our kits featuring some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, although a selection of other cases is available.

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

**OVERSEAS—Regulmes for list Europe—send 35p, other countries—send 75p.**
Micronta 1000 Ohms/Volt Multitester Very compact at 59 x 59 x 32 mm. Easy to read colour meter, pin jacks for all 8 ranges. Reads AC V, DC current and ohms. Mirrored scale. 20-027

Micronta Transistorized Signal Tracer Spot circuit troubles, check RF, IF and audio signals from aerial to speaker on all audio equipment. It has built in 5 cm speaker with volume control. 50 x 143 x 38 mm. 22-010

Micronta Dynamic Transistor Checker Shows current gain and electrode open and short circuit. Tests low medium or high power PNP or NPN types. Go/no-go tests from 5-50 mA on power types. "Quick-check" sockets 22-024

Micronta Auto Range Multimeter Gives you correct polarity, range and measurement — every time. Single function switch lets you choose DC 4 ranges; AC 4 ranges; DC current resistance, 4 ranges. LCD readout. Exclusive range hold facility. 22-196

£6.95

£9.95

£64.95
Realistic Direct Entry Programmable Scanning Receiver. Hear real-life drama on six exciting bands. With direct access to all frequencies, you can punch in actual frequencies for monitoring, storing in the computer's memory or just exploring. Big fluorescent display. Phase locked loop security. 20-9111

TRS-80 Model I C.P.U.'s. Ready to run from your TV monitor. Plug in and start computing. Contains 4096 bytes of user memory and can be expanded to 16K. 26-9051

£199.95*

£289.00*

*All prices include VAT.

IT'S POSSIBLE, ONLY AT Tandy
Better Equipment. Lower Prices. No Middlemen.
All these advantages...

- Instant all-weather starting
- Smoother running
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
- Improved acceleration/top speed
- Extended energy storage

..in kit form

SPARKRITE X5 is a high performance, top quality inductive discharge electronic ignition system designed for the electronics DIY world. It has been tried, tested, and proven to be utterly reliable. Assembly only takes 1-2 hours and installation even less due to the patented ‘clip on’ easy fitting.

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R P M. Contact breaker burn is eliminated by reducing the current by 95% of the norm. There is also a unique extended dwell circuit which allows the coil a longer period of time to store energy before discharging to the plugs. The unit includes built-in static timing light systems function light and security changer switch. Will work all rev counters. Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRIS ES EVERYTHING NEEDED

Die pressed case, Ready drilled aluminium extruded base and heat sink, coil mounting clips and accessories. All kit components are guaranteed for a period of 2 years from date of purchase. Fully illustrated assembly and installation instructions are included.

Roger Clark, the world famous rally driver, says “Sparkrite electronic ignition systems are the best you can buy.”

Sparkrite
HIGH PERFORMANCE ELECTRONIC IGNITION

Electronics Design Associates, Dept. PE 10/80
82 Bath Street, Walsall, WS1 3DE

Name
Address

Phone your order with Access or Barclaycard
inc. VAT and P&P QUANTITY REQ'D.
X5 KIT £16.95
ACCESS OR BARCLAYCARD No.

I enclose cheque/PO for £
Cheque No.

Send SAT brochure only required

Practical Electronics October 1980

MUSICAL MICRO 24 TUNE DOOR BELL

BUILD THE WORLD FAMOUS CHROMA-CHIME

Give your friends a warm welcome. Yes, think how delighted and amazed they will be to hear the musical Chroma-Chime play when they press your button!

The Chroma-Chime uses a microcomputer to play 24 well-known tunes. The kit is simplicity itself for ease of construction. Absolutely everything needed is supplied, including:

- Resistors, Capacitors, Diodes, Transistors, I.C. Socket and all hardware
- Texas Instruments TMS 1000 microcomputer
- Comprehensive kit manual with full circuit details
- Ready drilled and legended PCB included

Plays 24 well-known tunes including:
Star Spangled Banner, William Tell Overture, Greensleeves, Rule Britannia, Colonel Bogey, Oh come all ye faithful, plus many other popular tunes.

- No previous microcomputer experience necessary
- All programming retained on chip ROM
- Fully guaranteed
- Ideal present any time

TMS 1000N

ALL CHROMATRONICS PRODUCTS SUPPLIED WITH MONEY BACK GUARANTEE
PLEASE ALLOW 7-21 DAYS FOR DELIVERY

CHROMATRONICS, RIVER WAY, HARLOW, ESSEX.

Please send me:
TO: CHROMATRONICS, RIVER WAY, HARLOW, ESSEX.
Telephone (0279)418611
NAME
ADDRESS

I enclose cheque/PO value £
or debit my ACCESS/BARCLAYCARD account no.

Signature

CHROMATRONICS

Practical Electronics October 1980

MUSICALL MICRO 24 TUNE DOOR BELL

BUILD THE WORLD FAMOUS CHROMA-CHIME

Give your friends a warm welcome. Yes, think how delighted and amazed they will be to hear the musical Chroma-Chime play when they press your button!

The Chroma-Chime uses a microcomputer to play 24 well-known tunes. The kit is simplicity itself for ease of construction. Absolutely everything needed is supplied, including:

- Resistors, Capacitors, Diodes, Transistors, I.C. Socket and all hardware
- Texas Instruments TMS 1000 microcomputer
- Comprehensive kit manual with full circuit details
- Ready drilled and legended PCB included

Plays 24 well-known tunes including:
Star Spangled Banner, William Tell Overture, Greensleeves, Rule Britannia, Colonel Bogey, Oh come all ye faithful, plus many other popular tunes.

- No previous microcomputer experience necessary
- All programming retained on chip ROM
- Fully guaranteed
- Ideal present any time

TMS 1000N

ALL CHROMATRONICS PRODUCTS SUPPLIED WITH MONEY BACK GUARANTEE
PLEASE ALLOW 7-21 DAYS FOR DELIVERY

CHROMATRONICS, RIVER WAY, HARLOW, ESSEX.

Please send me:
TO: CHROMATRONICS, RIVER WAY, HARLOW, ESSEX.
Telephone (0279)418611
NAME
ADDRESS

I enclose cheque/PO value £
or debit my ACCESS/BARCLAYCARD account no.

Signature

CHROMATRONICS

Practical Electronics October 1980
**SPECIAL OFFER**

4K CMOS RAM (1K x 4) 450 NS

ONLY £6.95 (8 for £4.50)

The TC 6514P from Toshiba, CMOS equivalent of the 21141.

**STEREO! $100 SOUND COMPUTER BOARD!**

All you need is a 5-I0 Board. The choice of two unbeatable General Instrument ICs -AY-3-8910 MOSCMOS sound ic's. Allows you to include computer as an integral part of any communications or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE etc.

**KIT FEATURES**

- Two MOS computer IC's (AY-3-8910)
- 36 pins total
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amo or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
- Uses on Board audio Amp or your STERO.
**Base 2**

**MODEL 800MST**

- 80 COLUMN HIGH PERFORMANCE IMPACT PRINTER
- suitable for most Micros.

**ONLY**

£359 + VAT

**EXATRON**

TRS80

- Stringy Floppy
- COMBINES ECONOMY OF CASSETTE WITH SPEED & RELIABILITY OF DISC (TRS80 expansion interface not needed)
- 16k loads in approx. 24 secs.
- Wafers to 75ft (48k approx.)

**ONLY**

£149 + VAT

**PSU**

£5.50 + VAT

**Ohio Superboard II & Challenger IP**

- the no fuss start to Micro’s.
- **SUPERBOARD II**
  - £159 + VAT
- **SUPERBOARD II (48x32)**
  - £199 + VAT
- **POWER SUPPLY 5v.3A.**
  - £27 + VAT
- **CASE**
  - £27 + VAT
- **CHALLENGER 1P**
  - £209 + VAT
- **CHALLENGER 1P (48x32)**
  - £249 + VAT

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**STATIC RAM 2114 1-12 £3.00 each + VAT 13+ £2.50 each + VAT**

**VERIBITM 5¼” Discs £1.85 each (min. 10) + VAT**

**Mighty Micro**

**Be an ELECTRONIC ENGINEER**

Do something PRACTICAL about your future.

Firms all over Britain are crying out for qualified people with the right training, you could take your pick of these jobs.

Now, the British Institute of Engineering Technology will train you in your spare time to be an Electrical Engineer.

You risk nothing! We promise to get you through your chosen course—or, refund your fee!

So, join the thousands who have built a new future through home study Engineering courses.

**POST COUPON FOR FREE 44 PAGE GUIDE**

**BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY**

Aldermaston Court, Dept TPE07, Reading RG7 4PF.

**Name** (Block capitals please)

**ADDRESS**

**POSTCODE**

Other Subjects

**AGE**

Accredited by CACC

Member of ABCC

**JAYkits**

**DIGITAL MULTIMETER**

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

**FUNCTION GENERATOR**

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

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

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

**VERIBITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**STATIC RAM 2114 1-12 £3.00 each + VAT 13+ £2.50 each + VAT**

**VERIBITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**

**VERSABITM 5¼” Discs £1.85 each (min. 10) + VAT**
BRACKETS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>18556</td>
<td>Single 8 way</td>
<td>£0.09</td>
</tr>
<tr>
<td>18557</td>
<td>Single 12 way</td>
<td>£0.12</td>
</tr>
<tr>
<td>18558</td>
<td>Single 15 way</td>
<td>£1.00</td>
</tr>
<tr>
<td>18559</td>
<td>Single 20 way</td>
<td>£1.25</td>
</tr>
<tr>
<td>18560</td>
<td>Single 25 way</td>
<td>£2.25</td>
</tr>
<tr>
<td>18561</td>
<td>Single 30 way</td>
<td>£3.50</td>
</tr>
</tbody>
</table>

WIRE CONNECTORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22237</td>
<td>12 Way Terminal</td>
<td>£0.20</td>
</tr>
<tr>
<td>22238</td>
<td>12 Way Terminal</td>
<td>£0.25</td>
</tr>
<tr>
<td>22239</td>
<td>15 Way Terminal</td>
<td>£0.50</td>
</tr>
<tr>
<td>22240</td>
<td>15 Way Terminal</td>
<td>£0.60</td>
</tr>
<tr>
<td>22241</td>
<td>20 Way Terminal</td>
<td>£0.75</td>
</tr>
<tr>
<td>22242</td>
<td>20 Way Terminal</td>
<td>£0.95</td>
</tr>
<tr>
<td>22243</td>
<td>25 Way Terminal</td>
<td>£1.35</td>
</tr>
<tr>
<td>22244</td>
<td>30 Way Terminal</td>
<td>£1.75</td>
</tr>
</tbody>
</table>

ANTENNE INSERTS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22310</td>
<td>15 watt insert element with T</td>
<td>£1.12</td>
</tr>
<tr>
<td>22311</td>
<td>5 Watt insert element with 3/32&quot; bit</td>
<td>£2.33</td>
</tr>
<tr>
<td>22312</td>
<td>Replacement element for 15 watt</td>
<td>£3.25</td>
</tr>
<tr>
<td>22313</td>
<td>Iron core bit for 15 watt</td>
<td>£0.88</td>
</tr>
<tr>
<td>22314</td>
<td>Iron core bit for 30 watt</td>
<td>£0.88</td>
</tr>
<tr>
<td>22315</td>
<td>General purpose 1 watt iron bit with iron</td>
<td>£0.88</td>
</tr>
<tr>
<td>22316</td>
<td>Replacement element for 5 watt</td>
<td>£0.88</td>
</tr>
<tr>
<td>22317</td>
<td>Iron core bit for 5 watt</td>
<td>£0.88</td>
</tr>
<tr>
<td>22318</td>
<td>Iron core bit for 10 watt</td>
<td>£0.88</td>
</tr>
<tr>
<td>22319</td>
<td>Iron core bit for 15 watt</td>
<td>£0.88</td>
</tr>
</tbody>
</table>

VARIABLES

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22401</td>
<td>Single</td>
<td>£0.75</td>
</tr>
<tr>
<td>22402</td>
<td>Single</td>
<td>£0.60</td>
</tr>
<tr>
<td>22403</td>
<td>Single</td>
<td>£0.85</td>
</tr>
<tr>
<td>22404</td>
<td>Single</td>
<td>£0.50</td>
</tr>
<tr>
<td>22405</td>
<td>Single</td>
<td>£0.35</td>
</tr>
</tbody>
</table>

CABLES AND CONNECTORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22501</td>
<td>8 way cable</td>
<td>£0.20</td>
</tr>
<tr>
<td>22502</td>
<td>12 way cable</td>
<td>£0.25</td>
</tr>
<tr>
<td>22503</td>
<td>15 way cable</td>
<td>£0.50</td>
</tr>
<tr>
<td>22504</td>
<td>15 way cable</td>
<td>£0.60</td>
</tr>
<tr>
<td>22505</td>
<td>20 way cable</td>
<td>£0.75</td>
</tr>
<tr>
<td>22506</td>
<td>20 way cable</td>
<td>£0.95</td>
</tr>
<tr>
<td>22507</td>
<td>25 way cable</td>
<td>£1.35</td>
</tr>
<tr>
<td>22508</td>
<td>30 way cable</td>
<td>£1.75</td>
</tr>
</tbody>
</table>

BIB HIFI ACCESSORIES

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22601</td>
<td>12m 5 way Solderless connector</td>
<td>£0.25</td>
</tr>
<tr>
<td>22602</td>
<td>12m 6 way Solderless connector</td>
<td>£0.30</td>
</tr>
<tr>
<td>22603</td>
<td>12m 7 way Solderless connector</td>
<td>£0.35</td>
</tr>
<tr>
<td>22604</td>
<td>12m 8 way Solderless connector</td>
<td>£0.40</td>
</tr>
<tr>
<td>22605</td>
<td>12m 9 way Solderless connector</td>
<td>£0.45</td>
</tr>
</tbody>
</table>

TRANSFORMERS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22701</td>
<td>500VA 240V/12V</td>
<td>£2.00</td>
</tr>
<tr>
<td>22702</td>
<td>1000VA 240V/12V</td>
<td>£4.00</td>
</tr>
<tr>
<td>22703</td>
<td>1500VA 240V/12V</td>
<td>£6.00</td>
</tr>
</tbody>
</table>

CASING AND BOXES

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22801</td>
<td>5A Main circuit breaker</td>
<td>£0.20</td>
</tr>
<tr>
<td>22802</td>
<td>6A Main circuit breaker</td>
<td>£0.25</td>
</tr>
<tr>
<td>22803</td>
<td>8A Main circuit breaker</td>
<td>£0.30</td>
</tr>
<tr>
<td>22804</td>
<td>10A Main circuit breaker</td>
<td>£0.35</td>
</tr>
</tbody>
</table>

All prices include VAT. Add 50p per order after — just quote your Access of Barclaycard number. Terms: Cash with order, cheques, POS, payable to Bi-Pak at above address. Access and Barclaycard also accepted.

GIRO A/C No 3887006
Master Electronics
the new Practical way.

SEEING AND DOING

Conquer the 'Chip' — Easy-Fast-Exciting!

AND MASTER ALL THE NEW TECHNIQUES IN MODERN ELECTRONICS.

- Build an Oscilloscope.
- Carry out over 40 full experiments including work on Digital Electronic Circuits.
- Recognition of Electronic Components.
- Understand and draw Circuit Diagrams.
- Experience with handling Solid State Circuits and "Chips".
- Testing and Servicing of Radio, T.V., Hi-Fi and all types of modern computerised equipment.

Colour Brochure — without any obligation. Post to:
BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL
4 Cleveland Road, Jersey, Channel Islands.
Name
Address
Britain's first complete computer kit.

The Sinclair ZX80.

£79.95

Price breakdown
ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (including VAT and p&p) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); everything!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business. The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV... link it to an appropriate power source... and you're ready to go.

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter, and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:

- Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
- Unique syntax check: Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability - takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single-dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- TIMER under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse or under program control.
- Lines of unlimited length.

Fewer chips, compact design, volume production - more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer - typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines. For the ZX80, 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer - typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.
The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you—don't worry. They're all explained in the specially-written 128-page book free with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming—from first principles to complex programs. (Available separately—purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.


The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled and complete with mains adaptor, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt—and we have no doubt that you will be.

ZX80 software—now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

New dedicated software—developed independently of Science of Cambridge—reflects the enormous interest in the ZX80. More software available soon—from leading consultancies and software houses.
PRINCIPAL ELECTRONICS PROJECT 125 WATT POWER AMP KIT

SPECIFICATIONS
- Max. Output power: 125 watts RMS
- Operating voltage (DC): 50-80 Max.
- Bands: 4-16 ohms
- Frequency response: Measured at 100 watts 2500kHz:20kHz
- Sensitivity at 100 watts: 400mv @ 47k
- Typical T.H.D.: 0.5% at 100 watts 4 ohms
- Dimensions: 205 x 90 x 190 x 30 mm

The P.E. power amp kit is a module for high power applications - discos, units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, the output stage uses four 115 watt transistors normally only two would be used, resulting, a high powered regd unit.

The PC board is backprinted, etched and ready to solder for ease of construction, and the aluminium chassis is unfretted and ready to use, supplied with all parts and circuit diagrams.

125 watt power amp kit
ACCESSORIES
- Suitable L.S. coupling capacitor £1.00
- Suitable mains Power Supply Unit £7.50

ACCESSORIES available only when purchasing packs.

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES

MULLARD STEREO PREAMP MODULES AND TWO 12 WATT POWER AMP KITS.

In easy to build form P.C.B.s backprinted, etched and drilled ready to use.

DIY PACK 1
- 2 x power amp kits LP1182/ preamp module, suitable for ceramic and auxiliary inputs.
- £6.00

DIY PACK 2
- 2 x power amp kits LP1184
- preamp module suitable for magnetic ceramic and auxiliary inputs.
- £8.50

DIY SPEAKER KIT
- Two 6 x 5" approx. 4 ohm bass.
- £3.50

OFFER!
- SAVE MONEY by purchasing 12 + 12 amp kit, BSR record deck and speaker kit together for only
- £25.50 per kit

PRACTICAL ELECTRONICS CAR RADIO KIT

(Constructors pack 7)

£10.50

DIY STEREO PACK
- Easy to build by P.C.B.s backprinted, etched and drilled ready to use.
- £13.95

NOTE: for use with 4 to 8 ohms speakers.

BUILD A 12 WATS PER CHANNEL STEREO AMPLIFIER
ACCESSORIES AND L.S. KIT EXTRA (not available separately)

DIY PACK 1
- 2 x power amp kits LP1182 / preamp module, suitable for ceramic and auxiliary inputs.
- £6.00

DIY PACK 2
- 2 x power amp kits LP1184
- preamp module suitable for magnetic ceramic and auxiliary inputs.
- £8.50

DIY SPEAKER KIT
- Two 6 x 5" approx. 4 ohm bass.
- £3.50

ACCESSORIES: Available only at time of purchase of Bargain Packs.

12 + 12 WATT AMPLIFIER KIT
NOTE: for use with 4 to 8 ohms speakers.

With up-to-the-minute features, to complete you just supply screws, connecting wire and solder. Features include: fi in input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - t.p.s, speakers or headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 position button switch. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

BSR traveller record player deck with manual set down and return, complete with stereo ceramic cartridge. £8.50 plus £2.75 p&h

Output 100 watts RMS 200 watts peak.

READY TO PAY £32.90 plus (2.30 p&h)

ARISTON PICK UP

Anston pick-up arm manufactured in Japan. £11.95

COMPLETE AT OUR PRICE

100 WATT MONO DISCO AMPLIFIER

Brushed aluminium fascia and rotary controls. £86.00

COMPLETE AT £100 WATTS MONO DISCO AMPLIFIER

Price includes: 2 speeds with 45 rpm cartridge, amplifier ideal for home or disco use.

READY TO PAY £12.25 plus £2.75 p&h

30 + 30 WATT STEREO AMPLIFIER

Built and tested

Mullard II in teak simulate cabinet silver finished. £49.00

COMPLETE AT £76.00 plus £4.00 p&h

DIY SPEAKER KIT
- Two 6 x 5" approx. 4 ohm bass.
- £3.50

323 EDGWARE ROAD LONDON W2
218 HIGH STREET, ACTON W3 6NG

ACTON: Mail order only, No callers.

Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-6.30pm. Closed all day Thursdays.

PRACTICAL ELECTRONICS October 1980
CB—OPEN CHANNEL

At last we have the Government’s proposals on CB and we are pleased to see that they propose to allow the use of this facility in the UK. But wait, what are they really giving us? A very short range system for which equipment will be expensive, a system which we believe will be of little use or value to anyone—users or manufacturers.

Some manufacturers have indicated that they consider the use of a 928MHz system would be so small that it would not be worth producing equipment. What use is a range of about 10 miles—maximum—considerably less in cities—when the equipment will be very expensive.

We believe the Government is simply paying lip service to public pressure for a system. They may have been misled by the Office who have always been against any service and who must realise that, if instigated, these proposals will mean little or no extra work for them or anyone else. Alternatively, they may have misguided taken a lead from West Germany. The Government there has recently announced the proposed introduction of a 900MHz service in the future, but West Germany already has 27MHz CB and the 900MHz service will be an addition to that, which is a different kettle of fish.

The Government is now planning to clamp down on illegal use of 27MHz—there have been a number of convictions and proposed laws to ban the advertising and sale of any 27MHz systems will at least ensure that transceivers are no longer openly available in this country. This is a move with which we approve, anything that can be done to prevent further illegal use of this frequency is sensible, but the Government—having said it is in favour of Open Channel (as they call it)—must now make proposals for a usable alternative. They must provide a system which will meet the needs of the general public, not a system that is designed to silence the voice of the CB associations without giving anything away.

We suggest that they think again, that they seek some more informed, less biased opinion and that they try to act in the public interest and not just appear to do this.

Of course, some may say that any service is better than none. We do not concur, if 928MHz is introduced it will be virtually useless to the general public and will prevent any usable service ever being introduced—as indeed it may well be intended to do. The Government have stated that only a small increase in the Home Office staff will be needed to control the service—even with all the civil service red tape—so perhaps they do realise it will be of little use.

We do not want to follow the Australians, with all the problems they have found with 27MHz, but we feel that this useless sop will only tend to encourage illegal use of 27MHz.

Let’s stop pussyfooting around and get a viable system off the ground. A system that will ensure a good service and not encourage the cowboys.

It’s not too late (hopefully); in a reply to a written question from Mr. Patrick Wall MP, Mr. William Whitelaw made the following statement “...I intend to publish a discussion document on Open Channel within the next few weeks, and I shall take the public reaction to this into account in reaching final decisions.” Incidentally it would appear that “the next few weeks” in Government terms is in fact 13 weeks so things could move slowly.

Mike Kenward
VERSATILE DISPLAY

For those occasions when a VDU is overkill, and yet illuminating fixed legends is insufficient, Amber Controls have come up with an intelligent 2-line alpha-numeric display subsystem.

The liquid crystal 32 character display is microprocessor controlled, and its 5x7 dot matrix elements enable full ASCII upper and lower case. A further 5x1 matrix facilitates the use of a cursor.

Surplus programming capacity has allowed editing, split screen use and several modes of interfacing to be included.

An attractive feature of the Visual Display Module is its ability to display factory programmed messages, and even graphics, on receipt of the ASCII “ESC” code, followed by A to Z.

Optical isolation of the serial input and output allows TTL, 20mA current loop or V24 connection. There is also a strobed parallel input for direct keyboard interface.

Ease of interface having been assured electronically speaking by the use of a micro, the designers went on to make mechanical integration into a system simple too, by linking the display to the p.c.b. with a flexible cable. Power consumption is less than 2 watts.


NEAT AND TIDY

Here at last is an answer to the prayers of many constructors who are looking for a compact yet spacious means of storing tools and components—the Rolykit, from the Dutch Hagemeyer group.

Looking at the ingenious yet somehow obvious design of the Rolykit, it is surprising that something similar was not invented long ago.

When closed, it can be shaken, even thrown in the air and then opened to reveal everything still neatly in its place, conveniently laid out and ready for work. Some of the compartments are large enough to accommodate pliers, cutters, and reels of wire, while others are divided into smaller units, ideal for components.

The Rolykit comes in two sizes priced at around £12 and £15, and should be available from leading retail outlets and chain stores.

SPACE-AGE STATION

The new version of the Antex TCSU1 soldering station, meets the latest requirements for temperature-controlled soldering of delicate circuits and semi-conductors. The station is moulded in one of the toughest and most durable moulding materials available.

A significant addition is the anti-static earth connection to protect MOS devices from the damage, often unnoticed until too late, caused by static electricity. By inserting the jack with the special earthing cable in the socket at the side of the unit, a connection can be made to a specially made “earth” to eliminate any static electricity charges.

The soldering station is supplied with either the miniature CTC 40 watt iron or the XTC 50 watt model. Both models are fitted with 5-conductor silicone burn-free cable and 5 pin DIN sockets to connect with the 24 volt supply from the station. Thermocouples, fitted at the front of the irons, sense the temperature which is kept at a pre-set level anywhere between 65 and 420°C with an accuracy of 2 per cent. A range of 3 long-lasting bits, heavily coated with iron, is included with each iron for micro, miniature or ordinary soldering work. These bits slide easily on or off the stainless steel shafts of the irons; screws which may cause oxidation or “freezing” of bits to shafts and damage to the irons, have been carefully avoided.

Avoided also are such evils as magnetic fields, arcing transients or spikes; switching is done electronically at zero voltage.

The separate sponge tray which is supplied with each station, can be taken to a tap; this avoids spilling of water over the station.

The price for the TCSU1 (including either the CTC40 or the XTC50) is £38 plus VAT. Further information is available from: Antex Ltd., Mayflower House, Plymouth, Devon (0752 67377).
KEYBOARD CASE

A robust ABS case for self-contained alpha-numeric keyboards is now available from West Hyde Developments Ltd.

Known as the Princess Keyboard, the enclosure is vacuum formed in two halves which are clipped and then screwed together for rigidity in final assembly. The ABS plastic is easy to drill, punch and clean and the base incorporates a series of ribs for simple mounting of many proprietary keyboard assemblies.

The price for the Princess Keyboard is £10.75, and it is available direct from West Hyde Developments Ltd., Unit 8, Park Street Industrial Estate, Aylesbury, Bucks. HP20 1ET.

ELCB

The two main problems associated with conventional fuses is that they are too slow to protect equipment from serious damage and that they offer little protection against serious electrical shock since their ratings and slow operation may allow fatal currents to flow.

The earth leakage circuit breaker overcomes these problems by sensing any small earth leakage current flowing in a circuit or any equipment connected to it. This is achieved by comparing the currents in the live and neutral conductors and detecting any small imbalances. Because of its high sensitivity the ELCB can isolate the circuit or equipment before any serious damage can result.

A comprehensive range of ELCBs have now been introduced by B & R Relays. Called the HO6 Mainsafe series, they feature a wide range of ratings from 25 to 80 amps, with trip ratings from 30mA up to 500mA. This new range together with the existing HO4 13 Amp portable ELCB gives B & R full coverage of all ELCB applications.

The wide range of models available make it possible to protect an installation in a simple cost effective manner. For instance, overall house or building protection can be provided by fitting say a 63 or 80 Amp HO6 Mainsafe to give a 100 to 300mA trip sensitivity—sufficient to guard against fire or equipment damage. If further protection against electrocution is required, a more sensitive HO6 Mainsafe with, say, a 30mA sensitivity can be fitted to give protection on specific circuits or socket outlets. Alternatively, individual socket or appliance protection, eg. in a garage or damp location can be obtained using the HO4 13 Amp portable ELCB into which the appliance is plugged via a standard 13 Amp socket.

For further information contact B&R Relays Limited Templefields, Harlow, Essex CM20 2BG.

INTRODUCING RISCOMP

A new component shop supplying a wide range of components, test equipment and books to the hobbyist has been opened by Riscomp Ltd. The hours of opening are 9.00 a.m. to 5.00 p.m. Monday to Saturday, closed all day on Wednesdays.

Coinciding with the opening of their shop, Riscomp have introduced a low cost digital voltmeter known as the DVM 314. This module features a full 3-digit display with 10-99mV sensitivity, and has a display sensitivity of -99mV to +999mV with an accuracy of 0-1 per cent ± 1 digit. A single d.c. supply of between 7-12V capable of providing 220mA max. is required to power the unit, thus allowing the module to be operated by either a battery such as the PP9 or a suitable mains operated power supply.

The basic 3V maximum reading may be easily extended by the use of simple resistive attenuators with the required decimal point being selected by grounding the appropriate pad on the module.

SERVICE CASE

A new combined tool case and component cabinet has just been introduced by Link-Hampson.

The outer case is made of black simulated leather with a moulded carrying handle. Extra strength is given to the case by incorporating reinforcing side straps. The external dimensions of the case are 380mm x 317mm x 60mm, with a lift up top giving access to a tool carrying tray whilst the component storage drawers are accessible by folding down the front panel.

The price of the case, model 2501E, is £29.95 ex. VAT and p&p.

Link-Hampson Ltd., 5 Bone Lane, Newbury, Berkshire (0635 44796).

VERO CASES

To complement their existing range of grey cases Vero have introduced two models in two-tone brown.

The first type model 75/1713F (154 x 85 x 60mm) has a unique clip together design which requires no fixing screws. The front and rear panels are retained in position when the two halves are assembled.

The second type model 75/1714A (205 x 140 x 75mm) is the usual two section case held together by four screws. Front and rear panels are included as well as fixing points for horizontally mounted p.c.b.s.

The cases are priced at £3.58 (model 75/1713F) and £2.45 (model 75/1714A) excluding VAT and p&p.

It's faster and more thorough than classroom learning: you pace yourself and answer questions on each new aspect as you go. This gives rare satisfaction - you know that you are really learning and without mindless drudgery. With a good self-instruction course you become your own best teacher.

Understand Digital Electronics
In the years ahead digital electronics will play an increasing part in your life. Calculators and digital watches mushroomed in the 1970's -soon we will have digital car instrumentation, cash cards, TV messages from friends and electronic mail.

After completing these books you will have broadened your career prospects and increased your knowledge of the fast-changing world around you.

DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.00

This course is designed as an introduction to digital electronics and is written at a pace that suits the raw beginner. No preliminary knowledge is assumed other than the use of simple arithmetic and decimals and no electronic knowledge is expected at all. The course moves painstakingly through all the basic concepts of digital electronics in a simple and concise fashion: questions and answers on every page make sure that the points are understood.

Everyone can learn from it - students, engineers, hobbyists, housewives, scientists. Its four A4 volumes consist of:

Book 1 Binary, octal and decimal number systems; conversion between number systems; conversion of fractions; octal decimal conversion tables.

Book 2 AND OR functions; inverters; NOR and NAND gates; truth tables; Introduction to Boolean algebra.

Book 3 Positive ECL; De Morgans Laws; designing logic circuits using NOR gates; dual-input gates.

Book 4 Flow charts; delays; clock signals; flip-flops; shift registers; shift registers; half-adders.

DESIGN OF DIGITAL SYSTEMS £12.50

This course takes the reader to real proficiency. Written in a similar question and answer style to Digital Computer Logic and Electronics, this course moves at a much faster pace and goes into the subject in greater depth. Ideally suited for scientists or engineers wanting to know more about digital electronics, its six A4 volumes lead step by step through number systems and Boolean algebra to memories, arithmetic logic circuits and finally to an understanding of calculator and computer design.

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; representation of numbers; binary multiplication and division.

Book 2 AND functions; NOT, exclusive OR, NOR and inverse OR and exclusive OR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; memory addressing; three state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and astable (Dr feedback) counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; registers; control units; program ROM; address decoding; instruction sets; instruction decoding; central processor structure.

Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assembly; computers; executive programs; operating systems and time sharing.

Flow Charts and Algorithms
are the essential logical procedures used in all computer programming and mastering them is the key to success here as well as being a priceless tool in all administrative areas, presenting safety regulations, government legislation, office procedures etc.

THE ALGORITHM WRITER'S GUIDE £4.00

explains how to define questions, put them in the best order and draw the flow chart, with numerous examples.

GUARANTEE No risk to you.
If you are not completely satisfied, your money will be refunded upon return of the books in good condition.

CAMBRIDGE LEARNING LIMITED, UNIT RIVERMILL SITE, FREEPOST, ST. IVES, HUNTINGDON, CAMBS PE17 4BR, ENGLAND.

TELEPHONE: ST. IVES (0480) 67446

All prices include worldwide postage (airmail is extra - please ask for prepayment invoice).

Please allow 28 days for delivery in U.K.

Microcomputers are coming - ride the wave! Learn to program.

Millions of jobs are threatened but millions more will be created. Learn BASIC - the language of the small computer and the most easy-to-learn computer language in widespread use. Teach yourself with a course which takes you from complete ignorance step-by-step to real proficiency with a unique style of graded hints. In 60 straightforward lessons you will learn the five essentials of programming: problem definition, flowcharting, coding the program, debugging, clear documentation. Harder problems are provided with a series of hints so you never sit glazy-eyed with your mind a blank. You soon learn to tackle really tough tasks such as programs for graphs, cost estimates, compound interest and computer games.

COMPUTER PROGRAMMING IN BASIC £9.00

Book 1 Computers and what they do; READ, DATA, PRINT, powers, brackets, variable names; LET; errors; coding simple programs.

Book 2 High and low level languages; flowcharting; functions; REM and documentation; INPUT, IF...THEN, GO TO; limitations of computers, problem definition.

Book 3 Compilers and interpreters; loops, FOR... NEXT, RESTORE; debugging; arrays; bubble sorting; TAB.

Book 4 Advanced BASIC; subroutines; string variables; files; complex programming; examples; glossary.

THE BASIC HANDBOOK £11.50

This best-selling American title usefully supplements our BASIC course with an alphabetical guide to the many variations that occur in BASIC terminology. The dozens of BASIC 'dialects' in use today mean programmers often need to translate instructions so that they can be RUN on their system. The BASIC Handbook is clear, easy to use and should save hours of your time and computer time. A must for all users of BASIC throughout the world.

A.N.S. COBOL £4.40

The indispensable guide to the world's No. 1 business language. After 25 hours with this course, one beginner took a consulting job, documenting oil company programs and did invaluable work from the first day. Need we say more?

ORDER FORM

Please send me the following books:-

Digital Computer Logic & Electronics @ £7.00
Digital Design of Digital Systems @ £12.50
Algorithm Writer's Guide @ £4.00
Computer Programming in BASIC @ £9.00
BASIC Handbook @ £11.50
ANN COBOL @ £4.40

Your Booklist (Free)

Please charge me:

* Access/American Express/Barclaycard/Diners Club/Eurocard/Visa/Mastercharge/Trucard

Credit Card No.

Signature

Telephone orders from credit card holders accepted on 0480 67446 (Anafone).

Overseas customers (incl. Eire) should send a bank draft in sterling drawn on a London bank, or quote credit card number.

Name

Address

Cambridge Learning Limited, Unit 25, Rivermill Site,
FREEPOST, St. Ives, Huntingdon, Cambs PE17 4BR, England.
(Registered in England, No. 1328782)
Recession

The in-word this year is recession. We hear it morning, noon and night, presented generally in terms of utter disaster and catastrophe. Such pessimism is entirely misplaced. Surely we should be optimistic because the recession has precipitated a shake-out in industry that is long overdue by a good 20 years, perhaps even longer. Everyone knew that it had to come and that when it did the process would be painful. And in the older industries, more painful than most.

But when we look at the younger industries, of which electronics is the most striking example, quite a different picture emerges. GEC’s recently announced results show the group cracking through the £3 billion turnover ‘barrier’ despite unfavourable trading conditions further complicated by industrial disputes. About one third of the total business is now in electronics, of which electronics is the most lucrative. A case of swings and roundabouts.

The Chip Scene

As I write there is still no decision on INMOS, an ominous sign reflecting lack of enthusiasm for, if not imminent abandonment of, Government (i.e., taxpayers) support. But at least one aspect of the tangled saga of the chips has been resolved. The GEC-Fairchild joint project has been abandoned through lack of agreement with Fairchild’s new owners, Schlumberger. GEC has now acquired the original Fairchild share in the new factory at Neston, Cheshire. But instead of making chips the Newton plant will produce the Sting Ray lightweight anti-submarine torpedo for which Marconi Space and Defence Systems have an initial £200 million contract for final development and first production.

Sting Ray is potentially one of the UK’s brightest export projects. It is perhaps as much as five years ahead of the competition, certainly three years, and has built-in ‘intelligence’ in both the search and terminal homing phases of operation. Sales are expected to exceed £1 billion in the years ahead.

Energy

Before recession snatched the headlines from the chip the fashionable topic was energy. It has been gone away, only faded into the background in headline appeal. And so, almost ignored, was the world’s largest ever commercial contract for solar energy won by Lucas Energy Systems Ltd in the British-based Lucas engineering group. Under the contract 2,550 solar-power units are being built to power a radio-telephone network linking hundreds of villages in the mountains and equatorial forests in the interior of Columbia. Together the power units will generate a peak power of 100kW from solar energy to charge batteries to a total of 2,400kWh.

But that’s not the end of the good news. It is fashionable today, at least in the UK, to regard with scorn, if not outright contempt, the EEC. And yet the European Commission has recently voted £530 million to energy research, some 50 percent increase in funding and now comparing well with similar programmes in the United States, the Soviet Union and Japan.

A substantial sum will be spent on fusion research, the cornerstone of which is the Joint European Torus (JET) which is under construction in the UK at Culham and due to be completed and ready for the first vital experiments in 1983.

Those still fearful of the consequences of nuclear energy should be reassured by big spending on reactor safety projects, and in protecting the environment. And enthusiasts for alternative energy systems should be pleased with a doubling of research funds to £14 million in the mid-80s with an element of technical support for third-world countries who, in any case, in their sunnier climates are likely to be the main beneficiaries.

I note too, that Gulf and Western Industries in New York has a prototype Volkswagen ‘Golf’ modified for electric traction with a range of 155 miles at 55m.p.h., and it goes further at lower speeds. The zinc chloride battery is one third of the weight of a lead-acid battery of the same capacity. G & W hope to be in production with electric traction units by the mid-80s.

Monopolies

Debate will be at furious level on the very limited weakening of monopoly power in posts and telegraphs in the UK. But optimists like myself believe that the threat of competition will have a galvanising effect on efficiency—and that can’t be bad.
This month's Micro-Bus examines the Acorn Teletext VDU, an unusual memory-mapped VDU with the ability to display Prestel and Teletext pictures. The VDU card can be used with the low-cost System One microcomputer, and several programs are presented to demonstrate the use of the VDU with the System One for graphics.

**BLOCK DIAGRAM**

A block diagram of the Acorn Teletext VDU is shown in Fig. 2. It consists of three main parts: the VDU memory, the controller chip, and the teletext character generator. The VDU displays the contents of the IK of memory, which is switched between the VDU and the processor for half of each memory cycle; in other words, access to the VDU is transparent so that the processor can read from or write to the screen memory without affecting the display. The VDU is normally configured for a format of 25 lines of 40 characters, thus using 1000 bytes of the 1024 RAM locations. This format includes an extra line over the teletext format, which is 24 x 40. The memory is normally addressed as locations #0000 to #07FF.

**SCREEN FORMAT**

The format of characters on the screen is controlled by the 6845 CRT controller chip, and the format can, to a certain extent, be reprogrammed simply by altering constants stored in the 6845's registers. The 6845 is addressed as two memory locations; an address register and a data register. In fact the 6845 contains a total of 18 registers; the number loaded into the address register determines which of the other registers is selected as the data register. A drawback of using the CRTC is that it must be programmed before any display will be obtained. The routine of Fig. 3 illustrates how to do this using the 6502 micro.

The routine writes the sixteen values from a table after the program to registers #00 to #0F respectively, and sets the display up in 25 x 40 format with a flashing-underline cursor.

---

**Fig. 1. The Acorn Teletext VDU card**

**Fig. 2. Block diagram of the teletext VDU card; it interfaces to the computer's address and data lines**

**Fig. 3. Program for the 6502 micro sets up the VDU card for a 25 x 40 display, and a flashing-underline cursor**

Registers #00 to #0F determine the screen format. For example, to obtain a format of 16 rows of 32 characters set register #01 (number of characters per line) to #20, and register #06 (number of lines) to #10. The display can be turned off completely, without affecting the contents of the display memory, by setting register #06 to #00.

Registers #0C and #0D contain the high and low bytes respectively of the screen start address. The start address can be changed to alter the mapping of memory to the screen; for example, incrementing it by 40, the number of locations per line, will scroll the display.

The CRTC also provides a cursor, which can be flashing or static, and whose shape can be programmed. The type of cursor is determined by registers #0A and #0B. For the normal flashing underline cursor register #0A has the value #68; or cursors can be obtained by altering this register as follows:

<table>
<thead>
<tr>
<th>Function:</th>
<th>Value:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cursor off</td>
<td>#1F</td>
</tr>
<tr>
<td>Static block</td>
<td>#00</td>
</tr>
<tr>
<td>Slow flashing block</td>
<td>#60</td>
</tr>
<tr>
<td>Fast flashing block</td>
<td>#40</td>
</tr>
</tbody>
</table>

The position of the cursor on the screen is determined by registers #0E and #0F, which contain the high and low bytes of the cursor address.

The CRTC also provides a light-pen strobe input; a logic-level transition on this input will cause the address of the cell currently being displayed to be stored in the light-pen address registers, #10 and #11.
TELETEXT CONTROLLER

The character generation and display is performed by the SAA5050 Teletext Character Generator, which in addition to being able to display the usual and lower-case character set, has many attractive features such as: double-height characters; the ability to flash characters; display of characters in six colours or white against a background of any colour, black, white; and display of two different types of graphics. Furthermore, most of these options can be used in combination.

Most memory-mapped VDUs use spare bits in the display memory to select special options for each character; for example, the top bit of the character could be used to determine whether the character is displayed static or flashing. In the teletext VDU there are too many different options to enable them to be specified in this way for each character, so a rather cunning method is used instead. Certain control codes, when present in a line, change the state of the subsequent characters on that line. Thus a line will normally be steady, but if a 'flash' code is put on the VDU, all the remaining characters on that line will flash. It is even possible to make one word in a line flash by preceding the word with a 'flash' code, and following it by a 'steady' code.

The Teletext method of selecting special functions has one drawback: the control code will appear on the VDU as a blank cell, corresponding to the background colour; so, for example, it is not possible to display a line of contiguous characters all in different colours; there has to be a blank between each character.

GRAPHICS

To provide the facility for plotting graphs and histograms the character cell is divided into six picture elements, or "pixels", each of which can be either set to a colour, or cleared to the background colour. The state of each cell is determined by one bit of the code, as shown in Fig. 4. For the graphics symbols, bit 5 is always set. To display codes as graphics, rather than characters, they are preceded by a code specifying the graphic and the required colour.

![Fig. 4. Diagrams showing how the teletext graphics symbols are constructed for: (a) contiguous graphics, and (b) separated graphics](image)

The usual graphic mode is called "contiguous graphics", but there is also an option called "separated graphics" in which the pixels are separated by a thin border; see Fig. 4 (b).

If the whole VDU screen is to be used for graphics the first character of each line should be a "graphics colour" code; the overall resolution is thus 78 × 75. A routine to clear the display and set it up for white graphics is shown in Fig. 5.

![Fig. 5. Routine to clear the display, and initialise the display memory for graphics](image)

**EXAMPLES**

Some examples of displays generated by the Teletext VDU are shown in Fig. 6. The top line demonstrates the use of colour. The default colour at the start of each line is white; to display the word CYAN in the colour cyan it is preceded by an "alpha cyan" code, and it is followed by an "alpha white" code to return to white characters.

The second line illustrates the use of a different background colour. The background colour can be set to the current colour with the "new background" code; since the default colour at the start of a line is white, a "new background" code at the start of a line will give a white background. It is followed by an "alpha blue" code to cause the subsequent characters to appear in blue, which is dark against the white background. The background is returned to black after the text with a "black background" code.

**GRAPH PLOTTING**

The following two programs illustrate how the Acorn Teletext VDU can be used for simple graph-plotting. The routines were devised for the teletext method of selecting special set-up characters. In the Acorn VDU, the PLOT routine, in Fig. 7, plots a point, or pixel, on the display at the coordinates specified in the locations XC and YC. The coordinates (0,0) correspond to the bottom left-hand corner of the display, and (77,74) to the top right. Note that XC and YC are modified by the PLOT routine.

The program works by finding, in ADDS, the address of the location that contains the required pixel, and determines a number to

by Peter Mayne of London, who uses the VDU as a display on his Acorn System One micro-computer. The PLOT routine, in Fig. 7, plots a point, or pixel, on the display at the coordinates specified in the locations XC and YC.
add to that location to set the required pixel. Since there are three pixels per cell in the Y direction, the routine must divide the value of Y by three to find which line contains the required location.

The **GRAPH** program, Fig. 8, demonstrates how the PLOT routine can be used to plot a graph of an equation. As it stands, the program plots \( Y = \frac{1}{2}X + 16 \) for values of X from 0 to 63. The program also draws axes, and finally labels the graph with the equation; see Fig. 9. A delay is included to slow down the plotting.

**Fig. 8. Program for the 6502 micro to plot a graph on the teletext VDU**

**Fig. 9. Graph produced by the program of Fig. 8**

Before running the program, the routines of Fig. 3 and Fig. 5 should be loaded and executed at $0980$ and $0E80$ respectively to initialise the CRTIC and clear the screen for graphics.

**NINE PROBLEMS REVISITED**

One of the problems posed in the April Micro-Bus asked for a way to reverse the bits in a byte, on the 6800 micro, in under 10 cycles. A solution in hardware was proposed, but John Diamond of Coventry has solved the problem using only software by providing a look-up table in which each byte gives the reverse of that byte's position in the table. The six-byte routine to reverse a byte, shown in Fig. 10, takes only 9 cycles. It uses self-modifying code to avoid having to use the index register, thus saving several cycles. A further cycle can be saved by using zero-page memory.

The listing of Fig. 10 also includes an initialisation routine to generate the 256-byte look-up table. Other functions could be implemented simply by providing a different table.

Another of the problems was to write a programme to find the highest prime factor of a number using a rudimentary machine-code called MINIL. The solution was given without explanation, and readers were asked to provide one. J. Rennie of Somerset wrote:

"Your challenge to provide an explanation for one of the problems posed in the April issue of the MINIL program . . . proved to be quite irresistible, and I found the task most interesting. The program is based on a fairly simple algorithm (see flowchart of Fig. 11). Let \( N \) denote the number whose highest prime factor is to be found. Thus \( N = (P_0 \times P_1 \times \ldots \times P_n) \), where \( P_0 \) to \( P_n \) are the \( n \) prime factors of \( N \). The algorithm finds the highest factor of \( N \), working downward from \( N - 1 \), which is \( (P_0 \times P_1 \times \ldots \times P_{n-1}) \). This new number is then denoted \( N \), and the process is repeated to give the new factor \( (P_0 \times P_1 \times \ldots \times P_{n-2}) \). This is repeated until only \( P_0 \) is left. No more factors can be found and \( P_0 \) is the highest prime factor of the original number, and can be output."

"In the original MINIL program registers A and B hold the current values of \( N \) and \( X \), respectively, while steps 4-10 find the factors of \( N \). The two loops NOT and NEW are identical to loops 1 and 2 of the flowchart."

"A similar explanation of the program was received from Doug Letts of London. Readers interested in the MINIL language may like to try writing programs which find the greatest common divisor of two numbers, the integer factor of a number's square root, and the factorial of a number. But be warned: one of these problems is impossible, and the other two are not simple!"
The NEW
VIDEOTONE
Introduces DIRECT SELLING - the Ultimate Discount!!!

Coral Cartridges
Fast becoming one of the top names

MOVING COIL
UK's No. 1 Cartridge
MC 81 £48.87
777EX £35
777E £25

MOVING MAGNET
555SX £7.28
555E £14.22
666E £32.48

HEAD AMP
H300 £51.75
T100 £24.75

HEAD SHELVES
S100 £6
S101 £7
S200 £4

LOUDSPEAKERS
The complete fully reviewed range of Videotone Speakers which dominate within their class. Now at lowest ever prices.

D 100 £38
Minimax 11 £44
GB3 £50
GB2 £60
GBS £207
D 93 £40

MICROPHONES
MU 105-22 £29.30
MU 105-12 £22.25
MU 25 C £17.39

ELECTRONICS
This new range of Electronics from Videotone redefines the words quality and value for money to a new high.

30 watt amp MC Input SA4130 £75.00
Stereo Tuner ST4120 £68.00
Cassette full features SC3200 £98.00
50 Watt amplifier WA7700 £77.00
20 Watt amplifier LA2020 £58.00

HEADPHONES
HP 90 Headphone £12.65
HP 80 Headphone £9.69

SEND FOR OUR LATEST FREE BROCHURE AND DETAIL LIST OF LOCAL SALES OUTLETS IN THE U.K.

VIDEOTONE
98 CROFTON PARK ROAD,
CROFTON PARK, LONDON SE4
Tel: 01-690 8511/2

Please send me your Direct Selling Brochure and list of sales outlets.

Name
Address

Videotone

A MESSAGE FROM VIDEOTONE

Dear Customer

You will find that the products advertised on this page are the best possible value for money. They are only low in price because we have eliminated large amounts of selling costs that other brands have to suffer. These savings are passed directly on to you. We have full brochures on any specific item you may be interested in and a competent realistic staff of engineers at our London Showrooms to help you in your choice. Our consumer protection packages are comprehensive and we offer every form of financing you may require. We carry out our own servicing and are dedicated to giving Value for Money. We are confident our products are unbeatable. You may purchase with confidence because our Engineers have specially selected them from competitive sources throughout the world and we import them directly ourselves. Remember, you have 21 days trial period on all products. That is the measure of our confidence.

Practical Electronics October 1980
CONTROL PAIR

We can expect to see large numbers of cheap and capable radio control systems on the market in the near future, thanks to National Semiconductor. I suspect that many of these cheaper systems will fall into the category of "toys", even though these "toys" will be endowed with a digital proportional multi-channel control system which might have cost hundreds of pounds a few years ago!

At the heart of the new systems will be a pair of integrated circuits which between them comprise over 90% of the components required to build a complete 27MHz remote control transmitter and receiver system with two proportional channels and two on-off channels. The transmitter device is the LM1871, and with the addition of a few passive components an aerial, and a battery of between 5 and 16 volts, this diminutive 18 pin device can deliver a radiated signal sufficient to provide a reliable link to the receiver at ranges of at least 100 metres. The transmit frequency would normally be crystal controlled, and the operator controls can be provided by a couple of 500k pots (for the proportional channels) and a couple of toggle or pushbutton switches (for the on-off channels). The two pots can of course be linked to a joystick mechanism for the control of model aircraft or similar vehicles.

At the receive end another 18 pin device, the LM1872, is used to implement a sensitive and selective single conversion superhet with digital detection and decoding circuits and a powerful a.g.c. system. The LM1872 runs from a 6 volt battery supply and uses a crystal controlled local oscillator and a 455kHz i.f. frequency to obtain a sensitivity of better than 15 microvolts. After decoding, the two proportional channel outputs provide variable width pulse streams for direct input to most control servos. The two off-channels are latched and their outputs can source or sink up to 200 mA, sufficient to operate motor control relays or other actuating circuits directly.

The basic package offered by the chip set from National is undoubtedly aimed at the high volume market where costs need to be held to just a few pounds per system, but by suitable alterations and additions to the basic circuit it is possible to produce a system with additional proportional channels and with increased transmitter power for greater range. In short these devices should prove of great interest to serious radio control enthusiasts as well as to those of us looking forward to more fun on Christmas Day!

MOTHER CHIP

There is a lot of talk about 64K RAM chips at the moment, and many large advertesements in the professional journals proclaiming the imminent arrival of these devices from Texas, Motorola, and others. These new devices will all be NMOS dynamic parts, as this technology is always in the lead as far as capacity and cost per bit are concerned. Other technologies such as NMOS-static and CMOS-static are always one and two generations behind respectively, as evidenced by the current NMOS-static state of the art, a 16K device organised as 2K x 8 and the equivalent in CMOS-static, a 4K device organised 4K x 1 or 1K x 4.

These lower capacities are related directly to the physical size of the basic storage devices on the chips concerned. Dynamic storage cells are very small and simple, and the other technologies use bigger and more complex cells and so we have to make do with fewer of them for the same price.

In an attempt to short circuit the CMOS size disadvantage, Harris have come up with a new and quite unique device coded the HM6564. This new offering to those who need both large memory capacity and the well known advantages of CMOS low power technology, effectively leap-frogs two generations by being a 64K CMOS-static device, no less, and released at the same time or even before the 64K NMOS dynamics. An amazing breakthrough in CMOS memory technology? Not really. The HM6564 uses a single ceramic dual in line package with 40 pins, but mounted on the package are no less than 16 separate 4K x 1 chips which in themselves are standard devices usually packaged separately.

To the user, the HM6564 appears as two 8K x 4 arrays each with independent chip enables and write enables. A likely connection configuration would be to link the two blocks to form an 8K x 8 array of static RAM memory with a standby power consumption of only 5mW.

Because of the labour intensive nature of this type of packaging these devices will never be cost competitive with the NMOS dynamics, but for some applications where the small size of such a large parcel of memory can be put to good use, they will undoubtedly fill a real need.

COOL CUSTOMER

National have a new package to compete with TO5s where the older devices are used close to their maximum power dissipation, as they may be in stereo power amplifiers for example. The new package, coded TO237 is about the same size as any other plastic transistor package except that it sports a heat radiator tab on the top and has its leads preformed to fit the TO5 pin circle. The package uses a new patented epoxy plastic and National claim that devices using it can last up to eight times longer than equivalent devices packaged in metal cans, because the transistor chip is kept so much cooler for a given dissipation.

There are already 65 standard transistor types available in the TO237 package, including npn and pnp types and some direct replacements for standard TO5 devices. Prices are about 40% of the equivalent metal can price.

MOTOR CONTROLLER

The speed control of series wound a.c. motors is an ideal case for the use of phase-angle control via a triac power switch. Such motors are to be found in power tools, washing machines and fans, and the simplicity of triac speed control has made the technique popular even for low cost appliances.

Speed control can be achieved either open-loop, where no account is taken of load fluctuations, or closed loop where the motor back-EMF is used as feedback to stabilise motor speed even in the face of load changes.

A new circuit from Motorola, the TDA 1085A, is a complete motor control subsystem in a 16 pin package. Able to be used in both open and closed loop controller schemes, the new device needs only a few passive components and a triac to turn it into a cheap and capable speed controller. For applications requiring only a "slow" "medium" and "fast" speed selection there are programming package pins available to minimise external circuitry. Fully variable speed control is possible by means of an external 100k pot. To overcome surge currents due to stalled or stopped motors, the TDA 1085A, features a "soft start" circuit and current limiting.

This could be the answer for that drill speed controller you have always promised yourself!!
WHEN MAKING cine films it is often necessary, e.g. for fades, single-frame sequences etc., to be able to count accurately how many frames have been exposed. Most cine cameras nowadays have a set of flash contacts that close once per frame. The project described here uses this fact to produce a three digit frame counter capable of counting from single frame to full speed. The display can be blanked to save battery power but still retaining the count facilities, or can be set to zero by merely turning the power off briefly. The unit is connected to the cine camera by a flash lead and has proved itself to be of immense value.

HOW IT WORKS

IC1a and b are connected as a monostable multivibrator, (See Fig. 1) the purpose of which is to 'debounce' the flash contact switch S2 inside the cine camera. This is necessary otherwise spurious figures would result. The clock pulses are fed into IC2 which is quite a recently developed i.c. This is the 4553, a 3 digit BCD counter/driver. This chip produces a BCD output, which is fed into IC3, a BCD decoder and 7 segment display driver. The output is fed to all three displays at once, but only one is switched on at any one time because the cathodes are connected back to pins 2, 1, and 15 of IC2. The capacitor between pins 3 and 4 of IC2 control how fast the switching takes place between the digits, and the value of 1n makes the switching so fast that it looks like a continuous display. This technique is called multiplexing and is an ingenious way of saving on interconnecting wires and battery drain.

Normally pin 4 of IC3 is held high by R8, but if S3 is closed, pin 4 is brought low, and this blanks the display, but does not affect the counting process. This is a useful way of saving battery power during long count periods.

Pin 13 of IC2 is a reset pin which makes the display read 000 when it is high. To make sure that the display reads this at switch-on, a brief reset pulse is fed to this pin via C3. Pin 13 is then brought low by R4, and counting can start. This takes but a fraction of a second.

CONSTRUCTION

Readers are advised to use a p.c.b., and a recommended design is given in Fig. 2. Check that the i.c.s are mounted the right way round. The awkward part about construction is the mounting and wiring of the 3 digits. The author mounted them in 0.1 in. stripboard, breaking tracks where necessary.
The appropriate pins were then wired together with short lengths of insulated wire. A section of the front panel of the Verobox (aluminium) was cut away, and the display mounted using spacers and epoxy resin. The mounting pillars were removed with a hot wire, and the p.c.b. stuck down with double sided sticky pads. The two switches were mounted either side of the display, and a piece of red perspex placed in front of the display to improve the contrast. Constructors may like to add a push-to-make switch, in parallel with C3, to enable the display to be set to zero without switching the power off. Leads were then run from IC3 to the various digit segments, and the three cathodes, which are not wired together, are joined to the appropriate pins 2, 1, 15 of IC2.

A small hole was drilled in the back panel, and a long flash lead was purchased, one end cut off and soldered to the p.c.b. in the S2 position, and the other end is then connected to the cine camera.

If constructors find that they are still getting spurious counts (more than they have shot), it means that they have a "noisy" switch, and C2 needs to be increased slightly, to lengthen the monostable pulse.

Fig. 1. Circuit diagram. S2 is the flash contact switch inside the cine camera.

Fig. 2. Printed circuit layout (actual size)

Fig. 3. Component layout. In the prototype, a piece of stripboard was used to mount the displays behind the front panel window.

**COMPONENTS . . .**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
<th>Integrated Circuits</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>C1</td>
<td>IC1</td>
<td>S1</td>
</tr>
<tr>
<td>R2</td>
<td>C2</td>
<td>IC2</td>
<td>S3</td>
</tr>
<tr>
<td>R3, R4</td>
<td>C3</td>
<td>IC3</td>
<td>Verobox</td>
</tr>
<tr>
<td>R5-R7</td>
<td>C4</td>
<td></td>
<td>3 off l.e.d. 7 segment CC displays</td>
</tr>
<tr>
<td>R8</td>
<td></td>
<td></td>
<td>P.c.b. or stripboard</td>
</tr>
<tr>
<td>1M</td>
<td>10n</td>
<td>4001</td>
<td>Red perspex</td>
</tr>
<tr>
<td>220k</td>
<td>220n</td>
<td>4553</td>
<td>Battery clip</td>
</tr>
<tr>
<td>470k (2 off)</td>
<td>100n</td>
<td>4511</td>
<td></td>
</tr>
<tr>
<td>100 (3 off)</td>
<td>1n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100k</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>220n</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Practical Electronics October 1980
The advantage of the new design is that more space is available in the satellite and the propulsion system can be mounted internally. The launch system is called the Frisbee technique because the satellite is thrown clear of the shuttle with the spin motor set for a 2rpm rate. It is released by a spring catch giving a velocity of 1.5 feet/second. The satellite is easily clear of the shuttle and then the spin is increased to 30 rpm. The perigee kick motor is fired at 45 minutes after release. The motor kick lasts one minute. The satellite is then injected into the geosynchronous orbit and the twin apogee liquid fuel thrusters are fired to circularise the orbit. Meanwhile the apogee motor case is jettisoned.

Once the orbit is attained the folded aerials will be deployed. These consist of two helical arrays, one for transmission and one for reception. They have an allocated frequency in the UHF band. There are also aerials for the SHF band. Station keeping will be carried out using a monopropellant system of hydrazine by statically placed thrusters also built by Hughes.

**LANDSAT 2**

Landsat 2 which was retired from service at the beginning of the year has been restored to operational status. Engineers decided that it was the flywheel lubrication that was at fault. After several unsuccessful attempts to reactivate the three axis system the matter was left for several months. However during a communication exercise the flywheel responded, with the possibility of normal operation. By this time though the gas for attitude control had become depleted.

Research had been carried out with a view to using magnetic torque to keep the satellite operational. This has been a successful ploy. The satellite has three magnetic coils, one on each axis. By energising the coils at preselected points in orbit, the accumulated momentum which causes the flywheel to saturate, can be dissipated without the use of the gas.

Landsat 2 is now providing better imaging than before. There is still a problem because the four recorders are out of action. Communication therefore has to be direct to the ground.

**COMET CHASER GIOTTO**

The European Space Agency Science Programme Committee made the final decision to go it alone with a mission to intercept Halley's Comet. The point of interception will be just after perihelion, the point when it is nearest to the Sun, when for four hours the spacecraft will collect data. The flyby will take place in 1986 and it is hoped that much more will be known of the nature and composition of cometary bodies.

The Ariane will be used as the launcher and the tracking will be carried out by using the Parkes Radio Telescope in Australia and the Weilheim facility in Germany.

It is of the utmost importance to science that this encounter with Halley's Comet should take place not only because this opportunity will not come again for 75 years or so but also because science needs to know as much as possible about the cometary bodies. What is their make up? and how do they fit into the scheme of the Solar System?

Galaxy and the Universe? During that period of 75 years there will be such tremendous strides in space techniques it is important, as soon as possible to have confirmation or perhaps modification of the present cosmological theories.

**SMM, THE SOLAR MAXIMUM MISSION**

In February this year the special spacecraft SMM was launched upon a mission to study a star. That star is the nearest one to the Earth. It is the Sun, pouring down upon the surface of the Earth radiation over the full extent of the electromagnetic spectrum, giving life and destroying life for this is raw nature. Like so many items of study by scientists the more that is discovered the more there remains to be studied and understood. It provides the means for communications and is also the cause of preventing those very communications. It causes the atmosphere to become a destroyer while providing the means of subsistence for the flora and fauna of the Earth.

The spacecraft SMM will endeavour by its programmed activities to examine the radiations, the flares, the second to change conditions on the surface and from this, the observers will try to make sense from the data. The Sun is in the act of destroying even itself by flinging vast amounts of matter away every second. What appeared to the naked eye a signpost of stability is now known to be unstable, varying in size, with a temperature in its interior beyond anything that could be developed by man. Mankind by gradually sifting data and learning how to tame this controller of destiny is able in some measure to turn the situation to advantage. Part of this story is the proposal to collect the energy, beam it down to Earth and light up and warm towns and cities.

On board SMM there are seven instrument packages each with its own mission task. They are the gamma-ray spectrometer, the hard X-ray imaging spectrometer is an extremely sensitive instrument that can resolve down to 8 minutes of arc and detect X-rays with energies of the order of 3-5 to 30 keV. There is also a hard X-ray burst spectrometer to deal with some of the puzzles of the X-ray burst stars. This instrument has a caesium iodide detector which can operate up to 30 keV with a duration as short as 10ms.

An X-ray Polychromator which can provide spectra of emission lines at wavelengths between 0.14 and 2.24 nanometres.

An active cavity radiometer with three pyrheliometers will measure the emission of the solar radiation from far infrared to ultraviolet at about 0.1 percent accuracy.

An ultraviolet spectrometer and polarimeter which has a reflecting telescope with a field of view of 4 arc seconds square. The resolution of this instrument is 3 arc seconds. The main purpose of the instrument is to scan the chromosphere and the corona. This is a new instrument not used before.

Finally there is the Coronagraph—polarimeter. It will be possible to take pictures of the corona with a vidicon camera with about 900 by 900 picture elements. This system will work in the wavelength region of 400 to 700 nanometres.
Royal Horticultural Halls Elverton Street
Westminster London SW1
November 26-30 1980

It's all at Breadboard '80

This is the exhibition for the electronics enthusiast. From November 26-30 there is only one place in the universe for the electronics enthusiast to be — Breadboard '80, at the Royal Horticultural Hall in London. The majority of leading companies will be exhibiting, including all the top monthly magazines in the field. There will be demonstrations on most stands and many feature special offers that are EXCLUSIVE to Breadboard!

All aspects of this fascinating field are catered for, from CB to home computing, so whether you want to buy a soldering iron or a synthesiser — or just keep up to date with your hobby — don't miss Breadboard '80.

Advance Tickets, Modmags Ltd,
145 Charing Cross Rd, London WC2H 0EE

Faster than a scope
safer than a voltmeter

LOGIC MONITOR
LM-1

CONTINENTAL SPECIALTIES CORPORATION

C.S.C. (UK) Limited, Dept 5S,
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.
Tel: Saffron Walden (0799) 21682
Telex: 817477

Instant — simultaneous monitoring of the logic state of all IC nodes
Just clip it over your IC
LM-1 instantly and accurately shows both static and dynamic logic states on a bright 16 LED display.
LM-1 finds its own power.
LM-1 cuts out guesswork, saves time, and eliminates the risk of short circuits.
LM-1 is suitable for all dual-in-line logic ICs LED on = logic state 1 (high), LED off = logic state 0 (low), and each LED is clearly numbered 1 to 16 in the conventional IC pattern.

ONLY £28.70 (Excluding P&P and VAT)
Total £34.44 including box and instruction manual.

C.S.C. (UK) Limited, Dept 5S, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.
LM-1 £34.44 (incl. P&P and 15% VAT) Qnty. Req'd. For FREE Catalogue tick box □

Name: ____________________________
Address: ____________________________

I enclose PO/cheque for £__________________________ or debit my Barclaycard, Access, American Express No. ____________________________
exp. date: ____________________________

FOR IMMEDIATE ACTION — The C.S.C. 24 hour, 5 day a week service, Telephone: (0799) 21682, and give us your Barclaycard, Access, American Express number and your order will be in the post immediately.
THIS WAY YOUR ELECTROVALUE CATALOGUE IS ALWAYS UP TO DATE

EVERY THREE MONTHS WE PUBLISH AN UP-TO-DATE PRICE LIST FOR USE WITH OUR CURRENT CATALOGUE. THESE ARE MAILED FREE VIA OUR COMPUTER TO REGISTERED CUSTOMERS. IF YOU WOULD LIKE A FREE COPY JUST WRITE OR PHONE FOR CATALOGUE FREE IF YOU SO WISH

OUR MINI-SELECTION POINTS THE WAY!

EXAMPLE ONE – SOLIDERING IRONS

Onyx 50 £12.08 net

Isopt 50 £12.90 net

Ansco X25 £8.43 net

EXAMPLE TWO – PRINTED CIRCUIT MATERIALS

PCB 1000 x 150 mm

SRP 50 £1.38

70/93/5 £1.49

EXAMPLE THREE – SWITCHES

1/3 10 mA switch adaptors

EXAMPLE FOUR – CAPACITORS BY SIEMENS

Polyester 7.8mm PCM

1, 1.5, 2.2, 3.3, 4.7nF, 10, 22, 33, 47nF, 100, 150, 220, 330, 470uF 10% ±15% ±20%

INFORMATION – To show everything we supply would take about seven pages of closely packed type in this journal – the range is enormous, including not only opto devices and very advanced sophisticated items, but all the everyday things you need as well down to nuts and bolts! IT'S ALL IN CATALOGUE 10-120 PAGE CATALOGUE FREE FOR THE ASKING!

PRICES AND V.A.T. – All prices quoted here include V.A.T. for U.K. orders. Overseas buyers deduct 15% when ordering.

POSTAGE – For orders up to £7 75 value (U.K.) please add 40p for 1st, 80p for 2nd overseas orders post free in U.K. Overseas orders sent at cost (I.W.A. 40p).

DISCOUNTS – 5% allowed on non-net items if order value exceeds £11.50, 10% if order value exceeds £50. Quantity discounts price on most components.

ELECTROVALUE LTD.

DEPT. PE, 106, 28 St. Judes Road, Englefield Green, Egham, Surrey TW20 6BE. Phone Egham 33603 (STD 33603). London 287, Tel.: 264478.

Northern Branch (Personal Shoppers only) 680 Bumage Lane, Burnage, Manchester M19 1NA.

Phone 061 432 4943.

THE firm for speakers!

SEND 50p FOR THE WORLD'S BEST CATALOGUE OF SPEAKERS, DRIVE UNITS, KITS, CROSSOVERS ETC. AND DISCOUNT PRICE LIST.

AUDAX • AUDIOMASTER • BAKER • BOWER & WILKINS • CASTLE • CELESTION • CHARTWELL • COLES • DALESFORD • DECCA • EAGLE • ELAC • EMI • FANE • GAUSS • GOODMAN • HARBETH • ISOPHON • I.M.F. • JORDAN • JORDAN • WATTS • KEF • LOWTHER • MCKENZIE • MISSION • MONITOR AUDIO • MOTOROLA • PEERLESS • RADFORD • RAM • ROGERS • RICHARD ALLEN • SEAS • SHACKMAN • STAG • TANNY • VIDEOTONE • WHARFEDALE

WILMSLOW AUDIO (Dept. P.E.)

SWAN WORKS, BANK SQUARE, WILMSLOW, CHESHIRE SK9 1HF

Tel: 0625 253959

FOR MAIL ORDER & EXPORT OF DRIVE UNITS, KITS ETC.

Tel: 0625 256213

(SWIFT OF WILMSLOW) FOR HI-FI & COMPLETE SPEAKERS.

AT BLINKIN' LAST

COLOURBOARD II

THE NEW SO5 COLOUR VERSION OF OHIO SCIENTIFIC'S SUPERBOARD II IS HERE AND LIKE A TON OF BRICKS DOWN CRASHES THE PRICE OF STANDARD SUPERBOARD II

50M U.K. BLACK AND WHITE SUPERBOARD II £19.95 15% VAT POST FREE

COLOURBOARD II £200 15% VAT.

THE UNIQUE SPECIAL OFFER YOU CAN'T RESIST

£18.99

If bought with superbond or colour board these boards are at the discounted prices shown first. Also sold separately at the bracketed prices. Add 15% VAT.

Most items are available 24 hours a day. Inspections welcome.

WILMSLOW AUDIO (Dept. P.E.)

SWAN WORKS, BANK SQUARE, WILMSLOW, CHESHIRE SK9 1HF

Tel: 0625 253959

FOR MAIL ORDER & EXPORT OF DRIVE UNITS, KITS ETC.

Tel: 0625 256213

(SWIFT OF WILMSLOW) FOR HI-FI & COMPLETE SPEAKERS.

BATTERY ELIMINATOR KIT

50mA radio type with press stud connectors £1 1p, £1.49, 6V £1.49, 9V £1.49, 12V £1.49, 18V £2.60, DM5.20, 24V £4.80. Standard variable voltage models 2-18V £2.60, 18V £3.95, 12V £2.20, 6V £1.20. 12v car converter £6.79/9V £1.15.

BATTERY ELIMINATOR KITS

3-way switching type with 4-way multimeter 6/3/7/9 300mA £2.34. 100mA radio models with press stud connectors 12V £3.77, 9V £4.99. Fully stabilized model 3/6/7/9 300mA £6.50. Car converter 12V 30mA, input/output 3/4/6/7/8/12V.

SINCLAIR (THANKS PRODUCT)"


SINCLAIR ELECTRONICS

Dept PE, 32 Golds & Rd. Swenley, Kent BR8 8E2.

Mail order only. Please add 25p postage. Prices include VAT unless stated. Lists 27p post free. Overseas customers deduct 20%. Official credit orders welcome.

Practical Electronics October 1980

34
To tie up with our *Disco Desk* series PE has been able to arrange a special offer on these BSR decks either singly or in pairs. The decks are also excellent for use with general purpose audio systems.

**THE DECK**

★ BSR P182
★ Fitted ADC, QLM 30 Mk III stereo magnetic cartridge
★ Automatic cueing for 7, 10 or 12 inch records
★ Manual cue lever with viscous damping in both directions
★ S shaped pick-up arm with counter balance weight
★ 3 speed with idler wheel drive
★ Automatic and manual pick-up arm clip
★ Dynamically balanced 4 pole motor
★ Flared aluminium turntable
★ Rumble > -29dB relative to 1000Hz at 1.2 cm/sec
★ Wow < 0.03% r.m.s. Flutter < 0.08% r.m.s.
★ Ready wired phono output sockets
★ 240V 50Hz with 450mm (approx) long double insulated flying mains lead
★ Transit screws
★ Size approx 290 x 330mm

---

**Mail order only**

Please send me

<table>
<thead>
<tr>
<th>Deck/s</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>One deck £24 plus £2.50 p&amp;p (£26.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two decks £48 plus £3.75 p&amp;p (£51.75)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I enclose PO/Cheque No. Value

Name
Address

Please allow 28 days for delivery

OFFER CLOSES FRIDAY NOVEMBER 14 1980

Name
Address

To: RT-VC, 21B High Street, Acton, London W3 6NG
LEAD TESTER
I.C. LARE B.Sc. M.Sc.

For mono jack and Cannon connectors

ANY of the problems which occur in PA systems, be they for group or disco use, are the direct result of lead failure. It is worth remembering that a typical small group rig will need upwards of 40 signal leads and the probability of failure of at least one is fairly high. This is not surprising when it is considered that these leads suffer from repeated coiling, stretching, bending and beer. A faulty lead somewhere in the system can be very hard to find, particularly in the semi-darkness with time running out and so a lead tester must be considered as part of any PA setup. Regrettably, many lead testers available fail to check the lead properly, or do not stand up to life on the road, breaking down at the most vital moment.

The design presented here is for a tester that is easy to use, robust, and performs a rigorous test of the lead.

DESIGN PHILOSOPHY
In formulating a successful design the following conditions were drawn up.

a) Nearly all stage leads are either mono jack or balanced line with Cannon connectors. Other leads are sometimes used, but these tend to be rather diverse, and it is not possible to design an absolute tester for every combination. Accordingly, the tester was designed for jack and Cannon only.

b) The tester must be simple to operate. Once the lead is plugged in pressing a single button must initiate a complete test sequence.

c) Many testers check each core of the lead for open circuit, and then for shorts between signal cores and earth. This is acceptable for mono jack leads but fails when Cannon leads are tested. In such a lead a short between earth and a signal core will cause increased hum and some loss of signal, since the lead is then unbalanced—Fig 1. This will be found by a standard tester, but it will not find a short between the two signal cores which gives rise to total lead failure. The tester must therefore check each core, including the earth for open circuits, and also check for a short between any combination of cores.

d) The lead status should be clearly displayed, and the type of failure indicated. The display must be readable in poor light.

e) The tester must be self contained, robust and reliable.

THE CIRCUIT
The lead status is displayed on seven I.e.d.s, one green indicating that the lead has passed, the other six red ones corresponding to the possible failure modes. The circuit is designed around CMOS logic; this being compact and not requiring much supply current. It does however have one disadvantage since drive transistors are required for the I.e.d.s. TTL logic, although not requiring the transistors would present an unreasonable load on the battery.

The circuit is shown in Fig. 2. It consists of four D-type flip flops through which a '1' is clocked and used to check each...

Fig. 1. Non-fatal short on line
lead core in turn. The three core test circuits are identical. If the core is intact both inputs to the Exclusive-OR remain the same and no output is generated. An open circuit will cause the EX-OR output to go high, lighting the relevant I.e.d. The diode across the EX-OR only enables the transistor drive when the associated flip flop is high to prevent spurious open circuit indications if a short circuit is present. Diodes D2-4 prevent a level clash if a short exists. The cores are pulled down by the 100k resistors. This value is high enough to allow faults involving the semi-conducting layer found in microphone cable to be detected.

Any short circuits will be detected by the AND gate connected to each pair of cores. Again, the relevant I.e.d. will light up in the event of a failure. If no failures are detected the fourth flip flop will be clocked lighting the 'O.K.' I.e.d.

When an I.e.d. lights the base of TR8 is pulled down, and the inhibit line goes high, stopping the clock. This means that the status of the lead is displayed until the test button is released. The clock is inverted to ensure that the inhibit will only generate a high to low transition, thus not affecting the flip flop states.

The flip flops are initially set and reset by IC1d which holds the relevant inputs high for a brief period after test is pressed. Diode D1 allows the capacitor to discharge quickly after test is released.

If a mono jack plug is to be tested switch S1 bypasses IC3a so that core B is not tested.

CONSTRUCTION

The tester was built into a die-cast aluminium box, measuring approximately 150 x 80 x 50mm. The parts are fairly tightly packed, and it suggested that care is taken if a different box is used. Two printed circuit boards were used, the main one holding all the i.c.s and associated components, the other the display i.e.d.s and driver transistors. The details of the p.c.b.s are shown together. It is not possible to use sockets for the i.c.s because of the greater depth of the board.

The main board is fixed into the bottom of the box with three 6 BA bolts, a nut serving to separate the board from the base of the box. The battery pack fits in the missing section of the p.c.b. and was held in place with a single angle bracket.

The I.e.d. display is arranged as a circle with the three cores drawn as spokes. An I.e.d. is placed on the circle between the spokes and on each intersection to correspond to the Fig. 2. Circuit of Lead Tester. The inhibit connection is made between the two boards.
Fig. 3. Physical layout of I.e.d.s. The six on the circumference are red and the centre one green. The circle diameter should be 1in.

**COMPONENTS**

**Resistors**
- R1-8 100k
- R11, 14, 17, 18 22k
- R9, 10, 12, 13, 15, 16 10k
- R19 470R ½ watt
- R20 220k
All ½ watt carbon unless indicated.

**Capacitors**
- C1 1µF taut
- C2 0.1µF polyester C280
- C3 0.47µF polyester C280

**Semiconductors**
- D1-4 1N4148
- D5-7 OA90 or OA91
- D8-13 Red 2.9mm
- D14 Green 2.9mm
- TR1-7 BC184L
- TR8 BC214L
- IC1 4093
- IC2, 3 4013
- IC4 4070
- IC5 4081

**MISCELLANEOUS**
- Die cast box, approx 150 x 80 x 50mm. Battery holder for four HP7 in cube layout. Battery clip. Miniature double pole double throw switch. Miniature push button. Jack sockets. Male cannon chassis plug. Female cannon chassis socket. P.c.b. pins. 6 BA pillars, 0.375in and 6 BA nuts and bolts.

Fig. 4. Wiring from front panel components to main board

short and open circuits. Fig. 3. The green 'O.K.' I.e.d. is placed at the centre of the circle. The best way to drill the holes for these is to mark the centre position of the circle with a centre punch, and use a pair of compasses to draw a 1in circle. The top and bottom positions can then be punched in, and the remaining positions found by using the compasses as dividers. A 7/64in drill is exactly right for the 2.9mm I.e.d.s used.

The display p.c.b. is mounted on the top plate with three 6 BA pillars. These are fixed to the top panel with countersunk screws, the holes being filled and smoothed before spray painting the panel. White Letraset is used to complete the panel. The 'Test' button is placed for a right handed user, so the tester can be held in the left hand, and the thumb used to press the button.

The 'Earth' test is connected to the body of the jack socket and pin 1 of the Cannons. Signal A is connected to the jack tip and pin 2, whereas the signal B is only connected to pin 3. It does not matter which Cannon is connected to which end of the test circuit.

**TESTING**

Testing of the unit should present no problems. If any are encountered it is useful to slow the clock down by adding a 47µ capacitor across C1. Removing the inhibit line should light all the open circuit I.e.d.s in turn followed by the 'O.K.' I.e.d. A set of crocodile clip leads is convenient for checking that each combination generates the correct fail condition.

**USING THE TESTER**

The tester is simple to use and the fascia legending is self-explanatory. No battery check is provided as such, simply pressing 'Test' with no lead connected lights the 'Earth' open I.e.d. providing such a check. Note that a lead that fails might give an 'O.K.' reading after it has been moved about. This is because a fault clearing will allow the test to continue. This is quite deliberate and useful for suspected intermittent leads.

Practical Electronics October 1980
A selection of readers’ original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

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

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work and has not been accepted for publication elsewhere.

**ROULETTE WHEEL**

This circuit was designed for the entertainment of my baby daughter, and is in the form of a row of multi-coloured I.E.D.s lighting in sequence.

However, I discovered by converting the clock circuit into one of a decaying frequency, and by arranging the I.E.D.s in a circle, it could also be used as a roulette wheel by the older members of the family.

It is based on two 4015 shift registers which were chosen for their low power consumption (it draws 30mA when running but with an increase of 50 ohms or so in the collector resistors it drops to 20mA).

Bridging the touch plates applies a negative voltage to the base of TR16 via R2, causing it to turn hard on, thus supplying the potential IC3 requires, enabling it to clock the shift register at a frequency set by R3, R4, C1.

The clock will continue to pulse when the finger is removed for a time period set by R3, R4, C1.

The shift register circuitry is straightforward and the data input is controlled with the minimum of active components (Pin 15) IC1a. The data input will be kept low as long as there is a high present on any of the outputs fitted with a diode.

These diodes keep TR17 turned on, pulling (Pin 15) ‘low’. A ‘high’ is only applied when all output ‘highs’ have been shifted to the final I.E.D. output (Pin 10) IC2b in this instance. On the following clock pulse D29 extinguishes and the ‘high’ applied to (Pin 15) moves it on one place, illuminating the first output I.E.D., and also resetting TR17 via D1. To prevent any more ‘highs’ being entered. Initial switch on can produce unwanted states on the output but they are eliminated when the run contacts are bridged. The final output (Pin 10) IC2b was not used in the prototype as only 3 I.E.D. colours were available to me, so 15 I.E.D.s was an obvious choice to keep the uniformity of the wheel.

A. J. Kitching, Esh Winning, Durham.
THE locks on most old cars are so worn that virtually any key will open and start them, making them easy prey for joyriders or thieves.

My solution to this is the circuit shown right. With the hidden switch in the 'on' position it is possible to start the engine but any attempt to drive the car off results in a series of 'kangaroo' hops, forcing any prospective thief to abandon the car within a few yards. The figure left is for negative earth and the right for positive earth.

The device operates by shorting the contact breaker points for approximately 70ms in every 100ms.

The circuit consists of a 555 timer connected as an oscillator running at approximately 10Hz with its output triggering thyristor CSR I via R3, so that it conducts when the points are open effectively short circuiting them and disabling the ignition.

Alastair Mutch,
Aberdeen.

IN this circuit the transistors and their accompanying resistors and capacitors form a pulse generator (clock) whose frequency can be controlled by adjusting VR1. The output feeds a dual input 'AND' gate the output of which is high only when both inputs are high. The other input of this gate is initially high so that the output is high only when a clock pulse is generated. Therefore the 7490 received a series of pulses which are counted and a running total supplied in binary, this is converted by the 7442 into a decimal format and this is displayed by the I.e.d.s D1-10. Since only one I.e.d. can be on at any time this means that the light will appear to move across the array of I.e.d.s. The contestant has to try and press the switch at exactly the same instant as the centre I.e.d. is illuminated.

Upon pressing the switch a pulse is sent to the 74121 which sends out a fixed length pulse irrespective of the length of the input pulse. The length of the output pulse is determined by C1 and R1. The output of the 74121 feeds the input of a second 'AND' gate whose output is high when the switch and I.e.d. D5 are on together its output stops the counter and illuminates D12 indicating a hit. The output of the 74121 also feeds a binary counter which counts how many times the switch has been pressed and displays this value on the seven segment display.

After eight presses of the switch and no hits the D11 I.e.d. is illuminated indicating a fail. The circuit can be reset by temporarily disconnecting the power by a suitable switch.

D. Johnson,
Worsley.
Lancs.
NEW PC BIMBOARD. An exact printed circuit board equivalent of the BIMBOARD 1 plus 2 additional bus strips. Rows and columns of holes are numbered or lettered enabling components to be transferred one by one from a BIMBOARD 1 to the corresponding position on a PC BIMBOARD. Once soldered your project is functional, rugged, permanent.

PC BIMBOARD £1.72

LARGE PROJECTS

BIMBOARDS 2, 3 and 4. Utilise 2, 3 or 4 BIMBOARD's on 1.5mm matt black base plate standing on 4 non-slip rubber feet, 4 screw terminals for input power lines plus 2, 3 or 4 Component Support Brackets.


MULTI-POWER PROJECTS

BIMBOARD USE £0.65 BIMSTRIP £2.50 BIMBOARD LAYOUT PAD £0.65

FUN PROJECTS

Our BIMBOOK - 'Adventure in Microelectronics' - contains 20 fun projects all designed to fit into a BIMBOARD 1. Step by step instructions show exactly which holes the various components plug into. Start with the simple projects, build up to the more intriguing ones. Full parts list given.

ADVANCED PROJECTS

DESIGNERS 1, 2 and 3. Full prototyping units utilising 1, 2 or 3 BIMBOARD's mounted on a BIM 6607 BIMCONSOLES. 220/240Vac I/P via IEC plug and socket. Adjustable 5 to 25Vdc @ 100mA. Fixed +5V @ 1A. Fully isolated O/P's. Short circuit, fault, fold-back, protection. Power rail cable clamps along top of BIMCONSOLE accept stripped wire or 4mm plug. Component Support Bracket also included.

DESIGNER 1 £61.53, DESIGNER 2 £67.28, DESIGNER 3 £73.02

BIMPRODUCTS ORDER FORM

Type No./Name Colour Qty. Unit Price Total

BIMSTATION (19) £11.96

BIMIRON (18) £4.05

BIMSET (11) £6.80

BIMRIBBON (16) £3.96

BIMBOARD LAYOUT PAD £0.65

BIMBOARD LAYOUT PAD £0.65

MINI DESK BIMCONSOLES (1)

BIM1005 (161 x 96 x 58) £2.48

BIM1006 (215 x 130 x 75) £3.46

ALL METAL BIMCASE (2)

BIM1005 (161 x 96 x 58) £2.48

BIM1006 (215 x 130 x 75) £3.46

KEYBOARD BIMCONSOLES (4)

BIM7400 (355 x 178 x 102) £22.54

BIM7401 (431 x 178 x 102) £15.52

BIM7402 (508 x 178 x 102) £29.95

BIM7403 (508 x 178 x 102) £29.95

METAL & WOOD SIDED (W) BIMCONSOLES (9)

BIM8005 (169 x 127 x 70 [45]) £4.71

BIM8006 (143 x 105 x 56 [32]) £3.58

BIM8007 (143 x 105 x 56 [32]) £3.58

2 Herne Hill Road, London SE24 0AU

Telephone 01 737 2383

Telex 919693 Answer Back LITZEN G

Cables & Telegrams: LITZEN LONDON SE24

All prices are applicable from Jan 1980, include VAT & PP but please add 15% for Overseas Orders.
Secure your property with our security sentinel system which will protect up to six rooms. The system includes such features as entry/exit delays, auto siren reset, a two wire tamperproof alarm loop, fully automatic system status check and a battery back up facility.

In many games, a timer adds tension, particularly this timer, because it has a "booby" delay which can strike on any player's turn giving him only a few seconds to make his move.

SPEECH SYNTHESIS—Theory and hardware. PART 1
THE SHAPE OF SPACECRAFT
C.R.FRANCIS B.Sc., Ph.D.

In the years that have passed since the launch of the first Sputnik in 1957, the heavens have gradually become populated with our machines. There are many thousands of man-made objects orbiting around the earth, a few dozen in independent orbits around the sun, and a few in trajectories which will take them out of the solar system forever. There are also scores of space vehicles lying on the surface of the moon and the planets, and many have re-entered the earth’s atmosphere. The variation in shape, size and purpose of these objects is enormous. Even if we restrict ourselves to unmanned, non-landing spacecraft, and we ignore discarded jetsam such as clamps and ties, the variation is still very large.

Nimbus 6. One of a series of earth-observation satellites, Nimbus 6 was launched in 1975 into a 1100km sun-synchronous orbit, at an inclination of 100 degrees. The 830kg spacecraft is 3-axis controlled so that the instruments may remain earth-pointing. The attitude control system and the solar arrays are mounted as a separate unit linked to the payload assembly by an interconnecting truss. Thermal control louvres can be seen around the sensory ring. (By courtesy of General Electric).

The earliest spacecraft were of necessity very small and experimental, but nowadays it is not unusual for satellites to weigh several tons or to form parts of complex operational systems. Perhaps the best example of this is to be found in communications satellites; these are now a part of our everyday lives and many are operated and owned by commercial concerns. Experimental techniques have now largely been replaced by established design procedures.
The designers of spacecraft are constrained by many factors different from those encountered by more earth-bound engineers. We shall be looking at the effects of these factors on the spacecraft subsystems in more detail later, but let's take environmental effects as an obvious example. While terrestrial environmental considerations may include the weather, dust, humidity and possibly even unauthorised tampering, the spacecraft designer is much more concerned by the influence of vacuum, radiation, micrometeoroids and the weightlessness of free-fall.

To the layman then the external appearance of spacecraft may seem diverse and puzzling. There have been spheres large and small, from Vanguard, not much bigger than a grapefruit to the 100 foot diameter Echo balloons. Other spacecraft resemble boxes; TD-1A is illustrated and the OGO series are also examples of this type. Drum-shaped spacecraft are common. Geos, Intelsat and Tiros for example, and there are other strange and exotic shapes.

Why must spacecraft have these different shapes? There are obviously many factors—the purpose of the satellite, its payload, is the principle driving force and this is expressed through demands on the satellite subsystems.

**MISSIONS**

On the whole, satellites exist to carry a payload into space (as always, there are exceptions, the British satellite X4, for example, was simply a technology demonstration exercise, with no payload as such). This is the ultimate driver of satellite characteristics. The payload may consist of a single item, or may comprise a collection of instruments, experiments and so on. The categories into which these payloads may be placed are numerous; Table 1 lists many of the types of mission.

Payloads make demands on the spacecraft. Their properties and requirements which may need to be satisfied are: mass, volume, shape, power, telecommunications/control, telemetry, timing and synchronisation, instrument orientation, attitude measurement, attitude control, orbit control and thermal control.

Different payloads exhibit great variation in these properties and requirements. We may compare two examples; one representative of instruments carried as part of recent earth-observation payloads, the other typical of experiments carried by small scientific satellites in the late 60s and early 70s. The first is the Scanning Multichannel Microwave Radiometer, or SMMR, which has been flown on two American satellites, Seasat-1 and Nimbus 7, which were both launched in 1978. This instrument measures the microwave radiation emitted from the earth at 5 frequencies, in the range 6.6 to 37GHz; the characteristics of the earth's surface and the intervening atmosphere may be deduced from these measurements.

The second instrument is an ELF/VLF receiver which was flown on the British satellite Ariel 4 launched in December 1971. This experiment, which was designed at Sheffield University, also made measurements at 5 frequencies, but this time they were rather lower; ranging from 750Hz to 16kHz. These measurements are used in the study of wave-particle interactions in the magnetosphere. The important characteristics of these instruments are given in Table 2. Although there are great differences between the instruments, they do not, by any means, represent extreme cases.

We have pointed out that, in essence, the payload defines the characteristics of the spacecraft, but often the instruments in a payload are themselves constrained by the spacecraft capabilities. This may occur, for example if the agency responsible for a spacecraft announces the availability of limited space, power and mass, so that instruments or experiments must be designed within these limits.

**Table 1.**

<table>
<thead>
<tr>
<th>Types of Space Mission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific/Experimental</td>
</tr>
<tr>
<td>Astronomical</td>
</tr>
<tr>
<td>Communications</td>
</tr>
<tr>
<td>Navigation</td>
</tr>
<tr>
<td>Applications</td>
</tr>
<tr>
<td>Earth Observation</td>
</tr>
<tr>
<td>Environmental Monitoring</td>
</tr>
<tr>
<td>Meteorological</td>
</tr>
<tr>
<td>Earth Resources</td>
</tr>
<tr>
<td>Spy Satellites</td>
</tr>
</tbody>
</table>

**Table 2.**

<table>
<thead>
<tr>
<th>Characteristics of two representative payloads</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SMMR</strong></td>
</tr>
<tr>
<td><strong>ELF/VLF Receiver</strong></td>
</tr>
<tr>
<td><strong>Mass</strong></td>
</tr>
<tr>
<td>52kg</td>
</tr>
<tr>
<td>5kg</td>
</tr>
<tr>
<td><strong>Size</strong></td>
</tr>
<tr>
<td>2 boxes 15cm x 20cm x 33cm + 1 box 15cm x 20cm x 16cm + antenna 80cm diameter</td>
</tr>
<tr>
<td>1 box 20cm x 15cm x 15cm + loop antenna 3m diameter</td>
</tr>
<tr>
<td><strong>Power</strong></td>
</tr>
<tr>
<td>60W</td>
</tr>
<tr>
<td>0.35W</td>
</tr>
<tr>
<td><strong>Data output</strong></td>
</tr>
<tr>
<td>Digital 2000 bits/sec</td>
</tr>
<tr>
<td>Analogue, 17 channels sampled once every 27-92 sec. With 10 bit digitisation equivalent to 6 bits/sec</td>
</tr>
<tr>
<td><strong>Telecommands/Control</strong></td>
</tr>
<tr>
<td>12 commands</td>
</tr>
<tr>
<td>No commands</td>
</tr>
<tr>
<td>10 control pulses</td>
</tr>
</tbody>
</table>
Table 3. Correspondence between payload characteristics and spacecraft subsystems.

<table>
<thead>
<tr>
<th>Payload Characteristics</th>
<th>Spacecraft Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>Structure</td>
</tr>
<tr>
<td>Volume</td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
</tr>
<tr>
<td>Instrument orientation</td>
<td></td>
</tr>
<tr>
<td>Attitude measurement</td>
<td>Attitude and Orbit Control</td>
</tr>
<tr>
<td>Attitude control</td>
<td>System</td>
</tr>
<tr>
<td>Orbit control</td>
<td></td>
</tr>
<tr>
<td>Telecommands</td>
<td>Telecommand Telemetry and</td>
</tr>
<tr>
<td>Telemetry</td>
<td>Control System</td>
</tr>
<tr>
<td>Orbit tracking</td>
<td></td>
</tr>
<tr>
<td>Control and timing</td>
<td>Thermal Control System</td>
</tr>
<tr>
<td>Synchronisation</td>
<td></td>
</tr>
<tr>
<td>Thermal control</td>
<td></td>
</tr>
<tr>
<td>Power supply and</td>
<td>Power System</td>
</tr>
<tr>
<td>regulation</td>
<td></td>
</tr>
</tbody>
</table>

The requirements of the payload are met by the various subsystems of the spacecraft. These include such things as the power system and the thermal control system. The correspondence between requirements and subsystems is given in Table 3. Although it is not, strictly speaking, a subsystem itself, the orbit chosen for a spacecraft is also selected in response to payload requirements, and it has, as we shall see, a profound effect on the entire spacecraft.

Ariel 4. Ariel 4 was one of a series of British satellites. It was launched in 1971 into a 550km orbit at 83 degrees inclination. The 100kg satellite was used to study the ionosphere and magnetosphere. It was spin-stabilised with four deployable booms. There were many aerials, including the Sheffield VLF experiment loop aerial attached around the ends of the booms, alongside a magnetorquing coil. (By courtesy of British Aerospace)

Intelsat 4. Eight Intelsat 4 communications satellites were launched in the period January 1971 to May 1975, for the International Telecommunications Satellite Consortium, into geostationary orbit. Each was able to handle 5000 telephone channels (or 12 TV channels). The 595kg satellites have since been superseded by the Intelsat 4A and Intelsat 5 satellites. Although spin-stabilised the antennas could point continuously at the earth as they were mounted on a despun platform. Note the large area of the solar array required for the communications transmitters. (By courtesy of Hughes Aircraft Company)

**ORBITS**

The orbit is the closed path the satellite traverses through space. Most spacecraft orbit the earth, and the orbit is in general elliptical, with the earth at one focus. In many cases these orbits are approximately circular; orbit insertion errors tend to ensure that few satellites orbit in perfect circles.

There are many special orbits. Perhaps the most widely known of these is the geostationary orbit. In this case the orbital altitude is chosen so that the satellite takes 24 hours to make one revolution; it therefore always remains above the same spot on the earth spinning below. This altitude is 35,850km. This is only strictly true for an orbit in the equatorial plane, for otherwise the spacecraft could move North and South of the equator during each orbit. Geostationary spacecraft are therefore normally stationed in or near the equatorial plane, and must be able to maintain their position there.

Another specialised orbit is the sun-synchronous orbit. Here the spacecraft is in a comparatively low altitude orbit (normally less than about a thousand kilometres) with a near-polar inclination. This inclination is carefully chosen so that the orbital plane precesses under the influence of the earth's oblateness, at the same rate as the apparent motion of the sun around the earth during the year. In this way the sub-satellite track on the earth is
Starlette. The French Starlette satellite was simply a 25cm diameter sphere, weighing 68kg, inset with corner-cube laser reflectors. Laser ranging enabled the orbit to be accurately determined, for geodetic purposes. (By courtesy of CNES)

always at the same local time. This type of orbit is often used for remote sensing satellites, as the observations are more meaningful when made under the same angle of illumination.

We shall see that the circle of orbit often has a great effect on spacecraft design.

ATTITUDE AND ORBIT CONTROL SYSTEM

Satellites do exist which need no control of attitude or orbit. The Echo balloons were examples, and so are the laser-ranging satellites Lageos and Starlette. In almost every other case though some control of the attitude, and sometimes the orbit as well, is required. There are, essentially, two ways to stabilise the attitude of a spacecraft. It can either be spun about one axis so that it possesses gyroscopic rigidity, or control can be applied to all three axes so that the spacecraft can point in any desired direction for as long as control is maintained.

The type of control used is fundamental to the design, and it often determines what kind of payload can be carried. A spinning satellite enables angular surveys to be carried out, by astronomical instruments and magnetospheric particle detectors. Three axis control is necessary for many earth-observational instruments.

For a spinning satellite to be stable, the spin axis must be the axis of maximum moment of inertia. These satellites tend to be symmetrical about the spin axis so that they are dynamically balanced, and are often drum shaped. Sometimes part of the spacecraft is attached to a motor rotating at the same speed as the spinning spacecraft, but in the opposite direction so that this part remains stationary. This is called a de-spun platform and the satellite is a dual-spin spacecraft. Examples of this technique are the Intelsat 4 and 4A communications satellites where the despun platform enables the antennas to point at the earth though the rest of the spacecraft is spinning.

Power for the spacecraft is normally provided by arrays of solar cells and it is often sufficient to simply cover the sides of the spacecraft, if spin stabilisation is chosen. As the spacecraft spins, most parts of its surface will face the sun at some time. The three-axis controlled spacecraft by contrast, normally carries its solar cells on flat panels which are movable so that they may follow the sun no matter which way the spacecraft is pointing. Already we see the interaction between subsystems, and the effect of this on overall configuration.

Control of the attitude implies that means are available to measure the spacecraft attitude. This may be an Inertial Reference Unit, containing gyroscopes to provide an “internal” measurement, or “external” measurements by sun-sensors, earth sensors or star-trackers. Usually a combination of these methods is used.

Attitude control also requires some means of moving the spacecraft about each axis, in a controlled way. Thrusters or gas-jets are the obvious method, but fine control is difficult to achieve. Accurately controlled attitude manoeuvres may be performed by using reaction wheels—these are essentially flywheels attached to electric motors. As the motor accelerates the wheel in one direction, the spacecraft as a whole spins in the opposite one, so that the overall angular momentum is conserved. Momentum wheels are similar devices except that they spin in their undisturbed state, so that they possess gyroscopic rigidity; they are momentum bias devices, and are commonly used on 3-axis stabilised spacecraft. Small torques may also be achieved by using a magnetorquer. This is a loop of wire through which an electric current may be passed, to produce a magnetic field. This then interacts with the Earth’s magnetic field and can be used to rotate the spacecraft.

Some spacecraft also need to be able to adjust their orbit. Obvious examples are geostationary spacecraft; to maintain their geostationary condition under the perturbing influence of lunar and solar gravitational effects, substantial orbit control ability is required. This always has to be by means of thrusters—devices
which merely spin the spacecraft cannot change the orbit. To achieve geostationary orbit an apogee boost motor is required. This is normally a fairly large solid fuel rocket engine. Orbital measurements are not carried out by the spacecraft, but are made on the ground. The on-board equipment which enables this to be done falls into the Telemetry, Tracking and Command System.

POWER SYSTEM
These days the main source of power for spacecraft is the sun. Occasionally some sort of nuclear power source is used, and the earliest spacecraft tended to use batteries, with no means of charging them up—their lifetimes were consequently rather low. The dominant feature of most spacecraft therefore are the arrays of solar cells. We have already seen that spin-stabilised spacecraft often have solar cells all around their surface, as a result of the constantly changing angle of illumination, while three-axis controlled spacecraft have solar panels which follow the sun.

A little thought will quickly show that the number of rotation axes such panels will require depends on the orbit. For example an equationally orbiting satellite only requires an axis of rotation for its arrays, normal to the plane of the orbit (we can ignore the seasonal variation in the sun's position—at 23½ degrees each way it is not significant). OTS is such a spacecraft. Similarly a satellite in a sun-synchronous orbit only requires one axis, though the arrays may require to be tilted to this axis, depending on the angle the orbital plane makes to the sun. Sometimes however, two axes are required.

ESRO 4. ESRO 4 was launched in 1972 into an elliptical 245 x 1173km orbit, inclination 91 degrees. The 130kg satellite was spin-stabilised, with three deployable booms, and studied the ionosphere. (By courtesy of European Space Agency)

OTS. The Orbital Test Satellite is a forerunner to the European Communications Satellite programme. The 444kg, 3-axis controlled spacecraft was placed into geostationary orbit in 1977. This model shows some of the subsystems mentioned in the text. The solar cells are mounted on panels which turn about one axis, normal to the equatorial plane of the orbit to follow the sun as the antennas remain pointed at the earth. These antennas are not for TCC but form part of the payload; an experimental communications relay. The foil-like thermal blanketing and polished reflectors on the satellite's body, which are parts of the thermal control system, are visible; so too are the nozzles of two thrusters. (By courtesy of European Space Agency)

The amount of power required for a spacecraft, and therefore the area devoted to solar cells, varies greatly. Fig. 1 shows a histogram of the solar array power capability for a representative selection of spacecraft of the late sixties and the seventies. The spacecraft range from small scientific satellites to large communications satellites, and include spin-stabilised and 3-axis controlled vehicles. Clearly arrays providing a few hundred watts are the commonest size, and with an efficiency of the order of 10 per cent this implies an area of about 1m².

Fig. 1. A histogram of the power generated by the solar arrays of a random selection of 51 unmanned spacecraft
Large arrays, delivering in excess of 1kW will become more common in the 1980's. The extreme case of this is the satellite whose sole purpose is to collect solar power, so that it may be beamed to suitable receivers on the earth in the form of microwave radiation. This is the Solar Power Satellite concept, and here the array will generate about 10,000MW; clearly it will have to be very large—several kilometres square (see *Spacewatch* PE August 1980).

Sometimes a nuclear power source is used. American spacecraft use a Radioisotope Thermoelectric Generator, an RTG, where heat generated in a quantity of radioactive isotope is converted to electricity by thermocouples. The isotope need not be capable of sustaining a chain reaction. When the Russian space-vehicle Cosmos 954 crashed in Canada in 1978 it became clear that here the nuclear energy source was a true reactor, where a critical mass of material which can maintain a chain reaction is used, again to raise heat which can be converted to electricity.

The RTG is characterised by a need to maintain one junction of its thermocouples as cool as possible, and it is therefore covered with radiating surfaces which are normally fins. Such power sources may be used instead of, or in addition to, solar cells. Obviously if nuclear energy replaces solar energy the constraints on configuration due to the solar arrays are removed but new ones are added by the RTG. It must be able to radiate its heat away efficiently, and, on a long mission accumulated radiation damage due to stray radiation from the device must be limited. These factors normally ensure that the RTG must be accommodated on a boom away from the rest of the structure. This of course raises its own problems.

The power system must contain, in addition to its primary energy source, secondary sources (i.e. rechargeable batteries) and regulating and distributing subsystems. A power dump is also required. This equipment does not have a great impact on the structure and configuration of the spacecraft.

**TELEMETRY, TRACKING AND COMMAND**

The name of this system is self-explanatory, and again much of the system is internal equipment; transmitters, receivers, multiplexers, A-to-D converters, tape recorders and so on. The only item which is significantly affected by the configuration is the antenna subsystems. Often spacecraft have a multiplicity of antennas. These include VHF omnidirectional antennas for commands and for low data rate telemetry (though the VHF network is now being phased out), and directional S- and X-band antennas (the latter are not yet common) for high rate telemetry. High resolution imagery from spacecraft may require data transmission rates in excess of 100Mbs⁻¹, so the S- or X-band antenna requires high gain, or a high power transmitter! (In spacecraft terms of course. The RF power output is almost always less than 100W.)

For spacecraft in earth orbit, even fairly distant orbits such as the geostationary orbit, telemetry antennas are small and insignificant. (Note that we are here considering that the large antennas of communications satellites are part of the payload.)
However, planetary probes, which must return data from millions of miles away, normally need a large directional antenna, so that transmitter power can be kept low, and the transmitted data-rate as high as possible. The Pioneer and Voyager probes to Jupiter (and beyond) were completely dominated by their high-gain antennas.

**THERMAL CONTROL SYSTEM**

In our British climate we are not always aware of the full heating effect of the sun. Yet we have all heard of eggs being fried on bare rocks in desert regions and should therefore be able to appreciate that in space, depending on their surface finish, exposed surfaces can become very hot. Similarly, the coldest night on earth is positively warm compared to the temperature to which a shadowed object in space can fall.

It is the task of the Thermal Control System to regulate the spacecraft temperature to preset limits. These vary from item to item in the equipment inventory, but may be, typically, \(-10^\circ\text{C}\) to \(+40^\circ\text{C}\).

Solar heat inputs, and heat produced by onboard equipment, must be balanced against radiation losses to space, and the thermal inertia must be such that the temperature does not drop too far while the spacecraft is in shadow. Although some active devices are used, such as heaters and thermal louvres, much of the Thermal Control System lies in the surface finish of the spacecraft. Combinations of aluminised plastic film, polished metal surfaces and paint are used, to achieve the correct thermal properties.

This system therefore governs the final surface finish of the spacecraft; and explains why space vehicles often look as if they have been wrapped in cooking foil!

**STRUCTURE**

The mechanical structure of a space-vehicle is normally regarded as a system in its own right, and it really governs the appearance of the spacecraft. It holds all the other parts together and provides rigidity during manoeuvres, and particularly during launch.

The basic core structure may be of two types. These are the internally rigid structure where a central thrust tube supports platforms and other attachments, and the box-type structure with wall rigidity. Examples of each are shown in the accompanying illustrations. The materials used are lightweight and strong, and the commonest material for panels is aluminium honeycomb, a honeycomb structure made from thin aluminium foil with facing sheets.

In addition to providing support for the other systems and the payload, the structure performs a further important function. This is protection against the effects of the radiation belts. It is not always realised that electronic devices are susceptible to radiation damage, but this is so, and it is a cumulative process, like the damage to people. Consequently a compromise has to be reached between the lifetime of the spacecraft, the fraction of its time it spends in the radiation belt and which part of the belts are traversed (these are defined by the orbit) and the protection provided by the structure.

The structure is complicated by the addition of appendages. These appendages include the solar arrays, various antennas, and deployed experiments such as magnetometers.

The structure chosen is the result of configuration studies. Here the requirements of the payload are matched to possible configurations, bearing in mind the constraints we have described, plus any other constraints which may exist.

*Seasat*. Seasat was launched in 1978 into an 800km, 70 degrees inclination orbit. The 2200kg spacecraft was three axis controlled, and carried a number of earth-observation instruments. The use of the Agena bus (the upper stage of the launch vehicle which remains as an integral part of the spacecraft, providing AOCS, power, and other functions) has obviously dominated the design.
**PLEASE NOTE**

Schools, colleges, apprentice training schools etc.,

**I.C. REMOVAL TOOLS**

We are making a special offer on these tools. If you buy 50 or more on a cash with order basis we will only charge you 10p each (normally 30p). This offer is not available to retailers, distributors, companies etc., and the tools *must not be resold on a commercial basis.*

To take advantage of the offer please send a cheque or PO (made payable to IPC Magazines) and an order or letter on official notepaper. We can only supply quantity discount orders to official addresses, not to individuals.

**LAUNCH**

The launch imposes an inflexible set of constraints which every spacecraft must meet. The space inside launch vehicles is limited, and accelerations, vibrations and acoustic noise levels are high.

The available volume and mass which the launch vehicle allows are a strong design driver. Many spacecraft have obviously been designed to fit the cylindrical space within the launcher, and some even include the upper stage of the launcher as part of the spacecraft. Searsat is an example of this type. As a result of the limited space most appendages have to be deployed after launch, and this has given rise to many interesting deployment mechanisms.

When the Space-Shuttle comes into service, it’s primary purpose will be to launch satellites. It’s huge cargo-bay will ease many of the launch constraints, though some new ones related to safety will appear.

Although the spacecraft will spend most of its life in a weightless environment, it must be designed for strength along the longitudinal axis to cope with the launch acceleration, and it must be able to stand strong vibrations in all directions.

The illustrations accompanying this article show a diverse range of spacecraft. The reason for some of this diversity should now be clear, though manned spacecraft and many planetary landers may look as inexplicable as ever. These, though, are a different story altogether.

---

**Codespeed Electronics**

P.O. Box 23, 34 Seafield Road, Copnor, Portsmouth, Hants, PO3 5BJ

SOUND EFFECTS PCB brand new, made for spacecock noise toy. Gives 8 spacecock sounds with flashing LED's (speaker not supplied). £2.50 each. *Satisfaction guaranteed on all items or full cash refund.*

**Order (Including Post and Packing)**

Add 15% to the total cost of your order. V.A.T. add 15% to the total cost of your order (including post and packing).

Satisfaction Guaranteed on all items or full cash refund.
125W AMPLIFIER...

This 125W module, which has been designed for high power audio applications is a compact single board unit suitable for pop groups, discos, hi-fi, PA systems, etc.

The module, including a loudspeaker coupling electrolytic can be built for under £12.00 (see components list).

CIRCUIT DESCRIPTION

The complete circuit diagram of the module is shown in Fig. 1. Transistors TR1 and TR2 form a differential input pair, the output of which is d.c. coupled to the pre-driver TR3. Its mid-point voltage is set by the resistors R2 and R3. The level of negative feedback is determined by C3 and R7. Increasing the value of R7 will result in an increase in the negative feedback which improves linearity and distortion. However, C3 should not exceed 50µF otherwise "clamping" will result. The capacitors C4, C7 and C11 ensure high frequency stability.

The collector load of TR3 is "boot strapped" to the mid point via C8. The output from the input stage is connected to a complimentary driver pair via the diode D4. Under normal conditions D4 is forward biased but in the event of a high voltage occurring at the emitters of the power transistors, due to a short circuit at the loudspeaker terminals, the sensing resistors R28, R29, R30 and R31 will trigger the appropriate protection transistors TR5, TR7, TR4 or TR6. The protection circuit reverse biases D4 and clamps the bases of the drivers, TR9, TR10 to the mid point. When the short is removed normal operating conditions are restored.

The bias condition, which sets the quiescent current of the output transistors is determined by the collector-emitter voltage of TR8. This voltage is set by VR1. A stable quiescent current is maintained throughout the working temperature range of the module by transistor TR8 being in thermal contact with the heatsink. Any rise in temperature reduces the collector-emitter voltage of TR8 thus compensating for the current rise in the drivers and output transistors.

The bias path via TR8 which also carries the a.c. signal to TR10 has the junction of R15 and R16 “bootstrapped” to the mid point. The diode D5 ensures maximum drive at high power levels.

The output transistors TR11, TR13, TR12 and TR14 are parallel connected with independent emitter resistors. The diodes D2 and D3 limit the mid point swing to the level of the supply voltage as when an inductive load is connected without D2 and D3 the mid point voltage could become higher or lower than the supply voltage.

The output is shunted with a Zobel network (C9 and R14) and connects to the speaker via L1 and R8. This arrangement minimises the effect of the speaker’s inductance and presents the speaker with as near a d.c. load as possible. The coil L1 also enables electrostatic speakers to function without the need for a loudspeaker coupling electrolytic.

SPECIFICATION

<table>
<thead>
<tr>
<th></th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Power</td>
<td>125W r.m.s. (not continuous sine wave)</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>25Hz to 20kHz at 100W</td>
</tr>
<tr>
<td>T.H.D. 4 ohm lead</td>
<td>0.1% typical</td>
</tr>
<tr>
<td>at ½ power 8 ohm lead</td>
<td>0.07% typical</td>
</tr>
<tr>
<td>Signal/noise</td>
<td>78dBs</td>
</tr>
<tr>
<td>Sensitivity for 100W</td>
<td>400mV</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>47k</td>
</tr>
</tbody>
</table>

A power amplifier module with both open and short circuit protection which only requires a p.s.u. for operation.
be used. However, the shunt resistor R8 may require some adjustment but it should not be higher than 15 ohms otherwise severe ringing may occur.

**PREMATURE LIMITING**

Premature limiting may occur due to the spread in component values, particularly minor variations in the values of R24, R25, R26 and R27. The symptom of premature limiting is the break-up of sound at high power levels. Should this occur the value of R21 and R22 should be changed from 2k2 to 1k5.

**COUPLING CAPACITOR**

The load coupling capacitor which should be connected with the positive lead to the module must be at least 470pF 60V for a 16Ω load, 1000pF 60V for an 8Ω load and 2200pF 60V for 4Ω loads. The voltage rating can be reduced with the supply voltage but should never be less than two thirds of the supply voltage.

An unregulated power supply capable of giving 80V at 2-5A is suitable for use with each module the current rating can be reduced to 0-5A if a 16Ω load at 50V is used. Hum generated as a result of supply line ripple will be the controlling factor in the smoothing of the power supply.

**CONSTRUCTION**

The p.c.b. which is supplied with the kit requires drilling. All the holes should be drilled first with the exception of the power transistor holes. Particular care should be taken to drill the two heatsink fixing screws accurately. The p.c.b. can then be fixed to the heatsink and using the heatsink as a template all the power transistor holes can then be drilled. Make sure that all the holes are drilled in the centre of the heatsink holes as no insulation bushes are used. The power transistors should be mounted into position using mica washers and a silicon compound. The rest of the components can now be soldered. Note that TR9 and TR10 both have heatsinks fitted to them.

Carefully check all the soldered joints and using a multi-
Fig. 2. P.c.b. design

Fig. 3. Component layout for the amplifier
Note: C6 is not required
COMPONENTS . . .

Resistors
- R1, R11: 680 Ω (2 off)
- R2: 47 kΩ 5%
- R3: 68 kΩ 5%
- R4, R9, R17, R18: 10 kΩ (4 off)
- R5, R28, R29, R30: 3 kΩ 5% (5 off)
- R6, R15, R16, R32: 1 kΩ 5% (4 off)
- R7
- R8, R14, R20: 220 Ω (2 off)
- R10, R13: 2 kΩ 5% (2 off)
- R12: 12
- R19: 22
- R21, R22: 2 kΩ 5% (2 off)
- R23, R34: 39 (2 off)
- R24, R25, R26, R27: 220 Ω (2 off)
- R33: 330 Ω

All transistors: 1 W 10% carbon except where otherwise stated.

Semiconductors
- D1
- D2, D3, D4
- D5, D6
- TR1, TR2
- TR3
- TR4, TR7
- TR5, TR6
- TR8
- TR9
- TR10
- TR11, TR12, TR13
- TR14
- C8, C10
- C9, C12
- C11
- C3
- C4
- C5
- C7
- C8
- C9
- C10
- C12
- C11
- 680 Ω (2 off)
- 47 kΩ 5%
- 68 kΩ 5%
- 10 kΩ (4 off)
- 3 kΩ 5% (5 off)
- 1 kΩ 5% (4 off)
- 150
- 22
- 2 kΩ 5% (2 off)
- 39 (2 off)
- 0.1 (2 off)
- 47 μ (2 off)
- 470 pF
- 4 nH
- 100 nH (2 off)
- 47 μ (2 off)
- 12
- 820 μF
- 330
- TR1
- TR2
- TR3
- TR4, TR7
- TR5, TR6
- TR8
- TR9
- TR10
- TR11, TR12, TR13
- TR14
- 1 N4003 (3 off)
- BC212 (2 off)
- BC154 (red spot) (2 off)
- BC172 (white spot) (2 off)
- 7637
- TfP29 (white spot TO220)
- TIP30 (red spot TO220)
- TIP30 (red spot TO220)
- 2N3055 (4 off)

Semiconductors
- Germanium diode
- 1N4003 (3 off)
- Silicon diode (2 off)
- BC212 (2 off)
- 470 pF
- 47 μ (2 off)
- 150
- 820 μF
- 12
- 22
- 2 kΩ 5% (2 off)
- 39 (2 off)
- 0.1 (2 off)
- 47 μ (2 off)
- 470 pF
- 470 pF
- 100 nH (2 off)
- 47 μ (2 off)
- 12
- 820 μF
- 330
- TR1
- TR2
- TR3
- TR4, TR7
- TR5, TR6
- TR8
- TR9
- TR10
- TR11, TR12, TR13
- TR14
- 680 Ω (2 off)
- 47 kΩ 5%
- 68 kΩ 5%
- 10 kΩ (4 off)
- 3 kΩ 5% (5 off)
- 1 kΩ 5% (4 off)
- 150
- 22
- 2 kΩ 5% (2 off)
- 39 (2 off)
- 0.1 (2 off)
- 47 μ (2 off)
- 470 pF
- 470 pF
- 100 nH (2 off)
- 47 μ (2 off)
- 12
- 820 μF
- 330

Potentiometers
- VR1: 1 kΩ preset lin

Capacitors
- C1: 680 nF
- C2: 1 μF

Miscellaneous
- P.c.b.
- Heatsink
- Mica washers (4 off)

Inductor
- 47 μ 63V elect
- 1100p
- 140 μ 70V elect
- 470 pF
- 47 μ 35V elect (2 off)
- 100 nF (2 off)
- 4 nH

Constructors Note

A complete kit of parts for the amplifier module is available from Radio and TV Components, 218 High Street, Acton, London W3 6NG. A suitable power supply unit kit for the amplifier is also available from RT-VC.

meter check there is no continuity between the cases of the output transistors and the heatsink.

The inter wiring should be kept as short as possible with screened leads used for the input connections. Each module should be earthed to a central earthing point only, as should the power supply—ve mains, earth, etc. The main leads should be capable of carrying a continuous current of 2.5A. Generally speaking, the heavier the earth lead the better and 24/0.2 mm conductor is recommended.

OUTPUT POWER
To obtain the maximum output from the module a power supply of 80 V (the maximum allowable voltage) and a load of 4 ohms must be used. When the module is being operated at full power it should be mounted on an aluminium case or heatsink of at least 16 s.w.g. and with a surface area of 950 sq. cms.

With a 50 V supply (minimum voltage) and a load of 16 ohms the output power will be approximately 16 W and if an 8 ohm load is used, 32 W.

With the module connected to a suitable p.s.u. and loudspeaker, and with no input signal applied, VR1 should be adjusted for a total current reading of 50 mA.

The low initial resistance of the elements means that warm-up is achieved very rapidly after switching on, but once the switching temperature is reached equilibrium occurs, with heat losses from the element balancing the input power. Passing air through the heater results in a new, lower equilibrium temperature, which in turn causes the resistance to drop and hence increases the input power. The result is that the overall temperature of the block remains nearly constant at around the switching temperature, and heating power can be varied merely by controlling the flow of air.

An important feature of the elements is their inherent safety; if the air flow stops for any reason, the current flow into the device becomes self-limiting and the heater remains at the switching temperature. Other advantages include minimal temperature fluctuations, with no "dead spots" within the heater block.

MAGIC ELEMENT
An entirely new and intriguing type of heating element with built-in temperature control without the need for any external sensors or cutouts is now available from Salford Electrical Instruments Ltd. Known as PTC Honeycomb heaters, the new elements are available for use from 240 V or 110 V a.c. mains, and are ideally suited to use in domestic appliances and blown air applications in industry.

The heaters depend for their operation on the thermal properties of doped barium titanate, a semiconductor ceramic whose resistance increases sharply above a certain temperature, known as the switching temperature. The elements are available in round or rectangular shapes, with a "honeycomb" structure of hexagonal holes to ensure easy air flow over as large a surface as possible.

Self-regulating heater elements
THE circuit diagram of the Video Summer Unit is shown in Fig. 3.1. In addition to the R, G and B signals from the character generator, the TEA1002 requires a number of timing signals. These are all derived from signals available in the teletext decoder. The PAL switch input (pin 12) is a square wave at half line frequency which changes the colour burst phase on alternate lines to provide correct PAL encoding. It is generated by taking the GLR signal and dividing it by two with a binary counter. The counter is negative edge triggered to ensure that the timing of the PAL switch is correct. GLR is also used to generate the Colour Burst Flag (CBF) input to the TEA1002. It is gated with F1 in the 4528 monostable (IC16) to provide a 2.211s pulse which enables the colour burst encoder in the TEA1002 at the correct time. AHS is used as the composite sync input to the TEA1002 and also to trigger the second monostable of IC16. This generates a 4.5μs pulse which is adjustable to enclose the whole of the colour burst on the TV video signal. This output is then inverted and fed to the burst gate input of IC17. This enables IC17 to frequency lock its 8.8MHz oscillator to the frequency of the incoming burst. The oscillator output is then buffered and connected to the oscillator input of the TEA1002. The Picture On input from the teletext board is used to kill the oscillator whenever TV display is selected since there would otherwise be an ambiguity in the colours of the displayed text. This means that news flashes and subtitles are displayed in black and white only.

Pin 11 on the TEA1002 has a chroma band limiting filter connected to it to reduce the harmonics present in the TEA1002 chroma signals. This considerably improves the quality of the display but necessitates the use of a delay line in the luminance path between pins 6 and 7. A delay of 270ns effectively compensates for the delays introduced by the filter in the chroma path.

Pin 9 on the TEA1002 is used to select two different colour bar standards. For teletext use, it is grounded to give colours based on the BBC 95 per cent colour bar standard. If it is taken to the 5V supply, colours based on the EBU 75 per cent colour bars are produced which are more suitable for TV games.

The remainder of the circuit consists of a black level clamp which clamps the TV video black level to that of the TEA1002 video output, and an analogue switch to select either the TV video information or the encoded teletext display. The output of the switch is buffered and provides a signal suitable for driving the REMO 200 modulator directly.

The composite video output from the TEA1002 is shifted in d.c. level and reduced in amplitude to give a 1 volt signal on the input to the analogue switch and on one side of the long tailed pair. When the CBF signal is high, current flows in the long tailed pair and the p.n.p. transistor conducts to charge the 1μF clamping capacitor until the two bases of the pair are at the same potential.

The TV signal which is nominally 2.4V peak to peak is reduced in amplitude and buffered to provide a 1V signal at the output of the clamp.

IC19 is an analogue switch and when the blanking signal is low, the Y0 input is connected to the output giving a TV picture display. If the blanking signal is high as in teletext mode or during boxed information on news flash and subtitle pages, then the Y1 input is connected to the output giving a text display.

CONSTRUCTION
The Video Summer Circuit, sound amplifier and modulator are all mounted on the p.c.b. shown in Figs. 3.2. and 3.3. The through-board links shown by the square pads in Fig. 3.3. should be soldered first. Before soldering the rest of the components carefully check the links for continuity with a multimeter. It is recommended that i.c. holders are used for...
Fig. 3.1. Circuit diagram of the Video Summer Unit
COMPONENTS . . .

VIDEO SUMMER BOARD

Resistors
- R58  82k
- R58, R65, R71, R79, R89  6k8 (5 off)
- R60  22k
- R61, R63  2k2 (2 off)
- R62, R75  4k7 (2 off)
- R64, R68, R80, R85  10k (4 off)
- R66, R67  820 (2 off)
- R69, R74, R86  2k7 (3 off)
- R70  220
- R72  1k8
- R73  1k2
- R76  15k
- R77, R78  47 (2 off)
- R81, R87  3k3 (2 off)
- R82  100k
- R83, R88  470 (2 off)
- R84  1k

Potentiometers
- VR7, VR8  10k (2 off)
- VR9  5k

Capacitors
- C37, C49  220p (2 off)
- C38, C57  10µ 16V elect (2 off)
- C39, C45, C51  100n (2 off)
- C40, C50, C52, C53, C54  22n (5 off)
- C41  120p
- C42, C43, C44  100p (3 off)
- C46  560p
- C47  5-65p
- C48  47µ 16V elect
- C55  2µ 16V elect
- C56  1µ 16V elect

Semiconductors
- TR7, TR9, TR10, TR11
- TR12, TR14, TR15, TR16
- TR17  BC548 (9 off)
- TR8  BSX20

Miscellaneous
- IC15  4520
- IC16  4528
- IC17  TDA 2822
- IC18*  PE1X or TEA 1002
- IC19  4052
- IC20  TBA120S

POWER SUPPLY UNIT

Capacitors
- C58, C59, C63  220n
- C60  4700µ 25V elect
- C61  2200µ 25V elect
- C62  220µ 160V elect

Semiconductors
- D20, D21  1N4001 (2 off)
- D22  BY888 47V zener
- BR1  1 Amp bridge rectifier WO1
- IC21  LM340T-5
- IC22  LM340T-12
- IC23  LM78L24 CH

Miscellaneous
- S1 single pole switch
- LP1 neon lamp
- T1 mains transformer (30-0-30, 0-5A; 8-0-8, 0-2A)
- Fuse holder
- Case RB6
- UHF panel mounted sockets (2 off)
- UHF plugs (4 off)

the chips and care should be taken with the orientation of the transistors. Double check the correct types have been used.

SETTING UP

All the adjustments on the board can be carried out using an oscilloscope, a standard TV receiver and a source of broadcast video including teletext data.

First the CBF pulse on pin 6 of the IC16 should be adjusted to be 2-2µs wide. Then the pulse at pin 15 of the IC17 should be adjusted to just enclose the colour burst on the incoming TV video signal. Check that it is correct for all channels. It is now necessary to adjust the frequency of the reference oscillator (IC17). For this, it is necessary to display both TV video and coloured teletext simultaneously. To do this, select a newsflash or subtitle page which contains coloured information, then open-circuit the PON input (TR10 base). This allows the reference oscillator in IC17 to continue oscillating to give a colour display of the newsflash. Now short circuit together pins 7 and 8 of IC17 to allow the oscillator to free run, and adjust the crystal trimmer capacitor for the minimum beat of the colours in the displayed text. The oscillator is now correctly tuned, and the shorting link can be removed and PON reconnected.

Finally, the coil in the chroma filter on pin 11 of the TEA1002 should be adjusted for maximum colour burst amplitude at the TEA1002 output. This should correspond to minimum patterning on the teletext display.

PE1X MODIFICATION

Supplies of the TEA1002 are at present very limited. However, the PE1X can be used in place of the TEA1002.
Fig. 3.2. Video Summer p.c.b. design
Fig. 3.3. Component layout

Fig. 3.4. Circuit diagram of the p.s.u.
The PE1X, which is similar to the TEA1002 although it does not have the BBC colour bar option. If the PE1X is used, then additional components are required to simulate the BBC colour bars provided by the TEA1002. This is done by ORing together the R, G and B signals with diodes and using this signal to inject an extra current into the luminence channel at the delay line input. In addition, the PE1X has a 470Ω series resistor to pin 9.

The circuit diagram and the p.c.b. are shown for PE1X operation. If a TEA1002 is to be used then the series resistor R88 should be removed and pin 9 should be linked to 0V instead of 5V and the diodes D14 to D18 and resistor R57 should be removed from the daughter board.

**POWER SUPPLY UNIT**

The circuit diagram of the p.s.u. is shown in Fig. 3.4. Three output voltages are required by the decoder; +70V for the tuning voltage, with +12V and +5V for the TTL and CMOS.

The p.c.b. design is shown in Fig. 3.5 with the component layout in Fig. 3.6. The two voltage regulators (IC21, IC22) are mounted on the copper side of the board and their leads should be kept as long as possible. The p.c.b. is mounted at the rear of the case with the regulators bolted to the case.

Before connecting the p.s.u. to the system, carefully check the output voltage of each rail.

**NEXT MONTH: WIRING AND TESTING**
In this part the circuits of cards 2 and 3 and the assembly of the former will be dealt with.

**CARD 2**

Fig. 6 includes the panel mounted components and the interwiring that lies between Cards 1 and 2. The panel mounted components, however, will be dealt with in greater detail later.

S1 and S2 are the source switches, S3 is the monitor PFL selector and VR1 is the crossfader. IC1 raises the disc or line input signal to line level and provides RIAA bass boost. A degree of rumble filtering is provided by C11, which causes the gain of the stage to fall below 20Hz. The output of IC1 feeds the tone control stage and also the Sound-to-Light output via a mixer. C17 and C23 control the degree of midrange variation; to reduce the midrange boost and cut, a lower value, typically 2n7 should be substituted. C25 provides d.c. isolation thereby ensuring that the tone controls are quiet in action. Instead, the d.c. bias current flows through R25.

C27 provides lead compensation in order to achieve stability even when the wires leading to the tone controls are quite long. The value given is typical, and generally, for good performance it must be as small as possible. The precise value of C27 can only be determined when the completed unit is tested.

When wiring the board, keep the 'MA', 'CEN' and 'MI' tone control connection wires away from each other, and make the wiring as direct as possible. Again, use 16/0.2 wire for the OV connection and screened cable for the inputs.

**CARD 3 CIRCUIT**

The microphone input stage shown in Fig. 8 is intended for high output unbalanced capacitor microphones with a typical output of 1.5mV/µBar. A 47V line is needed to power the integral preamplifier in most capacitor microphones, and this voltage appears at the input socket. For this reason, the rarely encountered 4 pin XLR is used to lessen the chance of accidental connection of other circuits or microphones to the 47V supply.

**Fig. 6. Circuit of Card 2**

**IC1-IC4 PIN 7+15V
PIN 4-15V
C1-4 NE5534N**

**NOTE. MONITOR FEED IS DERIVED FROM RIGHT CHANNELS ONLY**

S DELINES END OF CARD AREA

1 EDGE CONNECTOR PIN REFERENCES
Fig. 8. Circuit of Card 3
## Resistors
- Card 2
  - R1—4: 22k, Metal oxide, ½ watt, 2%
  - R5—6: 100k
  - R7, 8: 270k
  - R9, 10: 1k
  - R11—12: 22k
  - R13—14: 100R
  - R15—16: 10k
  - R17—18: 2k7
  - R19—20: 10k
  - R21—22: 2k7
  - R23—24: 4k7
  - R25—26: 820k
  - R27—28: 1k

All ½ watt, 5% unless otherwise specified

## Potentiometers
- VR1: 25k quad slider pot with log/antilog tracks (Rivlin)
- VR2: 100k lin dual slider pot (Maplin type FX80B)
- VR3: 22k lin dual slider pot (Maplin type FX78K)

## Capacitors
- Card 2
  - C1, 2: 1μ, polycarbonate
  - C3, 4: 10p, ceramic
  - C5, 6: 150p, ceramic or polystyrene
  - C7, 8: 12n, polycarbonate
  - C9, 10: 1n5, polycarbonate
  - C11—12: 10p, 25V, PC electrolytic
  - C13—14: 470n, polyester, C280AE series
  - C15, 16: 1μ, polycarbonate
  - C17, 18: 10n, polycarbonate
  - C19, 20: 47n, polycarbonate
  - C21, 22: 47n, polycarbonate
  - C23, 24: 10n, polycarbonate
  - C25—26: 1μ, polycarbonate
  - C27, 28: 22p, ceramic (see text)
  - C29, 30: 22p, ceramic
  - C31, 32: 880n, polycarbonate
  - C33, 34: 22p, 25V, p.c. electrolytic
  - C35, 36: 100μ, 40V, axial electrolytic
  - C37—42: 100n, polyester, C280AE series

## Semiconductors
- IC1—4: NE5534N

## Miscellaneous
- S1—2: 'Min maka switch' with 3-way, 4-pole wafer (RS components, types 327—311 and 327—377)
- S3: Min. rotary switch, 4-way, 3-pole
- S4: Pushbutton illuminated switch with red lens and shield (RS 339—358, 339—409, 339—415), one each of these required

4 x 8 pin d.i.l. sockets
- Pointer type collet knobs to suit above switches
- Crossfader knob (Maplin type RX27E)
- P.c.b.—RS type 434-150

## Resistors
- Card 3
  - R1—2: 22k
  - R3: 4k7
  - R4: 2k2
  - R5: 3k3
  - R6: 10k
  - R7: 1k2
  - R8: 100k
  - R9—12: 47k
  - R13: 47k
  - R14—15: 100k
  - R16—17: 68k
  - R18—19: 1M2
  - R20—21: 1k
  - R22—23: 12k
  - R24—25: 33k
  - R26—27: 5k6
  - R28—29: 82k
  - R30—31: 4k7
  - R32—33: 680R, 1W
  - R34—35: 100R, 1W

All ½ watt, 5% carbon unless otherwise stated

## Capacitors
- Card 3
  - C1: 22p, ceramic
  - C2: 1μ, polycarbonate
  - C3, 4: 3n3, polycarbonate
  - C5, 6: 12n, polycarbonate
  - C7: 22p, ceramic
  - C8: 680n, polycarbonate
  - C9: 22μ, 25V, PC electrolytic
  - C10: 15p, ceramic
  - C11: 680n, polycarbonate
  - C12: 22μ, 25V, PC electrolytic
  - C13: 22p, ceramic
  - C14: 680n, polycarbonate
  - C15: 22μ, 25V, PC electrolytic
  - C16, 17: 15μ, 40V, electrolytic, axial
  - C18, 19: 47p, polycarbonate
  - C20, 21: 220n, polycarbonate
  - C22, 23: 15μ, 40V, axial electrolytic
  - C24, 25: 15μ, 40V, axial electrolytic
  - C26, 27, 28—33: 100μ, 40V, axial electrolytic

## Potentiometers
- VR1: 220k lin dual slide pot (Maplin type FX81C)
- VR2: 22k lin dual slide pot (Maplin type FX78K)
- VR3: 1k log dual slide pot (Maplin type H80DA)
- VR4—5: 10k enclosed cermet preset (RS components type 186-182)

## Semiconductors
- IC1—4: NE5534N
- IC5—6: NE555
- TR1—2: BC109
- D1: 2—2: Flush panel l.e.d. red (RS type 576-327)
- D3: 2: 47µ, 40V, axial electrolytic

## Miscellaneous
- SKT1: 4 pin female XLR socket (see text)
- SKT2: 3 pin male XLR socket (Maplin type BW92A)
- T1: Sowter microphone transformer (see text)
Fig. 9 shows alternative input circuit arrangements which will accommodate the vast majority of moving coil and phantom powered capacitor microphones. Phantom powering keeps the polarising voltage out of harm’s way and thus the common 3 pin XLR socket can be used. All the circuits shown in Fig. 9 provide similar performance to the input stage in Fig. 8, and the output voltage for the quoted microphone sensitivities is identical.

To achieve a good overload margin, the signal is not brought to line level immediately. Instead, it passes through the equalisation stage (IC2 and associated components) and the gain control (VR3).

The tone control potentiometers are not isolated from the input bias current of IC2, as in Card 2, because they are usually preset before a performance. If this is not the case, then the arrangement shown in Fig. 6 can be applied, i.e., a 1µ isolating capacitor and an 820k resistor to derive the bias current from pin 6 on the op.amp.

IC3 is a line driver, providing amplification to line level and a low output impedance. The microphone signal passes to the send-return switch and socket (shown later) and then to the mono mixer (IC4), together with the stereo lines. R8 and R13 prevent switch clicks, etc., by holding the voltage on the output capacitors at ground potential, regardless of any offset voltages that may be present.

Also on Card 3 are the peak indicator i.e.d.s which accommodate the vast majority of moving coil and phantom powered capacitor microphones. The 555 timer (IC5) is powered from the +15V rail because there are insufficient pins on the edge connector to provide a +12V rail.

This device can readily introduce noise on the supply rails, but in this case, because they are panel mounted, they can be fed from the auxiliary 12 volt supply. This supply does not feed any audio circuitry, apart from the monitor amplifier, thus noise levels on this rail are largely immaterial.

Professional VU meters have rigidly defined ballistics, frequency response and impedance and are designed to bridge 600 ohm lines directly. Panel space limitations prevented the use of such a meter, and a miniature meter with a VU scale was used. The genuine article is designed such that OVU occurs at +4dBm, but the non-standard OVU=OdBm was considered to be more useful. A VU driver was required to bring the level derived from stereo lines up to +4dBm, and cause OVU deflection in the meter. TR3 provides such amplification and VR4 allows accurate calibration.

Test the circuit as before, connecting all inputs to OV. Also connect pins 15 and 19 together to bias IC2 in the absence of VR1. To test this circuit, both rails must be connected, otherwise the op-amps will saturate and damage may result. Apply a 1kHz signal to pin 1 on the edge connector and cause the input level until the i.e.d. lights. Trimming of R15 and R17 may be necessary to achieve the desired indication level accurately. The VU driver is tested in a similar manner; in this case, a 776mV r.m.s. input signal should cause an OVU reading.

Next Month: More circuits and boards.
HI-FI FILMING

New British patent application 2 031 690 from Polaroid Corporation of Cambridge, Massachusetts (filed under the New Laws and dating back to September 1978) describes a complex, but interesting microphone system for a home movie camera. The aim is to facilitate direct sound recording with an integrated camera, recorder and microphone system. Home movie cameras which record sound direct onto the magnetic stripe of conventional (but pre-striped) Super 8 film are already available and the patent application may mean that Polaroid intends to launch a sound version of the Polaroid instant movie system. This is called Polavision and uses a modified form of Super 8 colour film which is automatically developed in a table-top player with a back projection screen. So far Polavision has been only a silent system.

Home movie cameras produce a considerable amount of noise i.e. motor and claw whirr which spreads from 100Hz to 6000Hz with a peak at around 2000 Hz. As this peak is in the centre of the speech frequencies any camera noise recorded on the film soundtrack is a considerable nuisance. Polaroid suggests a microphone system capable of efficiently rejecting sound at a chosen frequency and angle of incidence.

Figure 1 shows camera 17 with microphone 13 mounted on a boom and connected to a processing circuit 15. Figure 2 shows a design for circuit 15 which can be tuned to reject a selected sound spectrum in a solid cone angle marked by chain lines 22 in figure 1.

Microphone 13 is in fact a linear ray of four omni-directional microphone elements M1, M2, M3 and M4, spaced apart by distances D1, D2. An arriving sound wave thus produces four identical, but mutually phase shifted, output signals. In figure 2 summing channel 40 adds the signals from elements M2, M3 and subtractor 41 difference the signals from M1, M4. The output of subtractor 41 is integrated with respect to time, at 42 and combining means 46 adds the outputs from the summing and integrated channels. A gain control 44, 45 in each channel allows adjustment of the relative channel levels. The overall output, which appears on line 47, is recorded and can be reduced to zero at any desired frequency and angle of incidence by suitable selection of the relative gain at 44, 45 and the spacing D1, D2 between the elements. Extensive formulae are given in the patent to enable necessary calculations to be made.

A three microphone stereo system, with filtering to reduce wind noise, is also described, (Figure 3) A means of adding and subtracting microphone inputs by mechanical rather than electrical means is suggested (Fig. 4). Two microphones 126, 128, are arranged with their diaphragm axis mutually at right angles. When the output of microphone 128 is integrated and added to the output of microphone 126, the response pattern obtained is similar to that obtained with the circuit of Figure 2.

Points Arising

MICROPROMPT (July 1980)

Don't try running this as a program, it will not work. These lines contain corrections to the "LE PASSE-TEMPS" program. Our apologies for these errors.

```basic
40 DIMS(44), T(I): POKE 530, I: PRINT: GOTO 60
80 E = 0: F = 0: G = 0: FOR A = 1 TO 42: S(A) = 0: NEXT
705 FOR A = 0: TO 11: T(A) = 0: NEXT A
730 T(I) = T(I) + S(U)
830 FOR D = 0 TO 3: T(I) = T(I) + S(N): N = N + 6:
5 NEXT D: I = 1 + 1
850 FOR H = 0 TO 1: D = T(H): IF D = 4 THEN E = 1
950 FOR A = 1 TO 7: IF S(A) = 0 THEN 970
980 PRINT TAB(Z-LEN(M$)/2) M$: CHR$(13)
1010 IF MM = 0 THEN 1040
1070 IF G THEN G = 0: S3 = S3 + 1: GOTO 50
```
The Personal Computer Book

By Robin Bradbeer

Published by Input Two-Nine and distributed by MCB Publications Ltd., Bradford. 499821.

220 pages. 147 x 210 mm. Price £5.25.

ANYONE who has had even the briefest encounter with the world of personal computers and its literature will probably have come across the name Robin Bradbeer. Few would be better placed to put a book of this nature together. A freelance writer on personal computing, senior lecturer at the Polytechnic of North London, and founder of the North London Computer Club, the author has produced an excellent book, explaining the whole concept and meaning of the microcomputer revolution in simple terms. It goes on to explain languages, software and hardware, and most important of all—what you can do with a home computer once you have one!

The Personal Computer Book’s greatest strength is probably the appendices, which are as follows: (a) Binary Arithmetic; Octal; Hexadecimal; ASCII Code; (b) Bus Standards, (c) Manufacturers and Distributors in the UK, (d) Computer Clubs in the UK, (e) Magazines in English. (f) Bibliography of Selected Computer Books, (g) Glossary, (h) Some Hints on Kit-Build Systems.

Having served as a thorough introduction to the subject of microcomputers, therefore, the work should continue to serve as a most handy source of reference.

---

**Countdown**

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below.


D.C. Servo Motors (IEETE event) Oct. 14. SSEE, 75 Waterloo Street, Glasgow, at 7 p.m.


Drive Electric Oct. 14-17. Wembley Conf. Centre, London. Organiser (C) 0.05-834 2333.


Engineering Ireland Oct. 15-18. Leopardstown Exhibition Centre, V


Compec Nov. 4-6. Olympia.

BEX Nov. 5-6. Sophia Gardens, Cardiff.


Semiconductor International 80 Nov. 25-27. Metropole Convention Centre. T

BEX Nov. 26-27. Exhibition Centre, Bristol.


BEX 81 Feb. 4-5. Pavilion, Bournemouth.


BEX 81 April 8-9. Centre hotel, Liverpool.

All Electronics Show 81 April 22-24. Grosvenor Ho., Park Lane, London, F1


Entertainment 81 May 8-17 (weekend mornings trade only) NEC, Birmingham.

The European Consumer Electronics Show 81 May 10-13. Nuremberg Fair Centre, W., Germany. (Trade)

BEX May 11-22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth.


Semlab 81 June 2-5. Grand Hall, Olympia, London. The international scientific, educational, medical and industrial laboratory equipment exhibition. (Trade)

Components 81 (Electronic Components Industry Fair) June 9-12. Earls Court, London. This show will alternate yearly with Electronics, now that the IEA amalgamation with Electrex has ceased. I


Electronics 82 (Sub-titled International Electronics Control and Instruments Exhibition) May 24-28. 1982. NEC.
SPECIAL PURCHASE

OF TOP QUALITY

LCD MULTIMETERS

AC/DC CURRENT
22 RANGES

IT'S AS EASY AS A,B,C...

SPECIAL PURCHASE

OF TOP QUALITY

LCD MULTIMETERS

AC/DC CURRENT
22 RANGES

6100

6200

CHOOSE FROM FOUR MODELS

- 3½ digit autoranging (volts/Ohms)
- 200 hours battery life (2 pencells)
- 10 amp AC/DC (6220 & 6100)
- 1000v DC 600v AC
- 200 mA AC/DC (6200 & 6100)
- Range hold facility (6100 & 6110)
- Unit and range sign (6110 & 6220)
- Continuity buzzer (6100 & 6110)

RESOLUTION

100 µV: 1 mV AC
10 µA AC/DC: 0.1 Ohm
10 mA AC: 10A AC/DC

ACCURACY 6100/6110

0.5% DC Volts
1% AC Current
1.2% AC Current
0.5% Resistance

6200/6220

0.8% DC Volts
1.3% AC Current
1.4% AC Current
0.8% Resistance

OTHER FEATURES

(ALL MODELS)
Low power Ohms range.
Zero Adjust key.
Battery Warning.
In circuit resistance test.
Size 155 x 85 x 28 mm. 250 g.

- All prices include batteries/leads and UK VAT (UK c/p 65p)
- Order by post or telephone with Barclay or Access.

OR CALL IN AND SEE FOR YOURSELF

Cubegate Limited
AUDIO ELECTRONICS
301 EDGWARE ROAD, LONDON, W2 1BN
TELEPHONE 01 724 3564

FREE CATALOGUE
Send large SAE (17p UK)
Scribes, Companies, etc. free on request.

From Mr/Mrs/Miss (Block caps please) Ref. P.E.
Please supply
Qty. Model(s)
Exp. date
Or debit Barclay/Access No.

CONTINENTAL SPECIALTIES CORPORATION (UK) Limited, Dept. 5H,
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.

Cubegate Limited OPEN 9-6 SIX DAYS A WEEK

Audio Electronics

PRACETICAL ELECTRONICS OCTOBER 1980
KEELMOOR Quality...

Keelmoor Ltd is a company which has been established for a long time—we supply the products you have often bought from other companies. Our precision watches and electrical goods are renowned for their superb quality and reliability. We differ from other companies in that we import direct world-wide—that difference is passed on to you at unbeatable prices. You receive the goods faster and we provide a service and no catch guarantee of which we are justly proud. We employ experts world-wide whose job it is to seek out products of the highest quality at the lowest possible prices. Illustrated here is just a tiny selection of our comprehensive range. Just compare these items with those seen elsewhere—we are confident the prices will amaze you. You can save £££s.

GENTS 5 FUNCTION LCD

This is the foundation of our range and is ideal for the man requiring the basic functions of hours, minutes and seconds, with month and date. A backlight is included and the stainless steel strap provided is fully adjusted to suit any size of wrist. Guaranteed for one year, this watch represents fantastic value at only £4.95p.

ILLUSTRATED BELOW IS THE LADIES 5 FUNCTION LCD. This watch has the same time and auto calendar functions as the basic gents model described above, together with backlight and adjustable strap to suit the daintiest of wrists. It's compact, pleasing appearance makes it a very practical day watch and it is also often used for boys and girls. Available in black or white face.

These are just a few of our fantastic offers remember. A free colour catalogue is posted with every order. £5.95p

GENTS LCD ALARM WATCH

This model represents fantastic, incredible value for money. The 6 digit display continuously shows hours, minutes and seconds, or may be changed at will to hours, minutes and date. Its effective alarm is extremely useful and may be set to any time within a 24 hr. period. In addition, there is an alarm indicator, 4 year calendar and snooze repeater. £8.95p

FULLY GUARANTEED

We must emphasize all these items are fully guaranteed for one year. All electronic goods come complete with demonstration batteries which cannot be guaranteed. New batteries are available for only 60p.

BARCLAYCARD AND ACCESS CARD WELCOME. SEE COUPON.

HERE IS THE AMAZING 12/24 HOUR ALARM/CHRONOGRAPH

Along with the usual time and date displays, this multi-functional timepiece has a 24 hour alarm and a 1/100 second stopwatch. The time may be set to operate in 12 or 24 hour mode and the date can be in English or American format. The day of the week is continuously indicated and the stopwatch display may, on command, be frozen to show split/lap time while the stopwatch continues to run. Stopwatch operation does not effect normal time keeping. £12.95 only for this model. Also available with solar energy panel to conserve energy during daylight hours for £14.95.

From Watches to Clocks, from Calculators to Radios, from Binoculars to Tool Kits—KEELMOOR is the name for the right quality at the right price. Your personal catalogue will tell you more—free with every order.

LADIES QUARTZ LCD DRESS WATCH

This attractive ladies model with the standard 5 functions of hours, minutes, seconds, month and date has literally sold in tens of thousands. Available in gold or silver colours with 'sugar coated' finish. Please state first and second choice of square, round or oval design. £8.95p

THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH

If you want a watch from the top end of the market this is the one for you. Full calculator functions plus memory and percentage are combined with time and alarm functions to make this item an outstanding buy. Manufactured in Japan at the same factory that produces models for probably the most famous name in the watch business, this device represents sheer quality at an unbelievable price. Comes complete with backlight and button operating tool carried in the strap clasp. We advise you to order quickly whilst stocks last. £39.95p
We don't think you'll find items of this quality anywhere else at the price we offer. Order now, Christmas is round the corner and this is the way to make gift buying easier—and cheaper too.

WE ARE PROUD TO INTRODUCE THE AMAZING
MELODY ALARM CHRONOGRAPH

Today's technology has produced this fine watch which incorporates a musical alarm which plays a complete verse of 'The Yellow Rose of Texas.' Other functions included are as for model number 1.

£14.95p

NEW TO OUR RANGE, WE COMBINE PRECISION AND STYLE IN THIS—THE SUPER SLIM GENTS 5 FUNCTION CHRONOGRAPH

These watches need no special functions to make them stand out in a crowd—their slimness serves that purpose. If you've been put off digital quartz watches in the past because you require an ultra-slim design, now is the time to change. Is equipped with standard 5 functions and backlight.

£9.95p

AND FINALLY, WHAT MUST BE THE ULTIMATE IN SQUEEZING A QUART INTO A HALF PINT POT! THE INCREDIBLE MINIATURE LCD TRAVEL/ALARM CLOCK

As you can see from the photograph above this device is tiny and yet it continuously displays hours and minutes with auto calendar and night light. Invaluable for the busy traveller or simply for use in the modern home, it comes complete with its own travelling case and can easily be carried in top pocket or the smallest of handbags. It has even got a stand for upright position on table, shelf or sleeping compartment. An unusual gift to yourself or others at only £10.95.

£10.95p

THE KEELMOOR PROMISE
Keelmoor have a tremendous reputation to uphold, both in the retail and wholesale trades and so, with every product sold, we automatically give the Keelmoor Promise. This includes—
• NO RISK GUARANTEE—Try any of these items for 15 days and if you are not completely satisfied with the quality and value simply return it for a complete refund.
• ONE YEAR's FULL GUARANTEE on all products
• BACK UP SERVICE second to none

Every order dispatched by return, and is sent by recorded delivery. That is Keelmoor's Promise To You.
The new Toolrange catalogue

still the only catalogue of its kind

The new Toolrange Catalogue is still the only comprehensive single source of electronic tools and production aids. The product range has almost doubled since last year and now over 2,000 tools, toolkits and service aids are illustrated in full colour.

Products from over 100 top manufacturers are available from stock.

Over 60,000 catalogues are now in circulation. If you don’t have one simply write, telephone or telex Toolrange for your free copy.

Upton Road, Reading, Berks. RG3 4JA

Telephone: Reading (0734) 22245 Telex: 847917
YOUR SOUNDEST CONNECTION IN THE WORLD OF COMPONENTS

PETS

8N (8K RAM) £399
16N (16K RAM) £499
32N (32K RAM) £599
ALL WITH NEW KEYBOARD AND GREEN SCREEN.

PERIPHERALS

Service & Assistance available.
Interfaced available are:
X-Y plotters, analogue to digital converter, 16 channel interfaces, bi-directional interfaces, etc.

EXTERNAL CASSETTE DECK SUITABLE FOR ALL PETS £55

UK101

£179 in kit form
£229 ready built & tested
£249 complete in case

NO EXTRAS REQUIRED
* FREE SAMPLER TAPE
* FULL QWERTY KEYBOARD
* 8K BASIC
* RAM EXPANDABLE TO 8K ON BOARD (4K INC)
* KANSAS CITY TAPE INTERFACE

* New monitor allows full editing & cursor control.

£22

PRINTERS

TX-80 £375
EPSON TX-80 £375


BAUD RATE GENS
MC14411 8.75
MM5307 8.75

EDPROM'S

2708 4.95
2716 (5v) 13.95
2532 39.95

FOM'S

2513(UC) 5.95
2513(LC) 5.95

CPU'S

6502 9.50
8080 4.75
8085 25.95
6800 5.90
Z80 8.95

BUFFERS

81L92 1.25
81L96 1.25
81L97 1.25
81L99 1.25
SN74365 52
SN74366 52
SN74367 52
SN74368 52
BT26 1.75
BT28 1.75
BT95 1.57
BT96 1.57
BT97 1.50
BT98 1.57

BARCLAYCARD

PLEASE ADD VAT 15% TO ALL PRICES. POSTAGE ON COMPUTERS, PRINTERS & CASSETTE DECKS CHARGED AT COST. ALL OTHER ITEMS P&P 30p. PLACE YOUR ORDER USING YOUR ACCESS OR BARCLAYCARD (Min. Tel. order £5.00). TRADE & EXPORT ENQUIRIES WELCOME, CREDIT FACILITIES ARRANGED.
ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pick-ups, tuners, etc. using digital or analogue sound sources.

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power R.M.S.</th>
<th>Distortion Typical at 1KHz</th>
<th>Minimum Signal/Noise Ratio</th>
<th>Power Supply Voltage</th>
<th>Size in mm</th>
<th>Weight in gms</th>
<th>Price + V.A.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY30</td>
<td>15 W into 8 Ω</td>
<td>0.02%</td>
<td>100 dB</td>
<td>105x50x25</td>
<td>155</td>
<td>£6.34 + 95p</td>
<td></td>
</tr>
<tr>
<td>HY50</td>
<td>30 W into 8 Ω</td>
<td>0.02%</td>
<td>100 dB</td>
<td>105x50x25</td>
<td>155</td>
<td>£7.24 + 1.09p</td>
<td></td>
</tr>
<tr>
<td>HY120</td>
<td>60 W into 8 Ω</td>
<td>0.01%</td>
<td>100 dB</td>
<td>114x50x85</td>
<td>575</td>
<td>£15.20 + 2.28p</td>
<td></td>
</tr>
<tr>
<td>HY200</td>
<td>120 W into 8 Ω</td>
<td>0.01%</td>
<td>100 dB</td>
<td>114x100x85</td>
<td>575</td>
<td>£18.44 + 2.77p</td>
<td></td>
</tr>
<tr>
<td>HY400</td>
<td>240 W into 4 Ω</td>
<td>0.01%</td>
<td>100 dB</td>
<td>114x100x85</td>
<td>115 Kg</td>
<td>£27.88 + 4.15p</td>
<td></td>
</tr>
</tbody>
</table>

Load impedance - all models: 4 Ω - ∞
Input sensitivity - all models: 500 mV
Input impedance - all models: 100K Ω
Frequency response - all models: 10Hz - 45KHz - 3dB.

ILP Pre-amps are compatible with all ILP Power Amps and PSUs.

ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and apart from PSU 30 and 36 which are smaller PSU's - in all the other ILP manufactured PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents. They are also more efficient and have greatly reduced radiation.

PSU 30: ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66
£4.50 + £0.68 VAT

THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS
PSU 36: for 1 or 2 HY30's
£8.10 + £1.22 VAT

THE FOLLOWING ALSO INCLUDE TOROIDIAL TRANSFORMERS
PSU 50: for 1 or 2 HY50's
£8.10 + £1.22 VAT
PSU 60: for 1 HY120
£9.75 + £1.46 VAT
PSU 70: for 1 or 2 HY120's
£13.61 + £2.04 VAT
PSU 90: for 1 HY200
£13.61 + £2.04 VAT
PSU 180: for 1 HY400 or 2 x HY200
£23.02 + £3.45 VAT

Available also from Watford Electronics, Marshalls and certain other selected stockists.
this time with two new pre-amps

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers - HY6 for mono operation, HY66 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

Sizes - HY6 - 45 x 20 x 40 mm, HY66 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost. Inputs Sensitivity - Mag. PU - 3mV; Mic - selectable 1-12mV; All others 100mV; Tape IN - 100mV. Main OUT - 500mV. Frequency response - D.C. to 100KHz - 3dB.

HY6 mono £5.60
HY6 mono + VAT £6.84
HY66 stereo £10.60
HY66 stereo + VAT £12.19
Connectors included
86 Mounting Board £7.17p; 12p VAT
866 Mounting Board £9.99p; 15p VAT

- LOW DISTORTION - Typically 0.005%
- HIGH OVERLOAD FACTOR - 38 dB on Mag. P.U.
- LATEST DESIGN HIGH QUALITY CONNECTORS.
- REQUIRE ONLY POTS, SWITCHES, PLUGS AND SOCKETS.
- COMPATIBLE WITH ALL ILP POWER AMPS AND PSU's.
- NEEDS ONLY UNREGULATED POWER SUPPLY ±15V to ±60V.

* ALL U.K. ORDERS DESPATCHED POST PAID
HOW TO ORDER, USING FREEPPOST SYSTEM
Simply fill in order coupon with payment or credit card instructions. Post to address as below but do not stamp envelope - we pay postage on all letters sent to us by readers of this journal.

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

NO QUIBBLE 5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE — see below

Please supply

Total purchase price £

(£) Cheque □ Postal Orders □ International Money Order □

Please debit my Access/Barclaycard Account No.

NAME
ADDRESS

Signature
Our new catalogue is now available. It contains 100 illustrated diagrams, and over 300 pages of new stock. Send for a copy free! You will receive: • A reply paid envelope • A Mail Order form to facilitate rapid dispatch • A 50% Discount voucher All prices include VAT. Please add 50p carriage on all orders below £15.00.

76 College Road, Bromley, Kent BR11DE.

DISCO LIGHTING KITS!!!
First class constructional projects, c/w glass fibre P.C.B.'s & full instructions. No extra components needed to make a top rate working unit.

**L1**
3 channel sound-to-light.
300 w/channel 4x 100w input

**L2**
3 channel 3w);
200w in vitamins 200w in vitamins

**L3**
24 W slider dimmer
suitable for clubs/pubs

**L4**
A professional unit c/w face plate.

ALL KITS C/W
circuit, comprehensive instructions & full parts guarantee

Carriage on above 70p

UNREPEATABLE HI-FI BARGAIN
3 WAY LOUDSPEAKER KIT C/W BAFFLE (pre-cut)
Comprises:
* 6½" linen surround bass unit
* 5½" mid-range unit
* 3½" tweeter
* 3 way crossover, fixing screws & baffles
* 20 watts handling capability
Full instructions and parts guarantee
Must be heard to be believed!

SAXON ENTERTAINMENTS
327-333 Whitehorse Rd., Croydon, Surrey CR0 2HS.
(01) 684 8007
Order by phone—Access/Barcard/C.O.D.
Open Mon—Sat 9am—5pm.
To: Mitrad, 68-70 High Street, Kettering, Northants.
Please send me:

- Zetron clock radio(s) at £17.80 inc. p&p
- Seiko Watch(es) at £50.80 inc. p&p
- Pen Watch(es) at £12.00 inc. p&p

**Total value of my order £**

I enclose cheque/PO or debit my Access/Barclaycard:

No. _____________________ Signature ________________

Name: ___________________ (block letters please)

Address: __________________________

Credit card holders may telephone (0536) 522024 24 hours a day stating card number for immediate attention. All orders despatched within 48 hours. Delivery subject to availability. Full refund if not completely satisfied. Mitrad, Registered in England No. 1500613. Code: PE.
Buying one of our PROJECT PACKS will save you the hassle of tracking down all the odd components that hold up the completion of your project. Our packs include Printed Circuit Board, all the components listed in the article together with sockets and solder. Cases, knobs and other extras are supplied as extra items if required. Ask for more information...
Aitken Bros
35, High Bridge, Newcastle upon Tyne
Tel: 0632 26729

EXP300
550 contacts with two 50-point BUS bars. Size 162 x 133mm. £5.95.

Proto-Board 6 Kit
630 contacts, four 5-way binding posts, accepting up to 6 14 pin DIPs. £6.98.

CSC Logic Probes
LP-2 Economy Probe
Min. pulse width 200 nanoseconds. 300 KΩ input impedance, tests circuits up to 1 MHz. Detecting pure tones or single-shot event in TTL, DTL, HTL and CMOS circuits. £2.95.

LP-1 Memory Probe
£3.65

LP-3 High Speed Memory Probe
£5.75

CSC catalogue available. Please send S.A.E.

Calscope Super 6 £186-30
A portable single beam 8 MHz bandwidth oscilloscope with easy to use controls. High gain to 10 mV/cm and wide time base range from 1μs to 100 μs/cm. Full specification on request. Please send S.A.E.

Calscope Super 10 £251-85
A dual trace 10 MHz instrument of the very highest performance and quality. It has an accuracy of 3% which is achieved by the use of built-in stabilised power supplies which keep the trace rock steady over a wide range of mains fluctuations. Full specification on request. Please send S.A.E.

Sinclair Low Power Portable Oscilloscope SC110 £159-85
The SC110 has a 10 MHz bandwidth and sensitivity down to 10 mV per division. Full trigger facilities are provided, including bright line, auto with TV line and frame position. Please send for illustrated brochure.

Tmk 500 Multimeter 30,000 d.c. AC volts up to 10, 25, 100, 250, 500, 1000 DC volts, 0.25, 1, 2.5, 10, 25, 100, 250, 1000 DC current 0.5 μA, 5 μA, 50 μA, 12 amp. Resistance 0-6K, 60K, 6MΩ, 60MΩ. Decibels -20 to + 56 db. 50 pa, 50 MA, 500 MA, 12 amp. Resistance 0-6K, 60K, 6MΩ, 60MΩ. Size 152 x 73 x 40 mm. Price £25.95.

Sinclair DM235 Digital Pocket Multimeter
DC volts (4 ranges) 1mV to 1000V AC volts 1V to 500V DC current (6 ranges) 1 μA to 200MA Resistance (5 ranges) 1Ω to 20 MΩ. Price £39.95. Also -5-6. Price £25.95.

Sinclair DM350 & 450 as for DM235 below. Full spec. on request.

Sinclair DM450 Bench-Portable Digital Multimeter
DC volts (4 ranges) 1mV to 1000V AC volts (4 ranges) 1mV to 150V DC 0-2.5MHz. Size 255 x 148 x 40 mm. Price £159.85. DM350 34 digit display DM450 44 digit display. Both £251.85. Price £83.95.

Cablecard Number

Desoldering Tool £6.45

Benchtop Desoldering Pump

Monitors

Uncased from 3" to 12"
Cased from 5" to 20"
Semi professional or professional available from stock.

Monitor PCB's including Transformers and Tubes also in stock.

Phone or write for details.

Crofton Electronics Limited
35 Grosvenor Road, Twickenham, Middx.
Tel: 01 891 1513
NOTICE TO READERS
When writing to Classified Advertisers please ensure:
(A) That you have clearly stated your requirements.
(B) That you have enclosed the right remittance.
(C) That your name and address is written in black ink, in block capitals.
(D) That your letter is correctly addressed to the advertiser.
This will assist advertisers in processing and despatching orders with the minimum of delay.

RECEIVERS AND COMPONENTS
TUNBRIDGE WELLS COMPONENTS, Ballards, 108 Camden Road, Tunbridge Wells. Phone 31803. No lists. Enquiries S.A.E.

Low cost NEWLINE COMPONENTS
Allows the use of Test Modules
OUTPUT 2-15DC aT 1A
Speed 150 QP
Order: Valp, 50p
Fosmtransistor and transformer
5 Town Hall Yard, Market Place
Ashbourne, Derbyshire. Tel: (03925) 5733

100 Discs 85p, 50 Transistors 95p. 10 ICs 75p. All mixed.

EDUCATIONAL
CAREERS in Marine Electronics. Courses commencing September and January. Further details, the Nautical College, Fleetwood FY 7 6Z. Tel. 03917 79123.

CITY & GUILDS EXAMS
Study for success with I.C.S. An I.C.S. home study course will ensure that you pass your City & Guilds exams. Special courses for Telecommunications, Technical Installations, Radio, TV & Electronics Technicians, Radio Amateurs. Full details from:
ICS SCHOOL OF ELECTRONICS
Dept. Z272 Intersect House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

TECHNICAL TRAINING
Get the training you need to move up to a higher paid job. Take the first step now—write or phone I.C.S. for details of our over 30 specialist home study courses on Radio, TV, Audio & Servicing. Electronics, Computers. £3 or £5 Self build kit. Full details from:
ICS SCHOOL OF ELECTRONICS
Dept. Z272 Intersect House, London SW8 4UJ
Tel. 01-622 9911 (all hours)
State if under 18

SMALL ADS
The prepaid rate for classified advertisements is 24 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £8.00 per single column centimetre (minimum 2.5 cms). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Practical Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

SERVICE SHEETS
G.T. TECHN. INFO. SERVICE
7th Church St., Larkhall, Lanarks ML5 1HE
Any single service sheet £1 + large SAE.
1000's of sheets/manuals always in stock.
Sol purchasers of all T.V. Repair Systems
Grand Diagram Manual for Washing Machines
Single tubs/twin tubs/auto—only £13.50.
Repair Data any named T.V. £5.50 (with circuits, etc. £7.00). SAE for new issues, offares etc.
Phone 0969 883334 after 4pm.

BELL'S TELEVISION SERVICES for Service Sheets on Radio, TV, etc. £1.00 plus S.A.E. Colour TV Service Manuals on request.
S.A.E. with enquiry to B.T.S. 190 Kings Road, Harrogate, N. Yorkshire. Tel: (0423)55885.

FOR SALE
SINCLAIR ZX80 COMPUTER. Working 100% plus manuals, leads, power pack, programmes etc. Owner upgrading £85 or offer. King David 0202/422623 (day) or 02016/77183.
1x VISIONC 50V CAMERAS with 19 inch CCU's, circuit diagrams, connectors, etc. £45 each. 20 ins. metal cas-
ed monochrome monitors £30 each. Sony AV 3650 in open reel video machine, £125 volt model, £40. Prices inc.
VAT. JMF Video Supplies, 01-445-0452.
MK11 F.S.E. new keyboard, extra RAM, cassette interface £45. Telephone 01-948 54084.

COMPUNIT 101 8K, built, cased £270 various books included in price. Available, 15 Stewards Close, Sutton, Cambs. 0335-771822.
ZX80 COMPUTER. Working almost new, £60. 24 Church Walks, Llandudno, Tel. 75105.
ACORN MICROCOMPUTER. System one. Manufacturer assembled. Complete with power pack and manual. Perfect, demonstrated, £55. Road, 23, Cranbrook Manor, Road, Twickenham, 99 4429.
COMP UNIT UN51 assembled and working, cassette works at 600 band. £220. Tel. 01-399 3894.

NEW BACK ISSUES of "Practical Electronics" available 80p each Post Free. Open P.O./Cheque returned if not in stock.
BELL'S TELEVISION SERVICES, 190 Kings Road, Harrogate, N.Yorks. Tel: (0423)55885.

MAPLIN Drumset Rhythm generator kit. Plays fifteen different rhythms. Ready built and working. £70. Telephone: Ingrebourne 47504 (Romford).

100 CLOSE TOLERANCE, metal oxide resistors. Mixed values. £3. Also 120 monochrome monitors £30 each. Sony AV 3650 in open reel video machine, £125 volt model, £40. Prices inc. VAT. JMF Video Supplies, 01-445-0452.

HMREMADE/ORGAN in case. Two keyboards, room for pedals. Two 12 in. Fane speakers, 50 watt amp in working order, £70. Owner upgrading £85. Boud, 23, Cranebrook, Manor Road, Benfleet 53658.

BOOKS, BOOKS, BOOKS. Large Range of Electronics Books in stock. Send S.A.E. for list. Servo Radio (Dept PE10), 138/B Morton Road, Wimborne, SW19 1EQ.

BOOKS AND PUBLICATIONS
BURENORTH/POOLE, Electronic components for the hobbyist, and friendly service. Why not pay us a visit. M & H TELELECTRICS LTD. 353 Ashley Road, Parkstone. 742633.

TURN YOUR SURPLUS Capacitors, transistors, etc., into cash. Wisbech, Cambs. 0945-4188. Immediate settlement.


YOUR OWN P.C.B.'S & FRONT PANELS EASILY MADE, NO COMPLICATED PROCESSES Full details S.A.E.

DIAGNOSTIC PACKS:
Draughting packs: pb £1.67; panel £1.97. Processing packs: pb (£3) £2.10, panel (£6 + £9) £2.88. Drills, ochants, inc cat and all materials available.

R. S. QUALITY COMPONENTS LYNWOOD ELECTRONICS
20, Stour St. Avenue, Bournemouth, BH6 3PT.

SERVICE SHEETS from 30p and S.A.E. Catalogue 20p and S.A.E. with manual. Hamilton Road, 47 Bolsover Road, St. Leonards, Sussex.

Books and Publications

BOOKS, BOOKS, BOOKS. Large Range of Electronics Books in stock. Send S.A.E. for list. Servo Radio (Dept PE10), 138/B Morton Road, Wimborne, SW19 1EQ.

ANY REQUESTED SERVICE SHEET £1 + Large SAE. Full repair data any named T.V. £5.50 (with circuits, layouts etc.) £7.00. SAE for new issues, offers etc. Phone 0969 883334 after 4pm.
SITUATIONS VACANT

UNIVERSITY OF LONDON GOLDSMITHS’ COLLEGE
Psychology Department
Technician

Applications are invited for the post of Technician in the Psychology Department at either Grade 3 or Grade 1A level, to start as soon as possible.

Grade 3 Qualifications: O/N/COND/Civ/Guilds Intermediate level and experience in one or more of the following areas: General Laboratory Equipment, A/V, test gear, digital/analog, microprocessor, mini computer, prototype wiring.

Day release for relevant studies feasible.

Salary: £6,374 + 5 increments to £6,872 p.a. inclusive.

Grade 1A/1B Suitable for young person as a trainee technician.

Salary: £7,111 + 6 increments to £7,611 p.a. inclusive.

Write for further particulars to the Personnel Officer, University of London Goldsmiths’ College, New Cross, London, SE14 6NW stating clearly for which post you are applying. Closing date for applications 26th September, 1980.

INDUSTRIAL ELECTRONICS: Are you an Electronic Technician or Service Mechanic? Have you had an apprenticeship followed by at least 3 years recent practical experience in service and repair of electronic equipment? If so we can offer you employment as an INSTRUCTOR, with good promotion opportunities and pensionable security at Bristol, and Swindon skillcentres. Starting salary £6,000 p.a. rising by two increments to £7,110 p.a. For more information contact Miss A. Carran, M.S.C. T.S.D. 11, Park Place, Clifton, Bristol. Telephone Bristol 20661.

MISCELLANEOUS


Catalogue £1 postage please to:

RAMON CONSTRUCTOR SERVICES
Masons Rd. Stratford on Avon
Warwks. CV37 9NF 0789-4879

SUPERB INSTRUMENT CASES BY BAZELLI, manufactured from P.V.C. Faced steel. Hundreds of people and industrial users are choosing the cases they require from our vast range. Competitive prices start at a Low £1.05. Chassis punching facilities at very competitive prices, 400 models to choose from Suppliers only to Industry & The Trade. BAZELLI Dept No. 23, St. Wilfrids, Foundry Lane, Halton, Lancs., L1, 6LT.

BUILD YOUR OWN PROJECTS!

Items, our Electronic Construction Kit Data Sheets. Complete sets of plans now available for:

CO-2, 8 trans LED MW Multistage radio $1.80

Cut & 7 trans MW/LW Multistage radio $1.50

AV Converter Unit- range up to 100 miles $1.75

Car Speaker stereo set 4 ohms 5 watts $2.75

Car radio. Manual tuning MW/LW LISP $2.00

Car Cassette Radio, AM/FM/MP%, C1.30 to all orders under £10. Orders £10 and over, please add 10% carriage.

QOUTATIONS FOR LARGER QUANTITIES

Please ask 15% VAT. A.T. to total remittance.

All prices correct at time of going to press.

FLAIRLINE

Printed Circuit Board Supplies

Glass fibre, tinned and drilled, proto types to batch runs. Quick turn-round, competitive prices. Send S.A.E. for quotations. R. D. Electronics, 12, Whinbrooks Road, Oadby, Leicester, LE3 37627.

BURGAL ARMOUR: Latest Discount Catalogue out now! Phone C.W.A.S. Alum 0724 762674.

GUITAR/P.A./MUSIC AMPLIFIERS

100 watt superb treble/bass/bass overdrive. 12 months guarantee. Output at £49.50. £42.50. £35. 100 watt twin channel set, treble/bass per channel £62. 60 watt (£62.50) 3 channel set (£79), bass per channel £90. 200 watt 4 channel stereo cassette/bass per channel £90. 200 watt £78. 100 watt £54. 200 watt £65. High grade bass (£12.90). Overdrive fuzz with treble and bass boosters £20.50. 100 watt combo superb sound overdrive, sturdy construction, casets, unbreakable £88; twin channel £105; bass combo £115; speakers 18in. 100 watt £85; 100 watt £24; 50 watt £16; microphone Shure Unidyne £8.25.

Send cheques to P.O. WILLIAMSON AMPLIFICATION 62 Thorncliffe Avenue, Dukinfield, Cheshire. Tel: 061-308 2064

MK 14

Full programming manual at last!

* 216 pages for £5.95!

* programming, number-crunching, DMA, memory expansion, all those missing Mk 14 catalysts!


At your local bookshop, or direct from Tony Watson, Globe Book Services, Little Essex Street, London WC2.

(A/D 35p postage.)

7 SEGMENT LED's at low cost 0.3in, RH decimal, common cathode, FND70 series. Basic diagram included. £2 plus S.A.E for three. F. Rose, 13, Wallace Drive, Eaton Bray, Beds.

RYDER ORGAN SYSTEM

The W.V. classical design for full-size keyboards, including couplers. Expanded range of units now includes chorus, vibrato, combination stop control. AND -- a new reverb.

Data, prices, etc., please to:

HIKYON LTD. (P.), Woodside Crafts, Ladybridge Lane, Bolton BL1 5ED.

CLEARING LABORATORY: scopes, generators, P.S.U.'s, bridges, analysers, meters, recorders, etc. 0403-16736.

RECHARGEABLE BATTERIES

TRADE ENQUIRIES WELCOME

FULL RANGE AVAILABLE SAE for Details. 01-61-930-86 Booklet "Nickel Cadmium Power" plus Catalogue. Write to: Drivers, A.G. Ltd., 3, Willesden Drive, BOLDMORE, SUTTON COLDFIELD, WEST MIDLANDS, 021-384 9764 or see us at TICL 32, Great St. John's Street, Charing Cross, London WC2.

LOGIC ANALYSER/PULSE CATCHER in kit form £8.75

TARGET A variable speed game to test your reactions, in kit form £9.75

MYLAR FILM CAPACITORS -- 100V

0.001, 0.0015, 0.0022, 0.0033, 0.0047, 0.0068 -- 5p 0.015, 0.022 -- 6p, 0.033, 0.047, 0.068 -- 7p 0.1 -- 8p

Resistors -- High stability carbon film 1p

Orders under £5, add 30p. P&P.

Mail Orders only.

HERTS ELECTRONICS

16 Dunlin Road, Herts. Hemel Hempstead. Hemle, HP2 6U.L.

ULTRASONIC TRANSDUCERS. £8.25 per pair + 25p P&P.

Dataplus Developments, 81 Cholmer Road, Reading, Berks.

Cabinet and Flightcase Fittings

Prealysts, Coverings, Handles, Castors etc. Jacks and Sockets, Cables, Bulges, Reverb Trays. Emily Compressor, Radix, ACG Mics, Conversion Systems, ASS, Glassworks Horns.

Send 3p Postal Order for Illustrated catalogue copy.

ADAM HALL (P. E. SUPPLIES) Unit G, Carlton Court, Granger Road, Southend-on-Sea, Essex SS2 5ZB.

UK101 Software

UK101: Our most popular programs: 4K Alien Invaders; BK Home Finance. Our latest program: BK Assisted Runner; and our other firmware programs: 4K Snakes and Ladders; 4K Fruit Machine; 4K My Number - a new multiplaying Machine; £9.00 each or £5.00 for any two including P.S.P. Cheque or P.O. or just S.A.E. for details to Mr. Sect, Dept. Y, 1, Branksome Chase, Poignet, D. Devon TQ3 1EA.

UK101: Programmable Sound Generator

Add another dimension to your UK101. We will supply the P.C.B. list of parts, Hardware and Software Instructions and Software on tape. All for only £9.50.

UK101 Software on Tape

Our current project: BK Alien Invaders; BK Home Finance. Our latest program: BK Assisted Runner; and our other firmware programs: 4K Snakes and Ladders; 4K Fruit Machine; 4K My Number - a new multiplaying Machine, £9.00 each or £5.00 for any two including P.S.P. Cheque or P.O. or just S.A.E. for details to Mr. Sect, Dept. Y, 1, Branksome Chase, Poignet, D. Devon TQ3 1EA.
DIGITAL WATCH BATTERY REPLACEMENT KIT

These watches all require battery (power cell) replacement at regular intervals. This kit provides the means. You supply eyeglass, non-magnetic tools, watch screws, case knob and screwdriver case opener. Also one doz. assorted watch parts, full instructions and battery identification chart. Price £2.00. Send a postal order for complete kit and get into a fast growing business. Prompt despatch.

BOLSTER INSTRUMENT CO.
11 Percy Avenue, Ashtead, Middx. TW15 2PB.

MORE UK1D SOFTWARE from the guy who wrote "Le Pac". Phone (01)643 6111 after 6 p.m.

THE SCIENTIFIC WIRE COMPANY
PO Box 30, London E.4
ENAMELLED COPPER WIRE
SWG 1lb 8oz 4oz 2oz
8 to 29 2.76 1.50 0.80 0.60
30 to 34 3.20 1.80 0.90 0.65
35 to 40 4.00 2.00 1.10 0.80
41 to 43 4.75 2.60 2.00 1.42
47 8.37 5.32 3.19 2.50
48 to 49 15.98 9.88 6.38 3.69
SILVER PLATED COPPER WIRE
14 to 30 6.50 3.75 2.20 1.40
TINNED COPPER WIRE
14 to 30 3.85 2.35 1.34 0.90
Prices include P&P and wire data. SAE for list. Dealers enquiries welcome. Reg office 22 Coningsby Gardens.


EXACT TIME?

MSF CLOCK is ALWAYS CORRECT - never gains or loses, self setting at switch-on, 8 digits show date, Hours, Minutes and Seconds, larger digits. Hours and Minutes for easy QUICK-LASHE time, auto GMT/BST and 15 minute parallel BCD output for computer and audio output to record (with commentary) and show time on playback. Requires Radio-Beacon CX time signals, built-in antenna. 10000m range, absolute time £54.80. V.F.L. F.7 EXPLORE 10-150KHz. Received £13.70. Each fun-to-build kit includes all parts, circuit, case, parts, and manual; assurance so send now.

CAMEBRIDGE KITS
45 (FK) Old School Lane, Cambridge, CAMBRIDGESHIRE.

NO LICENCE EXAMS NEEDED

To operate this miniature, solid-state Transmitter Receiver Kit. Only £12.95 plus 35p P & P. Brain freeze? Try with a MINI-STROBE Electrical Kit, powered by "lightning flashes", vary for discos and parties. A mere £5.95 plus 35p P & P. Experiment with a psychological DREAM LAB, or pick up a fantastic space/sounds with the BIG EAR sound-catcher. Ready-made starters - Starter kit (5 sheets) each plus 35p P & P. LOTS MORE! Send 30p for lists. Prices include VAT.

BOFFIN PROJECTS
4 Cunliffe Road, Stoneleigh Ewell, Surrey (P.E.)


NATIONAL Personal Computer Users Association, 11 Spraying Street, Manston, Ramsgate, Kent (B.A.E. Details)

MAKE YOUR OWN PRINTED CIRCUITS
Etch Resistor Transfers - Starter kit, £10.60. Complete kit, £12.95. Massive Positive Transparencies from P.C. layouts in magazines by simple photographic process. Full instructions supplied. (20 x 25cm) negative paper and 2 sheets (18 x 24cm) positive film. £1.80. Drafting film (30 x 21cm) 23p per sheet. 17p stamp for lists and information. P&P 30p/10.

P.K.G. ELECTRONICS
OAK LODGE, TANSEL'S, DERBYSHIRE

CONGRESS AMPLIFIER

We supply all the designer approved parts for this exceptional kit, including high quality printed circuit boards. Complete kit, excluding metalwork with 20% discount on parts.

R'S, PC'S, PCB'S, semicons, controls etc, but excluding transformer with 10% discount on parts.

£41.79

All parts to build main amplifier.

£39.87

Mains transformer

£21.72

Smoothing caps & clips

£8.86

Front Panel

£3.20

Chassis (unpainted, pre-punched)

£15.98

All parts together with complete kit available at special price of £110.50. This offer also applies to previous purchasers of complete kits.

MAIL ORDER ONLY.

Please send A5 S.A.E. for full price details.

Terms: Cash with order. Cheques etc. should be made payable to:

CONGRESS ELECTRONICS PROJECT

14-21 days after sending order for delivery. Send order to:

Photostat of article available at £1.20

WICCA SYSTEMS LTD,
24 HILLCREST PARADE, COULSDON, SURREY.
Tel. 01-688 5255

Practical Electronics October 1980
C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instantly all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection); electronic variable dwell circuit (maximises spark energy at all speeds); pulse processor (overcomes contact breaker problems); Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In its ready built form (C30000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. Low cost adaptors available for rare cases.

Application list enclosed with each kit. Note: Vehicles with Smiths Jaeger rev. counters code RVI on dial will require adaptor type TO1.

What’s in the kits. Surefire’s own precision anodised aluminium extruded case, P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcbs, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.

C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instantly all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection); electronic variable dwell circuit (maximises spark energy at all speeds); pulse processor (overcomes contact breaker problems); Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In its ready built form (C30000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. Low cost adaptors available for rare cases.

Application list enclosed with each kit. Note: Vehicles with Smiths Jaeger rev. counters code RVI on dial will require adaptor type TO1.

What’s in the kits. Surefire’s own precision anodised aluminium extruded case, P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcbs, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.

C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instantly all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection); electronic variable dwell circuit (maximises spark energy at all speeds); pulse processor (overcomes contact breaker problems); Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In its ready built form (C30000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. Low cost adaptors available for rare cases.

Application list enclosed with each kit. Note: Vehicles with Smiths Jaeger rev. counters code RVI on dial will require adaptor type TO1.

What’s in the kits. Surefire’s own precision anodised aluminium extruded case, P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcbs, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.

C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instantly all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection); electronic variable dwell circuit (maximises spark energy at all speeds); pulse processor (overcomes contact breaker problems); Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In its ready built form (C30000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. Low cost adaptors available for rare cases.

Application list enclosed with each kit. Note: Vehicles with Smiths Jaeger rev. counters code RVI on dial will require adaptor type TO1.

What’s in the kits. Surefire’s own precision anodised aluminium extruded case, P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcbs, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.
when you build this

**PW 'SHERBORNE' SYNTHESISED AM/FM TUNER**

A state-of-the-art design, with microprocessor-controlled coverage of the long and medium-wave broadcast bands, the 49, 41 and 31 metre short-wave broadcast bands and Band II v.h.f., f.m. Manual tuning and automatic scanning modes are incorporated, plus an 8-station memory. And it doubles as a clock!

**Direct Conversion Receiver**

An ideal project for the beginner to short-wave listening. The prototype picked up stations from all six continents within hours of being completed!

**Rechargeable Handlamp**

A very useful NiCad powered torch for lighting up your darkest moments.
Build the P.E./Marshall's Teletext Project and convert your standard colour television receiver to receive Teletext and Oracle. We can supply either a complete kit of parts at £200 inclusive of VAT/postage & packing, alternatively kits of parts for the various sub assembly as follows:

1. Transmitter
2. Receiver
3. Decoder (supplied as a complete unit)
4. Summer Board
5. Tuner
6. Power Supply
7. Hardware and other parts

We accept American Express: Access: Barclay Card: Diners Card: also our own Marshall's Credit Charge.

Phone your order now to Margaret O'Donnell on 01-624 0805

Get a great deal from Marshall's

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches at any position up to 1KW on and off at preset times once per day. Kit contains: AY-5-1224 IC, 0.5° LED display, mains supply, display drivers, switches, diac, PCB. A full set of instructions.

CT1000K Basic Kit 16.90
CT1000KB with white box 156/131 x 71mm £17.40

MINI TRANSFORMERS

MKS MAINS TIMER

Based on the ZN1034E Timer IC this kit is capable of maintaining the temperature of an enclosure to within 0.5°C. A 12-hr period may be realised by minor component changes. Maximum load 1KW £19.00

MKS TEMPERATURE CONTROLLER

Based on the TDA1024 Zero voltage switch, this kit may be wired to form a 'burst fire' power controller or a 'proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0.1°C. 3KW £56

MKS BAR/DOT DISPLAY

Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £2.60

MINI KITS

These Kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER

Thermostat

Uses LM3911 IC to sense temperature (0°C max) and trip to switch heater. 1KW £9.00

MK2 SOLID STATE RELAY

Ideal for switching motors, lights, heaters, etc. with zero voltage switching. Supplied without triac. £2.20

MK4 PROPORTIONAL TEMPERATURE CONTROLLER

Based on the TDA1024 Zero voltage switch, this kit may be wired to form a 'burst fire' power controller or a 'proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0.1°C. 3KW £56

MK5 MAINS TIMER

Based on the ZN1034E Timer IC this kit will switch a mains load on or off for a preset time. Several 12-hr periods may be realised by minor component changes. Maximum load 1KW £4.50

INTEGRATED CIRCUITS

Standard makes

555 Timer


AY-5-1224 Clock

AY-3-1270 Thermometer

ICL7106 DTV/LED drive

LM371 Dual 10W Amp.

LM383 250mW low voltage Amp.

LM393 DUAL 6W Amp.

LM388 10W Audio Amp.

LM391 24V dual out.

LM386 28V 20mW low voltage Amp.

LM3201 2 Output Switch.

LM393 12V 25mA out.

LM3914 12V 25mA out.

LM3202 3 channel output.

LM394 4 digit display controller

M74HC197 7 segment/BCD converter

M74HC245 24 bit parallel with 7 req. o/p £4.50

5568 Touchdimmer

58163 Touchswitch 16-way £4.65

76477 Complex Sound Generator

TS4010S 80W Audio Amp.

TDA1065TV 7V/Audio Amp.

TSA1025 mute/VOLUME Switch

TDA2020 20W Audio Amp.

TDA7295 Audio Amp.

ZM1034 Timer

All IC's supplied with data sheets.

Data Sheets only, 10p each device

AND NOW A DIMMER THAT MAKES TOUCH DIMMERS OBSOLETE

Two years ago TK Electronics launched a new transmitter kit, the TD200K, which made known controlled dimmers obsolete. This was such a great success that many magazines and more retailers now produce similar packages. SO THAT OTHERS MAY FOLLOW, TK have designed a touch dimmer kit with an infra Red Remote Control, enabling you to switch and control the brightness of your lights from the comfort of your armchair etc. as well as manually by touching the frontplate directly. As with all our kits, these units come complete with all components. We have designed the light dimmer unit to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.

RC500K KIT

If you do not require a sophisticated multi-channel remote control, we have developed a simple single-channel output infra red transmitter and receiver set. The transmitter unit consists of a complete with a hand held box and requires a P31 (TV) battery. The receiver includes a triac capable of switching up to 500W at 240V a.c. and comprises a pre-amplifier bistable latch and a mains power supply, making the unit completely self-contained. The small size of the receiver enables the unit to be "built into" all kinds of equipment from lamps to tape recorders. The plastic front panel has no metal contacts or internal interconnections, ensuring complete safety and enabling the plate to be operated with ease. The plastic front panel has no metal contacts or internal interconnections, ensuring complete safety and enabling the plate to be operated with ease. The plastic front panel has no metal contacts or internal interconnections, ensuring complete safety and enabling the plate to be operated with ease.

We have designed the light dimmer unit to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.

DON'T FORGET to add 40p P&P and VAT to your total purchase.

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD VAT AT CURRENT RATE TO ABOVE PRICES. 40p P& P MAIL ORDER - CALLERS WELCOME BY APPOINTMENT.

TK Electronics
(P.E.), 106 STUDLEY GRANGE ROAD, LONDON W7 2LX. TEL. 01-579 9794

**SPECIAL OFFER: YOU MUST NOT MISS £127 + VAT**

**SAFGAN OFFERS ST-45 SINGLE TRACE OSCILLOSCOPE AT ONLY £127 + VAT P&P FREE TILL 10th OCT (1980)**

10mv/div ... 5MHz ... 4.4 CRT ... 1 YEAR GUARANTEE ... BRITISH SPECIFICATION

- **10mv/div - 5v/div in 9 cal steps.**
- **BANDWIDTH greater than 5MHz.**
- **TIME BASE 1 µs/div - 50ms/div in 15 cal steps**
- **x5 EXPANSION to 200ms/div**
- **x5 MULTIPLER TO 250ms/div**

Orders to: SAFGAN ELECTRONICS LTD.,
56 Bishops Wood, St. Johns, Woking, Surrey GU21 3QB. Tel. Woking 66836 or Woking 69560

OFFICIAL GOVERNMENT AND EDUCATIONAL ORDERS ACCEPTED
JET 010 ANALOGUE/DIGITAL ALARM CHRONOGRAPH

A superbly styled watch only 7.5mm thick (approx.) with a multi-functional digital display.

**ANALOGUE DISPLAY**
Independent hours and minutes with sweep second hand.

**DIGITAL DISPLAY**
Time: Independent 6 digit display of hours, minutes and seconds with am/pm indication (12 hour system) or 24 hour readout.
Calendar: Alpha day and date with automatic adjustment.
Alarm: The 24 hour alarm sounds for 60 seconds. 12 or 24 hour readout with alarm set symbol constantly displayed.
Chimes: The hourly signal, with symbol, can be switched on or off.
Stopwatch: Measures net times from 1/100 second to 1 hour.
Dual time, countdown and accumulation function availability.

This state-of-the-art watch is destined to become a classic.

**ONLY £62.50**

**SPECIAL SUMMERTIME OFFERS**
Excluding new models illustrated in this advertisement

A FURTHER 10% OFF

**SEIKO'S NEW SOLAR ALARM CHRONOGRAPHS**

Interval countdown alarm timer.
Weekly programmable alarm.
Comprehensive display of hours, minutes, seconds, day, date and month.
The 24 hour alarm can be programmed to ring on any day or days of the week.
The hourly chimes can be switched on or off.
The interval alarm timer can be set for any period of up to 16 hours and is repetitive until switched off.
The stopwatch measures net, lap and 1st & 2nd place times from 1/100 second to 20 minutes, then in seconds to 12 hours, the upper display indicating lap times, the lower display total time.
Stainless steel case and bracelet. Hardlex glass. Approx. 7 year battery life. 6 solar panels.

**£52.50**

Offer closes September 30th 1980

Send 25p for our illustrated catalogue

OFFER CLOSES SEPTEMBER 30TH 1980 SUBJECT TO AVAILABILITY

**SPECIAL OFFER £19.95**

**83QS-41B ALARM CHRONO**

**10% OFF**

All our normal discount prices for ALARM, ALARM CHRONO and CALCULATOR WATCHES.

**£69.95**

**20% OFF**

Priced includes VAT, P & P. Send your cheque, P.O. or phone your ACCESS or BARCLAYCARD number to:

**TEMPUS (Dept. PE)**
FREEPOST, 164-167 East Road
Cambridge CB1 1BR. Tel. 0223 312866
SERVICE TRADING CO
9 Little Newport Street, London WC2H 7JH

- 57 BRIDGMAN ROAD CHISWICK LONDON W4 5BB 01 995 1560

FT3 NEON FLASH TUBE
High intensity, internal ignitor, bright red. Price £5.00 + £2.00 P. & P. {E5.90 incl. VAT & P.)

WHY PAY MORE?

METERS (New) - 90 mm DIAMETER
A.C. Volt. Type: 655C, 4-25 A, 5-0-5 A, 0-10 V, 0-100 V, 0-1000 V.
D.C. Volt. 15 V, 30 V, 50 V, 100 V, 300 V.
All meters fitted with 10 p.p. £5.00 + £2.25 (E6.25 incl. VAT & P.).

DIGITAL INDICATORS
Made by Magnetics, D.C. Volt. Type: 655C, 0-25 A, 5-0-5 A, 0-10 V, 0-100 V, 0-1000 V.
Price: £18.00 + £1.50 P. & P. (E19.50 incl. VAT & P.).

INDEX
Hy-Lo Type Strobe Kit MV IV
Latest type xenon-white light tube tube. Solid state triggering and circuitting 230/420V, A.C. operation.
Generator and 100 watt 600V Melody lamp. Price £20.00 + £3.00 P. & P. (£28.20 incl. VAT & P.).

VARIABLE VOLTAGE TRANSFORMERS
- INPUT 230/240V a.c. 50/60 output 260V
- 0.5 amp. (max) £15.00
- 1 amp. (max) £25.00
- 2 amp. (max) £30.00
- 3 amp. (max) £35.00
- 5 amp. (max) £50.00
- 6 amp. (max) £55.00
- 10 amp. (max) £60.00
- 20 amp. (max) £75.00

- 3-PHASE VARIABLE VOLTAGE TRANSFORMERS
TRANSMITTERS
3VA inks. 30 amp. £108.43
2VA inks. 30 amp. £89.37
1VA inks. 30 amp. £63.10

LT TRANSFORMERS
13-0-13V a.c. 1-amp. £22.00 P. & P. (£28.00 inc. VAT)
0-24V/36V/72V/100V a.c. 12 amp £35.00 P. & P. (£42.00 inc. VAT & P.)
0-12V/24V/48V/72V/100V a.c. 10 amp £12.00 P. & P. (£15.00 inc. VAT & P.)
0-24V/36V/72V/100V a.c. 50 amp £90.00 P. & P. (£110.00 inc. VAT & P.)
0-12V/24V/36V/48V/72V/100V a.c. 120 amp £140.00 P. & P. (£175.00 inc. VAT & P.)

RELAYS
- 25A 200V (max) £45.00 P. & P. (£54.00 inc. VAT & P.)
- 50A 200V (max) £80.00 P. & P. (£96.00 inc. VAT & P.)
- 100A 200V (max) £150.00 P. & P. (£180.00 inc. VAT & P.)

SOLID BHT UNIT
auto. continuous operation. 10sec. £10.00 (E12.00 incl. VAT & P.)

A.C. CONTACTORS
Type: L5611, Coil 240V 90 contacts. Contact_make: 3 make, 3 break, 2 make, 3 break + £15.00 P. & P. (£20.00 incl. VAT & P.)

A.C. & D.C. CONTACTORS, DIN Rail, Type: L130A, Coil 240V, 500V. A.C. Contacts. 3 make 5amp up to 20 amp. Price £6.90 + £0.75 P. & P. (£8.65 incl. VAT & P.)

BEGE MOTORS
Price: £0.50 + £0.50 P. & P. (£1.00 incl. VAT & P.)

SOLID BHT UNIT
auto. continuous operation. 10sec. £10.00 (E12.00 incl. VAT & P.)

A.C. CONTACTORS
Type: L5611, Coil 240V 90 contacts. Contact_make: 3 make, 3 break, 2 make, 3 break + £15.00 P. & P. (£20.00 incl. VAT & P.)

A.C. & D.C. CONTACTORS, DIN Rail, Type: L130A, Coil 240V, 500V. A.C. Contacts. 3 make 5amp up to 20 amp. Price £6.90 + £0.75 P. & P. (£8.65 incl. VAT & P.)

BEGE MOTORS
Price: £0.50 + £0.50 P. & P. (£1.00 incl. VAT & P.)

SOLID BHT UNIT
auto. continuous operation. 10sec. £10.00 (E12.00 incl. VAT & P.)

A.C. CONTACTORS
Type: L5611, Coil 240V 90 contacts. Contact_make: 3 make, 3 break, 2 make, 3 break + £15.00 P. & P. (£20.00 incl. VAT & P.)

A.C. & D.C. CONTACTORS, DIN Rail, Type: L130A, Coil 240V, 500V. A.C. Contacts. 3 make 5amp up to 20 amp. Price £6.90 + £0.75 P. & P. (£8.65 incl. VAT & P.)

BEGE MOTORS
Price: £0.50 + £0.50 P. & P. (£1.00 incl. VAT & P.)

SOLID BHT UNIT
auto. continuous operation. 10sec. £10.00 (E12.00 incl. VAT & P.)

A.C. CONTACTORS
Type: L5611, Coil 240V 90 contacts. Contact_make: 3 make, 3 break, 2 make, 3 break + £15.00 P. & P. (£20.00 incl. VAT & P.)

A.C. & D.C. CONTACTORS, DIN Rail, Type: L130A, Coil 240V, 500V. A.C. Contacts. 3 make 5amp up to 20 amp. Price £6.90 + £0.75 P. & P. (£8.65 incl. VAT & P.)

BEGE MOTORS
Price: £0.50 + £0.50 P. & P. (£1.00 incl. VAT & P.)
Excellent metered parking
Close to Hammersmith Underground Station for Piccadilly, District & Metropolitan Lines
Bus no's. 260-266, 704, 27, 91 stop outside

Opens Tuesday 16th September, 1980
Opening Hours 9.45 am to 5.30 pm Tuesday to Saturday (Closed Monday)

Maplin mail-order – Now better than ever!

* Up to 8% discount for use with next order
* All prices include VAT
* Same day service on in-stock lines
* Over 95% of our stock lines in stock
* Large range of all the most useful components
* First class reply paid envelope with every order
* Quality components – no rejects – no re-marks
* Competitive prices
* Your money is safe with a reputable Company

On price, service, stock, quality and security, it makes sense now more than ever to make Maplin – your first choice for components every time!

Post this coupon now for your copy of our 1979-80 Catalogue price 70p
Please send me a copy of your 280 page catalogue. I enclose 70p (plus 46 p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.16. 35 or ten International Reply Coupons. I enclose £1.16.

Name
Address

Maplin Electronic Supplies Ltd
All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR
Telephone: Southend (0702) 564155.
Shop: 284 London Road, Westcliff-on-Sea, Essex. (Closed on Monday)
Telephone: Southend (0702) 564000.

Catalogue now available in all branches of WHSMITH Price £1.00

Stereo Cassette Tape Deck
Utilising the superb JVC deck made for Tandberg and a ready-made pre-aligned, tested and guaranteed module, this cassette deck has a superb sound and a high quality specification. We've got everything you need (except cabinet) including full instruction leaflet for only £39.95.
Order as XY36P (Cassette Recorder Kit)

Space Invaders
Fight the space invaders, be a polars captain or a spaceship commander. Full colour action on your own TV set and over 450 games to play.

Basic console with Combat cartridge (ACOOA) £99.50 + £2.50 carriage

All cartridges available including:

- Space Invaders (AC26D) £29.95
- Indy 500 (AC24B) £34.50
- Chess (AC26F) £34.50
- Golf (AC20A) £16.95
- Air Sea Battle (AC01B) £16.95
- Space War (AC02C) £16.95
- Brain Games (AC03D) £16.95
- Outlaw (AC03D) £16.95
- Street Racer (AC14Q) £16.95
- Breakout (AC05F) £16.95
- Olympics (AC04E) £16.95
- Breakout (AC05F) £16.95
- Slot Racers (AC19V) £16.95

All prices include VAT and carriage except where shown.