New Feature

SEMICONDUCTOR CIRCUITS ... USING CHIPS

PROJECTS • AUTOMOBILE TEST SET • PERSONAL STEREO AMPLIFIER • MAINS WATCHDOG • COMPUTING ZEAKER MICRO-ROBOT • ULTIMUM MICROFROPT • NEWS & FEATURES • SPACEWATCH MICROFILE • PATENTS REVIEW • INDUSTRY NOTEBOOK EXTRA! - EDITORIAL PAGES - EXTRA!
Get moving with these new developments in UK Robotics — advanced electrohydraulic designs for education, industry and now available to the home constructor.

HEBOT KIT
£85.00 kit
£10.00

HEBOT II

Up to the nano-second hard, firm and software developments embodied in a complete system. 12 Mega Hertz 16 bit CPU, 64K upwardly compatible DRAM, separate 16K video DRAM and 24K 11 Power Basic with overwrite. Supports up to four Disc drives of mixed type with 16 serial I/O ports. Programmable Baud rate and comprehensive E Bus interface designed to support real world applications.

Very high resolution graphics gives 3D simulation in 16 colours on 36 prioritised planes of user definable characters. Software FORTH coming includes this trendy language along with NOS C/PM.

Hardware components available separately with details in Nov., Dec, and Jan issues of ETI. Software features include: Real time clock, full renumber command, buffered I/O to free machine whilst top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

Example prices and specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Base: 19.5” x 11” x 7.5”</th>
<th>Lifting capacity:</th>
<th>Arm length: 14.0”</th>
<th>Weight:</th>
<th>4 axis model in kit form</th>
<th>5 axis model in kit form</th>
<th>Complete Systems as shown in Photograph on right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis S101</td>
<td>£1195.00</td>
<td>2000gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£255.00</td>
<td>1500gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis S101</td>
<td>£1195.00</td>
<td>2000gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£255.00</td>
<td>1500gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis S101</td>
<td>£1195.00</td>
<td>2000gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£255.00</td>
<td>1500gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis S101</td>
<td>£1195.00</td>
<td>2000gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
<tr>
<td>Genesis P101</td>
<td>£255.00</td>
<td>1500gm</td>
<td>29Kg</td>
<td>£425.00</td>
<td>£475.00</td>
<td>£675.00</td>
<td>£1950.00</td>
</tr>
</tbody>
</table>

All prices exclusive of VAT

GENESIS S101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS

Genetic P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER

MICROGRASP, INTERFACE BOARD AND ZX81

Printing, call to machine code routines, hexadec holdal support and user-friendly textual error trapping messages.

If computers interest you then the Cortex will expand your understanding infinitely more than off the shelf machines. Use it in business, education, research or just play with the incredible graphics capability. At Powertran we are using these machines in conventional roles, in product control and R & D. We shall co-ordinate the Cortex user group and distribute software for the TMS 9995 CPU. Complete 16 bit 64K computer kit £295.00 + VAT. Complete 16 bit 64K computer ready built £395.00 + VAT.

PORTWAY INDUSTRIAL ESTATE
ANDOVER HANTS SP10 3WN
Phone Enquiries (0264) 64455
Export Enquiries: Powertran International
Hollom Down Farm, Lopcombe Salisbury
Wiltshire SP5 1BP (0264) 781545
Telex: 477407 ZENMON

(Cybernetic Division)
World Leaders in Electronic Kit Design and Supply
CONSTRUCTIONAL PROJECTS

DIGIT TALKER by A. Wiggin
Interface system

AUTOMOBILE TEST SET by M. Tooley BA and D. Whitfield MA MSc
Offers a test facility for car electrics

ZEAKER by David Buckley
Low cost computer controlled robot

MAINS WATCHDOG by Chris Lare
Audio/visual warning system for mains failures

PERSONAL STEREO AMPLIFIER by R. A. Penfold
General purpose 6 watts per channel system

ULTIMUM by William Edwards
Three chip sound generator

GENERAL FEATURES

SEMICONDUCTOR CIRCUITS by Tom Gaskell BA(Hons)
Combination lock (LS7225): 3 tone chime (SAB0600)

MICROBUS by DJD
A bi-monthly focus on micro's for the home constructor

INTO THE REAL WORLD by M. Tooley BA and D. Whitfield MA MSc
Conclusion of series

NEWS AND COMMENT

EDITORIAL

NEWS AND MARKET PLACE
Including Countdown

BAZAAR
Free readers' advertisements

SPACEWATCH by Frank W. Hyde
Extra-terrestrial activities chronicled

INDUSTRY NOTEBOOK by Nexus
News and views on the electronics industry

SPECIAL OFFER—CASSETTES

PATENTS REVIEW
TV Warning and Automatic Cut-Out

MICROCONTROLLER DATA SHEET 4 by M. Tooley BA and D. Whitfield MA MSc

We regret that due to circumstances beyond our control we are unable to publish Micro-file this month

OUR JUNE ISSUE WILL BE ON SALE FRIDAY, MAY 6th, 1983
(for details of contents see page 31)
**OPTO ELECTRONICS**

- LED switches
- LED indicators
- Triac modules
- Triac, GTO, SCR, MOSFET modules
- Halleffect switches

**OPTO MATURE**

- LED displays
- LED panels
- LED arrays

**VOLTAGE REGULATORS**

- 1A 12/20 Planar Casing
- 5V, 7V, 9V (850, 900, 950)
- 5V, 12V
- 24V

**DIL SOCKETS**

- Low, Wide, Narrow
- 8 pin, 14 pin, 16 pin, 20 pin

**FZD OIL SOCKET**

- 16 way
- 24 way
- 28 way

**DIL PLUGS (Headed)**

- 10 pins
- 12 pins
- 16 pins
- 20 pins

**EURO CONNECTORS**

- R/A
- R/A
- Female Card Edge Connectors

**IDC CONNECTORS (PRADE pack types)**

- 2-pairs
- 3-pairs
- 4-pairs

**TRANSFORMERS**

- 230/240V
- 230/240V
- 230/240V

**SPEAKERS**

- 8 ohm
- 16 ohm

**COMPUTER CORNER**

- SEIKOSHA GP100A - Unhammer Printer, normal & double width characters, dot resolution 600x200 dots, parallel interface standard, FREE 500 Sheets £175

- SEIKOSHA GP 250X Printer £230

- ORIC 1 16K & 48K now available

- JUPITER ACE Microcomputer £78


- WEMON. Watford's 4K Ultimate Monitor IC for Superboard & UK101 £10

- VIDEO MONITORS.

- ZENITH 12" Hi-RES, Green Monitor 40/80 column select switch, value for money. £80

- TEX EPROM ERASER. Erases up to 32 ICs in 15-30 min. £39

- TEX EPROM ERASER with the Solid State 30 minute Electronic Timer £14

- SPARE 'UV lamp bulbs £9

- POWER SUPPLY, Regulated, Variable from +5V to +15V. Fully Cased £39

- MULTIRAIL PSU Kit. Output: +5V/5A; +12V/5A; +15V/1A. £60

- ±x4 matrix keypad (read switch assembly) £4

- C12 COMPUTER Grade BASF Cassettes in standard and expansion packs £12

- STACK-PACK. Unique 10 section stackable Drawers rack including 10 x C12 Computer grade Cassettes (BASF Tape). £50

- 8" & 9" Fanfold paper (1000 sheets) £7 (150p)

- Teleprinter Roll (no VAT) £3.50

- (P&P on some of the above items is extra) Call in at our shop for demonstration of any of the above items. So satisfied before you buy.

**WE-ROM for Acorn ATOM**

A highly sophisticated Acorn Atom Utility System. Add Smarter, stronger functions to your Acorn ATOM. £90

**PRINTERS**

- MX50F 240V Multi-Purpose Tractor and Friction Feed. 9x9 matrix, 80 column, 80 CPI, Bi-directional, Centronics Interface. £140

- BR10, 9600 Hi-res, bit image graphics, subscript & superscript, italics, Underlining plus Fuji Print 100 sheets paper. £324

- 3NEC PC-8023BE-C, 100CPS bi-directional logic, seek movement. 3-9x7 Dot matrix, super/subscript, underlining, tracks, decoders Friction/Tractor/2K Buffer, Proportional Spacing, at a Special Price. £300

**IDC CONNEXORS**

- 24 way RE
- 36 way Centronics

**BAMPHIL PLUGS**

- 7MHz £240
- 5MHz £325

**ASTEC UNMODULATORS**

- 12MHz £295
- 16MHz £400

**BMC MICRO & UPGRADE KITS**

- BBC Micro Model A £299; Model B (incl.) £399

- 16K MEMORY (3x4816-100ns) BBC1 £16.00

- Printer User I/O Port BBC2 £6.98

- Complete Printer Cable 36" £12.00

- Disc Interface Kit incl. DOS £65.00

- BBC Official Joysticks £12/perm

- Analogue I/O Kit BBC £6.45

- Serial I/O Kit BBC5 £6.70

- Expansion Bus Kit BBC6 £6.10

- Complete Upgrade Kit from Model A to B £43

- COLOUR MONITOR - MICROVITEC 141.4" 1111RGB Input. For BBC. Lead included. £249

- Complete range of Connectors, Cables, Quality Software, Accessories, Books, etc for BBC available. Send SAE for detail list.

**DISC DRIVES (BBC Compatible)**

- (12 months warranty on Drives)
- DISC 150A - Unlabeled Single 40 track 5" Single sided 100k £130
- DISC 150A with disk case with PSU, single sided 100k £140
- DISC 150A with disk case with PSU, double sided 100k £150
- DISC 200 B - Cased with PSU, track 5" Single sided, 200k £140
- DISC 200 B - Cased with PSU, double sided, 200k £150
- DISC 200 C - Cased with PSU, track 5" Double sided, 200k £140
- DISC 200 C - Cased with PSU, track 5" Double sided, 200k £150
- DISC 250 B - Cased with PSU, track 5" Single sided, 250k £150
- DISC 250 B - Cased with PSU, double sided, 250k £160
- DISC 250 C - Cased with PSU, track 5" Double sided, 250k £150
- DISC 250 C - Cased with PSU, track 5" Double sided, 250k £160
- DISC 300 A - Cased with PSU, track 5" Single sided, 300k £160
- DISC 300 A - Cased with PSU, double sided, 300k £170
- DISC 300 C - Cased with PSU, track 5" Double sided, 300k £160
- DISC 300 C - Cased with PSU, track 5" Double sided, 300k £170
- DISC 350 A - Cased with PSU, track 5" Single sided, 350k £170
- DISC 350 A - Cased with PSU, double sided, 350k £180
- DISC 350 C - Cased with PSU, track 5" Double sided, 350k £170
- DISC 350 C - Cased with PSU, track 5" Double sided, 350k £180

- 27MHz 32MHz 270MHz 215MHz 16MHz 9MHz 6MHz 3MHz 2MHz 1MHz 500kHz 224kHz 112kHz 56kHz 28kHz 14kHz 7kHz 3.5kHz 1.8kHz 32kHz 16kHz 8kHz 4kHz 2kHz 1kHz 500Hz 250Hz 125Hz 62.5Hz 31.25Hz 15.625Hz 7.8125Hz 3.90625Hz 1.953125Hz 0.9765625Hz

**ULTIMUM WATFORD’S most versatile MICRO EXPANSION SYSTEM.**

- APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. As published in P.E. starting from 3 December 1981

Send SAE for details.
PRACTICALLY ALL THE PARTS FOR ELECTRONICS
ENThusiasts (and Computing, Communications, Audio & Video Enthusiasts too!!)

The Spring '83 catalogue continues to expand to meet the needs of the electronics user — from the novice enthusiast to the professional aerospace designer.

AT YOUR NEWSAGENT OR DIRECT

ambit INTERNATIONAL
200 North Service Road,
Brentwood, Essex CM14 4SG
Telephone (Consumer Sales/Enquiries) 0277-230909 — Telephone (Industrial Sales/Enquiries) 0277-231616 — Telex 995194 AMBIT G
Data 24hrs (RS32/300baud) 0277-232628 — REWTEL

- Prices exclude VAT except where otherwise shown
- Postage and Packing 60p per pre-paid order
- Orders submitted using Ambit Stock Codes will be processed first
- Orders for in-stock items processed same day
- Hours (consumer sales) 8am-7pm Mon-Sat; (Industrial) 8am-6pm (Mon-Fri)

CIRCUIT MAKER
Revolution in circuit board maker kits from leading manufacturer

The Electrolube CM100 Circuit Maker provides everything necessary to produce positive photographic film masters from same-size published circuit layouts and to make either single or double-sided boards from these or other positive film masters.

Features:
- Economic and simple to use
- No expensive equipment required e.g. darkroom, cameras etc.
- Photographic experience not needed
- Simple etching process
- Universal exposure and assembly frame custom-designed, professional quality
- Ergonomically designed storage pack which includes free-standing shelf for chemicals
- Step-by-step instruction manual, workbench and trouble-shooting charts provided
- Special clearing process ensures excellent clear positive film masters
- Photoresist available in non-aerosol form to eliminate 'spotting' when applied to the board

Mercia Electronics, Coronet House, Upper Well St., Coventry CV1 4AF.

Send for full illustrated brochure and price details, post to:
Name: ...........................................
Address: ...........................................
Signature: ...........................................

PARNDON ELECTRONICS LTD.
Dept No 21 44 Paddock Mead, Harlow, Essex, CM18 7RR Tel 0279 32700

RESISTORS: 1/4 Watt Carbon Film E24 range ± 5% tolerance High quality resistors, made under strictly controlled conditions by automatic machines Bandaged and colour coded

£1.00 per hundred mixed (Min 10 per value)
£8.50 per thousand mixed (Min 50 per value)

Special stock pack 60 values, 10 of each £5.50

DIODES: IN4148 3p each Min order quantity - 15 stems

£1.60 per hundred

DIL SOCKETS:
8 pin - 10p, 14 pin - 15p, 16 pin - 12p, 18 pin - 16p, 20 pin - 21p,
22 pin - 25p, 25 pin - 29p, 26 pin - 27p, 40 pin - 42p

CAPACITORS, REGULATORS, SWITCHES, IC, TRANSISTORS, DIODES, ETC. ETC.

ALL PRICES INCLUDE V.A.T. & POST & PACKING — NO EXTRAS

MIN ORDER — U K £1.00 OVERSEAS £5.00 CASH WITH ORDER PLEASE

Same Day Despatch

TALK TO THE WHOLE WORLD
Study now for the RADIO AMATEUR'S EXAMINATION
We have had 40 years successful experience in training men and women for the G.P.O. Transmitting licence.

FREE R.A.E. brochure without obligation from:
British National Radio & Electronics School
READING, BERKS. RG1 1BR

Name ...........................................
Address ...........................................

If you wish to become a radio amateur send for our FREE R.A.E. brochure without obligation.

British National Radio & Electronics School

Circuit Breaker

Printed in Great Britain
Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

VOYAGER Car Drive Computer
- A most sophisticated accessory
- Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd
- Affords 12 functions centred on Fuel, Speed, Distance and Time
- Visual and Audible alarms warning of Excess Speed, Frost/Ice Lights left-on
- Facility to operate LOG and TRIP functions independently or synchronously
- Large 10mm high 400ohm fluorescent display with auto intensity
- Unique speed and fuel transducers giving a programmed accuracy of + or - 1%
- Large LOG & TRIP memories, 2,000 miles, 100 gallons, 100 hours
- Full Imperial and Metric calibrations
- Over 300 components to assemble

A real challenge for the electronics enthusiast!

AT-80 Electronic Car Security System
- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen
- Fits all 12V neg earth vehicles
- Over 250 components to assemble

High oneulity used throughout.

SX1000 Electronic Ignition
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12V neg earth vehicles

SX2000 Electronic Ignition
- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12V neg earth vehicles

TX1002 Electronic Ignition
- Contactless or contact triggered
- Extended coil energy storage circuit
- Inductive Discharge
- Three position changeover switch
- Distributor triggerhead adaptors included
- Die cast weatherproof case
- Clip-to-coil remote mounting facility
- Fits majority of 4 and 6 cylinder 12V neg earth vehicles
- Over 145 components to assemble

TX2002 Electronic Ignition
- The ultimate system
- Switchable contactless
- Three position switch with Auxiliary back-up inductive circuit
- Reactive Discharge
- Combined capacitive and inductive
- Extended coil energy storage circuit
- Magnetic contactless distributor trigger head
- Distributor triggerhead adaptors included
- Can also be triggered by existing contact breakers
- Die cast waterproof case with clip-to-coil fitting
- Fits majority of 4 and 6 cylinder 12V neg earth vehicles
- Over 150 components to assemble

All SPARKRITE products and designs are fully covered by one or more World Patents.

SPECIAL OFFER
"FREE" MAGIDICE KIT WITH ALL ORDERS OVER £45.00

MAGIDICE Electronic Dice
- Not an auto item for great fun
- Total random selection
- Triggered by waving of hand
don't miss
- Brings and flashes during 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and OFF switch on base
- Lighted display on top of triggerhead
- Over 100 components to assemble

SPARKRITE 82 Bath St., Walsall, West Midlands WS1 3DE England

NAME ____________________
ADDRESS ____________________

<table>
<thead>
<tr>
<th>KIT REF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENCLOSE CHEQUE</td>
</tr>
<tr>
<td>£</td>
</tr>
<tr>
<td>CHEQUE NO</td>
</tr>
</tbody>
</table>

PHONE YOUR ORDER WITH
SEND ONLY SAE IF BROCHURE IS REQUIRED

CUT OUT THE COUPON NOW!
WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

<table>
<thead>
<tr>
<th>Module Number</th>
<th>Output Power Watts (rms)</th>
<th>Supply Voltage (Volts)</th>
<th>Size mm</th>
<th>WT gms</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSU 44</td>
<td>15 x 2</td>
<td>4.8</td>
<td>120 x 28 x 60</td>
<td>MOSFET</td>
<td>£17.19 (Inc. VAT)</td>
</tr>
<tr>
<td>PSU 34</td>
<td>10 x 2</td>
<td>4.8</td>
<td>120 x 28 x 60</td>
<td>MOSFET</td>
<td>£17.19 (Inc. VAT)</td>
</tr>
<tr>
<td>PSU 24</td>
<td>5 x 2</td>
<td>4.8</td>
<td>120 x 28 x 60</td>
<td>MOSFET</td>
<td>£17.19 (Inc. VAT)</td>
</tr>
<tr>
<td>PSU 14</td>
<td>2 x 2</td>
<td>4.8</td>
<td>120 x 28 x 60</td>
<td>MOSFET</td>
<td>£17.19 (Inc. VAT)</td>
</tr>
<tr>
<td>PSU 04</td>
<td>1 x 2</td>
<td>4.8</td>
<td>120 x 28 x 60</td>
<td>MOSFET</td>
<td>£17.19 (Inc. VAT)</td>
</tr>
</tbody>
</table>

Practical Electronics May 1983
WITH A LOT OF HELP FROM ILP ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

Unicase

Over the years ILP has been aware of the need for a complete packaging system for its products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to complement the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost slave on the market in this format.

UNICASES

Price inc. VAT

<table>
<thead>
<tr>
<th>UNICASES</th>
<th>Separates</th>
<th>Price inc. VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC1</td>
<td>Preamp</td>
<td>£29.95</td>
</tr>
<tr>
<td>UP1X</td>
<td>60W/4Ω</td>
<td>£54.95</td>
</tr>
<tr>
<td>UP2X</td>
<td>60W/8Ω</td>
<td>£54.95</td>
</tr>
<tr>
<td>UP3X</td>
<td>120W/4Ω</td>
<td>£74.95</td>
</tr>
<tr>
<td>UP4X</td>
<td>120W/8Ω</td>
<td>£74.95</td>
</tr>
<tr>
<td>UP4X</td>
<td>60W/4Ω</td>
<td>£84.95</td>
</tr>
<tr>
<td>UP5X</td>
<td>120W/4Ω</td>
<td>£84.95</td>
</tr>
</tbody>
</table>

Please note X in part number denotes mains voltage. Please insert 0 in place of X for 110V, 1 in place of X for 220V (Europe), and 2 in place of X for 240V (UK). All units except UC1 incorporate our own toroidal transformers.

TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to ILP Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED. Allow 28 days for delivery.

Practical Electronics  May 1983
CAMBRIDGE LEARNING
SELF-INSTRUCTION COURSES

NEW MICROPROCESSORS & Microelectronics £6.50

Now you can learn all about microprocessors - their construction, design, and operation - using one programmed learning technique. Suitable for all ages, all levels of interest, this course has been designed for ease of understanding. It assumes no prior knowledge other than arithmetic; and at the end you will know what that piece of "black plastic" in your computer is actually doing.

Contents include: algorithm design, programmable logic, microcomputer architecture, a microprocessor family, semiconductor technology, number systems, arithmetic, integer and floating point, data representation and scaling, programming, microprocessor development system.

GSC SUPERKIT

Learn the wonders of digital electronics - without the problems of soldering.

This practical beginners' kit comes complete with instruction manual, components, and EXP300 breadboard to teach you all the basics of digital electronics. The only extra you need to buy is a 4V battery.

This self-instruction course teaches gating, boolean logic, R-S and J-K flipflops, shift register, ripple counters, and half-adders.

DIGITAL COMPUTER DESIGN £8.50

This up-to-date theory course covers the design of digital computers, both from their individual logic elements and from integrated circuits. You are first shown the way in which simple logic circuits operate and then, through a series of exercises, arrive at a design for a working machine.

Please send for our free boxlist for further information on these and our other courses.

GUARANTEE

No risk to you. If you are not completely satisfied, your money will be refunded upon return of the item in good condition within 28 days of receipt.

CAMBRIDGE LEARNING LIMITED, UNIT 26 RIVERMILL SITE, FREEPOST, ST IVES, CAMBS, PE17 4BR, ENGLAND.

TELEPHONE: ST IVES 104801 67446. VAT No 313026022

All prices include worldwide postage (airmail is extra - please ask for prepaid invoice). Giro A/C No 2709159.

Please allow 28 days for delivery in UK.

SPECIALKIT(S)* £19.90

DIGITAL COMPUTER DESIGN(S) £8.50

MICROPROCESSORS & MICROELECTRONICS £6.50

Please charge my

*Access: American Express / Barclayscard / Diners Club
Eurocard / Visa / Mastercharge / TruCard

Exp Date Card No

Signature

Telephone orders from card holders accepted on 0800 816 816. Overseas customers (including Eire) should send a bank draft or cheque payable to Cambridge Learning Ltd for £1.85. (*Delete where applicable)

Send Large order form with credit card number for the item in good condition within 28 days of receipt.

GUARANTEE

No risk to you. If you are not completely satisfied, your money will be refunded upon return of the item in good condition within 28 days of receipt.

CAMBRIDGE LEARNING LIMITED, UNIT 26 RIVERMILL SITE, FREEPOST, ST IVES, CAMBS, PE17 4BR, ENGLAND. (Registered in England No 1287621.)
### RESISTORS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1kΩ</td>
<td>100Ω</td>
<td>Carbon film</td>
</tr>
<tr>
<td>2kΩ</td>
<td>100Ω</td>
<td>Carbon film</td>
</tr>
<tr>
<td>30Ω</td>
<td>1kΩ</td>
<td>Metal film</td>
</tr>
<tr>
<td>100Ω</td>
<td>100Ω</td>
<td>Ultra stable</td>
</tr>
<tr>
<td>500Ω</td>
<td>100Ω</td>
<td>Low noise</td>
</tr>
</tbody>
</table>

### WIREWOUND RESISTORS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1kΩ</td>
<td>10kΩ</td>
<td>Polystyrene</td>
</tr>
<tr>
<td>10kΩ</td>
<td>100kΩ</td>
<td>Carbon film</td>
</tr>
<tr>
<td>100kΩ</td>
<td>100kΩ</td>
<td>Carbon film</td>
</tr>
</tbody>
</table>

### ROTARY POTS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20kΩ</td>
<td>10kΩ</td>
<td>Low noise</td>
</tr>
<tr>
<td>50kΩ</td>
<td>100kΩ</td>
<td>Low noise</td>
</tr>
</tbody>
</table>

### CERAMIC CAPACITORS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10nF</td>
<td>10nF</td>
</tr>
<tr>
<td>1μF</td>
<td>1μF</td>
</tr>
</tbody>
</table>

### TANT READS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10μF</td>
<td>1μF</td>
</tr>
<tr>
<td>100μF</td>
<td>100μF</td>
</tr>
</tbody>
</table>

### CAPACITORS
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1μF</td>
<td>0.1μF</td>
</tr>
<tr>
<td>1μF</td>
<td>1μF</td>
</tr>
</tbody>
</table>

### DIODES
<table>
<thead>
<tr>
<th>Value</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N4148</td>
<td>1N4148</td>
</tr>
<tr>
<td>1N4149</td>
<td>1N4149</td>
</tr>
</tbody>
</table>

### SCHEMATICS
- [Schematic Diagram](image)
- [Detailed Diagram](image)

---

**CRICKLEWOOD ELECTRONICS LTD.**
40 Cricklewood Broadway, London NW2 3EJ. Tel: 01 452 0161. Fax: 949877.

Here's a selection from our vast stocks. Full price list free on request. Orders by phone quoting credit card no. or by mail order. Cashiers welcome. All products first grade franchised source. All in-stock items dispatched same day. Extended hours, welcome, from Govt. Dept's, schools, etc. Discounted rates 15% or more on bigger orders. Please try us now. We've got what you need.
Test Instruments from Sifam

These instruments have all the features, accuracy and reliability you would expect from professional-quality equipment at less than you might expect to cost.

3½-DIGITAL MULTIMETERS
Both these instruments have the following features:
- Only two input terminals, common to all functions.
- Overload protection, autozero, autopolarity, over-range and low battery indications.
- Basic 0.3% DVM accuracy.
- Supplied with test leads, spare fuse, 9V battery and operator’s manual.

**DMM 2500**
(bench model)
Push-button operation providing 24 ranges in 5 modes.
+2k A.C./D.C.
+1000V A.C./D.C.
200Ω to 20MΩ resistance
Re-settable overload circuit breaker
2000 hours operation from 9V battery
Size: 155 x 120 x 43 mm

**DMM 2200B**
(hand-held model)
2 Teflon-bushed rotary switches providing 21 ranges in 5 modes.
+2k A.C./D.C.
+1000V A.C./D.C.
200Ω to 20MΩ resistance
1000 hours operation from 9V battery
Size: 155 x 120 x 57 mm

**DOM 810111**
(bench model)
Providing 21 ranges in 5 modes.
+1000V A.C./D.C.
+2A A.C./D.C.

**DRAGON 32 E173**
COMMODORE COMPUTERS
Commodore 64 £299. VICO 10 £110. Kit to allow use of an ordinary mono cassette recorder with the VIC 20 and the Commodore 64 £66. Commodore cassette recorder for these computers £28.95. Super high resolution cartridge £27.95. We stock most accessories.

**BIBER MICROCOMPUTERS**

**GENIE COMPUTERS**

**SINCLAIR AND ORIC COMPUTERS**
UK prices are shown first. The bracketed prices are export prices which include insured air-mail postage to all the countries of Europe including Norway, Sweden, Finland and Denmark. For overseas customers outside Europe an extra £5 postage per item is charged. Oric 1 A.K. Computer £157. £158 (Z80) £163 (Z80A) £165 (Z80A) £168 (Z80A) £170 (Z80A) £172 (Z80A) £225 (Z80A) £227 (Z80A) £229 (Z80A). ZX Printer £52.13 (64). ZX Spectrum £108.70. £129. ZX Spectrum 48K £112 (122). ZX Memory Upgrade for UK Spectrum (issue 2 only) £64. £65. ZX Microdrive (n/a) £65. ZX Microdrive 32 (n/a) £65. 5 Printer Rolls £10.43 (164). ZX81 Ram Disk - UK £18.04 (235). ZX £19.49 (394). 56K £69 (651).

**ORIC-1 48K COMPUTER £147.**

**PRINTERS**

**SV POWER KITS**
Fully stabilised 5V computer and TTL Power Kic. 1.5A £7.83. 3A £12.17. 6A £20.87.

**SHARP COMPUTERS**
We can supply Epson printers to run direct from the MZ80K (static kit needed) for £32 plus printer price. We also specialize in interfacing printers to the MZ80K, MZ80A, MZ80B and MZ80F both with and without the i/o box.
**REMOTE CONTROL - send us 30p**

 Hundreds of uses for doors and garages, car

 For a detailed booklet on

 Useful “sleep” function - turns on output for one hour.

 Now you can run your central heating, lighting, hi-fi system and Iota

 750mA max.

 Different combinations. The open sequence

 This KIT contains a purpose designed lock IC, 

 Includes all PCBs and components for one

 Transmitter for above

 Touchdimmer £7.00

 £4.00

 £2.00

 Rotary Controlled £3.50

 **EXCLUDE VAT**

 **FAST SERVICE**

 **LOW PRICES**

 No circuit is complete without a call to
Hobby Herald has all the latest news for the electronics hobbyist!

When you need to update yourself with all that is available in the “Do-it-yourself” market, then you need the Hobby Herald. Packed with product information essential to the electronics enthusiast, this new electronics catalogue lists over 60 exciting products ranging from All Purpose Cutters to Verobloc, the solderless breadboard. All products are available throughout the U.K. from over 200 stockists.

Hobby Herald

Alternatively ordering products through the Herald is simplicity itself, and you can pay by either cheque, Barclaycard or Access. So make sure you get your copy of Hobby Herald by ringing (04215) 62829.

BICC-Vero Electronics Ltd., Industrial Estate, Chandlers Ford, Hampshire, SO5 3ZR.

SUPER KITS!

S05 3ZR.

PHONOSONICS

PHONOSONICS MAIL ORDER, DIP 1 PE3/3, 22 HIGH STREET, SIDCUP, KENT DA14 6EH. 01-302 6184

Please use full address. Payment CHEQUE, POSTAL ORDER, BARCLAYCARD or pre-arranged collection. Prices incl. UK P.P. & 15% VAT. E&OE. Despatch usually 7 days on most items. Details of parts in above kits are stated in our comprehensive catalogue. Send SAE (10x14 or bigger) for Catalogue if you live overseas: please send £1.00 or equivalent. MORE KITS ARE IN CATALOGUE.
**BI-PAK BARGAINS**

**TRIACS — PLASTIC**
- 4 amp — 400V — 1000 sec — £2.05
- 5 amp — 500 sec — £3.00
- 10 amp — 200 sec — £5.00

**SLIDER**
- ALL AT 50p PER PAK
- SX63 5 x Lk Lm 40p
- SX65 5 x Lk Lm 40p
- SX66 5 x Lk Lm 45p
- SX67 5 x 1m Log 75p

**"IRRRESISTIBLE RESISTOR BARGAINS"**

<table>
<thead>
<tr>
<th>Resistor</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3120</td>
<td>10% Carbon Resistor</td>
<td>1.00p</td>
</tr>
<tr>
<td>3122</td>
<td>2% Carbon Resistor</td>
<td>2.00p</td>
</tr>
<tr>
<td>3123</td>
<td>1% Carbon Resistor</td>
<td>3.00p</td>
</tr>
</tbody>
</table>

**"CAPABLE CAPACITOR PAKS"**

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3120</td>
<td>100pF ±5%</td>
<td>0.50p</td>
</tr>
<tr>
<td>3122</td>
<td>10nF ±5%</td>
<td>1.00p</td>
</tr>
<tr>
<td>3123</td>
<td>100nF ±5%</td>
<td>2.00p</td>
</tr>
</tbody>
</table>

**OPTD 7-Segment Displays**
Brand New 1st Quality
LITRONIX DL 7716 pin
Red or Common Anode Displays 0-9 with right hand data signal provided. Order No. OPTD 100 for 25 Displays.

**BARGAINS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SX8205</td>
<td>Assorted Polysmylene Bead Capacitors</td>
<td>£0.75</td>
</tr>
<tr>
<td>SX8402</td>
<td>Assorted Silver Mica Caps</td>
<td>£0.50</td>
</tr>
<tr>
<td>SX8404</td>
<td>Assorted Metal Foil Caps</td>
<td>£0.25</td>
</tr>
</tbody>
</table>

**CAPABLE CAPACITOR PAKS**

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3120</td>
<td>100pF ±5%</td>
<td>0.50p</td>
</tr>
<tr>
<td>3122</td>
<td>10nF ±5%</td>
<td>1.00p</td>
</tr>
<tr>
<td>3123</td>
<td>100nF ±5%</td>
<td>2.00p</td>
</tr>
</tbody>
</table>

**SEMICONDUCTORS FROM AROUND THE WORLD**

100

1 Amp SILICON RECTIFIERS
- 500V 5 amp - £1.00
- 100V 10 amp - £1.50

**PROGRAMMABLE UNICHROME TRANSISTOR**
- TSOP 5800 plastic VE.EQ.Similar to 74LS04 - £0.75

**SILICON POWER TRANSISTORS**
- 50V 1A - £2.50
- 50V 2A - £3.50

**TECASBOTY**

The Electronic Components and Informative BegM of the Year.
A host of Electronic components including potentiometers — rotary and slider — potentiometers — linear and vential.
Resistors of mixed values from 2200ohm to 2.2M — 1/8 — 1/2 Watt. A complete range of diode types: including germanium and silicon types, plus disc and ceramic types.
Audio plugs and sockets of various types plus plugs, fuses, connectors, wire, nuts, bolts, panels, connectors, agency and two-Way and P.C.
Board. Thend an additional 1000 Semiconductors to include resistors, diodes, SCR's and other diode types, which are currently not available.
It all a Fantastic Value. No surplus of old and valuable and in current tools as well.

**MORE BARGAINS!**

- 50p per 100 pieces of 50V 1A— £2.50
- 50p per 100 pieces of 100V 1A — £3.00
- 50p per 100 pieces of 500V 1A — £3.50
- 50p per 100 pieces of 500V 2A — £4.00
- 50p per 100 pieces of 500V 5A — £4.50

**IC SOCKETS**
The lowest price ever.

- Price £1.50
- Price £2.00

**VOLTAGE REGULATORS**

- Price £5.00
- Price £7.50

**SILICON BRIDGE Rectifiers**

Comprising 4 x 14 amp rectifiers mounted on PCB.

- 15V - £1.50
- 4.5V — 5 Amps

**REGULATED Variables**

**SILICON CONTROLLED RECTIFIER**

- Price £5.00

**MINIATURE FM TRANSMITTER**

- Price £5.00

**MORE BARGAINS!**

- 50p per 100 pieces of 50V 1A — £2.50
- 50p per 100 pieces of 50V 2A — £3.00
- 50p per 100 pieces of 50V 5A — £3.50

**BI-PACKS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 pieces of Resistors</td>
<td>£5.00</td>
</tr>
<tr>
<td>20 pieces of Capacitors</td>
<td>£2.50</td>
</tr>
<tr>
<td>50 pieces of Transistors</td>
<td>£4.00</td>
</tr>
</tbody>
</table>

**NEW PRODUCTS**

- 100 Silicon Power Transistors — £2.50

**PROGRAMMABLE UNICHROMA TRANSISTOR**
- TSOP 5800 plastic VE.EQ.Similar to 74LS04 - £0.75

**MONEY IN THE BANK**

- 100 pieces of Resistors | £5.00 |
- 20 pieces of Capacitors | £2.50 |
- 50 pieces of Transistors | £4.00 |

**NEW PRODUCTS**

- 100 Silicon Power Transistors — £2.50
PE EDUCATION

The DoI recognises the value of PE projects in the educational environment! Well that might be a bit strong, but it is a fact that the Department of Industry is proposing a scheme to give robots to schools. In this country there are three companies making suitable small robots and now two of them, Powertran Cybernetics and Colne Robotics, have been involved with publication of robot designs in this magazine. In fact we have now published four designs for robots available from Powertran.

PE's commitment to education goes without saying and just as we were at the forefront of microprocessor learning and the development of personal computing, with publication of the UK101, we are also keeping up the pressure with a continuing involvement in robotics. This issue carries the first part of the highly educational project Zeaker, designed by David Buckley and for which Colne Robotics will be marketing kits.

BASIC PRINCIPLES

The schemes to give school children hands on experience, first of computers and now possibly of robots, are to be applauded but we begin to wonder if in its haste to help youngsters the Government is not failing to teach the technology behind these developments—electronics. It's all very grand to educate our youngsters to be aware of developments, to be able to use them and to appreciate the benefits they bring, but much of the wealth of industrial countries is based on the development and production of these very items that can assist the industrial world. We must never become so reliant on developments that we forget the basic principles of electronics on which they are built.

It is perhaps time to encourage the teaching of electronics in the way we now do computing lest this fundamental is trodden underfoot in the rush to keep up with the new developments it spawns. Computing and robotics are interesting and exciting but many PE readers can vouch that the experience is heightened by construction and understanding of the equipment in use. Such deep involvement in the tool being used also leads to new ideas and to the ability to fully understand limitations and develop ways to overcome them by basic design.

INNOVATION

We must make sure our country continues in the field at which it is best—innovative design in every area. Our software engineers are achieving a worldwide reputation for excellence, Clive Sinclair's achievements need no underlining and we are up with the rest in development of robots. We must not throw all this away by simply teaching our children how to use these tools and not providing them with sufficient basic knowledge of electronics and engineering to make them want to invent and develop the next generations of hardware.

Computers are not blessed with innovative thinking, they can only help achieve an end product from the basic ideas. One thing you can be sure of, PE will continue to thrive on ideas of a fundamental nature—even if these fundamentals do get overlooked elsewhere from time to time. We will also continue to employ these ideas in the design of equipment which is applicable to modern systems, be they computers, robots or whatever else comes along.

---

EDITORS

Mike Kenward  
Gordon Godbold  
David Shortland  
Mike Abbott  
Brian Butler

ART EDITOR

Jack Pountney

ASSISTANT EDITOR

Keith Woodruff

EDITOR/PRODUCTION

John Pickering

TECHNICAL EDITOR

Isabelle Greenaway

TECH. SUB EDITOR

Jenny Tremaine

ADVERTISER MANAGER

D. W. B. Tilleard  
Alfred Tonge  
Barbara Blake  
Brian Lamb

SECRETARY

Christine Pocknell  
01-261 6819

AD. SALES EXEC.

01-261 6697

CLASSIFIED SUPERVISOR

01-261 6819

AD. MAKE-UP/COPY

01-261 6601

Letters and Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to one published project only.

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 OFF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders

Binders for PE are available from the same address as back numbers at £4.60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £13.00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.
Clef Products...

Kits-Update Information

It is not always clear from the advertising that when specialist Kit Suppliers make a long term commitment to PE projects they are able to capitalise on constructor feedback to make modifications in specification or ease of construction. Some of these changes can be very minor but add considerably to the value of the final unit. This is particularly true of Clef Products who have recently provided the following update information on three of their popular musical projects.

MASTER RHYTHM: The facility to vary both tone colour and level of the instruments in this fully programmable Drum Machine is one of the factors which continue to make the PE Master Rhythm very competitive with any of the commercial units available today. This feature has been extended by incorporating access holes, with identification, into the bottom of the case to give rapid E.Q. for varying situations and musical requirements. Following publication of the PE Bandbox a 7 pin DIN socket was fitted to the front of the Master Rhythm to link the two units and to provide external connection of start, stop, clock, programmed pulse etc., to give sequencer drive and footswitch operation. The complete Master Rhythm Kit incorporates both these changes and costs £79.

BANDBOX: The heart of this unique "Backing Band" is a 6502 based Microcontroller, which has allowed specification improvements to be developed purely in software, i.e. by relatively cheap replacement of the Monitor EPROM integrated circuit. Existing customers are notified when a new facility becomes available and around 80% take advantage of the offer to part exchange the old EPROM, at a cost of around ten pounds.

MICROSYNTH: Allan Bradford, the designer of the Microsynth, had made various models of his basic concept, up to four octave compass, and in conjunction with Clef it was decided to adopt a 30 note format as the standard for the Kit. Apart from the musical advantage, this allowed the p.c.b. to be extended in length to include the power supply giving a single board construction. At the same time the front panel layout was then able to accommodate the overall level control and preset adjustments for Line and Headphone outputs. Finally a Keyswitch similar to the principle used in the Clef Electronic Piano range was included giving a further simplification of construction.

Full details on the above can be obtained from Clef Products (Electronics) Ltd., 44A Bramhall Lane South, Bramhall, Stockport, Cheshire SK7 1AH. 061-439 3297.

LITESOLD Soldering Systems

Litesold have modified their LE40 24 volt in-handle electronically controlled iron, to incorporate proportional band temperature control. Power to the heating element is only fully on or off outside a narrow temperature band centred on the set value. Within this proportional control band, power is supplied in regular pulses of equal interval, but of a length which varies according to the difference between the actual and set temperatures. At the set temperature, 'on' and 'off' periods are equal. Below this temperature the 'on' periods become progressively longer, and above it, progressively shorter, until the limits of the proportional band are reached, when power is continuously on or off. This feature provides much improved control, without temperature swing or overshoot.

External access is provided to the temperature adjustment, which can be set to any value between approximately 280-420°C. Temperature stability around the set point is typically within ±2°C. The iron is available complete with a power unit for £58.50 inc. VAT.

Litesold have also recently introduced a complete soldering/de-soldering kit for the electronics hobbyist. The kit is centred around a high efficiency 18 watt mains iron, constructed to latest electrical standards, and fitted with a 3.2mm copper bit. There are also two alternative bits included, of 1.6 and 2.4mm. The kit also includes a 3 metre reel of 18 s.w.g. flux-cored solder, stainless steel tweezers, three double-ended soldering aids and a reel of de-soldering braid. This provides all that is required for soldering and de-soldering on almost any electronics project, and is ideal for beginner or expert. The kit comes in a clear PVC wallet, and is available direct from Litesold at a very special mail order price of £14.55 inclusive of postage and VAT. Light Soldering Developments Limited, 97/99 Gloucester Road, Croydon, Surrey, CR0 2DN. (01-689 0574.)

CASSETTE FILING SYSTEM

For those of us who like things neat and tidy here's a drawer system for storage of cassettes. The Fischer C Box Drawer Unit is an easily accessible storage facility for data tapes containing long term information or games etc.

The cassette rests in a spring loaded box that opens at the touch of a button and incorporates splined hubs to prevent slackening of the tapes. There are ten individual boxes with easy change labels housed in each drawer unit, which can be stacked at the user's convenience.

Two designs are available: standard and deluxe (lockable) at £17.50 and £19.50 respectively inc VAT and p&p. Artur Fischer (UK) Ltd, 25 Newtown Road, Marlow, Bucks, SL7 1JY (06284 72882).
A flexible, automatic manufacturing facility which can machine batches of work in three days where conventional manufacture takes eight weeks, has been built using joint government and industry finance. The facility is flexible in that it can be reprogrammed to carry out virtually any batch turning operation.

The parts (along with their blanks) shown in the photograph, were machined by the FMS (Flexible Manufacturing System) called Scamp. This completely automated production line utilizes computer controlled turning, grinding and milling machinery, serviced by 600 Fanuc robots which remove the job pieces from a conveyor belt. The factory is manned by three engineers.

The plant is not in Germany, nor Japan, but here in the UK, and it is claimed to be a first. Scamp was developed and installed by Scamp Systems of Colchester, Essex, the home of Colchester Lathes, whose machines form much of the production line. A complex perpetual conveyor system, based on rollers, incorporates gates for controlling the queuing of work pieces. These pieces are conveyed on, and identified by, binary coded pallets. Automatic Vision Orientation fixtures optically observe and orientate the metal blanks correctly for insertion into cutting machinery. The whole process is under the control of a pair of Systime Series 5000E computers.

Scamp has overcome the majority of machine queuing problems associated with automated production. Department of Industry sponsorship was necessary because of the extremely high capital cost of the installation, which would not amortise itself on purely commercial grounds. However, the cost of robotics and electronics continues to fall, whilst the cost of labour continues to rise. It is the DoI's intention that their support scheme will spawn expertise in readiness for the crossover point.

---

British Engineering

East Anglia

Worms

Mr. D. Thursby, Sutton.

Mr. S. Rubie-Todd, Bristol;

Mr. D. Brown, Bristol;

Mr. E. Radley, Liverpool; and

Mr. S. Lambert, of Halesowen. Mr. Lambert

wants a full Micro-Professor system comprising microcomputer, EPROM programming board, and Speech Synthesiser board.

There were also four second prize winners who each receive a Micro-Professor MFP-1B microcomputer. These winners are: Mr. D. Brown, Bristol; Mr. E. Radley, Liverpool; Mr. S. Rubie-Todd, Bristol; and Mr. D. Thursby, Sutton.

Our thanks to all who took part, and to Flight Electronics for supplying the prizes.

---

Silicon News Corner

Bulletins announcing new semiconductor devices arrive at PE daily, so it is possible only to describe them briefly. Details of how to obtain further information are included, however.

Intersil

The ICL 7137 is designed to interface to a led display, and consumes only 200µA internally. It gives auto-zero to less than 10µV, zero-drift less than 1µV/°C, input bias of 10µA max., and rollover error of less than one count. Ideal for economic load-cell strain gauge and other bridge sensor measurements. A panel meter may be built using only seven passive components and a display. No overrange hangover or hysteresis effects.

The ICL 7115 is a fast CMOS monolithic 14-bit A/D converter which uses successive approximation. Interfacing to a µP is aided by the use of standard Write and Read cycle timing and control. Interface to 8, 12 or 16 bit systems is possible through byte organised, three-state outputs. Resolution is 0-003%, there are no missing codes, conversion takes 10µs, linearity and gain error is less than 1ppm/°C, 1ppm/µs, power consumption is 60W, and no gain or offset adjustment is necessary (0-006% F.S.). Intersil Datal (UK) Ltd, Belgrave House, Basing View, Basingstoke, Hants.

RCA

A low consumption BiMOS op amp featuring bandwidth/slew rate programmability, the CA3440 has two stages; a high gain (100kΩ) front end and a low impedance f.e.t./bipolar output stage. Input circuit features gate protected PMOS transistors. A phase compensation technique allows stable operation in unity gain follower configuration.

Ultra high speed, high current rectifier family. Reverse recovery time of the RUR 810 is less than 35ns. Available in TO 220AB packages, they are rated at 8A forward current, with PIV of 200V. RCA Ltd., Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx.

Burr Brown

A new f.e.t. input TO99 op amp, the OPA 105 requires an input bias of less than 1pA. Guaranteed initial offset of 2500V, with a drift of 2µV/°C.

Two high linearity voltage-to-frequency converters called the VFC62 and VFC320. Output pulse train repetition rate is proportional to Vin. They can also be used to convert a pulse train frequency back into a proportional voltage output! Linearity is +0.005%. Full scale drift is 50 ppm of FSR/°C. Low noise precision voltage reference, called the REF101, provides +10V ±5mV at 10mA, adjustable over ±2%. Noise is 100µV pp. Burr Brown, Cassiobury House, Station Road, Watford WD 1 1EA.

---

MICRO-PROFESSOR COMPETITION

In our Micro-Professor Competition, readers were invited to place eight features of a microcomputer teaching aid in the order, they considered, warranted the greatest consideration.

Having considered all entries, the judges chose a number of identical attempts listing the following selection as being the best received: 1-C; 2-E; 3-K; 4-A; 5-B; 6-D; 7-L; 8-J.

All tying competitors took part in a postal eliminating contest from which the first prizewinner emerged as Mr. K. Lambert, of Halesowen. Mr. Lambert wins a full Micro-Professor system comprising microcomputer, EPROM programming board, and Speech Synthesiser board.

There were also four second prizewinners who each receive a Micro-Professor MFP-1B microcomputer. These winners are: Mr. D. Brown, Bristol; Mr. E. Radley, Liverpool; Mr. S. Rubie-Todd, Bristol; and Mr. D. Thursby, Sutton.

Our thanks to all who took part, and to Flight Electronics for supplying the prizes.
DMM TEMPERATURE SENSOR

Anyone who has access to a digital multimeter can now use it as a versatile wide range temperature measuring instrument using standard type K thermocouples, by adding the DVM/TC Interface Unit.

This new device has a temperature range of -50°C to +1100°C and incorporates automatic cold junction compensation. Thermocouples are attached through a miniature compensated socket. A basic thermocouple, mating plug and battery are supplied as standard with this instrument. The output of 1 mV per degree centigrade is via a 0.75 metre coiled lead fitted with 4mm plugs. Long term stability is excellent and the low battery drain allows it to be used for continuous monitoring if necessary. Since the accuracy is not affected by the output loading (the DMM), it may be alternatively used to interface a low output impedance instrument such as a chart recorder. Priced at £42 including VAT and p&p, this interface unit is available from, Graham Bell Instrumentation, PO Box 230, 39 Derbyshire Lane, Sheffield S8 0TH (0742 892370).

INFRA-RED CONTROLLER

A two channel infra-red (IR) remote controlled light dimmer is now available in kit form, with separate transmitter and receiver units.

The receiver, designed to be controlled by its matching transmitter, gives independent remote on/off and variable control functions. Applications are extremely varied and include the automatic adjustment of both room temperature and lighting. In use, either of the two channels may be assigned to any one receiver, or two identical kits may be assigned to different channels and controlled individually by only one transmitter.

The receiver kit, supplied complete with housing, has a 240V a.c., 50Hz power supply and current consumption is 25mA maximum in the standby mode with a maximum control output of 300 watts. Reaction times from zero to maximum and maximum to zero are 7 seconds, with noise immunity ensured.

The transmitter, designed to operate an IR light dimmer, will control two receivers, with ON/OFF and dim commands. Specifications include bi-phase coded modulation, CMOS technology and power l.e.d. outputs, giving 15 mw/cm² maximum beamed power. Beam deflection is 30° with a reflector and 60° without.

The transmitter is priced at £15 plus VAT and the receiver at £33 60 plus VAT, both items require £1 p&p and are available from, Electronic & Computer Workshop Ltd, 171 Broomfield Rd, Chelmsford, Essex. (0245 62149).

The Open School

Many otherwise mature and competent people are nervous of trying a course in computing. The 'Open Computing School' at South Bank Polytechnic near Waterloo and Elephant and Castle, have developed courses designed to take complete novices to a position where they can design their own useful computer programs. Nor do they have to take a week off or spend a fortune. The Poly believes it is a unique type of service, allowing people who cannot commit themselves to a fixed timetable to work at their own pace, during the day or in the evening. The price is kept low to attract those who are paying their own fees, but the emphasis is on use in administrative work.

A number of managers and employers join in order to get an appreciation of what a microcomputer might do for their organisation, and clerical workers join with the object of improving their career prospects. Other students include engineers, teachers, translators and social service workers. However quite a number of students have no vocational interest but come just because they feel that they ought to keep up with the technological revolution. Some think it will help with the children's homework.

The Open School runs continuously throughout the college year. Special one-day appreciation courses can be provided for organisations on request. The introductory course costs £45. Write to Polytechnic of the South Bank at Borough Road, London SE1 0AA or Tel. Jack Flatow or Iris Mason on (01 928 8989) ext 2410.

Mobile Satellite

The advantages of having a portable satellite ground station for television are numerous, and the 'Beeb' are paving the way in seeking them out. Their 3M diameter, trailer mounted disc has been on many UK locations since its introduction in 1981. Its first overseas adventure was coverage of the UK team matches in the world cup in Spain last year.

More recently however it was borrowed by the Italian State Television Service for use at the International Slalom Ski event at Bormio, Italy. The ground station was used, from this difficult outside broadcast site, because a terrestrial network would have required five microwave radio links. Pictures of excellent technical quality were transmitted via satellite to the fixed ground station at Milan for local and European distribution. The mobile satellite ground station was built by BBC research engineers at Kingswood Warren in Surrey.
Briefly...

Alone, all alone on the bridge of the Kinokawa Maru, a Japanese 177,000 tonne ore/coal carrier, stands the commander. The ship appears deserted, like the Marie Celeste. The commander talks to himself, seemingly: but the ship answers back with a metallic, synthesised human voice:

"Full Ahead!" resounds the instruction.
"Full Ahead!" echoes the vessel in confirmation.

The engine builds up to full power with no further human involvement.

A handful of years ago this could have been the stuff of science fiction: but now it cannot. For fiction it is no longer. The tide of events in technology has lead Sumitomo Heavy Industries to build what they claim to be the first ship in the world which is capable of being manoeuvred at sea by a human voice.

The Kinokawa Maru is no ordinary ship, for not only is its main engine speed controlled by electronics with voice recognition and synthesis, but it is designed to consume 45% less energy per cargo tonnage. The overall design significantly reduces its crew's workload and the ship's tonne ore/coal carrier, stands the commander's platform, reducing further the crew's workload—and the crew!

The control system’s speech recogniser has a capacity of 40 words, which match the voice pattern of an authorised user. It will ignore all other voices. Its phoneme type synthesiser has a fixed vocabulary of 480 words, and a programmable vocabulary of 1000 words.

With rising transport costs truncating shipping activities worldwide the Japanese look set to stay full ahead as a major shipping nation. Each time the Kinokawa Maru puts to sea it leaves in its wake a message for the next generation of ship. To survive the weld of competition, this will need a level of automation that includes remotely controlled auxiliary machinery, too, reducing still further the crew’s workload—and the crew!

In contrast to the more common 850nm wavelength light source, the Wight connection will use 1300nm lasers. The monomode fibres give rise to less loss and signal scattering than multimode, allowing combined landline and underwater repeaterless transmission.

It is expected that in 1988 an intercontinental optical fibre link will go into service, a contract for which is to be awarded in November this year.

The first Motorola 68000 microprocessor to be made in Europe was produced at East Kilbride, Scotland, in February. The device was produced on their pilot production line at their existing plant; production will be transferred to the new facility (module Ill) when its construction is complete.

As a 32:16 bit microprocessor it is gaining popularity and is apparently a favourite with software writers, making it the most written for device of its kind. The design team had only one prerequisite in common say Motorola and that was, none of them had been involved in the design of previous older processors.

Aimed at European and Japanese markets (yes Japanese) the 68000 will find its home in systems such as personal computers, business machines, robotics and telecommunications as well as energy and medical fields. Motorola has been producing silicon chips at East Kilbride since 1972.

Countdown ...

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

International Materials Handling April 19–26. Earls Court. I
International Packaging Exhibition April 25–29. NEC B/ham. I
Midland Computer Fair April 28–30. Bingley Hall, B/ham. Z1
Biotech May 4–6. Wembley. O
Micro City May 10–12. Bristol Exhibition Complex. F3
Defence Components Expo May 10–12. Metropolitan, Brighton. I
Welsh Amateur Radio, TV & Electronics Rally May 22. Barry Memorial Hall, S. Glam. C

Motrades May 25–27. Sandown Exhibition Centre, Surrey. Z1
East Suffolk Wireless Revival May 29. Ipswich Civil Service Pavillion, Ingliston, Edinburgh. M
SEM/LA May 29-30, NEC Bham. M
International Computer Fair June 16-19. Earls Court. I
The Computer Fair June 16–19. Earls Court. Z1
Compec North June 21–23. Belle Vue, Manchester. Z1
Electronic Hobbies Fair. The best event ever for the UK electronics hobbyists comes round for the second time from October 27th to 30th at Alexandra Pavilion. Make a date now and watch these pages for EHF news each month. Z1

A8 Holographic Exhibitions £01-826 6423
C Reg. Rowles £0293 565656
E2 BARTG 89 Linden Grns., Enfield, Mdx.
F Tomorrow's World Exhibitions, Bristol
I Industrial Trade Fairs 021 705 6707
M Montbuid Exhibitions £01 486 1951
O Online £09274 28211
T Trident £0822 4671
Z BETA Exhibitions £01 405 6233
Z1 IPC Exhibitions £01 643 8040
**INTRUDER ALARM CONTROL UNIT**

**CA 1250**

This exciting new module offers all the positive features likely to be required when building an intruder alarm system. Whether used with only 1 or 2 magnetic switches or in conjunction with several ultrasonic alarm modules or infra-red units, a really effective system can be constructed at a fraction of the cost of comparable ready-made units. Supplied with a fully explanatory Data Sheet that makes installation straightforward, the module is fully tested and guaranteed. *Available in kit form £16.95 plus VAT.*

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

**ULTRASONIC ALARM MODULE**

**US 4012**

Fully built & tested

Adjustable range from 5ft. to 25ft.

A really effective fully built module containing both ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. The module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available (see right).

**INFRA-RED SYSTEM**

**IR 1470**

Fully built & tested

- Range up to 50
- 12V operation
- Supplied with full instructions
- Easily installed

Now available, a really effective infra-red system built to the high standards demanded by the security industry, and yet offered at this low price. The system consists of a transmitter and receiver which provide an invisible beam over distances from 1-50 ft. or more. When the beam is interrupted, a relay is energised in the receiver unit. The use of a modulated beam combined with the infra-red filters, prevent interference from artificial or sunlight, whilst LED indicators ensure easy alignment of the beam. Both units are housed in attractive black moulded enclosures which are easily mounted. Supplied with full instructions, the unit is ideal for use in conjunction with the Control Unit CA 1250 or as an independent unit.

**Power Supply & Relay**

- Units PS 4012 £4.25 + VAT
- Provides a stabilised 12V output and relay with 3A contacts. The unit is designed to operate one or two of the ultrasonic units. Fully built and tested.

**Siren Module**

- SL 157 £2.95 + VAT
- Produces a loud and penetrating sliding tone operating from 9-15V. Capable of driving 2 off 8 ohm speakers to SPL of 110db at 2M. Contains an inhibit facility for use with shop lifting loops or other break to activate circuits.

**Hardware Kit**

- HW 4012 £4.25 + VAT
- A really effective infra-red module with powerful speakers to SPL of 110db at 2M. Supplied with two keys and 5 horn speaker for use with CA 1250 or as an independent unit.

**Hardware Kit**

- HW 4012 £4.25 + VAT
- A really effective infra-red system built to the high standards demanded by the security industry, and yet offered at this low price. The system consists of a transmitter and receiver which provide an invisible beam over distances from 1-50 ft. or more. When the beam is interrupted, a relay is energised in the receiver unit. The use of a modulated beam combined with the infra-red filters, prevent interference from artificial or sunlight, whilst LED indicators ensure easy alignment of the beam. Both units are housed in attractive black moulded enclosures which are easily mounted. Supplied with full instructions, the unit is ideal for use in conjunction with the Control Unit CA 1250 or as an independent unit.

**Power Supply & Relay**

- Units PS 4012 £4.25 + VAT
- Provides a stabilised 12V output and relay with 3A contacts. The unit is designed to operate one or two of the ultrasonic units. Fully built and tested.

**Siren Module**

- SL 157 £2.95 + VAT
- Produces a loud and penetrating sliding tone operating from 9-15V. Capable of driving 2 off 8 ohm speakers to SPL of 110db at 2M. Contains an inhibit facility for use with shop lifting loops or other break to activate circuits.

**Hardware Kit**

- HW 4012 £4.25 + VAT
- A really effective infra-red module with powerful speakers to SPL of 110db at 2M. Supplied with two keys and 5 horn speaker for use with CA 1250 or as an independent unit.

**ACCESSORIES**

- 3 position Key Switch for use with CA 1250, supplied with 2 keys £3.43 + VAT
- Magnetic switch (with magnet) £1.17
- 5 Horn speaker for use with CA 1250 and SL 157 £4.95

**RISCOMP LIMITED**

- Dept. PES
- 21 Duke Street, Princes Risborough, Bucks.
- Princes Risborough (084 44) 6328

Please allow 7 days for delivery

**MASTER ELECTRONICS NOW!**

The PRACTICAL way!

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

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

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

You will do the following:
- Build a modern oscilloscope
- Recognise and handle current electronic components
- Read, draw and understand circuit diagrams
- Carry out 40 experiments on basic electronic circuits used in modern equipment
- Build and use digital electronic circuits and current solid state 'chips'
- Learn how to test and service every type of electronic device used in industry and commerce today. Servicing of radio, T.V., Hi-Fi and microprocessor/computer equipment.


Please send your brochure without any obligation to

**NAME**

**ADDRESS**

**POST NOW TO:**

**British National Radio & Electronics School**

Reading, Berks. RG1 1LR

**FREE!**

**POST NOW TO:**

**British National Radio & Electronics School**

Reading, Berks. RG1 1LR
LAST month the voice synthesis board was described. The board holds a vocabulary of 204 words each of which could be selected by means of a microcomputer or manually operated switches. When used with a computer the vocabulary could be built into sentences, thereby producing an interesting personality for the machine.

There are, however, many applications in which speech is a valuable asset but the expense and sophistication of a microcomputer is not warranted. Such applications are found in the car, home and factory and include speaking the digits on a panel meter or clock, delivering short messages such as INTRUDER AREA ONE, DANGER HIGH PRESSURE etc. or even providing a robust, lightweight alternative to a B.T. teleprinter or VDU.

Until recently, speech could only be reproduced by electro-mechanical systems using magnetic tape or plastic discs. But since the introduction of cheap, reliable large-scale integrated circuits it has become possible to model the human voice using a Linear Predictive Coding algorithm. This algorithm is made up of a random signal generator which forms the basic fricative and plosive sounds, a variable frequency signal generator which is used to produce different pitch sounds and a digital filter which, when configured by a computer in any number of high and low pass, band pass and band stop configurations, moulds the words themselves. The use of the algorithm reduces the minimum amount of memory needed to produce one second of speech from 96,000 bits to 1,100.

VOICE SYNTHESIS BOARD

The basic voice synthesis board consists of a 128K, VM61001 Voice ROM connected to a TMS 5100 Voice Synthesis Processor which in turn drives an audio output stage. A 640kHz clock is produced by RC network which is divided down to give a ROM clock of 160kHz. The 6 control lines which program the board consist of 4 data lines (CTL1-CTL4) and 2 clock lines. All the address data and instructions are loaded via these 6 lines.

Since 18 bits are needed to address one location in a 128K memory, and there are only 4 data lines, then 5 nibbles of 4 bits are loaded sequentially to form each address. Before each nibble is accepted by the processor it must be preceded by a Load Address instruction, thereby commanding the processor to forward the address to the memory over the 4 bit internal bus. The control signal M1 is brought high by the processor during a Load Address instruction which gates the CTL lines directly to the internal bus.

The memory has its own internal register, and can be accessed either in a direct or indirect mode. If, after loading an address, a direct instruction is used, followed by a Test Talk and Speak instruction, then data held in this memory address will be passed to the processor in a serial form via the ADD 8 line of the internal bus. The internal address register will automatically increment, and the processor will request another bit of data by toggling its MO line. The sequence will repeat until the last series of data instructs the processor to stop.

If, however, a Read and Branch instruction is used, followed by a Speak instruction, then the address loaded via the CTL lines will be taken as the address of the Look-Up table in which is held the address of the start of the data string. The memory then loads the latter address into its register and repeats the above sequence.

The TMS 5100 receives the speech data from the memory and immediately decodes it. The on-board 10 bit A-to-D converter produces an analogue speech signal from this which is then filtered and amplified by the audio output stage.

INTERFACE CIRCUIT

Fig. 2.3 shows a circuit which will produce speech from the voice synthesis board without the use of a microcomputer. The circuit has been designed to be as flexible as possible. Hence it can be operated with or without an EPROM. When the EPROM is inserted into the circuit it will convert coded data, such as that from a 3 digit, 7 segment display (Fig. 2.1), ASC II terminal or even BCD output, to that needed by the voice board. It can be used to multiply the words in a phrase by sequentially switching the inputs of
Fig. 2.3. Circuit diagram of Interface board. Capacitor C6 should be 100n. Remaining 100n's are supply decoupling
Fig. 2.5. Component layout
a single port to a maximum of 64 words. In addition, three word messages can be formed by linking the EPROM out and switching each input port to give the address data of the respective word. A circuit for the EPROM substitute is shown in Fig. 2.2.

The interface circuit consists of 7 four bit high impedance buffers connected to a 4 bit CTL bus. Each one of the buffers can be latched in turn to the CTL bus by means of two decade dividers which are wired in series. A further 9 bit bus is formed on the input to the board. Data which is present on any one of the three, 9 input ports, can be selected sequentially to form either an address for the code conversion EPROM or, if a jumper strip is inserted in the EPROM socket, the address of the look-up table of the word required. Each one of the 9 bits in all three inputs must be terminated to 0 volts or +5 volts for the board to operate successfully.

The output from the EPROM is connected to two 4-bit CTL buffers. The remaining four 4-bit buffers on the CTL bus are wired in such a way that, when they are enabled, they produce the four following instructions:

0000 0000 0000 0000
RESET
0010 LOAD ADDRESS
1100 READ & BRANCH
1010 SPEAK

CIRCUIT DESCRIPTION

When the speak input is brought high, both 555 timers start to run. Timer A runs at a frequency of 10kHz. Timer B can be set to give the rate at which the words are spoken. The first three clock pulses from 555 timer A step the decade counter and enable the 0000 buffer. Hence, three reset instructions are given to the processor. The next clock pulse enables the 0010 buffer which instructs the processor that the following nibble will be an address. The lower nibble from the EPROM is then latched to the CTL bus via its respective buffer. Once it receives a further clock pulse the decade counter is stepped and the 0010 buffer enabled. This is followed in turn by the upper nibble of the EPROM output being loaded onto the CTL bus. The decade counter then enables the 0010 buffer once more followed by the third 2-bit data buffer. The 0010 buffer is again enabled and followed on the next clock pulse by loading the 0000 buffer as data.

The decade counter then enables the 1100 buffer thereby instructing the processor to READ & BRANCH. The next clock pulse latches the 1010 and the processor begins to speak the first word. During this time the I.e.d. is switched on.

The decade counter is then held until the second 555 timer B times out. This steps the input counter IC10 which in turn enables the second 9-bit data port. In addition, the decade counter is reset and the above sequence repeated, thereby producing the second word.

The third word is produced when 555 timer B times out for the second time. This again resets the decade counter and steps the input counter which in turn latches the data present on the third input port onto the input bus. The input counter is stepped once more, thereby causing it to latch, which in turn inhibits 555 timer B and hence the sequence is halted.

CONCLUSIONS

The voice synthesis board can be used in most applications where speech is needed. It has the capacity to speak phrases of between 3 to 64 words; it can cope with coded input such as seven-segment or BCD, and it can be operated by a microcomputer or simply as a stand alone unit for application in the house, car or factory.

<table>
<thead>
<tr>
<th>COMPONENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors</td>
</tr>
<tr>
<td>R1, R2, R3, R5, R6, R11, R13, R15, R17, R19, R21</td>
</tr>
<tr>
<td>R7, R8, R9, R10</td>
</tr>
<tr>
<td>R4, R12, R14, R16, R18</td>
</tr>
<tr>
<td>Capacitors</td>
</tr>
<tr>
<td>C1, C7</td>
</tr>
<tr>
<td>C2</td>
</tr>
<tr>
<td>C3</td>
</tr>
<tr>
<td>C4, C5, C6, C8, C9</td>
</tr>
<tr>
<td>C10, C11</td>
</tr>
<tr>
<td>Integrated Circuits</td>
</tr>
<tr>
<td>IC1-IC5, IC8, IC10, IC12</td>
</tr>
<tr>
<td>IC11</td>
</tr>
<tr>
<td>IC6, IC14, IC16</td>
</tr>
<tr>
<td>IC7</td>
</tr>
<tr>
<td>IC17</td>
</tr>
<tr>
<td>IC8, IC13</td>
</tr>
<tr>
<td>IC19</td>
</tr>
<tr>
<td>Transistors</td>
</tr>
<tr>
<td>TR1-TR5</td>
</tr>
<tr>
<td>Diodes</td>
</tr>
<tr>
<td>D1-D7</td>
</tr>
<tr>
<td>D8</td>
</tr>
<tr>
<td>Constructor's note</td>
</tr>
<tr>
<td>Full kits of parts are available from the Warwick Design Group, 12 St. Georges Rd., Leamington Spa. (0926 34311) at £24 each. Kits are available to design Voice Synthesis Boards are priced at £37.</td>
</tr>
</tbody>
</table>

BAZAAR

MICROTAN 65 Factory built. £45. S. R. Powell. Tel: (0733) 7238. 6 Churnet Road, Forsbrook, Stoke-on-Trent, Staffordshire ST11 9BP.
BOUND volume R.C. '71-'72, plus 100's of P.W., E.E., R.C. offers, Mr. F. Edwards, 46 Longstaff Road, Southfields, London SW18.
2 METRES for £25. Multichannel Storno Viscount, working perfectly with toneburst and handbook. Buyer collects. Tel: Biggleswade 315075. Mr. N. J. Strange, 19 Wilsheres Road, Biggleswade, Beds.

100 UNUSED boxed valves, £50. Also 3,000 circuits, £50. R. MacDonald. Tel: Folkestone 75541.

8080 Components. CPU's, DMA's, USArt's etc. Only a few of each. Send s.a.e. for details. Robert Malos, 204 Corporation Rd., Grangetown, Cardiff CF1 7AY.

WANTED for 19 Set MKIII I ATU, vibrator p.s.u., full circuit data. Copies p.k. Also any HRO circuit data. A. C. Baglin, 19 Fore Street, North Tawton, Devon EX20 2DT. Tel: North Tawton (083782) 354.


SANWA ST4-3BF radio control four channel, three servo, unwanted present. £75 o.n.o. Tel: Horndean 593502. L. J. Mundin, 111 Hazelton Way, Horndean, Hants PO8 9DN.


MAJOR 588 80ch AM/FM/SSB, £70. Pair A1010 10 speakers, 10 watt, 10 inch, £10. Tel: Gainsborough (0427) 5848. D. Treble, 2 Pendeen Close, Gainsborough, Lincs DN21 1YE.

UNUSED TMX 500TU-B Multimeter with case and leads. £20. Tel: Yeatey 870628. Mr. F. Lucas, 6 West Fryerne, Yeatey, Nr Camberley, Surrey GU17 7SU.

Practical Electronics May 1983
In the early days of semiconductor design the variety of components available for general use were fairly limited. Transistors, diodes, and passive devices were predominantly used, and most circuits contained various combinations of these devices. The design emphasis was very much based on the methods and arrangements of interconnecting these devices, and on the passive component values used. Nowadays, the integrated circuit is the dominant type of component, with many circuit designs having no discrete transistors in them at all. Unlike diodes and transistors, however, the performance and operational parameters of an i.c. are often very difficult to specify. The electrical limits of performance must be detailed, of course, but the precise functioning and operation of the device must also be explained. For many i.c.s this explanation requires a number of tables, timing diagrams, and waveform diagrams. As a result, data sheets become very complex and contain a large amount of information which must be thoroughly assimilated before design can begin.

Many readers would like to use new semiconductor devices in their own projects but are daunted by the research necessary to enable them to do so. Initially, a suitable device has to be found, and then the relevant data has to be obtained; if it can't be found in a supplier's catalogue, then from whom? Many people don't have access to professional data services or distributors' information. Even if data has been satisfactorily obtained, it's often written in such a way that it proves difficult to put into practice. This is where we come to your help! This series of "application reports" features different semiconductor devices (mostly integrated circuits) with their pin connections and essential data clearly given. In many cases all the data that's available won't be given since much of it is of little value in the majority of design work and it would take up many pages every month! All the essential data will be given which as a result will be much easier to read and understand. Included will be a comprehensive description of how the device works, how it can be used, hints and suggestions for circuit arrangements, circuit diagrams, and finally a Veroboard layout for a typical circuit. This will give all the information needed to enable you to use the i.c. with confidence in designs of your own, often as a base for a larger project.

**RANGE COVERED**

The semiconductor devices looked at will cover the whole range of electronics with the exception of very specialised devices such as microprocessors (covered recently by "Microfile"), r.f., microwave, etc. These will range over op amps, audio amps, consumer i.c.s, display devices, encoders, decoders, power supply i.c.s; all these and many more will be covered. Some devices will be very new indeed, giving you access to the very latest technology. Others will be recently introduced or more familiar devices; the aim is to provide a comprehensive and wide ranging service.

Each month just one device or a small family of similar devices will be presented. However, to get the series off to a flying start, we feature two chips this month: an electronic combination lock, the LS 7225, and the SAB 0600 door chime.

**COMBINATION LOCK (LS 7225)**

The LS 7225 is a relatively new and very interesting 14 pin i.c. which takes a lot of the effort out of designing an electronic combination lock. It's a monolithic PMOS device, rated at up to 18 volts supply, and has a low quiescent supply current which allows it to run for a very long time on a small battery if required.

It has sequential logic to detect a valid sequence of four key depressions. There are three main outputs of the i.c.; one directly drives a l.e.d. to indicate when the device is in the locked state, a second latches to the on condition (logic 1) when the correct code has been entered, and the third provides a momentary on signal (again a logic 1) when the correct code has been entered. If any "unused" keys are pressed, or if any of the correct keys are pressed out of sequence, an "incorrect sequence output" of the i.c. is pulsed to logic 1 (i.e. a high level), and no changes occur to the main outputs of the device.

Various enable and delay facilities are also provided to ensure that a delay of several seconds or more is necessary between entering one code and being allowed to enter another one. This helps to prevent a light fingered person from typing in all possible combinations in a very short time! All the inputs have built in pull down resistors to help minimise the external component count. Power on reset is provided to set the i.c. into the "locked" state when power is first applied. Following such an application of power, the first correct sequence entered turns the lock off, then the next correct sequence turns it on again. The two main "unlock" outputs can drive many relays directly, providing that coil resistances of 1k or more are used.
KEY SEQUENCE INPUTS

These inputs are taken to logic 1 (i.e. a high level) by the relevant switches of the switch bank or keypad. Input 1 should be held at logic 1, while 2 is taken to logic 1 momentarily, followed by 3, then by 4. Only after Input 4 has been operated should Input 1 be allowed to go open circuit (or to logic 0); see the timing diagrams, Figs. 4 and 5, for clarification of this. Alternatively, by taking a capacitor from Input 1 to ground, the logic 1 level will be maintained for a short period after the first switch is released, giving a “time window” in which the other switches may be pressed. A 1µF tantalum capacitor will typically give a 4 second delay, which is quite long enough to allow the pressing of the other three switches. Note that this will also result in a delay before any further sequences can be entered; once the capacitor has been charged, it must be allowed to discharge before another sequence is started.

UNSELECTED KEY INPUT

All the unused switches or keys are connected in parallel and taken to this pin. Hence, if any incorrect key is pressed, this pin is taken to logic 1, the sequential logic is reset, and a pulse is fed to the “Incorrect sequence output” pin.

UNLOCK OUTPUTS

The momentary unlock output goes to logic 1 as soon as the correct sequence of switch or key inputs has occurred. It returns to logic 0 as soon as “Key sequence” Input 1 returns to logic 0, either when the first key in the sequence is released, or (if one is fitted) when the capacitor discharges a few seconds later. The latched “Unlock output” also goes to logic 1 as soon as the correct sequence of key inputs has occurred. To reset this to logic 0 (the “system locked” condition), the whole correct sequence must be entered again.

“LOCK ON” OUTPUT

This directly drives an i.e.d. with no need for any external resistor. This is lit when the lock is on, i.e. when the latched “Unlock output” is at logic 0.

PIN 3 is normally at 0V. Pin 6 is the +ve supply, which can be anything from +4V to +18V. As a rule of thumb, try not to go above +15V generally, to guard against any supply voltage fluctuations or noise pushing the voltage above the maximum rating for the i.c. Some capacitors across the supply rails should also be provided for decoupling; in Fig. 2 these are C5 and C6, with R1 and C1 providing further supply decoupling.

INCORRECT SEQUENCE OUTPUT

This gives a positive going pulse out (to logic 1) when any form of incorrect code sequence is entered. This pulse is extremely short in duration, only 15µs approximately, so be careful how you use it.

ENABLE SEQUENCE INPUT

This input, in common with all the others of the i.c., has a pull down resistor fitted internally, and is normally kept at logic 0 (or open circuit) to allow the system to operate. If it is taken to logic 1, then the sequence detection circuitry is disabled. This can be used in conjunction with the “Aux. delay” facility and the “Incorrect sequence output”, to provide a fixed delay (following an incorrect sequence entry) before another attempt at entering the correct sequence is allowed.
SLETTING SEQUENCE

no external ones are needed except for the logic 1, the Schmitt trigger inverter's output
doorbells seem unable to play calls. The only thing that the majority of these
designs. Just about every tune that you could
techniques, then later involving digital control,
originally based on simple analogue tech-

"off' their outputs do not go to OV of their
nearly at the positive supply rail, but when "on" their output voltage
stages; when "on" their output voltage
goes to logic 0, turning on the MOSFET out-

"Time Window": Key entry must be
completed in this time.
(This period must be allowed to end
before the next code is entered)

Fig. 4. Timing diagram, correct sequence

AUX DELAY INPUT/OUTPUT
The internal circuitry for this is shown in
Fig. 1. When pin 1 is taken high (towards
logic 1), the Schmitt trigger inverter's output
goes to logic 0, turning on the MOSFET out-
put stage and feeding a logic 1 level to pin 4.
An RC timing network can be used to delay
any signal fed to pin 1, which is "clipped up"
into a sharp edged logic change by the Schmitt
trigger input of the inverter, and fed to pin 4 as
just described. See Figs. 2 and 5 for further
clarification of how this works in practice.

POINTS TO NOTE
Because of the internal pull down resistors,
no external ones are needed except for the
"Aux. delay input". However, beware of tak-
ing any input up to the positive supply with a
resistor, since the internal and external resistors will combine to form a voltage
divider, making the input voltage to the i.c.
poorly defined. If you must use a pull up
resistor, try to keep it down to just 1 or 2
kilohms if possible. The outputs at pins 4, 5, 7,
and 8 are all unloaded MOSFET driver
stages; when "on" output voltage is
nearly at the positive supply rail, but when "off" their outputs do not go to 0V of their
own accord; they merely become open circuit.
If these outputs are being used to drive into
any other logic circuitry, add a suitable load
resistor to 0V; the 100k resistor R4 in Fig. 2 is
being used for just this purpose.

The Veroboard layout for the circuit is shown in
Fig. 3. As usual, take care with the
handling of both i.c.s, and avoid touching the
pins with your fingers. D5 protects the circuit
against the supply being connected the wrong
way round; since this may be a battery, it is a
worthwhile precaution. Don't forget to add
D2 and D3 to protect the i.c. against back-
e.m.f. spikes from any relays that you might
connect to the circuit. The more switches that
are provided, then the more difficult it is to

The two separate outputs of the digital
tone generator are mixed together at the sum-
ing section as the final decay progresses.
The three separate outputs of the digital
tone generator are mixed together at the sum-
ing input of the power amplifier. The latter is
designed to drive a load of 8 ohms or more,
which must be capacitively coupled via a 100µ

THE THREE TONE CHIME (SAB 0600)

The all-electronic doorbell has been a pop-
ular concept for many years now, being
originally based on simple analogue tech-
niques, then later involving digital control,
culminating in today's microprocessor based
design. Just about every tune that you could
think of can be played whenever the milkman
calls. The only thing that the majority of these
doorbells seem unable to play is a good,
simple, traditional, "ding-dong!"

The SAB 0600 is an 8 pin i.c. from Siemens
which is designed specifically to provide such
a chime. In fact, it is more of a case of "ding-
dang-dong", since three tones of descending
order of frequencies are provided, not just two.
The tones are harmonically related so that the
chime is always in tune, and sophisticated
logic control provides for a realistic and pleasing
decay of sound level. There is even a
power amplifier provided in the device, so that
only half-a-dozen passive components plus a
switch and loudspeaker need to be added to
make a complete door chime.

The block diagram of the i.c. is shown in
Fig. 7. When the device is triggered (by taking
pin 1 to the positive supply) an internal
regulator is turned on to supply regulated
to the rest of the internal circuitry. A
high frequency master clock oscillator is
provided, with its frequency determined by an
external RC network connected to pins 6 and
7; varying either the R or the C will cause a
change in the oscillator frequency. The output
of the clock oscillator feeds into a digital tone
generation circuit. The master clock is divided
down to provide the three chime frequencies,
ensuring that the musical relationship between
the tones is kept constant, and hence the
chime will remain in tune. The master clock is
then divided down still further, and this very
low frequency square wave is used to control
the timing of changes in relative amplitude
of the three tones. The amplitudes are controlled
independently, so that the first tone is decay-
ing away when the second one starts, and both
the first and second tones are decaying away
when the third one starts. The result is a very
natural and melodic sequence; in fact, if you
listen very carefully to the chime you can ac-
tually hear the amplitude decreasing step by
step at the end of the sequence as the final
decay progresses.

The three separate outputs of the digital
tone generator are mixed together at the sum-
ing input of the power amplifier. The latter is
designed to drive a load of 8 ohms or more,
which must be capacitively coupled via a 100µ
capacitor. Under these circumstances the i.c. will deliver 100mW without the need for any heatsinking.

Finally, an external capacitor between pin 8 and ground (0 volts) will act as a filter, rolling off some of the high frequency content of the square waves. The more filtering that is applied, then the subjectively quieter the chime seems to be, although of "smoother" tone, so the adjustment of this is a matter of personal preference. The chip's internal power supply shuts down when the tones have ceased. This reduces the current consumption to less than 1µA, which in combination with the supply voltage requirements of 6 to 11 volts makes the device ideal for powering by a small 9 volt battery.

**BASIC CIRCUIT**

The basic chime circuit is shown in Fig. 8. Varying R2 or C4 adjusts the frequency of the chime tones, and (because the timing of the digital tone generator is also derived from the master clock) the duration of the chime sequence; the higher the tones in frequency, the shorter the sequence will last. The value of C5 can be adjusted to give the most suitable tone to the chime.

If the chime is too loud for your liking, add a resistor in series with C2; anything up to 20 ohms should do the trick. C1 and C6 must be in place and as close to the i.c. as possible, since they ensure the stability of the whole circuit. Normally the three tones come in the order of descending frequency. If instability is present, the tones may seem to increase in frequency, or even change frequency as they are decaying away. The cure for this is simply to add more capacitance; increase the value of C1, or add more 100n disc ceramic capacitors across the supply rails close to the i.c. If the switch is very far away from the i.c. then add an 82k resistor between it and pin 1 of the i.c. (close to the chip itself) to limit any spurious induced currents to an acceptable level.

**ELABORATING IT**

The basic circuit of Fig. 8 works very well, but for the adventurous there is a more sophisticated circuit shown in Fig. 9, with its Veroboard layout given in Fig. 11. Two switches are provided, "Doorbell 1" and "Doorbell 2", so that both front and back doors of your house can be connected to the circuit. Doorbell 1 will give a short duration high frequency chime, and Doorbell 2 a longer, low frequency chime.

IC2c and IC2d form a simple flip-flop or latch circuit. If the Doorbell 1 switch is pressed, IC2d pin 11 goes to logic 0 and IC2c pin 10 goes to logic 1. This situation remains constant (even after the switch has been released) until Doorbell 2 is pressed, when IC2d pin 11 goes to logic 1 and IC2c pin 10 goes to logic 0, etc. IC3 is a quad CMOS analogue switch. This acts in a similar way to a relay, but in solid state form; if pin 13 (a "control" pin) is taken to logic 1, then pins 1 and 2 become "connected together" via a 300 ohm resistor internal to the i.c., and can pass analogue signals bidirectionally. Hence, if pin 13 goes to logic 1 and pin 12 is at logic 0, R3 is effectively connected between pins 6 and 7 of IC1, with R2 remaining unconnected. Similarly, if pin 12 is taken to logic 1 with pin 13 at logic 0, R2 is connected between IC1 pins 6 and 7, and R3 remains unconnected. By this means, the two doorbell switches will connect different resistors to IC1, which in turn will cause different frequencies of chime to be heard. IC2a and IC2b are merely connected to make an OR gate; if either one switch OR the other is pressed, then the chime i.c. is triggered.

**CIRCUIT NOTES**

R1 and C3 provide some simple filtering to help prevent the triggering of IC1 by spurious pulses. R6 and R7, together with D1, D2, D3 and D4, protect the circuitry against short duration high voltage pulses induced into the lengthy wiring between the doorbell switches and the actual circuitry itself. R4 and R5 provide biasing for the flip-flop when the switches are released. Changing the value of R3 will vary the low frequency chime, and changing R2 will similarly affect the high frequency chime. As with the simple circuit of Fig. 8, don't forget that R10 can be added to reduce the loudspeaker volume if required. Make R10 a wire link for full volume. C5 can be varied to alter the tonal quality of the chime. Again, be careful with decoupling capacitors C1, C6 and C7; add to these if instability is a problem. Finally, note that D5 is used to protect the circuit against incorrect connection of the battery — always a good
idea! Battery life will be many months in normal use, because the SAB 0600 turns itself off when not in use, and the CMOS i.c.s draw negligible current.

If more loudspeaker power is needed than can be provided by the i.c.'s own amplifier, then replace C2 by a 100n capacitor, and the loudspeaker by a 100k resistor (almost any values will do here), then feed the connection between this capacitor and resistor out to an external power amplifier. The signal level may need attenuating, though!

Why not experiment more with the circuit; running two SAB 0600 i.c.s together simultaneously could prove interesting, giving the effect of musical chords being played. Alternatively, try connecting the circuit of Fig. 10 to IC3 pins 12 and 13 in place of the circuitry shown in Fig. 9; this will cause a continual changing of frequency actually during the chime, which is a very strange sound indeed. Perhaps in the end, though, the most pleasant effect is the original one: a simple, melodious, three tone chime, which is a welcome change from so many modern electronic doorbells!

The SAB 0600 is available from TK Electronics, who also sell complete doorchime kits based on this i.c.

BAZAAR

SONY CV2000 Video. 405 lines, reel to reel, recorder, camera, monitor/T.V., microphone, tripod, cables, tapes, carry-case. £180 o.n.o. R. Swale, Oak Cottage, 615 Reading Road, Winnersh, Wokingham, Berks. Tel: Wokingham 784035.


PRACTICAL Electronics Nov. 64 to date. Some bound. Offers. N. Tawse, 96 Cold Overton Road, Oakham, Leicestershire. Tel: 0572 56355.


MICROTAN 65 full expansion (repaired), Tanex 7K RAM, XBUG (Ass/Diss) Motherboard, £85 o.n.o. Will split, £47 each o.n.o. G. Williams, 85 Salthouse Rd., Barrow-in-Furness, Cumbria LA13 9TN. Tel: (0229) 29152 before 7p.m.

WATFORD'S new version Wemon 4K monitor i.e. for enhanced Superboard (48 x 32 video). Original packing and documentation. £5. Call: Chang (041 332) 7655. K. Y. Chang, 70 1-up, Ashley St., Glasgow G3 6HW.

WORLDWIDE WANTED


PRACTICAL Electronics Nov. 64 to date. Some bound. Offers. N. Tawse, 96 Cold Overton Road, Oakham, Leicestershire. Tel: 0572 56355.


MICROTAN 65 full expansion (repaired), Tanex 7K RAM, XBUG (Ass/Diss) Motherboard, £85 o.n.o. Will split, £47 each o.n.o. G. Williams, 85 Salthouse Rd., Barrow-in-Furness, Cumbria LA13 9TN. Tel: (0229) 29152 before 7p.m.

WATFORD'S new version Wemon 4K monitor i.e. for enhanced Superboard (48 x 32 video). Original packing and documentation. £5. Call: Chang (041 332) 7655. K. Y. Chang, 70 1-up, Ashley St., Glasgow G3 6HW.

30 Practical Electronics May 1983
This is an instrument provided with variable sensitivity trigger pads that may be played with hands or drum sticks. It is capable of tailoring a vast range of sounds that include drums, cymbals, bells, explosions, triangles, gongs, rockets, marching feet, steam trains, wind and surf etc., as well as an equal range of abstract sounds.

A circuit that is useful as a signal conditioner to rescue poor recordings and enable them to be successfully loaded into a computer. If two recorders are available it permits programs to be copied directly without tying up a computer.

Nuclear power without radio-active waste is the target of a group of European scientists who built the little known giant of Oxfordshire—the JET Tokamak. This article will reveal their amazing toroidal machine, and its significance.
THE IRAS SATELLITE

After three years of working and planning the International Infrared Astronomical Satellite (IRAS) was launched successfully in January. The allocation of responsibility for this international project was distributed between the United States, the Netherlands and the United Kingdom. The act of launching was celebrated by an all night watch of the personnel on duty at Rutherford Appleton Laboratory, to which not only active participants in the project were invited but also their families, the press and other visitors.

The personnel on duty were fully occupied with their particular tasks and routines, but all this activity was kept available to the guests by the monitors set up in the lecture theatre. Continuous monitoring was available and all the countdown procedures could be observed.

Between events the visitors were given tabloid information from various members of the staff. Since each stage of the proceedings from the launch site at the Vandenberg Air Force Base in California was via live voice relay, the frequent "Mission completed" indicated in a loud voice as each procedure was finished often broke in over the local speakers voices. This seemed to increase the level and make the activities audible. The visitors could resist audibly counting with the rest. At 2.21 a.m. the command signal was sent from Chilton to the Goldston tracking station, at 2.25 a.m. the LOS (loss of signal) indicated that the pass over the Goldston sector had been successful and that the Satellite was in its way over the Indian Ocean. At 3.11 a.m. the AOS (acquisition of signal) and at 3.24 the LOS, followed by the Chilton pass at 3.29 a.m. Throughout the Chilton acquisition of signal the movement of the controlled dish at Chilton, fully floodlit, was observed. In its turn the LOS for Chilton was still observed for the purposes of the "show" was constantly interrupted as the launch preparations continued.

THE DUTCH EXPERIMENTS

Band 1. 8.5-15 microns
Detectors 15 silicon-arsenide
Band 2. 19-30 microns
Detectors 16 silicon-antimonide
Band 3. 40-80 microns
Detectors 16 germanium-gallium
Band 4. 83-119 microns
Detectors 15 germanium-gallium

The detectors are so arranged that each source encounters two detectors in each of the four wave bands which produce a 'signature' for a point source. By this method each area of observation is covered four times giving a probable source detection coverage of eight. Some of the special observations will involve the examination of well known asteroids and new ones which may be encountered. Thus this satellite will deal with almost any type or source of infrared that may be scanned by the telescope.

INFRARED ASTRONOMY

Recently a new dimension was brought into being using the UKIRT (United Kingdom Infrared Radio Telescope) high up on the mountain at Haewsi. This new dimension was the operation of the control centre at Edinburgh Observatory where sitting at a console the astronomer could operate the telescope and carry out normal duties. This was reported in detail in a recent issue of Spacewatch. It might therefore be thought that this new telescope operating in space is duplicating facilities. There is a very important reason for the new telescope which will in the course of the next 6 to 9 months complete the most comprehensive view of the infrared spectrum of the Universe. This reason lies in the fact that though a great deal of data has been collected there are gaps in the actual spectrum which cannot be "seen" from Earth. The reasons for this situation are concerned with the "forbidden" wavelengths which cannot be seen through the Earth's atmosphere for a number of reasons. It becomes necessary then to go outside the Earth where the whole spectrum can be observed.

There is another very important matter to be considered. This arises from the fact that the level of the radiation may be very low. To take this into account the sensitivity of the new telescope is such that it can detect levels down to one millionth of a watt per square centimetre. Special design and cryogenic operation becomes necessary to accomplish this. Yet though the signal at the receiver may only be minute the actual source and origin may be extremely great and energetic. This is the tremendous importance of the satellite telescope.

The heart of the satellite is the telescope. It is an f/9.6 Ritchey-Chretien type design with a 22.4 inch effective aperture on a mirror. The mirror itself is of light weight Berryllum. The effective field of view is 30 arc minutes. It has a focal length of ,500mm. There are 62 rectangular detectors which vary in size from 7.2 x 1.2mm to 7.5 x 5mm. These detectors form the focal plane array at the base of the telescope. The detectors observe in four wave bands.
**Official BBC Dealer**

**BBC COMPUTERS**

Model B: 348.95
Model B + Disc Interface: 441.95

**BBC MICRO DISC DRIVES**

- 150M, 2M, 32M: Up to £199
- 1M, 64K: Up to £200

**CARRIAGE**

Orders up to £199 sent by 1st class post and £200+ by Securicor.

**CHARGES**

- 0-6100 = £0.50, 6100-199 = £1.25, 200+ = £5.00

**PRICES**

All prices and carriage charges quoted are exclusive of VAT and are subject to change without notice.

**QUANTITY DISCOUNTS**

Available on most products. Please telephone for details.

**OFFICIAL ORDERS**

Welcome from Educational Establishments, Government Bodies and Public Companies.

---

**MIDWICH COMPUTER COMPANY LIMITED**

**DEPT PE, RICKINGHALL HOUSE, RICKINGHALL, SUFFOLK IP22 1HH**

**TELEPHONE (0379) DISS 898751**

---

**CARRIAGE**

Orders up to £199 sent by 1st class post and £200+ by Securicor.

**CHARGES**

- 0-£100 = £0.50, £100-£199 = £1.25, £200+ = £5.00

**PRICES**

All prices and carriage charges quoted are exclusive of VAT and are subject to change without notice.

**QUANTITY DISCOUNTS**

Available on most products. Please telephone for details.

**OFFICIAL ORDERS**

Welcome from Educational Establishments, Government Bodies and Public Companies.

---

**MIDWICH COMPUTER COMPANY LIMITED**

**DEPT PE, RICKINGHALL HOUSE, RICKINGHALL, SUFFOLK IP22 1HH**

**TELEPHONE (0379) DISS 898751**

---

**CREDITS ACCOUNTS**

Are available subject to status. Payment strictly nett 30 days.

**CREDIT CARDS**

Payment by credit cards is accepted on most products with no charge.

**OUT OF STOCK**

Items out of stock will follow with £0.45 carriage charge at our discretion, or a refund will be issued if requested.

**DELIVERY**

All stock orders received up to 3:30pm are despatched the same day.
WORKING on auto electrical systems must rank among the greats in the league table of love-hate activities. The fascination is all but irresistible; the wiring schedule and the components seem so simple and straightforward. In practice, the success or otherwise of any job concerned with auto electrics is based on a sound understanding of the principles involved, and having the appropriate test instruments. The Auto Test Set brings together a range of instruments usually to be found separately, and combines them into a compact and robust unit. By this approach it minimises the number of units which must be brought to bear, and perched precariously under the bonnet or dashboard, thereby minimising many of the frustrations which otherwise lie in wait for the unwary.

GENERAL DESCRIPTION
The Auto Test Set is essentially a group of closely related instruments which have been collected together in such a way that all of the functions remain available, but many of the necessary facilities are shared. An overall block diagram for the test set is shown in Fig. 1, and a summary of the specifications appears in the table. The schematic, and the full circuit diagram shown in Fig. 2, shows that the instruments fall into two main sections; those which use the meter for display, and those which do not.

The first group consists of the voltmeter, the tachometer, and the dwell meter circuits. These all share a common test probe known as the volts/coil probe, and the input signal is simultaneously applied to all three circuits. The output from each circuit can be selected for display on a large moving coil meter, ME1, by means of S1. This switch also effects range switching in the tachometer circuit. A conventional moving coil meter is used because it may easily be read to whatever accuracy required, and with such a display it is very much easier to detect trends; important during tuning and performance testing. A moving coil meter will also have the effect of averaging a signal which exhibits rapid fluctuation which might affect a digital type of display. In order to protect the meter movement from damage when not in use, a carrying position is provided on S1 to short the terminals when not in use. Further protection of the movement is provided by D9 and D10.

The second group of instruments include the circuit tracer and the lamp/fuse tester. Each of these has separate inputs with respect to ground, the V-input and the Z-input, respectively. The circuit tracer uses a voltage comparator and displays the result on a single i.e.d., with an optional audible warning. The lamp/fuse tester uses an impedance comparator and provides a GO or NOGO indication on two i.e.d.s, again with the option of using the (same) audible warning.

The overall instrument derives its power independently from the vehicle under test via SK3 and SK4; D11 provides visual indication of the presence of the necessary supply. The overall instrument is housed in a rugged diecast box, with the majority of the components mounted on a single-sided printed circuit board. The circuit and uses are described below for each constituent instrument in turn, before proceeding to the constructional details next month.
VOLTS/COL

VOLTMETER
TACHOMETER
Dwell Meter
POINTS STATE CIRCUIT

V - PROBE
Z - PROBE

VOLTS/COL

VOLTMETER
TACHOMETER
Dwell Meter
POINTS STATE CIRCUIT

V - PROBE
Z - PROBE

**Fig. 1. Block diagram of Auto Test Set**

VOLTMETER
TACHOMETER
Dwell Meter
STATE CIRCUIT

V - PROBE
Z - PROBE

**Fig. 2. Circuit for complete Test Set**

VOLTMEASURE
The Auto Test Set provides two scales for measuring voltages; a simple 0 to 15V range, and a 10 to 15V offset zero range. The first range simply inserts the appropriate series resistance, R12, between the potential to be measured and the meter, ME1. This provides an extremely useful general purpose voltmeter.

In many situations, particularly when interested in the state of the battery, it is rather wasteful to have an instrument which is accurate over a wide range. The range of values to be measured in such situations will usually be at the end of the scale. The provision of an offset zero voltage scale, therefore, allows a much clearer indication of the performance of the battery under load to be obtained. The nominal open-circuit terminal voltage of a conventional six-cell lead/acid battery is 13.2 volts. This value falls under load, especially as the internal resistances of the cells rise due to physical deterioration; and the voltage rises during charging. With the exception of starting, the battery voltage will rarely fall below 11 volts, and the voltage regulator should ensure that the terminal voltage does not rise much above 15 volts. The behaviour of the battery when extra loads, such as headlamps, are applied can give a useful guide to the overall condition of the battery and/or regulator circuit.

The offset zero voltmeter range is provided by using D18 to 'remove' 10 volts from the input potential. The load for the Zener diode is provided by R32, which causes a Zener
current of approximately 10mA to flow at the expected operational mid-scale value. In practice, the calibration of the offset zero scale will not be perfectly linear, with the maximum errors at either ends of the scale, but this should not prove to be a great handicap since the greatest use of the scale is in the clear indication of variations.

TACHOMETER

During engine tuning, it is usually necessary to make certain measurements (e.g. ignition timing advance) at known engine speeds. The 'tickover speed' also needs to be carefully adjusted to the correct value; it should not be so high as to waste fuel at idle, but again it should not be so low that the car has difficulty in moving off smoothly when required.

The measurement of engine r.p.m. makes use, in the main, of the fact that the distributor shaft rotates at exactly half the speed of the crankshaft in a conventional engine. As a result, the ignition circuit produces a pulsed signal across the primary winding of the coil at a frequency of N pulses per minute, where N is given by the equation:

\[ N = \frac{1}{2} \times \text{engine } \text{r.p.m.} \times \text{number of cylinders} \]

There are many ways in which the pulsed signal from the ignition coil may be sampled and converted to a voltage proportional to engine r.p.m., but the use of the National Semiconductor LM2917 i.c. produces one of the simplest circuits. The LM2917 is a linear monolithic device which contains a frequency-to-voltage converter, together with a high gain op amp/comparator designed to drive a relay or other external load up to 50mA. The tachometer section uses a charge pump technique and offers frequency doubling for low output ripple. Also provided in the i.c. is input protection, and an output which falls to ground level for a zero amplitude, to a d.c. voltage. The operation of the LM2917. The input switching level of the voltage comparator within IC1 is set by the combination of R4 and D8; the level at pin 1 must exceed approximately 600mV before the comparator switches. The output at pin 5 of IC2 is determined by the signal frequency, the capacitor selected by S1a, and the setting of VR1. The response time of the circuit is set by C6; increasing the value will increase the response time, and vice-versa. The series resistor for the internal Zener regulator, R5, is chosen to minimise the reference voltage variation over a supply range of 9 to 15V.

The calibration of the output for differing numbers of engine cylinders is achieved by S2, and the associated resistors, R26 to R31.

DWELL MEASUREMENT

The dwell angle of the contact breaker cam has a significant effect on the performance of an engine, particularly at higher speeds. Each vehicle has a specific dwell angle quoted for the distributor, and will have a value which depends on the design of the ignition circuit, and on the engine configuration. The distributor cam itself has a number of lobes, equal to the number of cylinders in the engine, symmetrically spaced on the shaft. The angular separation of these lobes will be 90°, 72°, 60° or 45° for engines with 4, 5, 6 or 8 cylinders.

![Fig. 3. The LM2917 frequency-to-voltage converter](image)

The integral voltage regulator sets the value of Vref and determines the trade-off between output ripple voltage and the response time of the circuit.

The circuit diagram for the complete tachometer is included in Fig. 2. The input from the ignition circuit is taken by connecting the volts/coil probes as shown in Fig. 4. The input signal at SK1 is then processed by R1, D1, R2, C2 and R3 to remove spikes and noise which may otherwise affect the operation of the LM2917. The input switching level of the voltage comparator within IC1 is set by the combination of R4 and D8; the level at pin 1 must exceed approximately 600mV before the comparator switches. The output at pin 5 of IC2 is determined by the signal frequency, the capacitor selected by S1a, and the setting of VR1. The response time of the circuit is set by C6; increasing the value will increase the response time, and vice-versa. The series resistor for the internal Zener regulator, R5, is chosen to minimise the reference voltage variation over a supply range of 9 to 15V.

The calibration of the output for differing numbers of engine cylinders is achieved by S2, and the associated resistors, R26 to R31.

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>RANGES</th>
<th>PROBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltmeter</td>
<td>0 to 15 volts f.s.d.</td>
<td>Volts/Points</td>
</tr>
<tr>
<td></td>
<td>10 to 15 volts offset zero</td>
<td></td>
</tr>
<tr>
<td>Tachometer</td>
<td>0 to 1500 r.p.m.</td>
<td>Volts/Points</td>
</tr>
<tr>
<td></td>
<td>0 to 5000 r.p.m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Both ranges may be used for 4, 5, 6 or 8 cylinder engines</td>
<td></td>
</tr>
<tr>
<td>Dwell Meter</td>
<td>0 to 45°, 60°, 72° or 90°</td>
<td>Volts/Points</td>
</tr>
<tr>
<td></td>
<td>Calibration depends on the number of cylinders fitted</td>
<td></td>
</tr>
<tr>
<td>Points State</td>
<td>An i.e.d. illuminates when the points are open</td>
<td>Volts/Points</td>
</tr>
<tr>
<td>Circuit Tracer</td>
<td>An i.e.d. illuminates when greater than 9-5 volts is present. Optional audible warning also available</td>
<td>V-probe</td>
</tr>
<tr>
<td>Lamp/Fuse Tester</td>
<td>GO/NO GO green/red i.e.d.</td>
<td>Z-probe</td>
</tr>
<tr>
<td></td>
<td>indication of lamp/fuse state. Green shows resistance less than approx. 150 ohms. Optional audible warning.</td>
<td></td>
</tr>
<tr>
<td>Carry</td>
<td>The meter movement is shorted during carrying for safety</td>
<td></td>
</tr>
</tbody>
</table>

36 Practical Electronics May 1983
The actual dwell angle is defined as the angle through which the cam rotates whilst the contact breaker points are closed. The correct dwell angle for a particular vehicle will be found in the workshop manual, but is typically around two-thirds of the angle between the cam lobes.

The correct adjustment of dwell angle is often a matter which is left somewhat to chance; the more approximate measure of points gap is frequently used instead. To ensure correct combustion, however, it is the dwell angle which is actually the important factor in maintaining good performance and fuel economy. The angle must be large enough to allow the core of the ignition coil to become magnetically saturated, but not so large that the coil starts to overheat, eventually leading to breakdown. Too small a dwell angle, however, will result in a poor spark, and may cause overloading of the capacitor and burning of the points at low engine speeds.

Dwell angle is most easily measured by observing the duty cycle of the voltage waveform across the points. If the duty cycle is 100% (i.e. points open all of the time), then the dwell angle is 0°; conversely, if the duty cycle is 0% (i.e. points closed all of the time), then the dwell angle is equal to the angle between the cam lobes.

In general, duty cycle and dwell angle are related by the following formula:

\[
\text{Dwell Angle} = \frac{\text{Cam Lobe Angle} \times 100\% - \text{Duty Cycle}}{100}\%
\]

The dwell measurement circuit, which is included in Fig. 2, makes use of two of the operational amplifiers in IC2. The contact breaker waveform is sampled by connecting the volts/coil probe as shown in Fig. 4. The waveform at SK1 is then filtered by R1/D1 to remove high voltage spikes, and by R2/C2 to remove high frequency noise. The filtered signal, which will have an amplitude of approximately two-thirds the input waveform, is then applied to the non-inverting input of IC1a. This amplifier is arranged as a voltage comparator, with the switching threshold set by R6 and D3. The overall effect is that the amplitude at SK1 must exceed approximately 1 volt to cause the output of the comparator to go high. The resulting comparator output is a rectangular waveform whose levels are limited only by the output saturation levels of the op amp itself; approximately 0-6V.

![Fig. 4. Connecting the Auto Test Set to measure engine revs and dwell angle](image)

### Components

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 4.7k</td>
<td>C1 10µ 16V elect</td>
</tr>
<tr>
<td>R2 4.7k</td>
<td>C2 10µ polyester</td>
</tr>
<tr>
<td>R3 22k</td>
<td>C3 68n polycarbonate</td>
</tr>
<tr>
<td>R4 10k</td>
<td>C4 22µ polycarbonate</td>
</tr>
<tr>
<td>R5 470</td>
<td>C5 100µ 16V elect</td>
</tr>
<tr>
<td>R6 10k</td>
<td>C6 1µ 35V elect</td>
</tr>
<tr>
<td>R7 150</td>
<td>R18 1k</td>
</tr>
<tr>
<td>R8 1k</td>
<td>R19 4.7k</td>
</tr>
<tr>
<td>R9 1k</td>
<td>R20 1k</td>
</tr>
<tr>
<td>R10 470</td>
<td>R21 4.7k</td>
</tr>
<tr>
<td>R11 10k</td>
<td>R22 2k2</td>
</tr>
<tr>
<td>R12 30k</td>
<td>R23 1k</td>
</tr>
<tr>
<td>R13 100k</td>
<td>R24 10k</td>
</tr>
<tr>
<td>R14 470</td>
<td>R25 100k</td>
</tr>
<tr>
<td>R15 1k</td>
<td>R26 100k</td>
</tr>
<tr>
<td>R16 220</td>
<td>R27 2k2</td>
</tr>
<tr>
<td>R17 4.7k</td>
<td>R28 50k</td>
</tr>
<tr>
<td>R18 1k</td>
<td>R29 62k</td>
</tr>
<tr>
<td>R19 10k</td>
<td>R30 75k</td>
</tr>
<tr>
<td>R20 10k</td>
<td>R31 100k</td>
</tr>
<tr>
<td>VR1 100k horizontal preset</td>
<td>C7 10µ ceramic</td>
</tr>
<tr>
<td>VR2 2k2 horizontal preset</td>
<td>C8 10n ceramic</td>
</tr>
<tr>
<td>All resistors 5% IW carbon types except where stated</td>
<td>C9 10n ceramic</td>
</tr>
<tr>
<td></td>
<td>C10 4117 16V elect</td>
</tr>
<tr>
<td></td>
<td>C11 4µ7 16V elect</td>
</tr>
<tr>
<td></td>
<td>C12 22µ 16V elect</td>
</tr>
<tr>
<td></td>
<td>C13 10µ 16V elect</td>
</tr>
<tr>
<td></td>
<td>C14 4117 16V elect</td>
</tr>
<tr>
<td></td>
<td>C15 111 35V elect</td>
</tr>
<tr>
<td></td>
<td>C16 22µ 16V elect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 BZY88 C12V</td>
<td>SK1 to SK7 Panel mounting terminals to constructor's choice</td>
</tr>
<tr>
<td>D2 BZY88 C9V1</td>
<td>Printed circuit board</td>
</tr>
<tr>
<td>D3 1N4148</td>
<td>Terminal pins</td>
</tr>
<tr>
<td>D4 Red l.e.d.</td>
<td>ME1-50µA large panel meter (Maplin RX54J)</td>
</tr>
<tr>
<td>D5* 1N4148</td>
<td>Diecast box approx. 190 x 110 x 60mm</td>
</tr>
<tr>
<td>D6 BZY88 C5V6</td>
<td>Ribbon cable</td>
</tr>
<tr>
<td>D7 1N4148</td>
<td>S1 2P 6W rotary switch</td>
</tr>
<tr>
<td>D8 1N4148</td>
<td>S2 3P 4W rotary switch</td>
</tr>
<tr>
<td>D9 1N4148</td>
<td>S3 SP on/off/on toggle switch—centre off</td>
</tr>
<tr>
<td>D10 1N4148</td>
<td>WD1 Piezoelectric or similar d.c. buzzer (RS 249-794)</td>
</tr>
<tr>
<td>D11 Red l.e.d.</td>
<td>KnoBs (2 off)</td>
</tr>
<tr>
<td>D12 1N4001</td>
<td></td>
</tr>
<tr>
<td>D13 1N4148</td>
<td></td>
</tr>
<tr>
<td>D14 Red l.e.d.</td>
<td></td>
</tr>
<tr>
<td>D15 Green l.e.d.</td>
<td></td>
</tr>
<tr>
<td>D16 Red l.e.d.</td>
<td></td>
</tr>
<tr>
<td>D17 BZY88 C4V7</td>
<td></td>
</tr>
<tr>
<td>D18 BZY88 C10V</td>
<td></td>
</tr>
<tr>
<td>D19 BC548</td>
<td></td>
</tr>
<tr>
<td>D20 BC548</td>
<td></td>
</tr>
<tr>
<td>D25 BC548</td>
<td></td>
</tr>
<tr>
<td>D30 LM2917</td>
<td></td>
</tr>
<tr>
<td>D31 LM324</td>
<td></td>
</tr>
<tr>
<td>D31 LM324</td>
<td></td>
</tr>
</tbody>
</table>

![image]
A few hours of crawling around under the dashboard, finding the point at which the voltage disappears. It is not so much that the job is difficult; it is tiring of diagnostic tasks. It is not so much that the job is difficult as it is a dry joint, broken wire or faulty component. The significance of such a fault requires a realistic and methodical approach if an undue amount of time is not to be wasted; stories of changing the alternator to mend a fuse bear witness to the penalty which can be incurred by hasty diagnosis. The first step, and often the only one required, is to investigate the state of the non-functioning component, or at least the component which appears not to be working, before moving back to more remote ones.

What is required is a test instrument which is more in tune with the requirements of the problem; simplicity is a prime consideration. In circuit tracing applications the exact value of the voltage detected is of only secondary importance. The major point is to detect that the circuit is continuous up to the point being measured, since the usual cause of the problem is a dry joint, broken wire or faulty component. The significant effort in such fault diagnosis is to localise the fault as quickly as possible, and then more precise measurements may be made if required.

The circuit tracer in the Auto Test Set provides a simple indication of the presence of a voltage of greater than approximately 9.5 volts. The indication is permanently provided by an I.e.d., but an additional buzzer indication may also be selected.

The circuit tracer basically consists of a voltage comparator circuit driving a load of an I.e.d. and an optional buzzer circuit.

The general principles of the circuit are shown in Fig. 5. The circuit tracing probe is the V-probe; the potential present at the V-probe tip is attenuated by 50% by the resistive attenuator, and then applied to the non-inverting input of the differential amplifier. The input to the inverting input of the amplifier is from a voltage reference source. The output of the amplifier is a saturated high level when the input voltage exceeds twice the reference voltage, thus turning the I.e.d. on. The buzzer circuit is arranged so that the buzzer is also on (if selected) when the amplifier output is high.

The lamp/fuse tester is designed to provide a simple and easy-to-use "go/no go" indication of the state of simple electrical components. The test can be used to examine the state of lamps, fuses, wiring, switches, relays, and indeed almost any passive electromechanical component. To assist in circuit tracing, particularly pin-pointing wiring breaks, a "go" result may also be used to activate the audible warning.

The lamp/fuse test circuit consists basically of an impedance comparator circuit which illuminates one of two I.e.d.s and an optional buzzer circuit. Which of the two I.e.d.s is illuminated is determined by whether the impedance

\[ \text{V}_{\text{supply}} - 1.2 \text{V (high)} \]

The dependence on supply voltage is eliminated by the clipper circuit made up of R8 and D6.

The average value of the processed waveform from IC1a is developed across C12, due to the integrating effect of R11/C12. A further op amp, IC1b, is arranged as a voltage follower to reduce the loading effects on the integrator circuit. The output low level saturation voltage from the buffer circuit is provided by VR2.

**CONTACT POINTS STATE**

The state of the contact breaker points is indicated by an I.e.d., D4, which is illuminated when the points are open. A switching transistor, TR1, is driven by the output of the voltage comparator stage in the dwell meter circuit.

**CIRCUIT TRACER**

Tracing wiring faults and broken connections in a vehicle wiring circuit must count as one of the more frustrating and tedious tasks. It is not so much that the job is difficult; it can, after all, be described as simply a matter of finding the point at which the voltage disappears.

A multimeter is understandably a natural first choice of diagnostic aid for the motorist with an interest in electronics. A few hours of crawling around under the dashboard, however, soon shows that it is no mean feat of skill to hold the two probe leads in position with one hand, while trying to operate the offending control with the other, and read the voltage on the meter.

What is required is a test instrument which is more in tune with the requirements of the problem; simplicity is a prime consideration.

In circuit tracing applications the exact value of the voltage detected is of only secondary importance. The major point is to detect that the circuit is continuous up to the point being measured, since the usual cause of the problem is a dry joint, broken wire or faulty component. The significant effort in such fault diagnosis is to localise the fault as quickly as possible, and then more precise measurements may be made if required.

The circuit tracer in the Auto Test Set provides a simple indication of the presence of a voltage of greater than approximately 9.5 volts. The indication is permanently provided by an I.e.d., but an additional buzzer indication may also be selected.

The circuit tracer basically consists of a voltage comparator circuit driving a load of an I.e.d. and an optional buzzer circuit.

The general principles of the circuit are shown in Fig. 5. The circuit tracing probe is the V-probe; the potential present at the V-probe tip is attenuated by 50% by the resistive attenuator, and then applied to the non-inverting input of the differential amplifier. The input to the inverting input of the amplifier is from a voltage reference source. The output of the amplifier is a saturated high level when the input voltage exceeds twice the reference voltage, thus turning the I.e.d. on. The buzzer circuit is arranged so that the buzzer is also on (if selected) when the amplifier output is high.

The lamp/fuse test circuit is designed to provide a simple and easy-to-use "go/no go" indication of the state of simple electrical components. The test can be used to examine the state of lamps, fuses, wiring, switches, relays, and indeed almost any passive electromechanical component. To assist in circuit tracing, particularly pin-pointing wiring breaks, a "go" result may also be used to activate the audible warning.

The lamp/fuse test circuit consists basically of an impedance comparator circuit which illuminates one of two I.e.d.s and an optional buzzer circuit. Which of the two I.e.d.s is illuminated is determined by whether the impedance...
between the Z-probe and ground is greater or less than the preset threshold. The general principles of the comparator are illustrated in Fig. 6. From this circuit, it can be seen that when there is no test load, the output level will be low, thereby illuminating the "no go" I.E.D.; conversely, when the test load is a short circuit, the output will be high and will cause a "go" indication. The switching point, i.e. the impedance for test load below which a "go" indication will be obtained, is determined by the two reference voltages and the value of R.

The lamp/fuse tester is built around IC2d, as shown in Fig. 2. The reference input to the non-inverting amplifier terminal is provided by an attenuator across the reference diode D17; this results in a reference of just under a volt. The other reference supply for the inverting input is provided by R7 and D2, and is at a level of 9-1 volts. The value of R22 sets the switching level of the comparator, in conjunction with the two reference levels as shown in Fig. 6, to approximately 150 ohms. This value has been chosen as it represents the resistance of a 1 watt automotive bulb, and as such represents probably the highest correct resistance likely to be met in practice.

Next month: Constructional details, testing and calibration will be presented.

---

**FREE! READERS' ADVERTISEMENT SERVICE**

**RULES**

Maximum of 16 words plus address and/or phone no. Private advertisers only (trades or business ads. can be placed in our classified columns). Items referred to electronics only. No computer software, PE cannot accept responsibility for the accuracy of ads. or for any transaction arising between readers as a result of a free ad.

We reserve the right to refuse advertisements. Each ad. must be accompanied by a cut-out valid "date corner". Ads. will not appear (or be returned) if these rules are broken.

---

**SYNTHESISER** 13 modules, keyboard and case. Cost £150+. Need attention, hence £80. For details, send s.a.e. Clive Longhurst, 40 Vale Rd., Chesham, Bucks HP5 3HH.

**MICROTAN 65**, Tanex, ASC11 keyboard rack mounted, some RTTY and some morse software, £150. DX302 receiver, new, £150. P. Harrison. Tel: Lichtfield (05432) 52824.


**UK101** 8K RAM card, fits J1 also B5, toolkit, £20. Mounted, £10 (p. & p.$2). Boards UK101 8K RAM card, fits J1 also B5, toolkit, £20. Mounted, £10 (p. & p.$2). Boards


**WANTED** Sugden P.51 power amplifier. Tel: 01-739 8422. Ext. 120 daytime.

**SUPERBOARD 3**, 8K RAM, 12K Basic, in plastic case, unwanted Xmas gift. Tel: 01-454 4368.

**PET** 8k computer. Old ROMS, integral cassette, sound box. First offer over £200. Andrew Holme, 92 Stone Cross Lane, Lowton, Nr Warrington. Tel: 01-204 4368.

**FIVE** octave keyboard, £20 ZX80, £20. Pye 9 inch b/w monitor, £20. Tel: Gainsboro, 0427 5848 (Linco).

**CHIPS**—£802A £10, 8253/8252/8275 £3, 93459/280A35/10—£7, 4116—16 for £7. J. E. Walker, 7 Warwick Place, Peterlee, County Durham SR6 2EZ. Tel: 866255 after 7pm.

**MULTIMETER** Miseco Mini 20 in strong plastic case, unwanted Xmas gift. Tel: 01-451 3093. Jack Anderson, 22 Landau House, Chatsworth Road, London NW2 4BW.

**SEVERAL** items of vintage test equipment for sale, s.a.e. for details. J. Glover, 1 Bryony Cottages, Hambleton, Godalming, Surrey GU8 4HH.


**FREE!** Please publish the following small ad. FREE in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules. I enclose a cut-out valid date corner.

Signatures

**Date**

Please write the RULES then write your advertisement here— one word to each box. Add your name, address and/or phone no. The coupon valid for posting before 6 May 1983. (One month later for overseas readers.)

**SEND TO**: PE BAZAAR, PRACTICAL ELECTRONICS, WESTOVER HOUSE, WEST QUAY ROAD, POOLE, DORSET BH15 1JG.

---

**FOR READERS WHO DON'T WANT TO DAMAGE THE ISSUE SEND A PHOTOSTAT OR A COPY OF THE COUPON (FULLY IN OF COURSE) WITH A CUT-OUT VALID "DATE CORNER"**
The Goonihilly Show
It seems incredible now that only a little over a decade ago few people had ever heard of Goonihilly. An unlikely, even comical, place invented perhaps by the Goons themselves or even earlier as a setting in a Wodehouse novel. Instead it turned out to be a very real piece of real-estate in Cornwall. In the summer of 1962 Goonihilly Downs emerged from obscurity to become world famous. But even then few of us glued to our tubes to watch the first ever live transatlantic television transmission via communications satellite realised the speed at which the new technique would become established.

Goonihilly today is not the only satellite earth terminal site in the UK but it remains the largest and, commercially, the most important. The addition this year of Goonihilly 5, the fifth big steerable dish in the complex, marks yet a further stage of expansion.

The new terminal is dedicated to maritime communications. The concept is not new as the first shipborne terminals were fitted in 1976. But take-up of the maritime satellite service has been painfully slow so that after some seven years there are only a little over 1,500 installations in service. This is mainly due to the ingrained attitude of many shipowners who regard the ship’s radio room and its operator(s), mandatory by international law for safety reasons, as an imposed overhead expense. Why go beyond the minimum requirement? Add to this the unhappy plight of world shipping in a trade recession and there is even greater reluctance to spend money on what could be senseless extravagance rather than prudent investment.

Goonihilly 5. Like its predecessors, was built by Marconi and is owned and operated by British Telecom who, in their newly acquired competitive spirit, have put together a sales package which could break through the apathy of shipowners. What BT is offering is direct dialling ship-to-shore telephone links between most destinations in the world at a cost of up to 50 per cent less than the already established service from the United States. Goonihilly 5’s global coverage embraces about 80 percent of the world’s shipping and offers total communications reliability round-the-clock, vastly superior to ordinary ship’s hf radio with its diurnal variations and ionospheric disturbances.

At present the rate of new shipborne installations is running at about 40 a month. It is estimated that by the end of this decade some 12,000 ships will have been fitted. This has to be good for business and good for shipowners, too. Of course the shipowners are still counting their pennies, with most of them anxiously monitoring their overdrafts, but shipping economics today are more than ever dependent on productivity. A tide lost or a cargo missed is big money. Instant and reliable communications can tip the balance from loss to profit. So the sales pitch is not whether a shipowner can afford it but whether he can afford to do without it.

The Big Fight
As I write there is no firm date for the forthcoming big fight. Both the main contestants are, however, in training with broad strategies defined, tactics to be decided much nearer the day. The champions in the blue corner might be described as political realists, the challengers in the red corner as political dreamers. The realists are favourite in the polls but the odds could and often do shift unpredictably. How will the result affect industry?

On the industrial front the main issue of principle between the two major parties is nationalisation and private enterprise. If we take history as a guide there will be no clear cut victory. Whatever might be said on either side, even written into manifestos, there has always been a compromise. No Labour government has killed off private enterprise, no Conservative government bought out the nationalised industry. The mixed economy is here to stay although the balance of mix may change. In the end all is compromise with Labour pouring money into private industry when in office and Conservatives pouring ever-growing amounts into failing State-run industries.

On the broad economic front Labour’s biggest punch, a straight left, is unemployment, supplemented by body blows on defence and withdrawal from the European Common Market. Such a combined attack could floor the Conservatives if only because it has great emotional appeal. But if the Conservatives can love their country too, and maybe a bit too much, it matters not. Labour has to be compressed into the past four years at the worst possible time in world trade with consequent unnecessary pain.

No, I haven’t forgotten the Liberal/SDP alliance. In the event of no decision the alliance will, in effect, become a biased referee favouring one side or the other. The alliance is itself a compromise but on withdrawal from the Common Market it will face the question they are more blue than red.

So, unless the extremists of either persuasion come unexpectedly from behind, there won’t be much change.

More Showbiz
It was perhaps inevitable after all the ballyhoo in 1982. Anyway, here it is, folks, the first ever International Conference and Exhibition on Satellite and Cable TV in Europe. Or Cable ‘83 for short. It will be held at the Wembley Conference Centre with over 50 authoritative speakers from the UK, Europe and North America.

The organisers, Online Conferences Ltd already have a racetrack in other IT areas and have used every emotive word and phrase they can think of to promote the event. Thus we have a scene which is “explosive and complex” but nevertheless calls for “an adaptive sensitive approach” in what is clearly “a dynamic situation”. I was especially intrigued by some of the conference topics. Under the heading of Marketing the question is posed, “Broadband-moneyspinner or black hole?” Under Direction we are promised a discussion on “The franchising jungle”. Under the heading of Issue Areas the no doubt vital question is posed “Can Go-go-go go slow?”. Again under Marketing there are talks on “Entering and surviving” and another question, “What follows the movies?”

The organisers say with evident satisfaction that there are likely to be few restrictions on Cable TV programme content, even fewer on imported material, and that the UK alone will shell out £2.5 billion into pockets of the participants. So roll up, roll up! How to win in this brand new game will all be explained from 10-12 May. A game? It must be. The advance billing says plainly “The major players are already jockeying for position”. Ugh!
Colne Robotics brings you the ZEAKER MICRO-MOBILE (as featured in this month’s construction project), a low-cost mobile robot for use with microcomputers. It’s compact (5x5x2") and rugged, with two separately-driven DC motors powering its wheels. Eight touch sensors indicate collision with obstacles to the computer, which can then instruct ZEAKER to take evasive action. Touching an obstacle triggers a two-tone alarm horn which changes in pitch according to direction of travel. A retractable pen, controlled by the computer, is provided to enable ZEAKER to trace its path and, if provided with appropriate software, produce logo graphics. LEDs indicate direction of motion and pen status, and with its two metres of umbilical ribbon cable ZEAKER can roam over any flat surface. Drive ZEAKER with any microcomputer fitted with an 8-bit bi-directional port (ZX81/SPECTRUM users note - we can supply a special interface). Complete with power supply, operation manual and basic software, ZEAKER is available at the special introductory price of only £59.95 (kit) or £79.95 (assembled) including VAT.

OTHER EXCITING LOW-COST ROBOTIC PRODUCTS

ROBOT VISION

COLVIS is a low-cost vision system which is able to see objects and remember their shapes! Its powerful, Z80-based dedicated microcomputer extracts information from the image produced by a 1024 (32x32) pixel solid state camera which is light enough to be mountable on the end of a small robot arm. Features of the image, such as area or hole count, can be remembered and used to recognise subsequent objects viewed. The system can also determine the position and orientation of an object and may be used either on its own or as an intelligent peripheral to any computer fitted with an 8-bit bi-directional port.

COLVIS costs only £395 (+ VAT and excluding T.V. monitor and cassette recorder).

I AM INTERESTED IN YOUR PRODUCTS AND WOULD LIKE FURTHER DETAILS OF:

[ ] ZEAKER  [ ] COLVIS  [ ] ARMROID

NAME

ADDRESS

COLNE ROBOTICS Co. Ltd.
BEAUFORT RD., OFF RICHMOND RD., EAST TWICKENHAM TW1 2PH

Meet ARMDROID I, the robot arm which has made Colne a world leader in micro-robotics! It can be driven by any micro-computer which has (or can be fitted with) an 8-bit parallel port, and comes complete with software which enables a sequence of moves to be ‘learnt’. Available in either kit or assembled form, ARMDROID I reproduces the actions of full scale industrial robots at a fraction of the cost. This precision, stepping-motor driven arm which has become an industry standard in education and industrial training, is now available to the enthusiast for between £300 and £600 (depending on options chosen).
ZEAKER is a small, low-cost computer-controlled robot vehicle designed to have all the normal functions of a "turtle" i.e. steering, lights, pen, horn and bump sensors but it is also capable of being expanded using photosensors for eyes to seek out or avoid light or to follow white lines etc; with a complex sound generator for special noises à la R2D2, and with computer speech.

It will easily interface to most popular microcomputers and can be programmed in a high-level language like BASIC, although a modular language like FORTH or PASCAL would be better.

Under program control Zeaker can go forward, backwards or rotate right or left on the spot; it has two navigation lamps: port and starboard (or eyes if you prefer) which can be turned on or off; a speaker which can emit a high or low tone or a combination of both; 6 tactile sensors which can detect a collision with an object in Zeaker’s path and finally but not least a pen which can be lowered or raised to enable Zeaker to draw Turtle Graphics. The up or down state of the pen is indicated by a lamp on the top of Zeaker.

Zeaker was designed to run on a tabletop, but will also run on smooth floors and because of this and to keep down the cost, the controlling electronics and power supply are contained in a separate box linked to Zeaker by a 2 metre umbilical cord (16 way ribbon cable). This separate box ('Zeaker Control Station') is linked to the microcomputer by two short ribbon cables.

DESCRIPTION OF ZEAKER (VEHICLE)
Zeaker’s chassis is a modified ABS plastic box inside which are two electric motors complete with gears, driving each of the two wheels; a small speaker for the horn and a solenoid to lower the pen.

Mounted in the lid of the box are the navigation lamps, or eyes (red and green i.e.d.s), the socket (SK1) to connect the umbilical cord and the pen status i.e.d. (yellow) whilst on the outside are the four Aluminium Fenders which when touched compress foam plastic blocks and make contact with screw heads in the side of the box, thus forming 16 simple switches which are paralleled into 6 groups (Fig. 11). Underneath at the front is a plastic "toe" to give Zeaker stability.

DESCRIPTION OF ZEAKER CONTROL STATION
The Control Station contains 4 Nicad C-cells to provide the power for Zeaker. This eliminates all the safety problems with mains powered equipment and thus it may be left without fear in the hands of the youngest child. Using Nicads also leads to a more compact power supply unit and a fully charged set will power Zeaker for at least 4 hours but including thinking time, human’s and Zeaker’s, this will easily stretch to 8 hours. To recharge the Nicads the computer’s power supply can be used, in the version here, the ZX-81 power supply simply plugs in the back and trickle charges the Nicads through a lamp which also acts as a reminder that the supply is on. The ZX-81 power supply will recharge the Nicads overnight.

A printed circuit board holds the driver transistors which switch on the motors, lights and solenoid. A 556 dual oscillator is used to provide the tones for the horn whilst a 74LS00 Quad NAND i.c. wired as a set/reset latch prevents the motors being switched into reverse as well as forward. On the front panel is a switch which isolates the control electronics from the Nicads and acts as an "off" switch for Zeaker. No robot (leastways with present technology) should be without an "off" switch.

VEHICLE CONSTRUCTION
First, the box should be modified as shown in Fig. 1, then the metal Fenders should be made and bent to shape using the template drawings in Fig. 2. The solder tags should be attached as shown in Fig. 3 and the bends checked again. Make up the pen arm and bracket (Fig. 4), once again this drawing can be used as a template for bending the pen arm. A corner of one of the motor gearboxes (Fig. 5) should be removed. (This will be the starboard motor assembly.) The motors and gearboxes should be assembled using only 4 of the black plastic gears with the long end of the small motor shaft shortened so the shaft is 39mm in length. Next press on the white gear wheel and put on the spacers. Assemble the gearbox and secure the end cap with polystyrene cement (for plastic kits) (Fig. 6).
Fig. 1. Cutting and drilling details for Zeaker's chassis

Fig. 2. Fender cutting and bending details. Note this drawing is full size and can be used as a template for cutting and bending the fenders.
Fig. 3. Method for attaching solder tags to fenders

END OF SCREW
FLUSH WITH FACE
OF NUT

SOLDER TAG POINTING UP

3 WASHERS
5 mm LONG SCREW

Fig. 4. Solenoid mounting bracket and pen arm. Note the pen arm drawing is full size and can be used as a template for cutting and bending the arm

Fig. 5. Servo motor modification

The tactile sensor screws and pillars should be fitted next (Fig. 7 and Table 1) and then the foam pads can be mounted as shown in the photograph. The starboard motor assembly should be bolted into position and a solder tag fitted on top of the front mounting lug to hold the speaker in position. Check that the output shaft does not bind on the sides of the case hole. The speaker can now be fitted in position under the solder tag and the toe components fitted to hold the speaker (Fig. 8).

The left motor assembly can now be positioned checking that it doesn’t bind. Now assemble the solenoid in its bracket, fit the plunger extension and spring (Fig. 4) and bolt the bracket to the bottom of the box fixing the pen arm underneath. The pen arm should be loose enough to move freely under solenoid control. Fit the pen and make sure that it is centred in the hole at the bottom of the box, adjusting the bracket position accordingly.

A fibre washer should be placed on each wheel shaft and then the wheels can be fitted (Fig. 6). Adjust the pen in its holder so that in the down position it projects about 1 to 1½ mm below the bottom of the wheels. The pen can then be shortened so that its top is level with or just below the top of the pen arm.

The Fenders should just drop in the slots of the box, after being eased over the foam pads. They should push in and make contact with the pillars very easily and the foam pads should spring them out again.

Fig. 6. Motor, gearbox and wheel assembly

VEHICLE PCB

The vehicle p.c.b. is shown in Fig. 9 with the component layout shown in Fig. 10. The components are mounted on the solder side of the board with the exception of SK1. Before fitting the components, solder should be run onto each square pad to form solder bumps. The diode, resistors and RF chokes should then be soldered, blobbing the ends of...
**Top and bottom contact points are identical**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SPACER LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>3mm</td>
</tr>
<tr>
<td>Side front</td>
<td>7mm (6mm spacer + 2 washers)</td>
</tr>
<tr>
<td>Side rear</td>
<td>6mm</td>
</tr>
<tr>
<td>Rear</td>
<td>3mm</td>
</tr>
</tbody>
</table>

**Table 1**

The leads into the solder bumps (Fig. 10). The 16-way Molex connector (SK1) should be fitted from the opposite of the board and soldered in place.

The p.c.b. should be bolted onto the lid of Zeaker using two fibre washers over the p.c.b. tracks. The l.e.d.s and link wires to the p.c.b. can be soldered next with the leads of the centre l.e.d. bent down and soldered to the two adjacent pads.

**VEHICLE WIRING**

All the top and bottom solder tags on the contact-points should be linked as should the side-rear and rear contact-
Fig. 11. Location of Zeaker's tactile sensors

Fig. 12. Motor and Sensor harnesses

Fig. 13. Wiring diagram for the vehicle

COMPONENTS...

VEHICLE

Resistors
R1, R2, R3  10k (3 off)

Capacitors
C1, C2  100n (2 off)

Semiconductors
D1  0.2 in red l.e.d.
D2  0.2 in green l.e.d.
D3  0.2 in yellow l.e.d.
D4  IN4001

Inductors
L1, L2, L3  Lamp RF chokes (3 off)

Miscellaneous
ABS plastic box (120 x 100 x 45mm)
Cover cap for toe
Micro Mold 38 x 13 wheel (2 off)
Como motors and gearboxes, small (2 off)
Keyswitch Varley 5V solenoid SM00
1-1/2in. dia. 8 ohm speaker
Pen holder—centre from 5A connector block
Clips for l.e.d.'s (3 off)
Molex connector 5332 series 16 pin
Aluminium for fenders, plunger extension and solenoid mounting bracket
Rod for pen arm
Fender foam pads (self-adhesive draught excluder)

Constructor's Note

The toe cover cap is available from most hardware stores and the wheels and motor gearboxes assemblies are obtainable from hobby shops.

A complete kit of parts for the vehicle (including machined, cut and ready bent items) and control station with a manual and software is available from Colne Robotics Ltd., Beauroad Road, off Richmond Road, Twickenham TW1 2PH (01-892 8197/8241). Price £59.95 inc. VAT.

Colne Robotics are also able to supply the separate parts, please write or phone for details.

Internal view of the vehicle
points (Fig. 11). The 6-way harness can then be fitted to the contact-points starting with the longest lead at the Front Port contact-point and then fit the speaker harness, finish the interwiring and fit the motor harness. Then slot the fenders into position and solder the fender links. Finally solder the harnesses to the appropriate pads on the p.c.b. (Fig. 13). The solenoid leads should be cut to 5½ inches, twisted together and soldered into place on the p.c.b. Check that when the lid is shut none of the wires foul the fenders and that they can be pushed in to make contact as before.

**VEHICLE CHECKOUT**

Using a signal/pin allocation diagram (Fig. 14) check with a multimeter that each of the sensor lines is shorted to OV when the appropriate contact pillar meets the fender and that upon release there is an open circuit. Apply +5V to the solenoid pin and check that the solenoid clicks in and lowers the pen, similarly check the lights with +5V. Applying 2V (1.5V will do) between motor common and the motor lines check that +ve voltage on the port motor line makes the motor go forward and -ve makes it go in reverse and check that a +ve voltage on the starboard motor line makes it go back and -ve makes it go forward i.e. to go forward port line is +ve and starboard line is -ve (to even out battery use).

**NEXT MONTH:** Control station construction.

---

**Avoid a break in the middle**

Make sure you get every issue when you're following projects in PRACTICAL ELECTRONICS. Use this order form for a year's supply to be posted to you.

**ANNUAL SUBSCRIPTION RATES** (including postage and packing) inland and overseas (surface mail) £13.00.

**PRACTICAL ELECTRONICS**

SUBSCRIPTION ORDER FORM

Please send me Practical Electronics each month for one year, I enclose a Sterling cheque/international money order for _______ (amount).

PLEASE USE BLOCK LETTERS

NAME Mr./Mrs./Miss

ADDRESS

POSTCODE

Make your crossed cheque/MO payable to IPC Magazines Ltd. and post to: Practical Electronics, Subscription Department, Dalkeith House, Perrymount Road, Haywards Heath, West Sussex RH16 3DM.

LISP

The most apparent difference between LISP and BASIC is the way programs are written. In BASIC the program is written as a number of statements which can be listed, edited etc; this is then RUN to perform the desired actions. In LISP the programming consists of defining 'functions' which have exactly the same status as the functions which constitute the language itself. For example, PLUS is a function provided in LISP for performing addition. How then do we call a function? The answer is that we first construct a list starting with the function name, and followed by the list of arguments that the function needs. Then we ask LISP to evaluate that list. Thus to add 2 and 3 we type:

Evaluate: (PLUS 2 3)

And the answer comes back:

Value is: 5

FUNCTIONS

A symbol can also be designated as the name of a function; we have already met PLUS, the LISP function for performing addition. How then do we call a function? The answer is that we first construct a list starting with the function name, and followed by the list of arguments that the function needs. Then we ask LISP to evaluate that list. Thus to add 2 and 3 we type:

Evaluate: (PLUS 2 3)

And the answer comes back:

Value is: 5

Arguments to functions are normally evaluated before being passed to the function, so we can write:

Evaluate: (PLUS (TIMES 1 2) (TIMES 4 6))

To find the answer to 1*2+4*6.

In addition to all the usual built-in functions, LISP contains functions for manipulating lists. The three most important ones are CAR and CDR (the names are historical) which break down lists, and CONS which constructs a list.

CAR returns the first element of a list, and CDR returns the list with the first element removed. Thus, suppose LISP had the value:

(ONE TWO THREE)

And CAR returns the element of the list.

Value is: 1

CONS is a function which constructs a list.

CONS takes two arguments, the second of which must be a list; it adds the first argument to the front of this list. Thus:

(CONS 4 LISP)

is (4 ONE TWO THREE).

Now, although arguments to functions are normally evaluated, one can prevent this by using the QUOTE function, which can be abbreviated . . . Thus:

(CAR '(ONE TWO THREE))

would give ONE as before. However:

(CAR (ONE TWO THREE))

would normally give an error because ONE is not a valid function.

So far we have not discussed how values are assigned to atoms. Again, this is by means of a function; the function, SETQ, takes two arguments, and the value of the second is assigned to the first. Thus:

(SETQ NO 4)

would give NO the value 4. (Note that this is one function that does not evaluate its first argument.)

We now need to look at the COND function which gives LISP conditional facilities. Consider the following example:

(COND
  ( (EQ VAL 1) (PRINT 'ONE) )
  ( (EQ VAL 2) (PRINT 'TWO) )
  ( (T) (PRINT 'THREE) )
)

COND is followed by a series of lists. The first element of each list is a condition; if this condition evaluates to a non-NIL value it is taken as being true or (T), and the remaining elements of the list are evaluated. For example, (EQ VAL 1) will have the value T if VAL is 1, and NIL otherwise. If none of the conditions are true COND returns NIL; normally, however, the last condition is T, as in the above example, so it will always be true.

DEFINING FUNCTIONS

Finally, the most important LISP function is DEF because it allows you to define new functions in LISP. As an example of defining a new function, let us see how a verbal description can be translated into a LISP function. The example used should be well known to everyone who has studied electronics: the calculation of the power dissipated in a resistor. This is given (in watts) by the equation: $P = I^2 \times R$, where $I$ is the current in Amps, and $R$ is the resistance. The function will be given the name POWER; after the name comes a list of the parameters that will be supplied to the function (in this case, I and R), followed by the actual definition of the function:

(DEFUN POWER (I R) (TIMES (TIMES I I) R))
Thus the answer is 19/5.

3 + 4/5 =

Practical involving rationals using this package are exact. floating-point calculations, all calculations in-

and rational number: 12/23. The package can then LISP this is represented as a list of two in-

tegers: for example, (12 23) represents the LISP this is represented as a list of two in-

dalegible. The rational -arithmetic package microcomputers, [RATIONAL -ARITHMETIC]
to LISP. Simple example which adds rational arithmetic datatypes. This is illustrated for the following

the programmer can extend the definitions of its power. For example, it might be useful to be able to define new types of data, such as complex numbers, vectors, and physical quant-
ties, to cope with some particular application. Most languages, BASIC included, would require the programmer to set up a sub-

language to handle the new datatypes. LISP, however, has the very attractive feature that the programmer can extend the definitions of the built-in functions to cope with new datatypes. This is illustrated for the following simple example which adds rational arithmetic to LISP.

RATIONAL-ARITHMETIC PACKAG

Most implementations of LISP, at least on microcomputers, only include integer arithmetic. The rational-arithmetic package provides a way of expressing numbers which are not exact integers by extending LISP's integer arithmetic to include a new datatypes, a rational number or ratio of two integers. In LISP this is represented as a list of two integers: for example, (12 23) represents the rational number: 12/23. The package can then be used to perform calculations on integers and rational numbers. Note that, unlike floating-point calculations, all calculations in-
volving rationals using this package are exact. To illustrate the package in use, we calculate 3 + 4/5:

Evaluate: (PLUS 3 4 5)

Value is: (19 5)

Thus the answer is 19/5.

The first step in writing the package is to provide a way of converting integers into rational form; thus the integer 6 should be converted into the rational number 6/1. We therefore define a function RAT that takes either a rational or an integer and always returns a rational; see Fig. 2.

It uses the built-in function LIST which makes a list out of its arguments. Thus:

Evaluate: (RAT 6)

Value is: (6 1)

Next we redefine LISP's built-in arithmetic functions with new names, so that we can refer to them in the definitions of the functions that are to replace them:

(DEFUN NORM (A B (AA) (BB) )

(LOOP

(SETQ BB B)

(QUOTIENT/ AA B)

(SEQ BB B) )

(COND

(EQ (EQ BB B) (QUOTIENT/ AA B) )

(0)

(COND

((EQ BB B) (QUOTIENT/ AA B) )

(T LIST

(QUOTIENT/ AA B) )

(QUOTIENT/ BB B) ) ) )

Fig. 4. New definition for PLUS works with rationals as well as integers.

RESISTORS NETWORK

Finally, as an example of how the rational versions of PLUS and QUOTIENT can be used, consider the practical problem of calculating the resistance of the resistor network shown in Fig. 1, represented by the list:

(PAR (SER (PAR 1 (SER 2 3) ) 4 5)

5 4)

From the laws governing resistors in series and parallel, namely:

s = a + b for resistors a and b in series, and

1/p = 1/a + 1/b for resistors a and b in parallel, we obtain:

(DEFUN SER (A B) PLUS A B )

(DEFUN PAR (A B) QUOTIENT 1 (PLUS QUOTIENT 1 A) (QUOTIENT 1 B) )

Finally, to calculate the resistance of the above network:

Evaluate: (PAR (SER (PAR 1 (SER 2 3) ) 4 5)

Value is: ( 145 59)

Thus the resistance is 145/59 ohms, (2-46Ω).
EVEN though most homes rely heavily on electrical power, a mains supply failure for a short period of time is generally little more than an inconvenience provided that it is noticed and any necessary action taken. During the night, however, it is unlikely that such a break will be observed with the result that all electro-mechanical clocks will stop for the duration of the break, and many digital clocks will simply reset. The result of oversleeping the following morning and eventually rising to find that the central heating has also stopped leaves little to the imagination.

More seriously, there are those who rely on mains electrical power for medical reasons and for whom the supply failure can be a worrying experience even though most medical equipment is fitted with battery back-up. It will always be a comfort to such people to have company during this time and it seems desirable to have a unit which will warn others of a mains failure.

The design presented here is for a small and cheap mains powered circuit which will light an I.e.d. and sound a tone if the mains fails. The circuit will detect quite short breaks (60ms) and thus should be more sensitive to mains failures than other items. It is intended that the completed unit be left switched on at all times and be used as a 'wake up' alarm in event of supply failure.

THE CIRCUIT
It was decided from the outset that the complete unit should be small and cheap to make. It is obvious that some form of battery supply to power the circuit, once the mains has failed, is needed and it was decided that a small nickel cadmium re-chargeable battery would be ideal. The cell is trickle charged during the time the mains is on by means of a small transformer mounted directly onto the circuit board.

The circuit is centred around a dual CMOS version of the well known 555 timer. One of the timers is used as a conventional astable oscillator to produce a 1kHz tone, the other as an edge triggered latch to detect and remember the supply failing. It is worth examining the action of the 555 used as a latch because it often provides a simpler and more compact solution than conventional logic designs.

In normal astable operation (Fig. 1) the capacitor charges up until the 'threshold' voltage is reached. At this time the output changes state and the discharge output pulls low, discharging the capacitor. This state continues until the 'trigger' voltage is reached when the output changes state again, the discharge output starts to float and the capacitor recharges.

It is obvious from this that the trigger is operated from a falling voltage and the threshold from a rising voltage. Both these inputs have the advantage that they are specifically designed to cope with slow edges, which would undoubtedly require a Schmitt trigger interface to conventional logic latches. To use the 555 as a latch is a simple matter of omitting the timing capacitor and associated resistors. Fig. 2 shows the schematic and truth table that results from this. It is important to note two main points about the trigger and threshold inputs.

Firstly, they should not be connected directly to the active supply rail which can cause lock-up in some manufacturers' parts which are not fitted with an internal bias generator and so a series resistor of some 220 ohms should always be inserted in series with the inputs, or the input should be a.c. coupled with a capacitor. The second point to note is that these inputs are level sensitive and not edge triggered, and should only be pulsed...
to activate them since unstable conditions occur if they are both active at once.

In this application it is required to detect a falling edge and so the threshold input is connected to 0 volts. This is acceptable since 0 volts is not the 'active' supply rail for the threshold input. Obviously once the 555 is triggered by a falling edge on the trigger input it will remain so until manually reset, in this case by the reset button connected to the 555 reset line.

The 15 volt Zener diode, D4, plays no part in the normal operation of the circuit and serves to limit the supply voltage to the i.c. should the battery ever become disconnected.

The actual fail detection circuit uses half a CMOS 556 as a latch with the threshold input grounded as previously described. When the mains voltage is present C2 will charge up to about 9 volts by virtue of R2 and clamp diode D5. This means that C3 is nearly discharged since R4 will hold pin 6 of the 7556 at about 9 volts as well. It is necessary to clamp the voltage on C2 to be about the same as the battery voltage or C2 would tend to discharge into the battery through R2 and the normal trickle charge path which would keep triggering the unit. When the mains input ceases C2 will discharge through R3 which in turn requires that C3 charges through R4, temporarily pulling the 7556 trigger input low as it does so.

The latch action of the timer is reset by S1, which simply grounds the reset input. Capacitor C4 is included to provide a battery power-up reset and prevent spurious noise causing erratic resets.

The output of the timer-latch is used to turn on an I.e.d. by means of a transistor buffer, required because the CMOS version of the timer cannot source sufficient current for this purpose. The output also enables a conventional astable oscillator, which, after suitable transistor buffering, is used to drive a small speaker. The volume level was limited in the prototype by a 47 ohm series resistor but this may be altered if required. The diode D8 acts as a clamp to prevent back e.m.f. from the speaker upsetting the operation of the astable circuit.

CONSTRUCTION

A small plastic box (120 x 40 x 65mm) was used to house the prototype, and the printed circuit board is designed to fit into this size of box. There is not much room in the box and it is suggested that the parts are roughly fitted and then any necessary holes drilled so that they do not foul the circuit board or the speaker. As a guide the prototype circuit board was mounted upside down in the box, the switch, i.e.d. and speaker fitting alongside the transformer below D1 and D2. The mains cable was fed through a hole in one end of the box. A 20mm hole was drilled in the bottom of the box 43mm from one end and covered with speaker cloth on the inside. The speaker was then glued in place above this hole so as to leave room for the battery plate (Fig. 4). The p.c.b. design for the circuit is shown in Fig. 5 with the component layout shown in Fig. 6.

A certain amount of care should be used when assembling the p.c.b. since parts of it carry mains voltages. Also note that if the board is to be manufactured using an etch resist pen at least 3mm should be left between those tracks carrying the mains supply and any others.
### COMPONENTS

#### Resistors
- R1: 1k5
- R2: 1k
- R3, R8: 1M (2 off)
- R4: 10M
- R5: 100k
- R6, R10: 56k (2 off)
- R7: 2k2
- R9: 2M2
- R11: 47

#### Capacitors
- C1: 10p, 25 volt tant
- C2, C3, C4, C5: 100n C280 type polyester (4 off)
- C6: 560p polystyrene

#### Semiconductors
- D1, D2, D3, D8: 1N4001 (4 off)
- D4: 15V Zener 400mW
- D5: 9V1 Zener 400mW
- D6: 1N4148
- D7: Red 0.2" I.e.d.
- TR1, TR2: BC184L (2 off)
- TR3: BFY51
- IC1: ICM7556

#### Miscellaneous
- 50mA fuse and two p.c.b. fuse clips
- 35 ohm speaker (or 80 ohm) to fit box approx. 50mm diameter
- Printed circuit board
- Terminal pins
- Push button switch
- PP3 nickel cadmium battery
- PP3 battery clip
- Aluminium sheet to make battery plate
- Plastic box 120 x 40 x 65mm, with ribbed inner walls
- Main 2 core cable and plug
- Grommet and cable tie
- Connecting wire

---

**Fig. 5. P.c.b. design**

**Fig. 6. Component layout**

---

**Fig. 4. Battery holder details**

The prototype board was held in place in the box by the lid. Two plastic combs usually used to clip boards in were glued to the sides of the box to be flush with the top of the slots in the box wall. The complete circuit boards balanced on these and was clamped into place by the lid.
A cable tie should be fixed around the mains cable on the inside of the box to prevent it being pulled out and a grommet must be used to stop the wire rubbing on a rough edge. A plastic box should be used but if a metal box is required it is essential that it is earthed very well. In any case the circuit board itself should be earthed as indicated.

**TESTING**

Ensure that the nickel cadmium battery is disconnected before testing commences. All live parts of the circuit board must be well covered in insulating tape before the unit is plugged in. The usual precautions for handling mains powered systems must be observed.

Connect a multimeter across the battery clips and switch on. The voltage should be slightly less than 15 volts. Switch off and repeat with the meter connected across D5 when a reading of 9 volts should be seen. If the tone sounds during this time and sounds very rough do not worry since with the battery missing the circuit supply is largely unsmoothed and 50Hz hum will be superimposed on the tone. Connect in the battery and press the reset if the tone sounds.

Switch the unit on and off and the tone should now sound cleanly and the I.E.D. should light. It may happen that the tone will sound briefly and fade out; this is due to the battery being flat and so the unit should be left on for some 24 hours in order to charge the battery up.

If problems are experienced and the I.E.D. does not come on when the power is removed unplug the unit and try connecting C2 to the +ve battery terminal and then removing it to simulate mains failure.

There is little to say about the unit in use. The prototype was fitted behind a bedside table and simply left alone. Do remember to reset it if the power is turned off for any reason since it will run until the battery is dead.

---

**PE SPECIAL CASSETTES OFFER**

**CHROMIUM DIOXIDE AUDIO CASSETTES**

**CHROME C60 & C90**
- 90p each (minimum of 5); 80p each (minimum of 25)

**CRO2 C90 CASSETTES**
- 115p each (minimum of 5); 105p each (minimum of 25)

**FERRIC C90 AUDIO**
- C90LH CASSETTES
  - 56p each (minimum of 5); 53p each (minimum of 26)

**PRICES INCLUDE VAT AND POSTAGE.**

These European-made tapes are excellent value and we are pleased to offer them to readers. They are covered by a money back guarantee (return within 21 days for refund). Not only are the tapes of high quality but the cassette are of screw together construction and the case labels have space for notes on the recordings.

Send valid coupon to:

Videotone Ltd., 98 Crofton Park Road, Crofton Park, London SE4.

Please send me ........ CRO2 C60 Audio cassettes at ........ p each (90p for 5 to 24, 80p for 25 or more; including VAT and postage).

Please send me ........ CRO2 C90 Audio cassettes at ........ p each (115p for 5 to 24, 105p for 25 or more; including VAT and postage).

Please send me ........ C90LH Audio tapes at ........ p each (56p for 5 to 24, 53p for 25 or more; including VAT & postage.)

I enclose cheque/PO for £ ......................... No. .........................

Name .................................................. Address ..................................................

Coupon valid for posting before 6 May '83 (or one month later for overseas readers).

---

Our Sister Publication

EVEryday ELECTRONICS features the following projects in the May issue:

**FREE!**

- TWO TRANSISTORS FOR USE IN EITHER OF THESE PROJECTS:
  - GUITAR HEADPHONE AMPLIFIER
  - M.W. RADIO/TUNER

**PLUS**

- LABORATORY AMPLIFIER — Test Gear '83
- PULSED TRAIN CONTROLLER

COMPUTER PROJECT

- REAL-TIME CLOCK & CALENDAR For BBC MICRO and APPLE II

Special Report

FX Computer Kit

ON SALE APRIL 15

PLACE AN ORDER WITH YOUR NEWSAGENT NOW!
Now with improved specifications

Y Deflection
Bandwidth: DC-10 MHz (-3dB)
Overshoot: Less than 1%
Sensitivity: 2mV-20V/cm
Input Imp: 1M ohm/26pf
Variable Control

X Deflection
Timbase: 0.2s - 0.2us/cm
Triggering: 2Hz - 30MHz(3mm)
Auto - level control
Bandwidth: 2kHz - 1MHz
Variable Control

General Information
Component Tester
For single components and in circuit
Calibrator
0.2V ± 1% for probe alignment
Power Supplies
Regulated including high voltage
A.C. Input
110, 120, 220, 240, V.A.C., 50-60 Hz
Weight
3.5 Lbs
CRT
Rectangular internal graticule
Accuracy
3% in vertical amplifier
Filter
"V. trigger filter
Trace rotation
via front pane

For more information on HAMEG's full range of top performance oscilloscopes contact:
HAMEG LTD.
74 - 78 Collingdon Street, Luton, Beds, LU1 1RX
Tel: (0582) 443174

The original oscilloscope with built-in component tester

HM 103 £158
UK List ex V.A.T.

PRACTICAL ELECTRONICS
TERASL CASSETTE
RECOROER KIT
ONLy £31.00 plus £2.75 p&p.
• NOISE REDUCTION SYSTEM • AUTO STOP • TAPE COUNTER • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS • TWIN V.U. METER • WIDE & FLUTTER 0.1% • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.
Kit includes tape transport mechanism, ready punched and backed printed quality circuit board and all electronic parts, i.e. semiconductors, resistors, capacitors, hardware, too, printed scale and mains transformer.
You only supply cooler & hook-up wire. Featured in April P.E. reprint 50p. Free with kit.

PERSONAL LS AMPLIFIER KIT
Amplifier for your personal stereo cassette player - as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.
Parts
Stereo power amp PCB with all components, £12.50 + £1.75 p&p. Power supply unit £11.95 + £1.50 p&p. Pair of eliptical speakers, £15.80 UK List + £1.15 p&p.

125W HIGH POWER AMP MODULES
The power amp kit is a module for high power applications - disco-unity, guitar amplifiers, public address systems and even high powered 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, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is performed and ready to use. Supplied with all parts, circuit diagrams and instructions.
ACCESSORIES: Suitable mains power supply kit with transformer, £8.50 + £2.00 p&p. Suitable LS coating electrolyte, £1.00 + £0.15 p&p.

BSR RECORD DECK
Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge and 45rpm spindle adaptor ideally suited for home or disco.

125W + £1.75 p&p.

SPEAKER BARGAINS
2 WAY 10 WATT SPEAKER KIT
8" bass/mid range and 3¾" tweeter. Complete with screws, wire, crossover components and cabinet. All wood pre-cut - no cutting required. Finish: chipboard covered wood simalute. size 145x8. £12.50 plus £1.75 p&p.

ALL CALLERS TO: 323 EDGWARE ROAD, LONDON W2. Telephone: 01-723 8432.
15 minutes walk from Edgware Road Tube Station.
New from 6 days a week 5 - 6. Prices include VAT.

RITCHIE
Practical Electronics May 1983
PERSONAL stereo cassette and radio/cassette units provide a surprisingly high output quality despite their diminutive size and the fact that they are not fitted with Dolby B decoders (a fixed amount of treble cut normally being used when playing back cassettes). Perhaps an obvious add on for these units is a small amplifier plus a pair of compact loudspeakers. This would enable several people to listen to the unit simultaneously, would give better stereo imaging than using headphones, but would retain a degree of portability and the personal stereo unit could be used normally when maximum portability was required.

Amplifiers of this type do not appear to be available ready made, but a simple home constructor design for such an amplifier forms the subject of this article. The unit provides an output power of up to about 6 watts r.m.s. per channel with a total harmonic distortion level of only about 0.1% (typical) at most power levels. This is sufficient to give good volume from a pair of small, inexpensive loudspeakers, and many loudspeakers of this type are not able to handle higher power levels. The signal to noise ratio is better than 70dB and the noise level is negligible in comparison to that produced by the signal source. The amplifier has proper bass and treble tone controls which give the user far better control of the tone than the simple high/low tone switches.

While results are obviously not in the super-fi class, when used with a personal stereo unit and pair of compact loudspeakers of reasonable quality a very versatile portable hi-fi system having a worthwhile level of performance is produced.

THE CIRCUIT

The circuit diagram of the tone, volume, and balance controls is shown in Fig. 1, and in Fig. 2 the power amplifier. Taking the controls first, this is a straight forward passive circuit of conventional design. The bass control gives about 12dB of boost and cut at 100Hz and the treble control gives a similar degree of boost and cut at 10kHz.

It is not strictly necessary for the unit to have a volume control since all personal stereo units have a volume control which would still function with the amplifier in use. Most personal stereo units also have some means of permitting channel balancing (usually by simply having a separate volume control for each channel). Volume and balance controls were included in the unit merely because it was felt that this would be more convenient in use, and experience with the prototype supports this belief. However, the output of the tone controls can obviously be coupled straight through to the power amplifiers if preferred, with VR3, VR4–104, R5, R6, R105, and R106 all being omitted, if the volume and balance controls are considered to be superfluous.

There is a loss of about 20dB or so through the tone and balance control circuits, but this is not important since an input level of about 1 volt r.m.s. or more will be provided by the personal stereo unit. This gives an output level of about 100mV r.m.s. from the control circuits, which is sufficient to drive a small power amplifier.

The power amplifiers each use a TDA2006 integrated circuit which is a modern device capable of excellent performance. This device only had five leadout wires; the supply terminals, the output, plus inverting and non-inverting inputs. This device has no internal bias circuits, and it is used in very much the same way as an ordinary compensated operational amplifier such as the 741C, but it has a Class B output stage which is capable of delivering a maximum output current of 3 amps and can produce an output power of several watts into a load impedance of a few ohms.

In this circuit the TDA1006s are used in the inverting amplifier mode with R7 (R107) and R8 (R108) setting the input impedance and closed loop voltage gain of the amplifiers. R9 and R10 are used to bias the non-inverting inputs of both amplifiers to about half the supply voltage, and C8 prevents hum or other noise on the supply lines from being coupled into the amplifiers via the bias circuit. D1, D2, D101 and D102 are protection diodes, and C5 plus C105 are supply decoupling capacitors which are mounted physically close to IC1 and IC101 respectively to prevent instability.
Practical Electronics

MAINS POWER SUPPLY

Although battery operation of the amplifier would have the advantage of making the unit self contained, this is not really feasible since a supply potential of about 22 volts is required, and at high output powers the current consumption of the circuit exceeds 800 milliamps. The simple mains power supply circuit of Fig. 3 is therefore used to power the amplifier.

This is a straightforward non-regulated design using a bridge rectifier and smoothing capacitor C9. There is a significant amount of ripple on the output of the supply, but the TDA2006 devices used in the power amplifiers have 50dB of supply ripple rejection, and the filter used in the bias circuit of the power amplifiers also gives good immunity to hum on the supply lines. This results in no discernible mains hum from the loudspeakers despite the simplicity of the power supply circuit.

T1 is a toroidal transformer which has two 9 volt secondaries that are used in series in this circuit. This gives an unloaded supply voltage of just over 28 volts, but this falls slightly under quiescent loading, and reduces to about 22 volts with both channels fully driven.

Fuse FS1 should be an antisurge type rather than the more common quick-blow variety since the secondary windings of T1 provide a series of pulses of current to C9, not a reasonably constant current flow. There is also a large current flow at switch-on as C9 initially charges up, and there would be a danger of a quick-blow fuse "blowing" unnecessarily.

CONSTRUCTION

A printed circuit board accommodates all the components apart from the mains transformer, on/off switch S1, and the sockets. Details of the printed circuit board and wiring of the unit are shown in Fig. 4.

Construction of the printed circuit board is easiest if the small components are soldered in place first, followed by the four controls, C6, C106, and finally C9. It would of course be possible to use ordinary potentiometers in the unit, but they would have to be mounted off-board and hard-wired to the component panel. Construction is far simpler using the correct printed circuit mounting potentiometers, and their use is strongly recommended.

Use pins in the printed circuit board at the points where it will be connected to T1 and the three sockets. Before soldering the integrated circuits into place carefully form the leadout wires of the devices and position them so that their mounting holes are aligned with the mounting holes in the board. It will be impossible to manoeuvre the integrated circuits into the correct position without risk of damage once they have been soldered into place. Make sure that the potentiometers are pushed right down into place before soldering them into position.

The recommended case is of aluminium and steel construction with approximate outside dimensions of 300 by 150 by 60mm, but any case having similar or larger dimensions should, with a little ingenuity, be just as suitable. Assuming the specified case is used the front panel is drilled as shown in Fig. 5, and this layout should be accurately copied or it will probably be impossible to fit all the components into the case.

When the four potentiometers are mounted on the front panel they provide the front mounting for the printed circuit board. An 18 s.w.g. aluminium mounting bracket is used to support the rear of the board and also provides a certain amount of heatsinking for the two integrated circuits. Details of the mounting bracket are provided in Fig. 6. One part of the bracket is placed between the printed circuit board and the heat tabs of the two integrated circuits, and then 6BA or M3 screws about 6mm long are used to bolt the bracket, board, and integrated circuits together. The lower part of the bracket is fixed to the base panel of the case, again using 6BA or M3 bolts about 6mm long. It is essential for the mounting holes in the base panel of the case to be accurately positioned, and it is probably best to fit the front panel, board, and bracket assembly in place in the case, check that the front panel is in the correct vertical position, and then use the bracket as a template to help mark the positions of the mounting holes on the base panel. A lack of accuracy here could make it impossible to fit the lid.

**Fig. 1. Tone, volume and balance controls**

**Fig. 2. Power amplifier**

**Fig. 3. Mains power supply**
Mains transformer T1 is mounted on the base panel of the case to the left of the component board, and the toroidal component specified in the components list is supplied complete with a mounting kit. A single 6mm diameter mounting hole is required. A large solder tag fitted on T1's mounting bolt provides a chassis connection for the mains earth lead. The chassis mounting fuseholder for FS1 is mounted at any convenient place on the base of the case close to T1. An entrance hole for the mains lead is drilled in the rear panel near to T1 and this hole must be fitted with a grommet to protect the cable. The input and output sockets are mounted at the other end of the rear panel.
Once all the components have been fitted in place the final wiring can be completed. Due to the fairly low sensitivity of the amplifier and the very weak magnetic field of the toroidal transformer used for T1 there is no need to use screened cable to connect the printed circuit board to JK1. If output sockets JK2 and JK102 are not insulated types be careful to connect these correctly or the output will be short circuited. The TDA2006 integrated circuit has thermal and output short circuit protection built-in incidentally, and accidental overloads on the output would probably not result in the destruction of the output devices. Of course, JK2 and JK102 can be replaced with two way DIN sockets or some other type of connector if this would be more convenient in use.

IN USE
The output of the unit is coupled to the input socket of the amplifier using a three way lead fitted with a 3-5mm stereo jack (which connects to the personal stereo unit) and a standard 6-35mm stereo jack (which connects to the input of the amplifier). Due to the fairly low source impedance and high signal level it is not necessary to use a screened lead. Personal stereo units normally have the output socket wired so that the tip of the output jack carries the left hand channel, incidentally.

The volume controls on the personal stereo unit should be set at a position that would give a high good volume level if the unit was used with headphones, but should not be advanced so far that there is a danger of clipping occurring during periods of high volume. The tone switch should be set to the "high" position. Volume, balance, and tone are then adjusted using the controls on the amplifier.

Only 8 ohm impedance loudspeakers are recommended for use with the Personal Stereo Amplifier since higher impedance types would give a much lower maximum output power, and lower impedance speakers would almost certainly overload the power supply and cause FS1 to rupture. It is not difficult to build your own loudspeaker enclosures using modern materials, but there are a number of suitable commercially produced speakers which are suitable. In either case make sure that the speakers are rated at about 5 watts r.m.s. or more. Note that bookshelf monitor speakers are not suitable for use with this amplifier due to the low efficiency of speakers of this type, which consequently need quite a high input power in order to give high volume levels.

HEATHKIT four band receiver AR-2000MK II, mint condition. Needs tuning on f.m. £90 o.n.o. Write: D. Johnston Esq., 42 Shore Street, Anstruther, Fife. Scotland KY10 3AC.
SYNTH., Korg MS20. Factory built, 2xVCO, 2xVCA, 2xVCF F-to-V. New, £470. £200/Disk Drive/Printer/w.h.y. Mr. E. Phipps., 77 Fitzpaine Rd., West Parley, Wimborne, Dorset BH22 8SF. Tel: (0202) 576681.
WANTED Construction details for converting 12V car battery charger to a CB power supply. Mr. J. Whitehurst, 2 Cumberland Rd., Congleton, Cheshire CW12 4PH.
ORGAN parts, including pedal boards, 5-octave keyboards, generator, chokes, stop tabs, many others, s.a.e. for large list. K. Wolsley, ‘Puffins’, Seaview Lane, Seaview, IOW PO34 5DG.
P.E. HI-FI tape link, abandoned project, all components, p.c.b.s. built, Bogen heads. 7" reel deck. £45. Mr. S. G. Waddington, 3 Merrick Esq., 42 Shore Street, Anstruther, Fife, Scotland KY10 3AC.
KEYBOARD, 5 octave, including mounted double pole gold-plated key switches. £30. Tel: 01-422 0536 (Harrow). R. Terrett, 291 Somervell Road, South Harrow, Middx. HA2 8UB.
TELEQUIPMENT D43 scope £10MHz bandwidth d.c. couple 100V/cm on ch2, £125. 0-30V 2A p.s.u. £25. 0-5V p.s.u. 1.5A, £10. Buyer collects. Mr. S. P. Ford. Beech Cottage, Church Road, Wereham, Kings Lynn, PE33 9AP. Tel: (0366) 500095.
LSI II memory board 32K, 18 bits, m.o.s., module No. M8045, as new. Open to offers. S. T. Whitehead, 131 Manchester Rd., Haslingden, Rossendale, Lancs BB4 6NT. Tel: Ross (0706) 216283.
TV WARNING

The unexciting title "Object Detecting Apparatus" for British patent application 2 090 411 from Tokyo Shibaura Denki of Japan, in fact covers a fascinating invention demonstrated by Toshiba at the London electronics trade shows in May 1981. Either by good planning or good fortune the invention has been shown off, other than under strict seal of confidence.

The Toshiba object detecting apparatus is a television set which senses the presence of a viewer and his or her distance from the screen. If a viewer comes too close and so risks getting eye strain, the set issues a warning in a synthesized voice. According to the patent the set says "You get too close to the TV set", and "stay away a little". In fact the Toshiba set, as demonstrated in Britain, spoke rather better English, "Watch from a distance for your eyes sake" it told anyone who got too close. The lengthy patent gives details of the clever circuits used to discriminate between furniture and viewers.

In Fig. 1 timing signal generator 26 is reset on the trailing edge of the output signals from oscillator 18. The output of monostable 20 controls oscillator 28, which generates an ultrasonic signal of between 40 and 60 kHz. This is radiated into the room by speaker 30.

Microphone 32 receives the wave reflected from furniture and viewers in the room and the received signal is amplified at 34, rectified at 36 and applied to sample and hold circuit 38. The sampled signal is compared at 40 with a reference signal from generator 42. Discrimination is achieved by storing the reflected signal during several periods of oscillator 18 and comparing the stored signal pattern with each subsequent received pattern. After counter 24 has clocked a given number of pulses e.g., 3, from oscillator 18 the flip-flop 52 is set.

Data stored in memory 54 is then successively compared with reflected data in judging circuit 56. If the stored and received data match there is no change in the room. When they don't match the judging circuit 56 produces an output which triggers speech synthesizer 58.

The inventors claim that the invention is also usable as a security system for detecting burglars in the room. The output of judging circuit 56 then can be switched to sound an alarm.

AUTOMATIC CUT-OUT

PCT application 82/03520 covers a device which could be useful for anyone who has a habit of leaving their soldering iron switched on and unattended. The application, which is filed in Germany, France, Britain, Japan and Holland, by Robert Franklin of California, is for an automatic power shut off system. It can be incorporated in any appliance which uses a heater element and is thus a fire hazard and expensive waste of energy. Or it can be connected as an add-on extra.

Fig. 1 shows the basic idea. Appliance 49, such as a soldering iron, receives a.c. power on line 46, 47. Triac 45 gates power to its heater element 53 via thermostat switch 52.

Use Detector and Timer (UDT) 1 has a master oscillator 12 which drives clock counter 15. This is pre-set to establish a period during which use of the appliance must be registered by a detector 2 to prevent a power shut down. Detector 2 can work by sensing motion of the appliance 49, or a grip on its handle, and can be either a touch sensitive switch, a piezo electric motion detector, a strain gauge, or a light or magnetic sensor. When detector 2 senses use, it re-sets UDT to zero. If no use is detected before the pre-set time, of say 15 minutes, runs out, then audible alarm 55 sounds and warning light 54 glows. This tells the user that the power is soon going to be turned off if the appliance isn't used. If it is used, the detector 2 resets the UDT to zero and it then starts counting again. If it isn't used then, 15 seconds after the warning, optic coupler 43 is switched off. This removes the gate drive for triac 45 which shuts off the power to appliance 49. Power is restored by touching the use detector 2 or momentarily unplugging UDT 1.
"The legendary "MINIMAX" — the small speaker producing "Large speaker" sounds. Peak handling 100 watts.
ONLY £74.95 A PAIR!!!

VIDEOTONE — For full range of loudspeakers, in-car, C.B., Video, audio & video cassettes, etc. Write for full details.

VIDEOTONE
98 CROFTON PARK ROAD,
LONDON SE4.
Tel: 01-690 8511, etx. 32.
Send for our free brochure and
details of outlets in the U.K.

CORAL
Moving Coil Cartridge — The MC88E is a high output cartridge
— so you do not need to use a head amp. EXCEPTIONAL
VALUE AT ONLY £29.95

Seoum Hi-Fi rep-
resents EXCELLENT QUALITY AT A
REALISTIC PRICE!
The range offers a choice of amplifiers,
tuner/amplifier, tuner,
and the excellent
SC4200 stereo cas-
sette recorder.

THE SCIENCE OF AUDIO

5Hz TO
100MHz
TOMORROW'S TOOLS TODAY

GLOBAL SPECIALTIES CORPORATION

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

G.S.C. (UK) Limited, Dept. 5D, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AZ
MAX 100 FREQ. COUNTER
Unit price inc P&P 15% VAT £124.20

Name
Address

I enclose cheque/P.O. for £
American Express card no.
exp. date

For Free catalogue tick box

Practical Electronics May 1983

FOR IMMEDIATE ACTION — The G.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.

Fill in the coupon for further details ...

*price excludes post, packing and VAT
MICROPROCESSORS in control situations are concerned with the real world where the majority of situations involve the control of equipment which has not necessarily been designed with microprocessors in mind. This is particularly true of most mains-powered equipment, and in this part of the series we begin by examining some useful methods of power control. The essential theme of these techniques is to bring the power of the micro to bear in a control sense, while keeping the power source in the application safely at arms length.

A desirable aspect of any control system is that it should be able to talk to the operator. The series so far has made little mention of the topic of display driving, and this omission is covered by concluding the series with a description of some of the more commonly encountered numerical display techniques.

POWER CONTROL DEVICES
The traditional method of interfacing an electronic control circuit to a load which is connected to an a.c. supply has involved the use of an electromechanical relay. Such devices offer a simple, low cost, solution to the problem of maintaining adequate isolation between the control circuit and the potentially lethal voltages associated with the supply mains. Relays do in fact, offer many of the characteristics of an 'ideal' switch including very low 'on' resistance, very high 'off' resistance and a coil to contact breakdown voltage which is usually in excess of several kV. There are, however, several very serious disadvantages of the humble electromagnetic relay. These are principally associated with the transitory condition which occurs between the true 'on' and 'off' states. When current is applied to energise the coil of an electromagnetic relay, the relay contacts are relatively slow to react and, after this initial delay in response, several milliseconds of contact bounce can occur. This rapid fluctuation in the 'on' and 'off' state can cause rapid changes in load current which in turn may result in severe erosion of the relay contacts coupled with electromagnetic radiation over a wide range of frequencies.

When the energising current is removed from the relay coil, there is again some delay in the operation of the contacts and, whereas there is less likelihood of bounce on opening than closing, the air-gap between the relay contacts tends to ionise as the contacts open. Since the ionised air acts as a relatively good conductor, the arc only becomes extinguished when the line voltage approaches that required to sustain the arc. In this condition an excessive level of power can be dissipated in the space between the contacts. There is thus a safe working limit for every relay beyond which the contacts may suffer permanent damage and eventually burn-out! Readers should also note that, whereas a relay may be rated for operation at 240V a.c. its d.c. rating may be considerably less. This is due, in virtue of the fact that any arc produced between the contacts will become extinguished at the end of a half-cycle of the a.c. mains. With a d.c. supply of more than 50V, an arc may persist for some considerable time.

Modern semiconductor devices have fortunately provided the circuit designer with some elegant solutions to the problems of a.c. and d.c. power control. Silicon controlled rectifiers (also known as thyristors) and their derivatives have become commonplace in many power control applications, such as motor speed control and light dimming.

A silicon controlled rectifier (s.c.r.) is a four layer three terminal semiconductor device. Such a device will conduct a unidirectional load current whenever the rectifier has been triggered by the injection of a pulse of current into its gate. Provided that the latching value of current is exceeded, the device will remain in the 'on' conducting state until the anode current falls below a certain minimum value. This holding value is the minimum anode current that can flow through the s.c.r. and still maintain conduction. Such a condition can, of course, easily be achieved by momentarily interrupting the supply to the device. The symbol and internal arrangement of an s.c.r. is shown in Fig. 1.

![Fig. 1. Symbol and internal arrangement of a thyristor](https://example.com/figure1)

An s.c.r. is, by virtue of its unidirectional property, ideally suited to d.c. power control applications. In a.c. circuits a single s.c.r. can only provide control over half-cycles of the supply. The triac is a development of the s.c.r. which can be used to pass or block current in either direction. The device essentially comprises two thyristor devices connected in anti-parallel but sharing a common gate electrode. The symbol and internal arrangement of such a device is shown in Fig. 2. The triac, like the s.c.r., has a minimum holding current below which conduction cannot be maintained. The device can, however, be triggered by both positive and negative gate current pulses. A complete discussion of the properties and characteristics of s.c.r. and triac devices is beyond the scope of this series and, where further information is required, readers are recommended to consult one of the currently available thyristor and s.c.r. manuals.
OPTO-ISOLATORS

Opto-isolators provide a means of coupling signals without the need for a direct electrical connection between devices. Signals are conveyed by means of a beam of infra-red radiation linking an emitting device to a detector housed in a common light-proof enclosure. The emitting device usually takes the form of a gallium arsenide diode whereas the detector may take one of several forms including phototransistor and photo-Darlington arrays. Photo-coupled s.c.r. and triac devices are also available. A variety of opto-coupled devices are shown, together with their conventional pin-outs, in Fig. 3.

The maximum voltage which can safely be applied between the input (emitter) and output (detector) terminals of an opto-isolator is usually in the range 1 to 7.5kV. This is comparable with the coil to contact breakdown voltage of most electromechanical relays. The insulation resistance of an opto-coupled device is generally around 10^11 and 10^12 ohm. This should be more than adequate for most applications including coupling to the 240V a.c. mains supply.

The efficiency of an opto-coupled diode, transistor or Darlington is usually expressed in terms of current transfer ratio (c.t.r.). This is simply the ratio of detector (output) to emitter (input) current. A typical c.t.r. for an opto-coupled transistor is 0-5 whilst that for an opto-coupled Darlington can be as much as 800. Since c.t.r. varies widely with emitter current, values must be specified for operation under particular conditions (i.e. emitter current, temperature etc).

The infra-red emitters of most opto-isolators have a maximum continuous current rating of between 20 and 60mA. The forward voltage drop of such a device is usually around 1-2V whilst the maximum reverse voltage may be as low as 3 to 5V. A fixed current limiting resistor is often connected in series with the emitter in order to limit the current when driven from a conventional TTL logic gate. Values of between 180 and 270 ohm will limit the emitter current to between 17 and 10mA, respectively. Whereas the emitter is common to a range of opto-coupled devices, detectors tend to vary quite considerably. Desirable characteristics include not only a high value of c.t.r., but also a fast response. Devices which may be perfectly adequate for control applications in conjunction with the supply mains may be quite unsuitable for high speed data transmission. A range of fast opto-isolators have recently become available. Typical of these is the HCPL2601, the simplified internal block diagram of which is shown in Fig. 4. The detector is coupled to an integrated high gain amplifier which is followed by an AND gate. An enable input is provided to this gate and it, in turn, is followed by an open collector Schottky clamped transistor. An internal screen provides a common mode transient immunity of 1kV/µs. This is equivalent to rejecting a 1MHz sine wave of no less than 300V pk-pk!

**PRACTICAL POWER CONTROL CIRCUITS**

A practical arrangement for interfacing a microcontroller or microcomputer to a load driven from the a.c. mains supply is shown in Fig. 5. This simple circuit uses a Darlington opto-isolator coupled to a triac. When the input is held 'low', gate current flows and the triac conducts allowing current to flow through the load. Note that triggering only occurs on positive half-cycles of the supply and thus this circuit is limited to a maximum load of around 500W. Fig. 6 shows an arrangement which employs an opto-coupled thyristor in conjunction with a bridge rectifier and triac. The bridge rectifier allows triggering on both positive and negative half cycles of the supply. The series C-R network connected across the triac is known as a 'snubber' and is used to compensate for
Fig. 5. A simple a.c. power control circuit using a Darlington opto-isolator

the effects of an inductive load. This network may be omitted when the load is purely resistive (such as an electric fire or light). An arrangement using an opto-coupled triac is shown in Fig. 7. Additional components have been included to cater for severely reactive loads. Where the power factor of the load is unknown, components should be fitted for a power factor of 0.9. This circuit is capable of controlling load powers in excess of 1 kW.

Fig. 6. An a.c. power control circuit using an opto-coupled thyristor

Fig. 7. Power control arrangement using an opto-coupled triac

Table 2. Component values for use with reactive loads

The control of displays is one of those areas of microprocessor system design, rather like keyboard handling, where the designer has the opportunity of making a number of hardware and software tradeoffs. The actual details of the tradeoffs which may be made, or even considered, will usually be determined by the characteristics of the particular application. In general, however, the factors to be considered will include: the amount of hardware involved, the complexity of the software required, the time available to perform the task, the memory space required, the speed of response, and any other tasks which must be performed concurrently.

Fig. 8. Driving a single 7-segment display through a PIA

Particular applications will have their own additional design constraints over and above those described above. Displays in hand-held applications, for example, will have tight space and power consumption constraints. The first step in all cases, however, will be to determine the extent to which hardware and software tradeoffs are practical, or even available; there is, after all, little point in deciding to use regular timer interrupts in a system where all of the user interrupt facilities have already been utilised.

Having defined the problem, and detailed the working limits for any solution, the designer is left with the task of producing a working design. There are few truly general guidelines which may be given, but careful consideration of flexibility, adaptability, future expansion possibilities, simplicity/modularity, and cost will usually help to narrow down the range of available choices. The discussion below covers some of the ways in which a typical seven-segment display may be controlled, and illustrates many of the practical considerations.

One straightforward way of driving a single common-anode seven-segment display is shown in Fig. 8. The A side
Table 3. PIA output values to illuminate individual segments

<table>
<thead>
<tr>
<th>SEGMENT TO BE ILLUMINATED</th>
<th>VALUE WRITTEN TO PIA OUTPUT REGISTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>01</td>
</tr>
<tr>
<td>b</td>
<td>02</td>
</tr>
<tr>
<td>c</td>
<td>04</td>
</tr>
<tr>
<td>d</td>
<td>08</td>
</tr>
<tr>
<td>e</td>
<td>10</td>
</tr>
<tr>
<td>f</td>
<td>20</td>
</tr>
<tr>
<td>g</td>
<td>40</td>
</tr>
<tr>
<td>d.p.</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 4. PIA output values for numerical displays

<table>
<thead>
<tr>
<th>NUMBER TO BE DISPLAYED</th>
<th>VALUE WRITTEN TO PIA OUTPUT REGISTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3F</td>
</tr>
<tr>
<td>1</td>
<td>06</td>
</tr>
<tr>
<td>2</td>
<td>5B</td>
</tr>
<tr>
<td>3</td>
<td>6F</td>
</tr>
<tr>
<td>4</td>
<td>7D</td>
</tr>
<tr>
<td>5</td>
<td>07</td>
</tr>
<tr>
<td>6</td>
<td>7F</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
</tr>
<tr>
<td>8</td>
<td>7c</td>
</tr>
<tr>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>a</td>
<td>5E</td>
</tr>
<tr>
<td>b</td>
<td>79</td>
</tr>
<tr>
<td>c</td>
<td>71</td>
</tr>
</tbody>
</table>

Table 5. Function table for the 7447 decoder/driver

<table>
<thead>
<tr>
<th>DECIMAL OR FUNCTION</th>
<th>INPUTS</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LT RBI</td>
<td>B A 91/RBO</td>
</tr>
<tr>
<td>0</td>
<td>1 1</td>
<td>1 0 1</td>
</tr>
<tr>
<td>1</td>
<td>1 X</td>
<td>0 0 1</td>
</tr>
<tr>
<td>2</td>
<td>1 X</td>
<td>0 1 0</td>
</tr>
<tr>
<td>3</td>
<td>1 X</td>
<td>0 1 0</td>
</tr>
<tr>
<td>4</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>5</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>6</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>7</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>8</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>9</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>10</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>11</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>12</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>13</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>14</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>15</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>BI</td>
<td>1 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>RBI</td>
<td>0 X</td>
<td>1 0 0</td>
</tr>
<tr>
<td>LT</td>
<td>0 X</td>
<td>1 0 0</td>
</tr>
</tbody>
</table>

Fig. 9. Pin configuration for the 7447 7-segment decoder/driver

Fig. 10. Alternative scheme for driving a decimal display

added (this may require a loop and test approach in some processors) to the contents of the index register. The index register will now point to the value which must be output to the PIA to display the number required. The display value is then picked up using the index register, and output to the PIA register.

In contrast to the software look-up table, it is possible to use hardware to perform the output processing. Applications
MULTI-DIGIT DISPLAYS

The single-digit display techniques described above may easily be extended to provide multi-digit displays; in the main it is simply a matter of increasing the number of PIAs used and providing the necessary additional driver hardware. Before very many digits have been added, however, it becomes noticeable that the number of peripheral components and connections required increases in direct proportion to the size of the display. This, in turn, decreases the overall reliability and increases the amount of board space required. A suggested policy is that simple techniques are applicable for displays which can be handled by a single PIA or similar peripheral interface. Beyond this limit, it is probably time to consider the use of intelligent or multiplexed display techniques. Intelligent displays are beyond the scope of this series, but multiplexed displays will usually offer realistic and cost-effective solutions to a wide range of controller display requirements.

Multiplexed displays rely on the fact that the display only needs to appear to be stable for it to be acceptable to the operator, and therefore it does not need to be driven with a 100% duty cycle. Rapid scanning of a display, coupled with the response characteristics of the display (i.e. the light output does not instantaneously fall to zero when the drive voltage is removed), and the afterglow in the operator's retina, means that it is possible to make the CPU scan AND perform other processing tasks apparently simultaneously.

A typical multiplexed seven-segment display configuration is shown in Fig. 11. The 8-digit display is connected between the A and B sides of a single PIA; The A side determines which of the segments are selected, and the B side determines which of the digits (if any) are actually turned on. To illuminate a particular segment, it must be selected (PAO to PA7) AND turned on (PBO to PB7).

More than one segment may be selected at any one time, and more than one digit may be turned on. In normal practice, however, each digit is turned on in sequence, and the display scan routine selects the appropriate segments for that digit position. The single digit display can be thought of as a multiplexed display with one digit permanently turned on, i.e. omit the B side of the PIA and connect the common anode directly to the supply, as shown earlier in Fig. 6.

The display must be scanned often enough to avoid the display flickering, and this usually means that the scan rate is at least 50 to 100 times per second. This may be achieved by including the display scan routine in the main infinite control loop, or by arranging for a regular timer interrupt (every 10 to 20 msec) to initiate a display scan. In many applications the former method may be quite adequate, but the user must be aware that any operation in the main loop which uses a significant amount of time may result in display flicker whenever it is executed. The infinite loop approach does, however, mean that it is possible to trade display flicker against available processing time in applications where a task is not executed often, but when it is run it justifies degradation of display quality.

During each display scan it is normal practice for the scan routine to read from a display table to determine the output values for each digit position. In this way, the remainder of the control software only amends the contents of the display table once each time a change in display is required. This amendment is usually via a standard subroutine which converts the numerical value from the caller into the appropriate display code. The display routine is thus kept separate from the remainder of the control software, and they communicate via a well-defined interface, i.e. the subroutine.

For the display shown in Fig. 11, the display scan routine (when invoked) would output the values 01, 02, 04, 08, 10, 20, 40, 80 (hex) to the PIA B output register to select digits 1 to 8 in turn. The interval between changes is set by the time required for the display to achieve usable brightness (typically 1–2 msec), and is usually set by a software delay, although a hardware timer may be used instead if the hardware exists. As each digit is turned on, the corresponding value is read from the display table and output to the PIA A output register. At the end of the cycle it is advisable to turn off all digits, otherwise the last digit (8 in this case) will appear unequally bright.

The multiplexed display combined with the software display table technique has many advantages for the system designer. As far as much of the software is concerned the display appears as a fully latched and decoded unit; the decoding is actually done by the interface subroutine. The hardware, on the other hand, has been kept to a minimum and there is a wide range of multiplexed display hardware available at competitive prices. In all, a good example of a hardware/software tradeoff.

CONCLUSION

This concludes the series on the interfacing and use of microprocessors in real control situations. Of necessity, the subjects covered represent only a small proportion of possible applications. The intention, however, has been to encourage the use of microprocessors in the real world, and to this end the subjects covered should provide a good basis for the development of micro-based projects.

Fig. 11. An 8-digit, 7-segment multiplexed display scheme
Tandy Testers For Reliability  
Accuracy and Value ...

£49.95

£32.95

21 Ranges - 30,000 Ohms/Volt. Features “beep” continuity function and easy access to battery and fuse compartment. DC Volts: 0 to 1000, 7 ranges. AC Volts 0 to 1000, 5 ranges. DC current 0 to 10 amps, 5 ranges. Resistance: 0-1-10k-1-10 megs. (centre scale 10) dB: -20 to +82 dB. 5 Ranges. Accuracy: ± 3% DC, ±4% AC. 61/16 x 57/16 x 25/8”. With instruction manual. Requires one 9V, and one “C” battery.

Micronta™ Clamp Meter. Safe to use, this clamp-on AC ammeter is designed to measure AC current without disconnecting or breaking the line being checked. The meter incorporates a pointer lock switch holding the pointer in position (for reading later) when the meter cannot be seen while measuring. AC current: 0-6-15-60-150-300 amperes. Accuracy ± 3%. Size: 7¾ x 2⅓ x 1¼”. With carry strap.

LCD Multitester

Features “beep” continuity check and autoranging function! Measures up to 1000 VDC, 500 VAC, 200 mA (both AC and DC). 2 megs resistance. Accurate to within ±1 digit. 6¾”. Requires two “AA” batteries. 22-192 £69.95

18 ranges, 3” meter. DC Volts: 0-1000. AC Volts: 0-1000. Current: 0-50 µA, 0-250mA, DC. Resistance: Rx1, Rx10, Rx100 (24 ohms, centre scale) dB: -20 to +62 in four ranges. Accuracy: ± 3 DC, ± 4 AC. 22-201 £16.95

20K Ohms/V Multitester

Dynamic Transistor Checker

Dynamic Transistor Checker

Makes Go/No-Go tests on small signal and power types and permits matching of similar transistors. Indicates relative current gain, “opens”, “shorts”. Socket plus hook clip leads for in-circuit tests. Output jacks for external meter or scope. 2¾ x 4⅛ x 1¼”. Requires “AA” battery. 22-025 £9.95

Digital Logic Probe

Ideal For Digital Troubleshooting!

Obtains power from circuit being tested. Indicates high, low or pulsed (to 10 MHz) logic states. Minimum detectable pulse width is 50 ns. Tests almost every logic family including TTL, LS, CMOS, DTL. 7¾ x 1⅜”. 34” leads. 22-301 £17.95

OVER 300 STORES AND DEALERSHIPS NATIONWIDE

Check your phone book for the Tandy Store or Dealer nearest you.  

Known as Radio Shack in the USA. Prices may vary at individual stores. Offers subject to availability.

Practical Electronics May 1983
The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidal offer in size, weight, lower radiated field and thanks to ILP, PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with a no price penalty.

**NEW! NEW! NEW!**

LOW COST PROFESSIONAL TEST INSTRUMENTS

100MHz, 600MHz, and 1GHz Models

Also available at Electrovalue, Maplin, Technomatic and Barrie Electronics.

For 240V primary (UK) insert "2.. in place of "X.. in type number

For 220V primary (Europe) insert "1- in place of "X- in type number

In place of "X" in type number equivalents, and are available with 110V, 220V or 240V primaries coded as follows

**Lowest price available.**

21 days manufacture for urgent deliveries.

**Orders despatched within 7 days of receipt for single or small quantity orders.**

*5 year no quibble guarantee.*

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows

**IMPORTANT.** Regulation — All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain full load voltage.

For 110V primary insert 0 in place of X in type number

For 220V primary (Europe) insert 1 in place of X in type number

For 240V primary (UK) insert 2 in place of X in type number

Also available at Electrovalue, Maplin, Technomatic and Barrie Electronics.

The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidal offer in size, weight, lower radiated field and thanks to ILP, PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with a no price penalty.

**NEW! NEW! NEW!**

LOW COST PROFESSIONAL TEST INSTRUMENTS

100MHz, 600MHz, and 1GHz Models

Also available at Electrovalue, Maplin, Technomatic and Barrie Electronics.

For 240V primary (UK) insert "2.. in place of "X.. in type number

For 220V primary (Europe) insert "1- in place of "X- in type number

In place of "X" in type number equivalents, and are available with 110V, 220V or 240V primaries coded as follows

**Lowest price available.**

21 days manufacture for urgent deliveries.

**Orders despatched within 7 days of receipt for single or small quantity orders.**

*5 year no quibble guarantee.*

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows

**IMPORTANT.** Regulation — All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain full load voltage.

For 110V primary insert 0 in place of X in type number

For 220V primary (Europe) insert 1 in place of X in type number

For 240V primary (UK) insert 2 in place of X in type number

Also available at Electrovalue, Maplin, Technomatic and Barrie Electronics.
USER MONITOR ROUTINES

There will be many applications where peripheral hardware connected to the Microcontroller will require a regular opportunity to gain a share of the CPU processing time to perform some function, but without using interrupts. An example might be to maintain a continuous display of elapsed time on a 4-digit I.E.D. module connected to a user PIA, using the value of TICK which is held in DISBUG RAM. The majority of the processing required would be to refresh the I.E.D. digits in a similar fashion to that employed by DISBUG. Such a task could be performed by writing a user routine and using all of the available CPU time to perform it. This approach, although successful, would tie up the total CPU resources for what is essentially a ‘background’ task. The Microcontroller is capable of excuting more than 200,000 typical instructions every second, so it should be possible to perform some sort of background servicing at the same time as providing the normal DISBUG facilities.

The overall design of the infinite control loop in the top-level DISBUG routine was shown in Part 3 of the Microcontroller series. The code for this routine occupies twenty bytes, starting at the bottom of the EPROM at location F800, and is shown below. It can be seen that, just before jumping back to restart the loop, a user-defined monitor routine is called in the main loop. Once again this makes use of a software vector held in DISBUG RAM (UMRSA at location 03C4, 2 bytes long). At start-up the initialisation routine initialises this vector to point to a default service routine at F82B, which is simply an RTS instruction, and therefore the call has no effect other than a slight delay. Since the vector is held in RAM, however, this can easily be overwritten to define an alternative service routine; the technique is identical in concept to that used for the PF1 and PF2 keys, see Data Sheet 2.

User-defined monitor routines are written as subroutines, and must end with an RTS instruction. Once the start address in user RAM has been placed in 03C4/5 (UMRSA), the routine will be called every time round the monitor loop. No call will be made, however, when the keyboard scan produces an uncertain result; that used for the PF1 and PF2 keys, see Data Sheet 2.

The following brief memory map highlights some of the more significant routines within DISBUG for the benefit of the experimenter and enthusiastic disassembler. All except those marked with an asterisk are written as subroutines.

**DISBUG top level control routine**

The addition of a user-defined routine to the existing monitor, in the form of either a single routine or a nested suite of routines, allows the facilities of the basic monitor to be extended to suit particular applications. By suitable programming, the user PIA’s may even be configured to allow the use of extra keyboards and/or displays.

**INTERRUPT SERVICE ROUTINES**

Whenever a user interrupt is recognised by the 6800 (i.e. IRQ asserted and user interrupts not masked out), the CPU saves the registers on the stack, masks out further interrupts, and jumps to the address contained in locations FFF8 and FFF9. In DISBUG, these two locations point to a routine called IRQINT at location FF90, and the code for this routine is shown below.

IRQINT first of all checks to see if the interrupt was caused by an RTC ‘tick’, and if so it increments TICK in DISBUG RAM and resets the appropriate display PIA interrupt flag. The second action of IRQINT is to jump, using the software vector from IRQSRA (03DC and 03DE in DISBUG RAM), to the user interrupt service routine for any further interrupt processing required. The IRQSRA vector is set up by the DISBUG initialisation routine to point to DEFISR (see below), which simply dismisses the interrupt and returns to the original program in the usual way.

Users may define their own additional interrupt processing by overwriting the vector in IRQSRA with the appropriate start address. The user-supplied routine should be written as a handler which terminates in an RTI instruction. On entry to such a user-defined routine, RTC interrupts will have been handled, but user interrupts will still be masked.

**DISBUG MEMORY MAP**

The following brief memory map highlights some of the more significant routines within DISBUG for the benefit of the experimenter and enthusiastic disassembler. All except those marked with an asterisk are written as subroutines.
TO COMPLETE the series of sound generating peripherals, we describe a nine channel sound card complete with amplification. The card makes use of the General Instrument “sound chip” (three to be precise) which can be programmed to generate a wide range of sounds. The chip has been around for some time, which makes it a cheap and reliable way to convert bytes into musical (or totally non-musical) audio signals.

THE AY–3–8910

The sound chip is programmed via a set of internal registers. The 40-pin package leaves a lot of spare lines which have been allocated to parallel ports, so as a bonus, the card offers five, 8 bit ports which can be set up as inputs or outputs. These lines are TTL compatible.

In each chip there are three tone generators, which use programmable counters to determine the period of the tone. As these counters are 12 bits long, a reasonably accurate representation of the “well tempered” musical scale can be generated. The three generators can be used quite independently, or rather like the organ, they can be mixed to provide a complicated tone made up of synthesised harmonics, which gives added colour to the sound produced.

Each tone generator is fed into an envelope generator made out of a 4 bit D-to-A. The amplitude of each channel can be set, or provide some shaping by varying the amplitude with time. Some useful envelopes are pre-programmed into the chip, keeping the amount of external programming to a minimum.

In addition to the tones, a noise generator is provided. It is possible to colour the noise by setting a 5 bit time period in one of the internal registers, so that sounds from a low roar to a hiss are possible, very useful for games.

Two 8-bit ports are accessed by other registers in the chip. Each port can be set to all inputs or outputs.

THE CIRCUIT

Fig. 7.1 shows the circuit for the sound card. It is made up of an interface to the motherboard (decoding and a parallel port—the now familiar 8255), three AY–3–8910 sound chips and a low power amplifier to reproduce the sound through a small speaker. There is a pick-off for external amplification, but the highly “in-phase”, square wave signals produced by most computer sound generators is not well suited to your best hi-fi as the signals impose a heavy load on the amplification and speakers. The port occupies four memory locations, the decoding allows one to map this area

<table>
<thead>
<tr>
<th>COMPONENTS . . .</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistors</strong></td>
</tr>
<tr>
<td>R1</td>
</tr>
<tr>
<td>R2</td>
</tr>
<tr>
<td>R3</td>
</tr>
<tr>
<td>R4</td>
</tr>
<tr>
<td>R5, R6</td>
</tr>
<tr>
<td>R7</td>
</tr>
<tr>
<td>All resistors</td>
</tr>
<tr>
<td><strong>Potentiometers</strong></td>
</tr>
<tr>
<td>VR1</td>
</tr>
<tr>
<td><strong>Capacitors</strong></td>
</tr>
<tr>
<td>C1</td>
</tr>
<tr>
<td>C2</td>
</tr>
<tr>
<td>C3, C7–19</td>
</tr>
<tr>
<td>C4–6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrated Circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1–4</td>
</tr>
<tr>
<td>IC5</td>
</tr>
<tr>
<td>IC6</td>
</tr>
<tr>
<td>IC7–9</td>
</tr>
<tr>
<td>IC10</td>
</tr>
<tr>
<td>IC11</td>
</tr>
<tr>
<td>IC12</td>
</tr>
<tr>
<td>IC13, 14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 P.c.b. mounting low profile keyboard switch &amp; cap</td>
</tr>
<tr>
<td>TB1 4-way p.c.b. mounting terminal block</td>
</tr>
<tr>
<td>2 x 32-way A + C male right-angle DIN41612</td>
</tr>
<tr>
<td>WE07 SBD printed circuit board</td>
</tr>
<tr>
<td>8-pin d.i.l. socket</td>
</tr>
<tr>
<td>14-pin d.i.l. socket (3 off)</td>
</tr>
<tr>
<td>16-pin d.i.l. socket (4 off)</td>
</tr>
<tr>
<td>40-pin d.i.l. socket (4 off)</td>
</tr>
<tr>
<td>3.579545MHz crystal</td>
</tr>
</tbody>
</table>

SAE to Watford Electronics (see Advertisers’ Index) for price list of kits.
DECOUPLING
10 x 100n Capacitors, C8 - C17, adjacent to IC's between +5V and GND.

Fig. 7.1. Circuit diagram of Sound card
to anywhere in memory by setting switches (1−14). For ease of description we have continued to use the 8255 (there is one on most of the cards in this series, including the motherboard). Setting up the card is a matter of setting up this port and then writing to the AY−3−8910 registers via the control lines PA0−PA7 and PBO−PB4. A push button on the board allows you to reset the board. On power up, reset is automatic, but you can use PB5 to make reset possible from the host system, by setting link 1.

To calculate the values for the contents of the Tone Period and Fine Tune registers, given the input clock and the desired output tone frequencies, we simply rearrange the above equations, yielding:

(a) \( TP_{10} = \frac{f_{\text{clock}}}{16T_{P0}} \)

(b) \( CT_{10} + \frac{FT_{10}}{256} = TP_{10} \)

Table 7.4. Link functions

<table>
<thead>
<tr>
<th>Link</th>
<th>position</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>open</td>
<td>power-up and manual reset, PB1, R3, C2</td>
</tr>
<tr>
<td>2</td>
<td>default</td>
<td>board always in address space, board may be mapped in and out by motherboard 8255</td>
</tr>
<tr>
<td>3</td>
<td>default</td>
<td>board is memory mapped</td>
</tr>
<tr>
<td>4</td>
<td>open</td>
<td>memory mapped</td>
</tr>
<tr>
<td>(pair)</td>
<td>made</td>
<td>I/O mapped, omit IC1,2,13 and S1−8</td>
</tr>
</tbody>
</table>

Table 7.3. Tone frequency formulae

CONSTRUCTION

Refer to the overlay (Fig. 7.2). This is a simple board to assemble. Use sockets for the i.c.s. These make repair etc. much easier. The crystal should not have its leads bent at the base as this might damage the housing.

Set the switches 1−14 by determining the area in memory to which the board is to be mapped (say 4120H), then translate this into binary (0100000100100000) discard the least significant two bits (01000001001000). For each zero in the pattern, turn on the corresponding switch (SO, in this case). Referring to the overlay (Fig. 7.2). This is a simple board to assemble. Use sockets for the i.c.s. These make repair etc. much easier. The crystal should not have its leads bent at the base as this might damage the housing.

If you want to reset the board via the 8255, short link 1, but leave out C2.

TESTING

The AY−3−8910 is a little more tricky to set up, because of its large number of registers. Obtain the data sheet for the internal register layout of this chip. The BASIC program of Table 7.1 is a commented test program which shows how the tone registers are set up. Table 7.2 gives details of how each individual register is accessed on each sound chip. Table 7.3 shows the simple formulae needed to calculate a particular tone, given the colour burst crystal supplied with the sound board. For more complicated applications, a full manufacturer’s data sheet, complete with examples, is available with the kit, see Components List.

NEXT MONTH

A serial and parallel port card with a real-time calendar clock which has battery back-up, so the correct time is always on tap.
MAIL ORDER ADVERTISING

British Code of Advertising Practice

Advertisements in this publication are required to conform to the British Code of Advertising Practice. In respect of mail order advertising where money is paid in advance, the code requires advertisers to fulfill orders within 28 days, unless a longer delivery period is stated. Where goods are returned undamaged within seven days, the purchaser’s money must be refunded. Please retain proof of postage/despatch, as this may be needed.

Mail Order Protection Scheme

If you order goods from Mail Order advertisements in this magazine and pay by post in advance of delivery, PRACTICAL ELECTRONICS will consider you for compensation if the Advertiser should become insolvent or bankrupt, provided:

(1) You have not received the goods or had your money returned; and

(2) You write to the Publisher of PRACTICAL ELECTRONICS summarising the situation not earlier than 28 days from the day you sent your order and not later than two months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required. We guarantee to meet claims from readers made in accordance with the above procedure a soon as possible after the Advertiser has been declared bankrupt or insolvent. This guarantee covers only advance payment sent in direct response to an advertisement in this magazine not, for example payment made in response to catalogues etc., received as a result of writing to such advertisements. Classified advertisements are excluded.

OVERSEAS ORDERS

Overseas readers are reminded that unless otherwise stated, postage and packing charges published in advertisements apply to the United Kingdom only.

Readers wishing to import goods from the United Kingdom are advised to first obtain from the advertiser(s) concerned an exact quotation of the cost of supplying their requirements carriage paid home.
The first Electronic Hobbies Fair in 1982 immediately established itself as the foremost consumer electronics exhibition—the biggest attendance and the largest number of exhibitors. The 1983 Fair will build on the success and the experience of the first year. It will be 1983’s largest and most influential shop window for the whole range of electronic equipment and components for the electronics hobby enthusiast—constructional projects, home computers, amateur radio, video games, musical instruments and peripheral equipment—whether for the beginner, the specialist or the all-round enthusiast.


Make a date for 1983. October 27-30, Alexandra Palace, London. For more details contact: The Exhibition Manager, Electronic Hobbies Fair, Reed Exhibitions, Surrey House, Throwley Way, Sutton, Surrey SM1 4QQ

Please send more information on Exhibition stand space ☐
Please ask a salesman to telephone ☐
Name ________________________________
Position ________________________________
Company ________________________________
Address ________________________________
Telephone Number ________________________________

The Exhibition Manager
Electronic Hobbies Fair
Reed Exhibitions
Surrey House, Throwley Way
Sutton, Surrey SM1 4QQ
SMALL ADS

The prepaid rate for classified advertisements is 34 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £11.20 per single column centimetre (minimum 2.5 cm). All cheques, postal orders etc., to be made payable to Practical Electronics and crossed "Lloyds Bank Ltd". Treasury notes should always be presented by post. Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Practical Electronics, Room 2612, IPC Magazines Limited, King's Reach Tower, Starmond St., London SE1 9LS (Telephone 01-261 5846).

NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser to check both prices and availability of goods before ordering from non-current issues of the magazine.

BOURNEMOUTH/BOSCOMBE: Electronic components specialists for 13 years. Inventories of Radio Supplies. Late Holdenhurst Road. Now at 36, Ashley Road, Bournemouth. Tel. 702242. Closed Weds.

---

BRAND NEW COMPONENTS AVAILABLE

Extended Basic for: UK101/0HIO

Extended Basic provides an upgraded Basic for most UK101/0HIO machines. ExBasic is powerful, fast, and very expandable with 59 extra commands as standard, plus many features not found on more expensive systems. ExBasic uses a totally different concept to other add-on command chips, and as a result the user may add his/her own commands, and unlike many inferior ways of extending Basic, ExBasic’s commands do not need prefixes like & or % in front of them. The commands may be used in programs as well as in machine code programs giving even the most standard OHIO/UK101 one of the most powerful Basics around.

Two chips add 39 extra commands: VDU, DRAW, UNDRAW, BLK, STORE, TEST, HUNT, XRN, FILL, FILM, REG GO, SRS, REPEAT, UNTIL, CALL, DOKE, DEEK, MC, PUSR, EGOTO, LERN, EYEP, EYEPK, PUTFAT, CLS, CUR, HOME, GET, INAT, XRN, NORM, FIND, OLD, PAUSE, TRACE, VIEW, ELSE, MON.

---

FANTASTIC ELECTRONIC BARGAINS

VERSATILE BENCH POWER SUPPLY UNITS

Contains high quality transformer made to exacting specifications giving one 20v output and one 20-0-20v output. All outputs 3amps, 0.5c. Input 110v/250v, 12v/5v. 150w. Price £4 per unit. 2 pairs £7.50 post free (4 units £11.00 post free).

---

BUMPER BOX OF BITS

WOW!!! We've got so many components in stock, we can’t possibly list them all! – So buy a box, in it you'll find resistors, capacitors, displays, switches, panels with transistors, diodes, etc, coils, pots... and so on. All modern parts - guaranteed at least 100,000 hours, minimum weight 10Ibs. ONLY £8.50 inc. VAT. Post free. Contact COLES HARDING & CO. 103 SOUTH BRINK, Wisbech, Cambs. Tel: 0945-741 5841 (Inc. rate 33p per word, inclusive prices). Thyronics Control Systems. 8 Sandling Road, Maidstone, Kent, Maidstone 675354.

---

ORDER FORM

Please insert the advertisement below in the next available issue of Practical Electronics for...

insertions. I enclose Cheque/P.O. for £...

(Cheques and Postal Orders should be crossed Lloyds Bank PLC, and made payable to Practical Electronics)

---

NAME

ADDRESS

---

Send to: Classified Advertisement Department

PRACTICAL ELECTRONICS

 Classified Advertisement Dept, Room 2612, King’s Reach Tower, Stamford Street, London SE1 9LS. Telephone 01-261 5846. Rate: 34p per word, minimum 12 words. Box No. 60p extra.

---

Company registered in England. Registered No. 53626. Registered Office: King’s Reach Tower, Stamford Street, London SE1 9LS.

---

5/83 Practical Electronics May 1983
TELEVISION COMPUTER RADIOCOMMUNICATIONS & RADAR SERVICING

2 YEAR full-time course, with a high practical content, approved by the Technician Education Council and leading to TEC DIPLOMA in ELECTRONIC & COMMUNICATIONS ENGINEERING

- PRINCIPLES of ELECTRONICS
- TELEVISION (MONO/COLOUR)
- VIDEO CASSETTE RECORDERS
- CLOSED CIRCUIT TELEVISION
- DIGITAL & MICROELECTRONICS
- COMPUTERS & MICROPROCESSORS
- RADIOCOMMUNICATION & RADAR

Short courses (from 13 weeks) are available in the above individual specialisms for applicants with CGLI, TEC, HNC, BSc etc which lead to TEC or College Diploma awards.

Next two courses commence April 25th & Sept. 19th.

Prospectus from:

LONDON ELECTRONICS COLLEGE
Dept. AA, 20 Penywern Road
London SW6 9SU. Tel: 01-373 8721.

EDUCATIONAL

CAREERS IN MARINE ELECTRONICS. Courses commencing September and January. Further details, The Nautical College, Fleetwood FY7 8EZ. Tel. 03947 72723.

AERIALS

AERIALS & TV INTERFACES Treble incoming signal. Price £7.00. SAE leaflets.

ELECTRONIC MALL ORDER LDN. Ramsgate.

bottom. Lancaster BL1 9AG.

BOOKS AND PUBLICATIONS

ANY PUBLISHED, full-size service sheet by return £2 + 1s.6d.

STICKY TEMPLATES (Pat. Pending) "One of the neatest, most comprehensive and most useful of these car computers...

CENTURION ALARMS
We manufacture, you save £££'s. Send s.a.e. or phone for our Free list of professional. D.I.Y. Burglar Alarm Equipment and accessories. Discount up to 20% off list prices, e.g. Control Equipment £115.36, Decoy Bell Boxes from £5.95 inc.

TRADING ENQUIRIES WELCOME

4849-21000 or 048408 35527 (24 hr. ans.)

BURLINGTON ALARM EQUIPMENT, Ring Bradford (0274) 309290
for our catalogue or call at our large showroom opposite Odsal Stadium.


MISCELLANEOUS

CONSUMER THE CHIP,... Master modern electronics the PRACTICAL way by SEEING and DOING in your own home. Write for your free course brochure now to British National Radio & Electronic School, Dept C2, Reading, Berks RG1 1BR.


CSIC ASSOCIATE (feasibility unit). SAE for list of copper and resistance Wire.


CABINET FITTINGS

Fretcloths, Coverings, Handles, Castors, Flight Case Locks & Parts, Jacks, XLRs, Burgins, Reverb Trays, P & N mic Stands, Plug Ins and Parts, Jacks, XLRs. Flight Case Locks & Parts, Jacks, XLRs.


WE manufacture, you save £££'s send to, or phone for our free list of professional D.I.Y. Burglar Alarm Equipment and accessories. Discount up to 20% off list prices, e.g. Control Equipment £115.36, Decoy Bell Boxes from £5.95 inc.

TRADING ENQUIRIES WELCOME

4849-21000 or 048408 35527 (24 hr. ans.)

BURLINGTON ALARM EQUIPMENT, Ring Bradford (0274) 309290 for our catalogue or call at our large showroom opposite Odsal Stadium.

MAKE YOUR OWN PRINTED CIRCUITS

ELect Retal Transfers - Starter pack £5.15, lines, pads, 1c. pads £2.50, large range of single lines in stock at 50p per sheet. Master Positive Transparencies from P.C. layouts in magazines by simple photographic process. 2 sheets negative paper, 2 sheets positive film (AA) £2.25, £Photo-realist spray (200 ml) £5.90 (p+p 65p). Drafting Film (4A) 25p, Precision Grids (A4) 65p. 215ip for all information and price list. P&P 50p per order plus extra where indicated.

P.K.G. ELECTRONICS

OAK LODGE, TANSLEY, DERBYSHIRE.

USEFUL IN VISUALISING AND PREPARING CIRCUIT DESIGNS. Compatible with any P.C. design system. Rates from £34.50 incl. VAT.

A REAL TIMESAVER IN THE WORKSHOP

NEW STICKY TEMPLATES (Pat. Pending)

INEXPENSIVE self-adhesive clear acetate TEMPLATES - especially designed to ELIMINATE TROUBLES MARKING OUT of panels and instrument cases when mounting POPULAR CONNECTOR TYPES. Simply peel off protective backing and APPLY DIRECTLY to the surface to be worked, then cut and drill to outlines and centres shown. SAVES HOURS of work - PLUS makes LINING UP MULTI-CONNECTOR ARRAYS so easy, as vertical and horizontal centres are printed on Stickers. Will not harm existing finishes, in fact PROTECTS AREA around cut-out and prevents punches and skidding. INVALUABLE on LAYOUT & WIRING DRAWINGS too.

Send £5.40 incl. VAT & P&P for selection pack (90 templates) or ask for leaflet.

FUTRONICS TECHNOLOGY (UK) Ltd.
13 North Avenue, London W13 8AP
Trade Enquiries Invited. Please allow 10 days for delivery.

PE CAR COMPUTER

One of the newest, most comprehensive and most useful of these car computers that we have yet come across.

Economy - save petrol by improving your driving technique and improving the tuning of your car.

Security - protect your car by disabling the ignition. Enter a personalised combination to restart.

Attractive, easy to fit, easy to operate - comes complete with all parts needed. Full instructions provided.

PE car computer Easy-to-assemble kit of parts Ignition cut-out

All prices include VAT. Allow £1 post & package. Goods by return.

Send S.A.E. for list of separately available parts.

PIMAC SYSTEMS LTD
20 Bloomfield Road, Moseley, Birmingham B13 9BY.
Tel: 021-449 0384

RESISTORS RM-10MO (less 7Ms) £2.50 range. 168 valves. 0 25W 5% TOL. Boxed sets 10 per value £20.25 per value £40 inc. P&P. CW13 C. Hallit, 20 Bull Lane, Midsven Newton. Dorchester. Dorset DT2 1BJ.

PRACTICAL ELECTRONICS P.C.B.'s 1.5mm fibreglass, drilled and solder resist coated. SAVE MONEY - Boards PRINTED ready for own etching and drilling send SAE for price list. LECTROPRINT, 17 Showell Road, Busbury, Wolverhampton, West Midlands. Tel. 0902 721805.

FOR SALE

RESISTORS RM-10MO (less 7Ms) £2.50 range. 168 valves. 0 25W 5% TOL. Boxed sets 10 per value £20.25 per value £40 inc. P&P. CW13 C. Hallit, 20 Bull Lane, Midsven Newton. Dorchester. Dorset DT2 1BJ.

PRACTICAL ELECTRONICS P.C.B.'s 1.5mm fibreglass, drilled and solder resist coated. SAVE MONEY - Boards PRINTED ready for own etching and drilling send SAE for price list. LECTROPRINT, 17 Showell Road, Busbury, Wolverhampton, West Midlands. Tel. 0902 721805.

FOR SALE

RESISTORS RM-10MO (less 7Ms) £2.50 range. 168 valves. 0 25W 5% TOL. Boxed sets 10 per value £20.25 per value £40 inc. P&P. CW13 C. Hallit, 20 Bull Lane, Midsven Newton. Dorchester. Dorset DT2 1BJ.

PRACTICAL ELECTRONICS P.C.B.'s 1.5mm fibreglass, drilled and solder resist coated. SAVE MONEY - Boards PRINTED ready for own etching and drilling send SAE for price list. LECTROPRINT, 17 Showell Road, Busbury, Wolverhampton, West Midlands. Tel. 0902 721805.

FOR SALE

RESISTORS RM-10MO (less 7Ms) £2.50 range. 168 valves. 0 25W 5% TOL. Boxed sets 10 per value £20.25 per value £40 inc. P&P. CW13 C. Hallit, 20 Bull Lane, Midsven Newton. Dorchester. Dorset DT2 1BJ.

PRACTICAL ELECTRONICS P.C.B.'s 1.5mm fibreglass, drilled and solder resist coated. SAVE MONEY - Boards PRINTED ready for own etching and drilling send SAE for price list. LECTROPRINT, 17 Showell Road, Busbury, Wolverhampton, West Midlands. Tel. 0902 721805.
**OPEN ALL HOURS**

The new EMOS ELECTRONIC COMPONENT WAREHOUSE is now open Monday to Saturday 9 a.m. to 4 p.m. You will easily find us opposite the John O'Gaunt Hotel on the A45. Even more fantastic bargains to be found.

**LARGE ELECTROLYTES:**
- Computer Grade
- Made by Sanyo or General Electric.
- Following values available:
  - 100 µF @ 25V
  - 300 µF @ 7V
  - 1200 µF @ 15V
- Prices – fantastic value!
- Choose from at least £0.33 each.
  - 710 @ 45V
  - 60 @ 450V
  - 32 @ 450V
  - 1 @ 450V
  - 0.90 @ 600V
  - 3 @ 450V

**CROSSOVERS**
- 2-WAY 3000 c/s 40 watts 8 ohm £6.50
- 4-WAY 3000 c/s 80 watts 16 ohm £7.50

**POWER PACK KITS**
- Mains stabilized power pack 9 volt 400mA D.C. with overload protection and P.O. payable to EMOS Ltd. Allow up to 14 days for delivery, large SAE for comprehensive catalogue.

**R.C.S. LOW VOLTAGE STABILISED POWER PACK KITS**
- £3.95 Post.
- All parts and instructions with Zener diode printed circuit, mains transformer, 240V, output 6 or 7 or 9 or 12 V D.C., up to 100mA or less. Please state voltage required.

**TEAC EFFECT PLINTH OUT FOR BSR**
- £1.50

**BOOK SHELF HI-FI ENCLOSURES TEAK£17.15 8 x 11 x 8 5/8 in. Liberty. £3.50 Post.

**TEAK EFFECT PLINTH cut for BSR £9.50**

**TINTED PLASTIC EQUIPMENT COVERS**
- £0.95 Post.

**PRACTICAL ELECTRONICS**

- May 1983
- Price: £12.00

**WORLD RADIO & TV HANDBOOK 1983**

**PRINCIPLES OF TRANSISTOR CIRCUITS**
- by S. W. Amos
- Price: £7.50

**THE CATHODE-RAY OSCILLOSCOPE & ITS USE**
- by G. N. Patchett
- Price: £4.50

**SERVICING HOME VIDEO CASSETTE RECORDER**
- by M. Hobbs
- Price: £5.50

**ELECTRONIC PROJECTS IN PHOTOGRAPHY**
- by R. A. Penfold
- Price: £5.00

**HOW TO GET THE MOST FROM IT**
- by I. Sinclair
- Price: £6.50

**DESIGN OF ACTIVE FILTERS WITH EXPERIMENTation**
- by R. G. Green
- Price: £5.00

**GET MORE FROM YOUR PERSONAL COMPUTER**
- by I. Hickman
- Price: £6.50

**LEARNING TO USE THE VIC-20 COMPUTER**
- by R. Greene
- Price: £4.50

**BASIC PROGRAMMING**
- by B. J. Holmes
- Price: £4.50

**ALL PRICES INCLUDE POSTAGE**

**THE MODERN BOOK CO.**

- BRITAIN'S LARGEST STOCKIST of British and American Technical Books

**219-211 PRAED STREET LONDON W2 1NP**

Phone 01-402 9176 Closed Saturday 1 p.m. Please allow 14 days for reply or delivery.

The Advertising Standards Authority.
ASA Ltd., Brook House, Tottington Place, London WC1E 7HN.
MONITORS

HIGH RESOLUTION – AND LOW COST!

Either cased or open frames to OEM's. The specification is right, the price is even better.

Phone or write to our Sales Manager, Richard Cox, for immediate action.

CROFTON ELECTRONICS LTD
35, Grosvenor Road, Twickenham, Middx, TW1 4AD.
Telephone: 01-891 1923/1513 Telex: 295093 CROFTN G

Universal Ni-CAD, battery charger. All plastic case with lift up lid. Charge/Test switch. LED indicators at each of the following charging points.

Charges: PP9 (9V), U12 (1.5V penlight), U11 (1.5V "C") U2 (1.5V "D"), Power: 220-240V AC. Dims: 210 x 100 x 50mm. Knock down price only while stock lasts.

Order No. £6.00

Multimeter & Transistor Tester

DC volts: 0-1v-2.5v-10v-50v-250v-1000v ±3%
AC volts: 0-10v-50v-250v-1000v ±3%
DC current: 0-50uA-2mA-25mA-0-25A ±3%
Resistors: Minimum 0.2-2-20-200-200k ohms
Mid-scale: 20-200-2k-20k ohms
Maximum: 2k-20k-200k ohms

Leakage current: 0-150uA at Zik range
0-15mA at X10 range
0-150mA at X1 range

Only £11.95 Order No. HT 320

Please allow 10 days for delivery.

CITY AND GUILDS CERTIFICATES

Excellent job prospects await those who hold one of these recognised certificates. ICS can coach you for:

Basic Electronic Engineering (C&G/ICS)
Radio Amateurs

CERTIFICATE COURSES

TV & Audio Servicing
TV, Radio and Audio Engineering
Radio & Amplifier Construction
Electronic Engineering*
Computer Electronics*
Industrial Electronics*
Radio Frequency Electronics*
Introduction to Microprocessing*
Electrical Contracting & Installation

*Qualify for IET Associate Membership

ICS Approved by CACC

Member of ABCC

POST OR PHONE TODAY FOR FREE BOOKLET

Please send me your FREE School of Electronics Prospectus

Subject of Interest

Name

Address

Post to: Dept G273
ICS School of Electronics
160 Stewarts Road
Oxon OX10 8ES
Telephone: 01-6022 9911

STORAGE CABINETS

Steel cabinets. 12" wide x 5" deep x 22" high finished blue with clear plastic drawers.

Available units:

<table>
<thead>
<tr>
<th>Type</th>
<th>Drawers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2260</td>
<td>60 x A</td>
</tr>
<tr>
<td>2248</td>
<td>48 x B</td>
</tr>
<tr>
<td>2224</td>
<td>24 x C</td>
</tr>
<tr>
<td>2276</td>
<td>16 x D</td>
</tr>
<tr>
<td>2208</td>
<td>8 x E</td>
</tr>
<tr>
<td>2236</td>
<td>4 x A, 4 x D, 2 x E</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Drawers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2260</td>
<td>60 x A</td>
</tr>
<tr>
<td>2248</td>
<td>48 x B</td>
</tr>
<tr>
<td>2224</td>
<td>24 x C</td>
</tr>
<tr>
<td>2276</td>
<td>16 x D</td>
</tr>
<tr>
<td>2208</td>
<td>8 x E</td>
</tr>
<tr>
<td>2236</td>
<td>4 x A, 4 x D, 2 x E</td>
</tr>
</tbody>
</table>

ONLY £19.90

MILLHILL SUPPLIES
66 THE STREET, CROWMARSH, WALLINGFORD
OXON OX10 8ES. Tel. 0491 38653
Delivery within 7 days

Technical Training in Radio, Television and Electronics

ICS have helped thousands of ambitious people to move up into higher paid, more secure jobs in the field of electronics—now it can be your turn. Whether you are a newcomer to the field or already working in the industry, ICS can provide you with the specialist training so essential to success.

Personal Tuition and Guaranteed Success

The expert tuition and personal guidance by fully qualified tutors, backed by the ICS guarantee of tuition until successful is the key to our outstanding record in the technical training field. You study at the time and pace that suits you best and in your own home. In the words of one of our many students: "Since starting my course, my salary has trebled and I am expecting a further increase when my course is completed".

MILLHILL SUPPLIES

66 THE STREET, CROWMARSH, WALLINGFORD
OXON OX10 8E. Tel. 0491 38653

Delivery within 7 days
### INDEX TO ADVERTISERS

<table>
<thead>
<tr>
<th>A.D. Electronics</th>
<th>74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambit</td>
<td>4</td>
</tr>
<tr>
<td>Audio Electronics</td>
<td>8</td>
</tr>
<tr>
<td>Bicc Vero</td>
<td>12</td>
</tr>
<tr>
<td>Bi-Pak</td>
<td>14</td>
</tr>
<tr>
<td>Blackstar Limited</td>
<td>68</td>
</tr>
<tr>
<td>British National Radio &amp; Electronics School</td>
<td>4, 20</td>
</tr>
<tr>
<td>Cambridge Learning</td>
<td>8</td>
</tr>
<tr>
<td>Centurion Alarms</td>
<td>77</td>
</tr>
<tr>
<td>Clef Products</td>
<td>74</td>
</tr>
<tr>
<td>Colne Robotics</td>
<td>41</td>
</tr>
<tr>
<td>Cricklewood Electronics</td>
<td>9</td>
</tr>
<tr>
<td>Crofton</td>
<td>79</td>
</tr>
<tr>
<td>The C.R. Supply Co.</td>
<td>76</td>
</tr>
<tr>
<td>Electronics World</td>
<td>76</td>
</tr>
<tr>
<td>Electrovalue</td>
<td>13</td>
</tr>
<tr>
<td>Enfield Electronics</td>
<td>79</td>
</tr>
<tr>
<td>Futronics</td>
<td>77</td>
</tr>
<tr>
<td>Gresson (EMOS)</td>
<td>78</td>
</tr>
<tr>
<td>G.S.C</td>
<td>61</td>
</tr>
<tr>
<td>Adam Hall Supplies Ltd.</td>
<td>77</td>
</tr>
<tr>
<td>Hameg</td>
<td>54</td>
</tr>
<tr>
<td>ICS Intertext</td>
<td>79</td>
</tr>
<tr>
<td>I.L.P. Electronics</td>
<td>6, 7, 68</td>
</tr>
<tr>
<td>London College</td>
<td>77</td>
</tr>
<tr>
<td>Maplin Electronics</td>
<td>Cover 4</td>
</tr>
<tr>
<td>Mercia</td>
<td>4</td>
</tr>
<tr>
<td>Midwich</td>
<td>33</td>
</tr>
<tr>
<td>Millhill Supplies</td>
<td>79</td>
</tr>
<tr>
<td>Modern Book Co.</td>
<td>78</td>
</tr>
<tr>
<td>Myers Electronics</td>
<td>76</td>
</tr>
<tr>
<td>Parndon Electronics</td>
<td>4</td>
</tr>
<tr>
<td>Phonosonics</td>
<td>12</td>
</tr>
<tr>
<td>Pimac</td>
<td>77</td>
</tr>
<tr>
<td>P.K.G. Electronics</td>
<td>77</td>
</tr>
<tr>
<td>Powertran Cover 2</td>
<td>76</td>
</tr>
</tbody>
</table>

### TECHNOMATIC LTD 01-452 1500 01-450 6597

#### CONNECTOR SYSTEMS

<table>
<thead>
<tr>
<th>I.D. CONNECTORS</th>
<th>O Connectors</th>
<th>DIL HEADERS</th>
<th>RIBBON CABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (Block Type)</td>
<td>9 way 15 way 25 way 35 way</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>No of Header</td>
<td>20</td>
<td>15 16</td>
<td>15 16</td>
</tr>
<tr>
<td>10 20 30 40</td>
<td>150 160 170 180</td>
<td>150 160 170 180</td>
<td></td>
</tr>
<tr>
<td>25 30 35 40</td>
<td>150 160 170 180</td>
<td>150 160 170 180</td>
<td></td>
</tr>
<tr>
<td>30 35 40</td>
<td>150 160 170 180</td>
<td>150 160 170 180</td>
<td></td>
</tr>
<tr>
<td>35 40</td>
<td>150 160 170 180</td>
<td>150 160 170 180</td>
<td></td>
</tr>
</tbody>
</table>

#### TECHNOMATIC CABLES

- **JUMPER LEADS**
  - 24" Ribbon Cable with headers & sockets
  - 100 160 200 240 300 400 500 600 |
  - 1000 1500 2000 2400 3000 4000 5000 6000

- **EURO CONNECTORS**
  - Inch Edge Connectors
  - DIN STD
  - 25 way Male 250p Female 350p
  - 50 way Male 550p Female 650p

- **EDGECOJECTORS**
  - 8" 1" 150p
  - 2 x 32 way 650p
  - 2 x 32 way 600p
  - 2 x 32 way 550p

#### SPECIAL OFFER

| 2114-450 | 250p |
| 2100-450 | 250p |
| 4164-2 | 350p |
| 2716(5V) | 350p |
| 2732 | 350p |
| 2532 | 350p |

#### OFFICIAL BBC DEALER

- **BBC Model B £399 including VAT. (Carr. £3)**
- **Model A to B upgrade kit £49.50**
  - Installation charge £15
  - Individual upgrades and all mating connectors available.

#### BBC DISC DRIVES

- **Disc Interface Kit £95**
  - Installation £20
- **BBC Single Drive £235. BBC Dual Drive £799**

### BBC COMPATIBLE DRIVES

| Single 100K | £190 200K £255 400K £345 |
| Dual 200K | £360 400K £480 800K £610 |

- **Cable for Single Drive £8. Dual Drive £12.**
- **(Carr. Single Drive £6, Dual Drive £8)**
- **Discoettes: 40 track SS £15, 80 track SS £24, 80 track DS £32.**

#### VIEW 16K WORD PROCESSOR ROM £52

- **TELETEX RECEPTOR £95.65 + £5.5p**
- **PRESERVICE RECEIVER £90.00 + £2.5p**
- **2ND PROCESSOR + 64K RAM £195 + £45.5p**

Please phone to confirm delivery details.

### PRINTERS

- **NEC PC1028 BE**
  - 80 col 100 dtp dot matrix printer, Bi-directional, Logic sensing, 2K buffer, Forward and Reverse line feed, Hi Res & Black Graphics, Proportional Spacing, International and Greek character sets, Auto underline, Friction/tractor selectable.

#### EPSON MX80 F/T3 and EPSON MX100 F/T3

- **MX80 80 cols 100 dtp. MX100 100 cols 136 cols. Logic sensing, Bi-directional, bit matrix printing, 9x9 matrix, Auto Underline. MX83 F/T3 £220, MX100 F/T3 £340.**

#### SEIKO S/C 102A

- **80 col. 30 dtp dot matrix printer, High Res Graphics, Std & double with characters. £190 + £5.5p.**

#### OLVETTI SPARK-JET PRINTER

- **50 Lines/min or 83 cps, 1K buffer, full graphics, 96ASCII Characters, 7 x 7 dot matrix, £365 + £6.5p.**

As recommended by ACORN.

ACORN ATOMS ALSO AVAILABLE IN STOCK.

SEND FOR OUR BBC/ACORN LIST.
SPEECH SYNTHESISER FOR ZX81 and VIC20

THE MAPLIN TALK-BACK

Now your computer can talk!

• Allophone (extended phoneme) system gives unlimited vocabulary.
• Can be used with unexpanded VIC20 or ZX81 — does not require large areas of memory.
• In VIC20 version, speech output is direct to TV speaker with no additional amplification needed.
• Allows speech to be easily included in programs.

Complete kit only £24.95.
Order As LK00A (VIC20 Talk-Back).
LK01B (ZX81 Talk-Back).

Full construction details in Maplin Projects Book 6.
Price 70p. Order As XA06G (Maplin Mag Vol. 2 No. 6).

MAPLIN'S FANTASTIC PROJECTS

Full details in our project books. Issues 1 to 5. 60p each.

In Book 1 (XAO1B) 120W rms MOSFET Combo Amplifier
• Universal Timer with 18 program times and 4 outputs
• Temperature Gauge
• Six Vero Projects

In Book 2 (XAO2C) Home Security System
• Train Controller for 4 trains on one circuit
• 60Hz watch with multiple modes
• Miles-per-Gallon Meter

In Book 3 (XA03D) ZX81 Keyboard with electronics
• Stereo 25W MOSFET Amplifier
• Doppler Radar Intruder Detector
• Remote Control for Train Controller

In Book 4 (XAO4E) Telephone Exchange for 16 extensions
• Frequency Counter 10Hz to 60MHz
• Ultrasonic Intruder Detector
• 1/0 Port for ZX81
• Car Burglar Alarm
• Remote Control for 25W Stereo Amp

In Book 5 (XAO5F) Modern to European standard
• 100W 240V AC Inverter
• Sounds Generator for ZX81
• Central Heating Controller
• Panic Button for Home Security System
• Model Train Projects
• Timer for External Sounder

In Book 6 (XAO6G) Speech Synthesiser for ZX81 & VIC20
• Module to Bridge two of our MOSFET Amps to make a 350W Amp
• ZX81 Sound on your TV
• Scratch Filter
• Damp Meter

MAPLIN'S NEW 1983 CATALOGUE

Over 390 pages packed with data and pictures and all completely revised and including over 1000 new items.
On sale in all branches of WH SMITH
Price £1.25

MAPLIN ELECTRONIC SUPPLIES LTD.
P.O. Box 3, Rayleigh, Essex SS6 8LR
Telephone: Sales (0702) 552911 General (0702) 554155

Shops at:
- 159 King St., Hammersmith, London W6. Telephone: 01-748 3926
- 284 London Rd., Westcliff-on-Sea, Essex. Telephone: (0702) 554000

Lyon Square, Perry Barr, Birmingham. Telephone: (021) 356 7292