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```
PRINT VAL(X) + 10
REM RETURN
STOP
```

**FUNCTIONS**

- ABS(X)
- ATN(X)
- COS(X)
- EXP(X)
- LOG(X)
- PEER(X)
- PFS(X)
- SIN(X)
- SOR(X)
- TAN(X)
- SQR(X)
- SGNS(X)
- TRN(X)
- STRS(X)
- CSAVE(X)
- CHN(S)
- FRE(X)
- I(N)
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- SPS(I)
- TMS(X)
- VAL(X)

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Great new Crofton double!

Self contained MONITOR

PCB

- Compact size, 5" x 7"
- Complete with power and video plugs, plus leads
- Scan coil assembly as standard supplied
- Transformer, tubes, and surrounds available
- 15v Mains or 12v DC power
- Ideal for O.E.M. use

ONLY £35.50

EX VAT AND P&P

Crofton Electronics
Crofton Electronics Limited, 35 Grosvenor Road, Twickenham, Middlesex. Tel.: 01 891 1923

---

DIGITAL MULTIMETER
- DC Volts: 1mV to 1000V
- AC Volts: 1V to 500V
- DC Current: 0.1mA to 9.2A
- 3½ digit LCD
- Auto Polarity & Zero
- 1% accuracy (DC volts)
- Designed around Intersil 7106 IC
- Total cost around £30 (incl. case)

FUNCTION GENERATOR
- 30mV to 10V pk-pk
- 1Hz to 10kHz
- DC coupled
- Sine, Square & Triangle
- Separate TTL output
- Designed around Intersil 8038 IC
- Total cost around £25 (incl. case)

Provided in a JAYkit is a Printed Circuit Board, a punched and lettered Front Panel, a Circuit Diagram and Instruction Sheet and a comprehensive and up to date Component List showing suppliers and current prices. Difficult pieces of hardware such as screws, washers etc. are supplied with the kit.

To: JAYEN Developments
21 Gledenide, Bar Hill, Cambridge CB3 8DY
Tel.: (0525) 80289

Please send:
- DM-2 @ £5.45
- FG-1a @ £4.95
  (incl. VAT and P&P)

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

---

NAME ____________________________
ADDRESS _________________________

---

Practical Electronics  December 1979
**Mullard**

**AUDIO MODULES IN BARGAIN PACKS**

**CURRENT CATALOGUE**

**PRICE S. AT OVER 23 PER PACK**

**SEE OUR PRICES**

1. **PACK 1** 2 x LP1173 10W RMS output power audio amp modules + 1 LP1184/2 Stereo pre amp for ceramic and auxiliary input.
   - **OUR PRICE** per £1.00

2. **PACK 2** 2 x LP1173 10W RMS output power audio amp modules + 1 LF1183/2 Stereo pre amp for ceramic, ceramic and auxiliary inputs.
   - **OUR PRICE** per £1.00

**ACCESSORIES**

Suitable for use with all modules. Includes 10 watt amplifier, 15 watt rectifier, smoothing capacitors, and series resistors. Contains 2 controlling parts and 2 rotary stereo controls for treble, bass, volume and balance.

**COMPANY**

**Per pack £1.50**

**FOR PERSONAL SHOPPERS ONLY**

**STereo System**

Simply ahead...

ILP'S NEW GENERATION OF HIGH

ILP modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With ILP performance standards and quality already so well established, any advances in ILP design are bound to be of outstanding importance — and this is exactly what we have achieved in our new generation of modular units. ILP professional design principles remain — the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. ILP modules are for laboratory and other specialised applications too.

PRODUCTS OF THE WORLD'S FOREMOST SPECIALISTS IN ELECTRONIC MODULAR DESIGN

10 Practical Electronics December 1979
and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multifunction equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz-0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power R.M.S.</th>
<th>Distortion Typical at 1KHz</th>
<th>Minimum Signal/Noise Ratio</th>
<th>Power Supply Voltage</th>
<th>Size in mm</th>
<th>Weight in gms</th>
<th>Price + V.A.T.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY30</td>
<td>15 W into 8 Ω</td>
<td>0.02%</td>
<td>80dB</td>
<td>-10 -0 +20</td>
<td>105x50x25</td>
<td>155</td>
<td>£6.34 + 95p</td>
</tr>
<tr>
<td>HY50</td>
<td>30 W into 8 Ω</td>
<td>0.02%</td>
<td>90dB</td>
<td>-25 -0 +25</td>
<td>105x50x25</td>
<td>155</td>
<td>£7.24 + E1.00</td>
</tr>
<tr>
<td>HY120</td>
<td>60 W into 8 Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>-35 -0 +35</td>
<td>114x50x85</td>
<td>575</td>
<td>£15.20 + £2.20</td>
</tr>
<tr>
<td>HY200</td>
<td>120 W into 8 Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>-45 -0 +45</td>
<td>114x50x85</td>
<td>575</td>
<td>£18.44 + £2.77</td>
</tr>
<tr>
<td>HY400</td>
<td>240 W into 8 Ω</td>
<td>0.01%</td>
<td>100dB</td>
<td>-65 -0 +65</td>
<td>114x100x85</td>
<td>1.15Kg</td>
<td>£27.68 + £4.15</td>
</tr>
</tbody>
</table>

Load impedance - all models 4 - 16 Ω
Input sensitivity - all models 500 mV
Input impedance - all models 100 KΩ
Frequency response - all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS

I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms - one with circuit panel mounted on conventionally styled transformer the other with toroidal transformer having half the weight and height of its conventional laminated types.

PSU 36- for 1 or 2 HY30’s £8.10 + £1.22 VAT
PSU 50- for 1 or 2 HY50’s £8.10 + £1.22 VAT
PSU 70- with toroidal transformer for 1 or 2 HY120’s £13.61 + £2.04 VAT
PSU 90- with toroidal transformer for 1 HY200 £13.61 + £2.04 VAT
PSU180- with toroidal transformer for 1 HY400 or 2 x HY200 £23.02 + £3.45 VAT
PSU 30- ± 15V at 100mA to drive up to five HY5 pre-amps £4.50 + 68p VAT

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

ALL U.K. ORDERS DESPATCHED POST PAID

HOW TO ORDER, USING FREEPOST SYSTEM

Simply fill in order coupon with payment or credit card instructions. Post to address as below but do not stamp envelope - we pay postage on all letters sent to us by readers of this journal.

Please supply
Total purchase price £
I enclose Cheque □ Postal Orders □ International Money Order □ Please debit my Account/Barclaycard Account No.
NAME
ADDRESS
Signature

ELECTRONICS LTD.
FREEPOST 2 Graham Bell House, Roper Close, Canterbury, Kent CT2 7EP.
Telephone (0227) 84778 Telex 905780

Practical Electronics December 1979
Are your meters good enough?
If your recordings are spoilt by uneven levels and overloads—install Soundex professional PPM's now.

The Soundex PPM 402 priced at £34.95 (plus VAT), has a closely specified electrical performance with a meter scale that has been developed from the BBC and VU scales providing high clarity and accuracy of indication. Special Features include:
- Bipolar rectification
- Closed loop meter drive
- Wide frequency response
- Low current consumption
- Amplitude dependant amplifier
- Attack and decay circuits

Send for technical literature on the new 402

Bulgin Electronics
One of the Bulgin Group of Companies
Park Lane, Broxbourne, Herts, Tel: Hoddesdon 64455

FREE LINE-UPOSCILLATOR WORTH NEARLY £5 WITH ALL ORDERS PLACED BY NOVEMBER 23RD '79

See us on Stand 609 at Electronics '79, Olympia, November 20-23rd where the full Soundex range will be on display.

CRESCENT RADIO LTD.
1 ST. MICHAELS TERRACE, WOOD GREEN, LONDON, N22 4SJ (MAIL ORDER DEPT.)

FLIP Push button Heads or Tail.
Complete kit and full instructions supplied.
A pocket game. Easy to build and great to play. Kit price £5.25 + 78p VAT.

3 KILOWATT PSYCHEDELIC LIGHT CONTROL UNIT
100W lighting per channel, max. + 3 channels sound to light and music in a robust metal case, with a sensitivity control for each channel i.e. Bass, middle and treble. Full instructions make this unit easy to connect to your present amplifier. 2.5 mm jack socket.
Still only £20.00 + £3 VAT.

U.S.A CO-AXIAL PLUG SOCKETS AND ADAPTORS

Send 30p STAMP FOR THE WORLD'S BEST CATALOGUE OF SPEAKERS, DRIVE UNITS, KITS, CROSSOVERS, ETC. AND DISCOUNT PRICE LIST

WILMOSLOW AUDIO (Dept. P.E.)
SWAN WORKS, BANK SQUARE, WILMOSLOW, CHESHIRE SK1 1HF
Discount Hi-Fi, etc. at 5 Swan Street
Tel: Wilmslow 528598 for Speakers  Tel: Wilmslow 526213 for Hi-Fi
TRITON SINGLE PERSONAL COMPUTER

Three new exciting expandable systems designed for ease of construction and flexibility. Kits come complete with case, power supply, full keyboard, PCB. All components available separately. See catalogue. Full hardware & programming manual available. The system is easy to expand and is well supported. Features: 2, 5, 6 or 7k basic in Erom (See catalogue)

- Single board
- Basic in eprom
- Holds up to 8k memory
- 64 graphic characters
- UHF or video output
- Plug in expansion boards
- Cassette interface
- Three firmware options

From £286

BI DIRECTIONAL MATRIX PRINTER £595 +VAT

The BDB80 is a low cost, 80 column line printer with microprocessor control to provide excellent reliability and performance.

- 5x7 Dot matrix
- Full asscl char set
- 84 lines per minute
- 10 char per inch
- 10 lines/sec
- Self test
- 5 lines/ inch
- paper advance
- Fully cased

A UNIQUE PRINTER FAST AND RELIABLE

Switch selectable baudrate from 110 to 9600 on a standard V24 and RS232 interface. Send SAE for further details. Ideal printer for Triton or any system requiring high speed reliable hard copy. We can supply consumables.

COMPONENTS 74LSXX

<table>
<thead>
<tr>
<th>Value</th>
<th>Catalogue No.</th>
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<tbody>
<tr>
<td>74LS245</td>
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<td>74LS241N</td>
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<tr>
<td>74LS240</td>
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</tbody>
</table>

TRITON DOCUMENTATION

Available separately as follows

- L4-1 Listing of 1K monitor 2k byte basic: £5.70
- L5-1 User documentation on level 6-1 firmware: £1.20
- L5-1 Listing of 1K monitor and 2-5k basic: £5.50
- L6-1 User documentation on 7k basic interpreter: £1.80
- Motherboard, 8k Ram and 8k Eprom constructional details £6.00
- User group newsletter subscription £4 per annum. Triton software send SAE for list of programs available for Triton.

EXPANSION MOTHERBOARD TRITON

Expand your Triton simply and easily with our new 8-slot motherboard complete with its own P.S.U. takes 8 plug-in Euro cards. Plug-in 8k Ram card and Eprom cards now available. Kit complete with PSU & S1 set connectors

8K RAM CARD

Triton 8k basic Ram card, 2114 Low power 8k.
Static RAM. On board regulator, memory jump select.
PCB only £15
Kit less £35 inc. all sockets & components.

£97 +VAT

8K EPROM CARD

Triton 8k Eprom card kit. Designed to take up to 8x2708 Eproms (11x8)

PCB only £15
Kit less £35
Eproms (blank) £3
Plus VAT

£97 +VAT

S100 boards

8k Basic RAM board (16K)
8k Basic RROM board (256k)
280 cpu board (2MHz)
280 mother board (4MHz)
2708/2716 EPROM board
Prototype board (kite board)
Video display board (HD44780)
128K RAM.
Dual bus motherboard
K2 disk operating system
Assembly's Make Assem

Matrix Printer £595 +VAT

Cassette interface
UHF or video output
Single board
Full hardware & programming
keyboard, PCB. All components

Switch selectable baudrate from 110 to 9600 on a standard V24 and RS232 interface. Send SAE for further details. Ideal printer for Triton or any system requiring high speed reliable hard copy. We can supply consumables.

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- Motherboard, 8k Ram and 8k Eprom constructional details £6.00
- User group newsletter subscription £4 per annum. Triton software send SAE for list of programs available for Triton.
Stereo 30

**Complete Audio Cassette**

£22.06 + 65p p&p T & M.R.S.

The Stereo 30 comprises a complete stereo pre-amplifier and power supply. This, with the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs. This pre-amplifier is designed to provide an output of up to 125W RMS with distortion levels below 0.1%. It is supplied with full instructions, back panel, knobs, switch, fuse and fuse holder and universal mounting brackets.

**AL60**

**Audio Amplifier Module**

25 watts R.M.S. £5.95 + 35p p&p

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25W RMS with distortion levels below 0.1%.

**AL80**

**Audio Amplifier Module**

35 watts R.M.S. £6.25 + 35p p&p

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W RMS with distortion levels below 0.1%.

**AL250**

**Audio Amplifier Module**

125 watts R.M.S. £7.45 + 35p p&p

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

**SMP80**

**Stabilised Power Supply**

£5.06 + 35p p&p

Designed to power two ALSOs at 15 Watts per channel simultaneously. Circuit Technique includes full short circuit protection.

**PA100**

**Stereo Pre-Amplifier**

£18.46 + 45p p&p

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button switch gives a choice of inputs together with two filters for high and low frequencies.

**MPA30**

**Magnetic Cartridge Pre-Amplifier**

£3.43 + 35p p&p

Enjoy the quality of a magnetic cartridge with your high fidelity stereo equipment using the MPA30 which employs state of the art pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

**PA12**

**Stereo Pre-Amplifier**

£8.95 + 35p p&p

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL20, 30 Audio Amplifier Modules, the PS12 power supply and the FM Transformer. Features include output volume, balance, bass and treble controls. Complete with tape output.

**PA11**

**Stereo Pre-Amplifier**

£19.47 + 80p p&p

**PS12 Power Supply Module**

Power supply for AL20A-30A, PA12, 450 etc. Transformer T65G. Input A.C. Voltage 15-20V. Output D.C. Voltage 25-30V approx. (Depends on input.) Output Current 800mA maximum. Dimensions 60 x 43 x 26mm.

£1.73 + 35p p&p

**BP124 Siren Alarm Module**

American Police siren powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for burglar alarm, fire detector, and other security purposes.

**ST15A Stereo Amplifier Kit**

Build your own top quality amplifier, save yourself pounds. The ST15A kit comprises the following modules, 2X AL20 amplifiers, 1 x PA100 pre-amplifier, 1 x MPA30 sub-power supply, 1 x SMP80 stab. power supply, 1 x SMP80 stab. power supply. All modules are supplied in kit form, complete with full kit instructions. Kits covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.

Price £60.00 + 83p p&p. Order No. 2240.

**ST15A ACCESSORY KIT**

A beautifully designed genuine TEAK WOOD veneered cabinet to fit the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuse Sockets, Noetry etc. Ideal for the MSA. Size: 45mm x 25mm x 60mm. Price £21.94 + 83p p&p. Order No. 2240.

**TRANSFORMERS**

**T90** For use with 5 x AL20A, MPA30, Order No. 2936 Price: £34.50 + 83p p&p.

**T200** For use with AL20, 30 modules, Order No. 2936 Price: £3.74 + 55p p&p.

**T2550** For use with AL50 and SMP80, Order No. 2936 Price: £6.21 + 1.00 p&p.

**T2570** For use with ALS0 and MPA30, Order No. 2938 Price: £7.37 + 1.00 p&p.

**T50** For use with ALS0, Order No. 2940 Price: £5.98 + 80p p&p.

**T2041** For use with ALS0 and AL50, Order No. 2240 Price: £7.82 + 85p p&p.

**CASES**

**TEAM 30**, 32 x 23 x 8 cm. Designed for use with our lines 30 Audio System but two proved very helpful to home constructors. Fitted with solid wooden front and back, on 125, £8.43, £8.95, £8.70.

**TEAM 40**, 42 x 23 x 8 cm, forked for ALGEMEK0 Audio Kit. Useful for the home constructor requiring an amplifier sleeve. Rear has no front or back panel, on 140, £8.83, £9.50.
**Proprietors and Enthusiasts from BI-PAK**

**AL120**
- **AUDIO AMPLIFIER**
- **50W R.M.S.**
  - **OUTPUT POWER**: 50 Watts R.M.S.
  - **SUPPLY**: 70 Wats
  - **LOAD IMPEDANCE**: 8 - 16 ohms
  - **TOTAL HARMONIC DISTORTION**: 0.05% Max, (Typically 0.02%)
  - **FREQUENCY RESPONSE**: 20Hz - 20kHz
  - **RESPONSE FREQUENCY**: 2.8 - 20kHz
  - **SENSITIVITY**: 500mV
  - **MAX HEAT SINK TEMP**: 45°C C.
  - **DIMENSIONS**: 192 x 89 x 49 mm

**SPM120**
- **STABILIZED POWER SUPPLIES**
  - **SPM120/85**: 48V-1A
  - **SPM120/55**: 55V-1A
  - **SPM120/65**: 65V-1A
  - **CURRENT OUTPUT**: 1.5A
  - **RIPPLE**: 1.5A
  - **12A-120mA. £1,84. p&p 35p.**

**SIGNAL/NOISE RATIO**
- **SENSITIVITY**: FSD 200UA OdB 130UA
- **TOTAL HARMONIC DISTORTION**: ± 15dBs at 75Hz
- **20Hz to 20kHz**

**ADAPTORs**
- AC-DC enables a large range of battery operated radios, recorders, etc to be run off the mains. £12.20. p&p 35p.
- Suitable for 120-240V AC or DC at 300mA. For radios, recorders etc. on £138. £3.22. p&p 35p.

**CROSSOVER NETWORKs**
- 2-WAY crossovers for high and low frequencies to connect speakers - high frequencies to tweeters, low frequencies to woofers. £15.50. p&p 35p.
- 3-WAY for 8 ohm speakers up to 30 watts. Frequency: 1,000Hz, £16.4. p&p 35p.
- 3-WAY for 8 ohm speakers up to 30 watts. Frequency: 1,000Hz, £16.4. p&p 35p.

**MICROPHONES**
- **DYNAMIC MICROPHONE**
  - Superior quality portable cassette recorder microphone with built-in remote control switch and lead fitted with a 5 pin 24P plug (female), £4.85. p&p 35p.
  - Provides a direct replaceable connecting lead. £2.50. p&p 35p.

**STANDS**
- GROO-DEESECHROME HIGH GRADE SPEAKER STANDS
  - Length 325mm. £1,53. £3.95. p&p 35p.
  - Length 500mm. £2.99. £4.95. p&p 35p.

**WINDSHIELD COVERS**

**HEADPHONES**
- **PA200 STEREO PRE-AMPLIFIER**

**BIB**
- **HI-FI ACCESSORIES**

**GROO-STAT**
- The Bib Grow Stat sturrn relay neutralizes the static charge on records and other plastic surfaces. £10.00. £10.00. p&p 35p.
**ADAPTORS**
- 2-WAY crossovers for high and low frequencies to connect speakers - high frequencies to tweeters, low frequencies to woofers. £15.50. p&p 35p.
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**WINDSHIELD COVERS**
Just a little bit more...

Compare its features:
- Z-80A 48MHz CPU: The most powerful 8-bit processor on the market.
- 280A 418142. CPU: The most powerful 8-bit processor on the market.
- 111K Basic: resident on board, MICROSOFT Basic, the industry standard, with extensions for on-screen editing, graphics, machine code interfacing. Optimized for spud (see benchmarks below).
- Kansas City cassette interface for reliable storage of programs and data at 300 or 1200 baud, with full checksum error detection.
- Kansas City cassette interface for reliable storage of programs and data at 300 or 1200 baud, with full checksum error detection.

Nas-sys monitor: A powerful 2K machine code monitor provides an ideal environment for learning about and developing machine code programs. Nas-sys uses a blinking non-destructive cursor, with 22 commands. ASCII terminals are fully supported via the terminal. Users can add their own I/O drivers via the system I/O vector table to support other devices.

Nas-sys commands are:
- A - Hex arithmetic
- B - Copy
- C - Copy
- D - Execute
- E - Execute
- F - Execute
- G - Generate
- H - Generate
- I - Intelligen copy
- J - Execute at FPA
- K - Execute at FPA
- L - Execute at FPA
- M - Execute at FPA
- N - Execute at FPA
- O - Execute at FPA
- P - Execute at FPA
- Q - Execute at FPA
- R - Execute at FPA
- S - Execute at FPA
- T - Execute at FPA
- U - Execute at FPA
- V - Execute at FPA
- W - Execute at FPA
- X - Execute at FPA
- Y - Execute at FPA
- Z - Execute at FPA

On board P.I.O. - An uncommitted P.I.O. (MK 3881) giving 16 programmable I/O lines with handshake.

On board RS-232 - Will Interlace directly into any standard teletype - allowing use of BASIC or Nas-sys from the teletype.

Full on-screen editing: a complete screen editor with cursor movement (UP, DOWN, LEFT, RIGHT), Insert and delete, backspace etc.

Screen display of 16 lines at 48 characters: Stable, clear display to British television standards. Full 128 ASCII character set; option for further 128 graphics characters.

Fully buffered NASBUS compatible: Well defined bus structure with a range of expansion cards; including (shortly) a floppy disc system with CP/M - the Industry standard operating system.

**PERSONAL COMPUTER WORLD BENCHMARK TESTS**

<table>
<thead>
<tr>
<th>Computer</th>
<th>Apple II+</th>
<th>Acorn 380Z</th>
<th>PET</th>
</tr>
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<tbody>
<tr>
<td>BM1</td>
<td>1.2</td>
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<td>1.4</td>
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There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (0452 29451).
THE COUNTRY

Even in the face of a Government paper, which basically reports that the microprocessor revolution will create more employment in the foreseeable future, and the recent Labour Party commitment to microelectronics at its conference, some bodies are still spreading gloom over the electronics industry and the country. Even if there are sound arguments behind such pessimistic views, we are pleased to report that at last we are beginning to stop procrastinating and get on with the job in hand.

Many component distributors have been reporting an increase of up to 60 per cent in sales, this increase started back in August—normally a quiet month in the industry. The boom is generally attributed to the employment of m.p.u.s in new designs and equipment causing a market expansion, especially in demand for memories. The problem is that we are now years behind the Americans and our industry has been so slow to react to the new technology that a very high percentage of the newly developed equipments are being imported because, as yet, there are no British competitors.

It seems to us that, as a nation, we excel at the investigation and discussion of possible social problems and both management and workers—usually for very different reasons—are initially set against the speedy introduction of new techniques and technology. Both the lengthy strikes at The Times and ITV have had much to do with new technology. Unless our basic attitudes to progress change we will suffer a lower standard of living and new technology will cause unemployment—because we refuse to allow it to be used. We must all be prepared to change our views and retrain ourselves if necessary; if we do and if we move quickly we will ultimately all prosper.

THE HOBBYIST

Unfortunately the present buying spree by industry is creating component supply problems and once again we suspect the hobbyist is beginning to suffer. There has been a world shortage of ROMS and this has affected the supply of parts for home computers. Delivery dates are again lengthening and sometimes being broken by manufacturers, so have some sympathy with your component retailer if he is out of stock and says it could be a month or two before a certain device is again available—very often he can only pass on information from the manufacturer and that information has, in the past, sometimes proved to be unreliable.

These problems also have a bearing on the projects we bring you. Recently we have been investigating the possibility of publishing a constructional design for one of the latest devices, only to discover that no mask-programmed single chip processors, suitable for our purpose, were available in less than six months. Steps are now being taken to circumvent the problem with the use of a PROM—this alternative will cost slightly more but the six months gained will be worth it. However, the supply of PROMS and RAMS is now under some strain so we must also watch that position carefully. The time problem is not because we are small hobbyist buyers—we have been discussing a device costing about £6,000 to get into production with one of the world’s largest suppliers.

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Technical Queries

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

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

Back Numbers

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 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £3·75 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 £10·60 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.
Market
Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by
Alan Turpin

and
David Shortland

HUNTRON TRACKER

The Huntron Tracker is a versatile instrument for trouble-shooting solid state circuits. The unit is capable of in-circuit testing of a number of discrete components: i.e., transistors, FETs, diodes, i.e.s, Zeners, UJT's, electrolytic capacitors and gate controlled devices.

The Tracker uses a scope display, two non-polarised leads and three impedance ranges. The scope display show the condition of the device under test indicating “shorts”, “opens” and “leaks”. Both the forward and reverse response of the component can be displayed on the scope screen.

The price of the Tracker will be around £500. MTL Microtesting Limited, 1-15 Butts Road, Alton, Hants. GU34 1EN (0420 88022).

DTL/TTL, CMOS PROBE

The 3300A logic probe which has a 1 Megohm input impedance is supplied with two i.e.s clips (a single pole and a 16 pole), carrying case and operating instructions.

The instrument operates on voltages from 5V to 18V d.c. and is protected against reverse p.s.u. connections and input over voltage.

Two i.e.s are used to detect high and low logic levels with the TTL threshold being 2.2V ± 0.2V for logic ’1’ and 0.6 ± 0.2V for logic ’0’. The CMOS threshold is 70 per cent of the supply voltage ± 0.5V (logic ’1’) and 30 per cent of the supply voltage ± 1.0V (logic ’0’).

The price of the 3300A is £14.50 plus VAT and p&p. Watford Electronics, 33/35 Cardiff Road, Watford, Herts. WD1 8ED (9023 40588).

NEW CASES

Three new cases have been added to Vero Electronics range of moulded enclosures.

A desk top case (228 x 216mm) which is ideal for control equipment and keyboards is available in two versions, one with a raised top unit for digital readouts, encoders and other switches. Both have a base section moulded with an integral rear panel to accommodate connectors and plugs. Six mounting bosses are also provided in the base with holes to take self-tapping screws. Top and base sections screw together and the kit comes complete with aluminium front panels and fixing screws.

The other case, 150 x 85 x 45 mm high, has a front panel for identification and controls, which is protected by a raised edge all round. Assembly of components and connections to the front panel is simple as with the case cover removed, components are accessible from all sides. The front panel is connected to the base by moulded posts and retained by the case cover. P.c.b. mounting pillars are moulded into the base, and a raised end surface is provided for cable grommets or components.

The price of the three cases are £9.50, £7.60 and £4.60 respectively.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants SO5 3ZR (0421 569111).

DRILL AND DE-BURR

The step configuration of these Unibits allows drilling and simultaneous de-burring of a range of holes with one bit. Five bits cover holes from 4mm to 34mm in 1mm or 2mm steps. Unibits are said to cope with sheet steel, brass, aluminium, copper, plastic and wood. Price from £7.38 inc. VAT, exc. p&p.

Toolrange Ltd., Upton Road, Reading RG3 4A (0734 294446).
**HP-41C**

The latest programmable calculator from Hewlett Packard has a 12-character liquid crystal display, alpha-numeric keyboard and a memory which can retain data and programs after the calculator has been switched off. The type of memory can be selected from 448 bytes or 63 data storage registers or any blend of bytes and registers required.

The HP-41C has a total of 130 mathematical, scientific and statistical functions which are identified on the keyboard or can be used by either spelling the name of the function or assigning it to a particular key replacing a function which is not needed in the calculation. Two overlays are provided to enable users to re-label the keyboard with the functions they use most.

For problems in specialised areas such as engineering, aviation, finance, surveying etc. plug in modules are available together with handbooks. Any created programs should be assigned a name and then keyed in and whenever the program name is entered the program is automatically carried out.

Peripheral devices available for use with the HP-41C include: memory modules, magnetic card readers, plotting printer and an optical reader for bar codes. The card reader can be used to record programs which on replay become part of the calculator's memory. The programs on the card can also be instructed only to execute the program and not allow alterations. The thermal printer can print numbers, letters (upper and lower case), special characters, graphics and produce high resolution plots from data of programs.

The price of the HP-41C is £190, the card reader £135 and the printer £260 plus VAT and p&p.

Hewlett-Packard Ltd., King Street Lane, Wokingham, Berks. (0734 784774)

**US CRAZE**

As one of the latest crazes in the US at the moment is hand held computer games you won't be surprised to hear that many manufacturers are predicting this Christmas as the start of the "craze" period for these games over here. Tempus are offering a range of games which includes Digits, a variation of Mastermind or Codebreaker where the player must guess a hidden number in as few attempts as possible.

Amaze-A-Tron which is a maze game for two players who must find their way through a maze using coloured pegs on a 25 key matrix board. There are eight game variations and over one million different mazes available.

The U.F.O. Master Blaster Station is a game in which you shoot down as many U.F.O.s as possible before they reach your station. The U.F.O.s can change course, disappear or descend in pairs and you can increase the difficulty by increasing the speed of descent.

Each timer fits into standard octal or 1-pin bases and are compatible with many existing types. The price range of the timers is from £15.50 to £18.00 excluding VAT and p&p.

A.I., 70 Broomfield Road, Chelmsford, Essex CM1 1SW (0245 68459).

The price of these games vary from £13.95 to £22.50 ex. VAT and p&p.

Tempus 19-21 Fitzroy Street, Cambridge CB1 1EH.

**PLUG-IN TIMERS**

A new range of plug-in timers introduced by Adonis Instruments can be used to time intervals between 1 sec and 100 hours.

Both "delay on energise" or "interval delay" types are available and all types have the facility for "external start" from a remote signal. A range of voltage types are stocked, varying between 12V and 240V with each timer having 2-pole changeover contacts rated at 10A/250V.

Protection against mains transients and reverse polarity connection are built into the timers and the time period can be set either with the control on top of the case, or fixed and adjusted with an external control.

The instrument which is housed in an ABS case with an adjustable carrying handle will give over 2000 hours life from a single battery.

Lascar Electronics Limited, Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex, SS13 1LH (0268 727383).
CRYSTAL SET
For anyone trying to find a Christmas present suitable for young children that will be both educational and interesting then the answer could be a crystal set. Many of us had our first introduction to electronics through such a set and Home Radio are hoping they will be able to addict youngsters to the hobby with their crystal set which is easy to build and requires no soldering. The price of the set is £2-50 including VAT and p&p. Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey CR4 3HD (01-648 8422).

BIMBOARD BUS-STRIP
To augment their existing range of 0-fin breadboards, Boss Industrial Mouldings have introduced a 2 line Bus-Strip for use where two existing integral rails of a Bimboard are insufficient for a particular circuit design. The price of the bus is £1-92 excluding VAT and p&p. Boss Industrial Mouldings Ltd., 2 Herne Hill Road, London SE24 0AU.

OPTOELECTRONIC SHORTFORM
Optron, the US specialist manufacturer of optoelectronic devices whose products are handled exclusively in the UK by Norbain Electro-Optics Division has just brought out a new shortform catalogue giving details of its latest optoelectronic emitters and sensors. They range from phototransistors, infrared light emitting diodes, and matched emitting diodes and phototransistors to photodarlington emitters and photodiodes.

NEOSID
Neosid Limited have recently established a new outlet to cater for the amateur constructor.

A broad selection of the parent company's products are included in their new Small Order Catalogue, which covers a full range of ferrite components i.e. beads, screw cores, rods, E, I and U cores, also coil assemblies, plastics formers and trimming tools.

The catalogue is available free of charge from Neosid Small Orders, P.O. Box 86, Welwyn Garden City, Herts, AL7 1AS. (Please send stamped addressed envelope.)

PANEL TIME
Have you ever wanted an l.c.d. clock to mount on the front panel of a project, amateur transceiver, teletext control box?
Ambit International are now stocking a miniature panel clock that can display time, day and date. The unit is quartz controlled, has a back light, and an alarm function to drive a bleeper or other indicator. Running consumption is 6µA, accuracy is within ±2.5 minutes per year, and height of the characters is up to 0.5m. The display shown has a character height of 0.25in. Price is £10-60 inc. VAT and p&p.
Ambit International, 2 Gresham Road, Brentwood, Essex, CM14 4HN.

FREQUENCY SYNTHESIZER
The FS-1B is a frequency synthesiser control unit module, comprising input prescalers, swallow counter, programmable divider, switchable filters and clock buffer.
It is programmed from a three line connection (clock/data/enable) with a 15 bit word that determines the reference frequency and output frequency of the VCO connected in the phase locked loop.
Frequencies in the range 20kHz to 200MHz may be programmed in conjunction with either discrete switch entry, hardwiring or simple computer control. A simple BASIC program exists to provide facilities for LF/MF/HF/VHF tuning options, so that owners of NASCOM, PET and similar systems may readily operate the module in conjunction with a voltage tuned radio having a buffered local oscillator output.
Various reference frequencies are available, both in conjunction with an on-board selection in the data control, and the use of different frequency crystals.
Priced at £24.95 in one-off quantities, the FS-1B is available from Ambit International, 2 Gresham Road, Brentwood, Essex CM14 4HN (0277 227050).

CSC CASE
The new hand-held case from CSC has been designed to house small, portable electronic systems such as calculators, counters, remote control units, communications devices and portable meters etc.

Measuring 76 x 152 x 8mm the case comes complete with assembly screws, antenna connector, red plastic front facia panel, sub-miniature jack connected to a battery snap connector and a battery compartment. There is sufficient room for keyboards, speakers, microphones or controls on the front panel.
The price of the case is £3-00 ex. VAT and p&p. CSC, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

NEW SHORT FORM OPTOELECTRONIC

The Ambit FS-1B Frequency Synthesiser is introduced in this shortform catalogue

FREQUENCY SYNTHESIZER

The Ambit FS-1B Frequency Synthesiser is introduced in this shortform catalogue

FREQUENCY SYNTHESIZER

The Ambit FS-1B Frequency Synthesiser is introduced in this shortform catalogue

PE AT BREADBOARD '79

DECEMBER 4th–8th AT ROYAL HORTICULTURAL HALLS, ELVERTON ST., WESTMINSTER

We will be exhibiting a range of projects and hope to include: Ultrasonic Alarm; Solid State Car Instruments; EPROM Programmer; Ultrasonic Cleaner; Teletext; Digital Frequency Meter; Compukit UK101 with peripherals; Short Range Communication Transmitter and Receiver; Modern; Pushbutton Car Radio; PE Diomatic and perhaps a few more forthcoming attractions. Interested? Then come along and see for yourself.

20 Practical Electronics December 1979
A computer range from £500

The number one micro-computer in Britain today, selling more than 1,000 per month!

The Commodore PET computer range is versatile and affordable. Programs can be written in Basic, the easiest computer language to learn. There is also machine language accessibility for professionals.

The PET is a fully expandable system, peripherals being available (peripherals such as dual drive floppy discs and printers). There are already over 300 standard programs, tested and in use in commercial, scientific, educational and many other applications throughout Britain. The PET is a portable and professional computer that operates by plugging into a normal 13 amp mains.

Service and advice is readily available through the nationwide network of dealer outlets.

For a demonstration contact your local dealer—some of whom are shown here. In case of difficulty contact Commodore Information Dept (PE2), Commodore Systems, 360 Euston Road, London NW1.

Associated Commodore dealers:

BIRMINGHAM
Camden Electronics 021-773 6240
CPS (Data Systems) 021-707 3866
Taylor Wilson Systems Knowle 6192
BOLTON
B & B Consultants 0204-26644
BOURNEMOUTH
Stage One Computers 0202-23570
BRADFORD
Achroyd Typewriter & Adding Machine Co 0274-31635
BRENTWOOD
Direct Data Marketing 0277-229379
BRISTOL
Bristol Computer Centre 0272-23430
Sumoria Tedbown 0272-26685
CAMBRIDGE
Cambridge Computer Store 0223-60655
CARDIFF
Sigma Systems 0222-21515
COLUMBIA
Dataview 0206-78991
DEBY
Davidson Richards 0332-368603
DURHAM
Dyson Instruments 0385-66937
EDINBURGH
Micro Centre 031-225 2022
EXETER
A C Systems 0392-71716
GRIMSBY
Allen Computers 0727-40568
HEMEL HEMPSTEAD
Data Efficiency 0442-57137
HOVE
Amplicon Electronics 0273-720716
LEEDS
Holdene 0532-459459
LIVERPOOL
Aughton Automation 051-548 6050
Cortex Computer 051-263 5783
Dams Office Equip. 051-227 3301
LONDON E2
Ragnarolk Elec Sys 01-981 2748
LONDON E1
Sumlock Bondain 01-253 2447
LONDON N14
Micro Computer 01-852 5101
LONDON NW
Da Vinci Computers 01-202 9630
LONDON SW1
Micro Computer Centre 01-876 6009
LONDON W5
Adda Computers 01-579 5845
LONDON WC1
Euro Calc 01-465 3113
LONDON WC2
TLC World Trading 01-634 3893
MANCHESTER
Cypher (UK) 061-632 7604
Executive Reprographic 061-226 1937
Sumlock Elec Sys 061-834 4233
MATLOCK
Love Electronics 0629-2817
MORLEY W. Yorks
Yorkshire Elec Svs 0532-522811
NORWICH
Sumlock Bondain 0603-26259
NOTTINGHAM
Belos (Systems) 0602-4106
OXFORD
Orchard Electronics 0491-35529
PLYMOUTH
JAC (Infor. Systems) 0752-62618
PRESTON
Preston Computer Ctr 0772-75684
READING
CSR Computers 0734-61492
SOUTHAMPTON
Business Electronics 0703-738248
Symtes 0703-37733
Xitan Systems 0703-37740
SUNDERLAND
Teapoint Ass Systems 0763-73130
WOKING
RPM, Brookwood 01111
Petalec 04862-69032
YEAL
Computerbits 0355-26522
NORTH SCOTLAND
Thistle Computer Kirkwall 3140
NORTHERN IRELAND
Medical & Scientific Lisburn 77533
Beckman 3020
The multimeter that defies competition

This is not just another new multimeter. Backed by over 40 years’ experience and worldwide sales, it sets out to beat the competition on virtually every count. To whet your appetite, here are just a few of the features that set it apart.

Accuracy—long term high accuracy ensured by a highly stable band gap reference element and thin-film resistors.

Reliability—total number of electronic parts reduced to less than 40 to give real reliability.

Portability—easy to hold, stand or hang, it weighs only 453 g (16 oz).

Continuity check—continuity can be checked in less than 100 milliseconds.

10A current range—up to 10A ac or dc without special adaptors.

Overload protection—voltage inputs and resistance ranges comprehensively protected.

Long battery life—9V transistor battery provides up to 2000 hours continuous operation, two years typical use. Send for the full technical specification and see how the 3020 defies comparison—pound for pound—with any other multimeter on the market.

BECKMAN
Beckman Instruments Ltd
Sales and Marketing Organisation
Queensway, Glenrothes, Fife, Scotland, KY7 5PU.
Telephone: (0592) 753811 Telex: 72135
CAPTAIN ZILOG

Zilog would like to draw your attention to their brand new microprocessor, the 16 bit Z8000.

Interesting electronics engineers or hobbiests in yet another new microprocessor will probably be difficult, and the fact that a comparable device from Intel, the 8086, has been around for several months won't make things any easier.

Technically, the Zilog Z8000 is a big leap forward, with the power of a minicomputer and an address range of up to 8 megabytes. It is probably more powerful than the Intel competition, but it seems that it will soon itself be upstaged by an even more powerful device from Motorola, the 68000. All this has put Zilog in the awkward position of not being the first and not being the best device from Motorola, the 68000. All this has put Zilog in the awkward position of not being the first and not being the best

But this may be altered to suit the application. It is possible for instance, to program just a single tune consisting of up to 251 notes. The chip does offer great flexibility to designers, as it can also generate tunes from data held in external PROMs.

In addition to its programming options, the AY-3-1350 may operate in a number of different circuits, making it suitable for a wide variety of different applications. In a doorchime for instance, it can be connected to play any one of 25 pre-selected tunes from the front door bell push, with one of 5 tunes from the back door. In addition a third bell push can be wired to play a simple chime. All the tunes would be selected by switches or matrix board inside the chime cabinet.

A further possibility is to connect the circuit to a number of different bell pushes on each door. This might be useful for telling which different tradesmen are calling, or which member of the family is required at the door. Mother, father, brothers and sisters could each have their own particular "call" tune. In addition further variations could be made for back door, side door, or events like the arrival in an apartment used by an elderly relation.

Applications exist in low cost paging systems, where key personnel are each allocated one tune. A brief tune played over loudspeakers in a noisy factory would be much easier to recognise than a spoken name.

The circuitry may be connected so that the AY-3-1350 is virtually no power consumption when in the standby condition. When any bell push is activated the circuit plays a tune and then automatically powers down again to conserve batteries—even if the visitor keeps his finger on the bell push. Releasing the button and repressing would cause either the same tune to play again, or the next tune to be selected, depending on the precise operational mode of the device. Alternatively, the circuit may be wired to replay tunes over again until the button is released.

With the addition of an external ROM or PROM the standard AY-3-1350 will play any tune or tunes desired. These could be 28 tunes averaging 8 notes each or one tune of up to 251 notes. This would provide about 1–2 minutes worth of music. The pitch, tone and speed of tunes played may be independently set by simple external components. These may be either preset or brought out as potentiometers as a user control. Either switch closures may be used to trigger the device or a capacitive touch switch using a few external interface components.
THE EPROM programmer is a memory-mapped peripheral for the 2708 family of Erasable Programmable Read Only Memories (EPROM's) and programs at about the maximum possible speed (around 2 minutes). The p.c.b. contains its own power supply giving +12V, -5V, +27V, and only requires +5V and a 9–0–9 volt transformer. On board, there is 1K of RAM for storing information to be transferred to the EPROM. The EPROM may be read before or after programming for verification, and used in-situ as a normal 1K block of Read Only Memory. The programmer thus effectively expands the host system by 2K of memory (1K of EPROM and 1K of RAM), with the added facility of being able to reprogram the EPROM section. Connection of the machine is simple and almost identical to the PE VDU connections.

Eleven Address Bus Lines (A0–A10), eight Data Bus Lines (D0–D7), a Read/Write line and some address decoding logic is all that is required. Interface to the COMPUKIT UK 101 and many other machines requires just a couple of d.i.l. plugs. The COMPUKIT would allow the necessary routines to be written in BASIC. A minimal MPU system containing the machine is shown in Fig. 1.

Use of the programmer is restricted to writing the desired target program or data into the 1K of on-board RAM, running and checking it, and then switching on the programmer which then takes around two minutes to copy the RAM contents onto EPROM. The machine automatically hands EPROM and RAM back to the MPU system.

EPROM THEORY

Each individual cell within the 2708 contains a "floating gate", which is able to collect a charge from a "pumping" pulse-train produced by a programmer. When sufficient charge has been accumulated within this completely insulated storage element, the cell, initially showing a "one", will return a "zero" along its data line when read.

The 2708 family members have a quartz window in the upper surfaces of their packages. Through this, a strong ultra-violet light may penetrate to knock the electrons in the storage elements out of their shallow energy levels and allow them to leak away via the substrate.

This clears the cell back to a "one". The organisation of the 2708 causes 8 cells (one byte) to be read and programmed at a time, hence requiring normal Address and Data lines.

To program the EPROM, the programmer produces a succession of addresses along A0–A9, and, for each, presents the data to be programmed along D0–D7. The EPROM thus starts, after erasure, with FF (8 "ones") in each location.

The requirements of the 2708 family demand that all locations be presented with data a large number of times during the programming sequence. The number of such complete addressing cycles is determined by the speed of operation.

The Block and Connections diagram shows a typical Read Only Memory device with the addition of a Programming pin. This pin is pulsed up to +27 volts during programming.

The CS/WE pin is a normal chip select except when programming, when it is held at +12 volts. The timing Diagram (Fig. 3), shows the signals necessary to program the 2708. It should be emphasised that the programming cycle consists of cycling through all 1024 memory locations N times and presenting the data to be stored over and over again. The sequence is as follows. CS/WE is switched to +12V, the first address and data are presented and >10µS later, pin 18 is pulsed up to +27V. These conditions are held for 0.1 to 1ms (0.5ms is chosen for the machine presented here) and then pin 18 drops to zero and the next address and data loaded. The cycle from address 0 to address 1023 thus takes a little more than a half second.
This entire sequence is then repeated a number of times. The total number, N, of such loops is between 100 and 1000 (possibly more) depending upon the width (tp) of the program pulse (+27 volts). The formula for determining N is: $N \times tp > 100ms$. Thus, for 0.5ms, N is a minimum of 200. The total programming time for this number is slightly over 100 seconds.

The EPROM starts with its locations containing FF, thus if the programmer presents just FFs to the EPROM, it will retain its "erased" state. Even though each memory location must be accessed during programming (many times in fact), those presented with FF will remain untouched. Thus, a block of the EPROM may be programmed selectively without affecting the rest of the device. In fact, this is true of an EPROM already containing any other block of information. Contents of that block, whatever they may be, remain unaffected by the programming procedure as long as FF is presented to each of its locations during the cycles.

Indeed, a single bit in any given location can be set to zero selectively by presenting 1's everywhere else during programming.

It should be noted that the machine described here is not suited to the single supply 2716, nor types of EPROM other than 2704, 2708 and the multi-supply 2716. The reason for this is that the cycle-timing diagram requirements are quite unique to this family.

Fig. 4 shows the hardware set-up of the programmer. The heart of the device is in the timing control block. It is here that the cycles of sequentially presented addresses are produced, as well as the correct repetition rate and number of complete loops necessary.

The counter-produced addresses are switched over to the RAM and EPROM by the Address Bus switch after a Program Request signal is received. A Ready line, and I.e.d. on the p.c.b., signals when the programming cycle is in progress.

The RAM is held in the READ state, and the Counter addresses RAM and EPROM sequentially. The RAM (which holds the desired program) places the data on the Data Bus and hence onto the input pins of the EPROM. The timing control then waits a few microseconds and switches the 27 volt level on to the Program pin of the EPROM for 0.5ms.
Fig. 4. Block diagram of EPROM Programmer

COMPONENTS...

Integrated Circuits
IC1  7474
IC2  4024
IC3  4040
IC4  2708 or 2716 EPROM
IC5, IC6  2114 (2 off)
IC7, IC14  74LS244 (2 off)
IC8, IC13  7400 (2 off)
IC9  74123
IC10–IC12  74LS157 (3 off)
IC13  79LS05
IC14  78L12

Sockets
14 pin  4 off
16 pin  5 off
18 pin  2 off
20 pin  2 off
24 pin  1 off

Miscellaneous
T1   Mains transformer, Sec. 9–0–9V at 1A
S1   Double pole single throw
Pins for through-board connection
Double sided 0.156in. pitch 50-way edge socket
Printed circuit board

Constructor’s Note
The kit excludes T1, S1, IC4 and edge socket, but sockets are included for all I.C.s.
Fig. 5. Memory and switching of the Programmer. S1 is in the "Program" position. Links are shown connected for 2708.

The cycles continue until complete and the EPROM and RAM are then handed back to the MPU system for normal use.

It should be clear then, that the role of the MPU system hosting the process is to provide for the RAM, programs or data to be "burned" into EPROM. To this effect, the RAM should be filled with FFs beforehand, so that any unused RAM space does not affect the EPROM.

The RAM and EPROM form a normal part of the MPU's address map, such that programs and data may be stored in either or both for running and use in-situ. The only time the memory is not available to the MPU is during programming. When the tri-state buffers are switched off, the data Bus of the MPU system is disconnected from the machine.

Last month, in the final part of the COMPUKIT UK 101 article, "plug-in" methods of expanding the machine utilising the upper part of the 2114 memory were described. This is the most convenient method of attaching a programmer and is described next month.

POWER SUPPLY

The Power Supply Unit (Fig. 6) gives all necessary power levels except for the +5V which is usually available from the MPU system. An external transformer with a secondary of 9–0–9 volts at 1 Amp is necessary for the PSU and may be purchased from Modus Systems Ltd., who can also supply the p.c.b. and full kit.
The software to run the programmer should be in the machine already. Any MPU system must have routines for accessing information from the user, usually via a keyboard, and placing it in any memory location desired. By this means, the RAM block may be filled with the necessary data by hand. The only software necessary will be a small routine to fill the RAM with FFs if the whole EPROM is not programmed. Verification of EPROM contents is, again, performed via the computer’s normal system of reading out data from any selected memory location, by simply reading through the appropriate EPROM addresses, as with any block of memory in your machine.

A short flow-chart to fill the RAM with FFs is presented in Fig. 8. This can be written for any simple machine-code based system and requires either one testable 16-bit register for scratchpad, or two 8-bit locations to store an address.

The flow-chart will code into instructions more easily on some machines than others. For instance, 6800 and 280 both contain 16-bit registers and may be used with ease to discover when the last address in RAM has been set. SC/MP and 6502 do not have this facility and checking sixteen bits for scratchpad, or two 8-bit locations to store an address.

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**THE SOFTWARE TO RUN THE PROGRAMMER**

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**USE OF THE MACHINE**

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As a final note on the above, it is possible to perform the setting of RAM to FF by hardware. All the facilities for stepping through memory exist on the programmer, and it is just a question of keeping the EPROM disabled, the RAM in the write-state, the Bus buffers tri-state and all Data lines to a logic “one”. This will fill the RAM with 1s as IC3 cycles through once.

Next month, the final part covers the rest of the hardware, p.c.b. layout, construction and hardware interfacing to your system.

---

**Fig. 8. Flow diagram to fill the RAM with FFs**

---

The EPROM Programmer may be run from the UK101

---

**Countdown**

Organisers: Please send details of exhibitions, club open days and other events to Mike Abbott at least six weeks in advance. Inclusion will be subject to space etc.

---


All-Electronics Show (1980)—April 29–May 1, Grosvenor House, Liverpool. Exhibition and seminars, with the co-operation of Liverpool City Council. Details: Online.

The Mersey Micro Show—April 30, May 1, 2, 1980. Adelphi Hotel, Liverpool. Exhibition and seminars, with the cooperation of Liverpool University. Details: Online.


IBC 80—Sept. 20–24, Metropole Centre, Brighton. Details: Secretariat, IEE, Savoy Place, London WC2R 0BL.

---

**POINTS ARISING**

**SIX CHANNEL MIXER (September 1979)**

Switch S3b, terminal 4, should be connected to terminal 4 of switch S3a and not to OV.

**DIGITAL TEMPERATURE CONTROLLER (October 1979)**

The values for C6 and C9 should be transposed in the circuit and components list.
PATENTS REVIEW

PRECIPITATION SENSOR
British patent application 2 0 1 0 4 8 6 from Surface Systems Inc. of Missouri, USA (applied for under the new laws and dating back to December 1977) describes a module for automatically sensing wet and icy conditions on a road or airport runway surface.

LIQUID MAGNET
British patent application 2 0 0 9 4 1 4 from the French company Societe Nationale D'étude et de Construction de Moteurs D'aviation was filed under the new patent laws and dates back to November 1977.

Although the invention is concerned primarily with a magnetic means of measuring the thickness of passageways inside gas turbine blades, it is clear that the principle described has much wider applications. The specific aim of the invention is to check that the cooling passages inside a turbine blade are accurately formed, with adequately thick walls. To achieve this the passages are temporarily filled with ferro-magnetic fluid. This material, which was developed (like so many others) for use in space, is a suspension of magnetic particles in liquid which behaves like a fluid magnet. Because ferro-magnetic fluid is expensive, it is introduced into the passageways and withdrawn after use by a simple piston and cylinder arrangement.

A probe 11, like a metallic pencil, is wound with a coil 12 on a core 13. This coil forms one branch of an a.c. bridge 14, of which the other branches are formed by potentiometers 15, 16 and 17. The bridge is supplied at a first diagonal by a.c. from generator supply 18, 19 and a measuring frequency of around 5kHz. The signal is applied via resistor R1 and thermistor T1 to compensate for any small change in the value of capacitor C1 caused by temperature. Because a relatively low frequency sine signal is used, oscillator 15 can be placed up to 500 feet from sensor electrode 11 without significant loss.

Whenever there is water or ice precipitation the sensor surface is connected capacitively and conductively to the surface 6. This causes a significant loss of current from electrode 11 to surface 6. The amplitude of the signal appearing at the input of amplifier 17 is thus a function of the change in the capacitance and conductance between sensor electrode 11 and surface 6. The output of amplifier 17 therefore decreases as precipitation accumulates on the sensor. Precipitation circuit 23 provides an indicator or alarm trigger signal when the output signal 21 of amplifier 17 falls to a predetermined level.

In one modification of the invention a delay circuit is incorporated to ensure that the temporary removal of ice or water from the sensor block by passing vehicles does not affect the overall reading.

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

The module can trigger a visible or audible alarm, for instance light up a danger sign, when a surface becomes slippery and dangerous; or a series of sensors can provide air traffic control with a continuous readout of airport runway conditions.

A block 3 of epoxy resin material, with silica glass or sand filler for strength and resistance to wear, is embedded in the surface 6 to be monitored. A square electrode 11 of metallic foil is encapsulated in the block thereby providing both capacitance and conductance paths to surface 6.

In the circuit diagram the capacitance path is represented by phantom capacitors C1 and C3, and the conductance path by phantom resistor G1. A constant-voltage oscillator 15 and capacitor C5 supply electrode 11 with a sine wave signal at a
## VARIABLE VOLTAGE TRANSFORMERS

**INPUT** 230/240V a.c. 50/60 OUTPUT

**VARIABLE 0-260V**

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<th>220 volt (5 amp)</th>
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**SHRINKING**

- 220 volt (1 amp) 40 mm 26.00 100 volt (1 amp) 40 mm 26.00
- 100 volt (1 amp) 40 mm 26.00
- 50 volt (1 amp) 40 mm 26.00
- 25 volt (1 amp) 40 mm 26.00

**GARAGE PACKAGES**

- V.A.T. included Price (£) £9.00

## LT TRANSFORMERS

**0-15V-20V**

<table>
<thead>
<tr>
<th>Type</th>
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**0-150V**

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## SERVICE TRADING CO

**All Mail Orders**

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<tr>
<td>Royal Mail or DHL</td>
<td>15 Little Portland St.</td>
<td>London WC2H 7JU</td>
</tr>
<tr>
<td>Phone: 01-437 0576</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ACCOUNT CUSTOMERS MIN. ORDER £100**
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Madonnas Vinegrove announces a drought that just won't go into Bringin. Singalong at Bosset knows it's a given. Different classical and popular tunes will fill the pop-hare weired for your 1999 sense of the season you are expecting it all. Door tunes is not just good fun and a wonderful icebreaker, but it is also very functional and beautifully designed to enhance your home. There is something for Christmas, something for by your friends to see and visit your home and welcome for the Queens Door tunes a way to install and two expert extremes for volume. Chile and spirits.

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Reduce the scratch noise from your favourite records, the rumble from a worn turntable or the noise of record warps and pressing imperfections, with this straightforward stereo design.

We do not believe an Ultrasonic Cleaner has ever been published as a constructional design. Why? Because the transducer and tank pose buying problems. A kit supplier has solved these problems for us and next month we will bring you a design for half the cost of a commercial unit.

Softy is a general development tool for MPUs and next month our contributor, Dr. A. A. Berk, reviews this new line in the micro scene.
This ultrasonic burglar alarm is a two unit system: a Movement Detector and a Control Unit. The Movement Detector, which contains the ultrasonic transmitter (X1) and receiver (X2), will detect movement within a room and then send an alarm signal to the control board. The Control Unit contains the keyswitch for on/off control of the system, the delay circuits, and the relay for controlling the alarm as well as the battery back up circuit in case of mains failure.

CIRCUIT OPERATION

When the burglar alarm is switched on a 40kHz signal is transmitted from the ultrasonic transducer (X1) which is detected by the receiving transducer X2. This sets up an ultrasonic pattern within the protected room. If an object moves within this field a frequency shift occurs (due to the Doppler effect) to the waves which are reflected from the moving object. The transducer X2 will therefore receive two different frequencies (40kHz and the shifted frequency which can be higher or lower than 40kHz); these will combine to produce a beat note. The frequency of this audio or sub-audio beat note will be the difference between the two ultrasonic frequencies. This beat frequency is then amplified, filtered and used to operate the alarm.

MOVEMENT DETECTOR

The circuit diagram of the Movement Detector is shown in Fig. 1. If constructors wish to use the Detector Unit on its own the relay RLA and D15 (shown in the shaded area) should be fitted and the value of C13 increased to 22 microfarads. If both units are to be used the two wire links shown on the Movement Detector board should be fitted. The 18V output from the transformer (T1) is fed to the bridge rectifier formed by D11 to D14, smoothing capacitor C15 and the voltage regulator (IC2) to obtain a stabilised 12V supply.

The 555 timer (IC3) is connected as a variable square wave generator the output of which (pin 3) is fed to the ultrasonic transmitter (X1). The transmitted signal from X1 is

---

Fig. 1. Circuit diagram of the Movement Detector
picked up by the receiver X2 and amplified by TR2 and TR3 with resistor R14 providing 100 per cent feedback making this stage very stable. The a.c. gain of the stage is determined by C8 which shunts the high frequency signals in the feedback path therefore increasing the gain of the stage (50 times the input voltage at 40kHz).

As only the positive going signal is required at the output of this stage the bias is offset from the normal half supply rail to provide a better operating working voltage for the diode detector as well as a greater overload margin for the input stage.

The output from TR3 collector passes through the envelope detector D7 and the CR network C9, R16 which removes the 40kHz signal. The signal from TR3 collector is rectified by the relay. The collector of TR7 remains low until C13 discharges through TR6 turning off both TR6 and TR7 and switching the collector voltage of TR7 high.

**Internal view of the Movement Detector. Note that the relay RLA has been included**

The output from TR3 collector passes through the envelope detector D7 and the CR network C9, R16 which removes the 40kHz signal. The signal from TR3 collector varies the d.c. level across C9 and provides both the bias and the signal for the next stage. This stage is basically the same as the first stage with the exclusion of the load resistor for TR4 collector.

**SPECIFICATION**

- 0.5 sec alarm function test at switch on.
- 2 sec delay to suppress invalid movement.
- 20 sec delay at switch on to prevent alarm operation on leaving room.
- 20 sec delay on entry to allow the alarm to be cancelled.
- 2 min alarm before cancelling (alarm is pulsed at 2 Hz).
- Quiescent current 25µA at 12V d.c.
- 18V battery back up in the event of a mains failure.

The capacitor C11 limits the HF response by applying negative feedback to TR5 so that the ultrasonic component of the signal is not amplified. R17 and C10 were chosen to provide a suitable bandwidth for Doppler shift frequencies.

The output from TR5 is fed to the diode pump network (D8, D9) via C12 which rectifies the signal and charges C13 to convert the beat note to a steady voltage. When the voltage across C13 reaches 2-6V, TR6 turns on and the i.e.d. (D10) is illuminated. TR7 is also turned on via R20 and the collector voltage of TR7 falls to zero. This fall in collector voltage is passed to the control unit via the wire link and the common output of RLA on the Movement Detector Board.

However if the relay RLA is used the falling collector voltage of TR7 is used to energise the relay from the un-stabilised 18V supply, whilst D15 suppresses any spikes generated by the relay coil. The collector of TR7 remains low until C13 discharges through TR6 turning off both TR6 and TR7 and switching the collector voltage of TR7 high.
CONTROL BOARD

The circuit diagram of the control board is shown in Fig. 2. R1 forms the collector load for TR7 (on the detector board) and when the collector voltage is switched low there is a two second delay caused by R2 and C1 before the voltage on pin 1 (IC1a) goes low. This delay prevents invalid movements from triggering the alarm. Gates "a" and "b" of IC1 form a bistable which is reset at switch on by C2 and takes 20 secs to charge, this allows the house to be left without triggering the alarm. If no movement is present the output of gate "a" is low and C3 is discharged.

The output of gate "c" is high which holds the input of gate "d" high and its output, which holds TR1 off and the relay de-energised, is low. At switch on the relay energises
for 0.5 sec to provide an alarm test every time the system is switched on.

When movement is present for more than 2 secs the input of gate "a" goes low setting the bistable with the output of gate "a" going high charging C3 through R3, R4. This allows the input to gate "c" to go high and its output low releasing the input of gate "d". Gate "d" forms a 2Hz Schmitt oscillator, the frequency being determined R8, C4. The output from gate "d" passes through R9 driving TR1 and energising RLB. D6 suppresses the back e.m.f. from the relay coil.

The output of gate "c" also discharges C2 which after 2 mins resets the bistable and cancels the alarm. D1 and D4 discharge C2 and C3 at switch off.

Diode D7 has the battery voltage connected to its anode and the unstabilised 18V to its cathode. Because the unstabilised voltage will be higher the diode is turned off. When the main voltage falls the diode will conduct and the battery voltage will be applied to the system. When the main supply is re-established the diode D7 automatically switches off the battery voltage.

CONSTRUCTION

In the prototype system the movement detector and the control unit were mounted into two separate ABS boxes.
The transducers are mounted inside grommets on the front panel with the indicator I.e.d. mounted mid way between them. If the I.e.d. is not required on the front panel it can be placed inside on the p.c.b.

**Internal layout of the Control Unit**

The p.c.b. design for the Movement Detector is shown in Fig. 3 with the component layout in Fig. 4. After the board has been soldered and checked it can be mounted into the case and connected to the terminal block. The transducers should be soldered to the board using screened leads.

The p.c.b. design and component layout for the Control Unit are shown in Figs. 5 and 6. After soldering and checking, the p.c.b. should be mounted into the case together with the keyswitch. The two PP9 batteries were mounted outside the case on the prototype although if a larger case is used they could be mounted inside. The two units should be wired together as shown in Fig. 7.

**ALARM OPTIONS**

The system can be fitted with an external piezo electric transducer which can directly replace RLB and D6, driven from the collector of TR 1.

If an external alarm is used it can be connected via the contacts of RLB and either a mains or 12V d.c. buzzer used.

**INSTALLATION**

The detector is prone to both vibration and air currents therefore the points shown in Table 1 should be observed to avoid false triggering of the alarm.

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<tbody>
<tr>
<td>a) Do not place the unit on a vibrating surface.</td>
</tr>
<tr>
<td>b) Close doors and windows.</td>
</tr>
<tr>
<td>c) Do not point the unit at a wall with a radiator or convector heater.</td>
</tr>
<tr>
<td>d) Objects should not be placed within 5 feet of the unit as this will limit its sensitivity.</td>
</tr>
<tr>
<td>e) The external alarm should be far enough away from the unit so as not to produce vibration.</td>
</tr>
<tr>
<td>f) Cats, dogs and other household pets should be taken into consideration.</td>
</tr>
<tr>
<td>g) If more than one unit is used care should be taken to ensure the two ultrasonic “fields” do not interact the alarm to trigger.</td>
</tr>
</tbody>
</table>

**SETTING UP**

The variable resistor VR1 should be adjusted for the maximum d.c. level at TP1. The sensitivity of the unit can be checked by moving in front of the ultrasonic transmitter and receiver and noticing the I.e.d. movement indicator. Finely adjust VR 1 until the maximum sensitivity is obtained.

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Practical Electronics December 1979
Two British firms were involved in the development and construction of the 3.8 metre UKIRT. They are Hadfields Ltd., who have had so much experience in the design and development of telescopes over many decades and are now a unit of Northern Engineering Industries, and G. F. Parsons who are famous for their original work on the 250ft diameter radio telescope at Jodrell Bank. Hadfields are now part of the Lonrho Group.

The UKIRT was commissioned by the Science Research Council in 1975. The contract went to the Special Projects Division of Hadfields Limited. Work commenced in the spring of 1975.

Modern telescopes and other instruments in use for astronomy are now very much concerned with electronics. Control systems abound and astronomy cannot be seen now as an isolated activity for it, by reason of the space industry involved, not only in the scientific experiments but in all systems involving navigation and the practical guidance of space vehicles. The infra red telescope by its very nature covers a wide field of technology. The mechanics are concerned with the elements such as control and instrumentation which is so sensitive that just tilting on its axis can set the mirror in a condition of distortion. Such conditions not only affect the performance of individual tasks but have long term possibilities in ageing and deterioration of the materials used. This is primarily where the control system depends on electronics.

The mirror was to be 3.8 metres in diameter and 29 centimetres in thickness. Now apart from the very critical parameters involved in the manufacture of such a mirror, its performance at all angles is prodigious. The final result must be such that distortion must be held to an almost inconceivable low level. The contours of the surface of the primary mirror is held by a special support of three rings with a total of eighty pneumatic cylinders. These are electronically controlled. The result has been to achieve sub arc second performance under all normal operating conditions.

The material of the mirror is a glass ceramic called Cer-Vit. Normal glass would not be suitable for a mirror of this size and nor would it be able to resist thermal distortion which is one of the great hazards with large mirrors. Cer-Vit is not subject to this defect and indeed is almost unaffected by thermal changes. It should be noted here that even a minute distortion of the surface can result in a confused image at the focus and thereby nullify measurements.

The rest of the optical system consists of smaller mirrors all made of Cer-Vit. One of them is a plane mirror used in the Coude beam. This has a major axis of 1.5 metres and a thickness of 3 centimetres. The mirror blanks were purchased from Owens of Illinois and figured by G. F. Parsons.

The principle of operation is in a number of modes. Two of these will be described.

The primary mirror is at the "bottom" of the main structure. This receives the radiation from the sky and directs it on to a secondary mirror at the "top" of the structure. The radiation is then again returned toward the primary mirror. Different secondaries may be used. In one case the radiation passes from the secondary mirror through a hole in the centre of the primary mirror to a point about one metre behind the primary. This is the Cassagranian focus. At this point the radiation is recorded by instruments mounted on the frame of the telescope. Thus all instruments in a similar mode have to be mounted on the telescope since it traverses the sky and the instruments must follow. The amount of such instrumentation has a limiting factor. To overcome this, one means of plane mirrors another focus independent of the position of the main axis of the telescope is achieved. This is called the Coude focus. By means of plane mirrors the beam from the system can be diverted so that it remains independent of the motion of the telescope itself. This enables large and bulky apparatus to be accommodated in a basement below the telescope.

The remainder of the telescope apart from the optical systems was designed and constructed by Hadfields of Sheffield. The whole completed telescope was built, tested, dismantled and conveyed to the final site there to be erected and put into operation by that Company under the guidance of the Royal Observatory Edinburgh.

**COMPUTER CONTROL**

Many of the mechanical and control systems are new concepts in control. A high proportion of this innovative design is found in the unique electronic record. Any British astronomer may apply for time to use the telescope.

**SHUTTLE SCHEDULE**

The first space shuttle schedule shows that between 1981 and 1984 all thirty-eight flights are already fully booked. The customers are US business enterprises, foreign Governments, many departments of the US Government in which no less than 12 space labs are required each having many experiments aboard.
In this final part board construction together with interwiring and final setting up will be detailed.

CONSTRUCTION
The authors' projectors are made largely of plastic with a metal lamp house which gets very hot so there is no suitable heatsink surface for the triacs. To get round this problem the prototype system, shown in the photographs, was built in two boxes. One houses the majority of the electronics while the other, which also doubles as a heatsink, is for the triacs. Two boxes were used so that the high current connections to the triacs could be kept short whilst leaving the control box free to be positioned in a convenient position when making a recording. Connection to each projector is via a short length (approx. 400mm) of heavy duty mains cable while a screened multi-core cable connects the triac drivers to the control box. Other constructors may have projectors with exposed cool metal surfaces in which case the triac housing can be eliminated and the projectors connected directly to the control box.

The price of the multi-way connectors used in this arrangement amounts to nearly £18—one third of the cost of the whole unit. Many constructors may therefore prefer to mount a heatsink on the side of their plastic bodied projectors thereby eliminating the need for expensive connectors. The connection from each projector to the control unit then comprises 5 light current signal leads plus earth so a DIN audio connector can be used, reducing the cost of connectors to no more than £2.

TRIAC HOUSING
Fig. 1 shows the circuit that is contained within this housing. Straight-through connections are provided for the slide change and power supply connections to each projector while additional inputs from the main control box trigger each triac. The connections to the control box carry only small currents and are made by a multi-core screened cable (to reduce radiation from the triac trigger pulses) terminated by a 15-way D-type plug and socket (PL2, SK2). D-type plugs and sockets are also used for the connections to the projectors. Each way of these connectors can carry a maximum of 5A and in this arrangement four pins are connected in parallel for each of the two load carrying connections.

The circuit is housed in an aluminium die-cast box which should be painted with matt black spray paint after drilling. Before mounting the triacs on the inside of the box make sure that all paint is removed from the area and apply a thin film of heatsink compound to the mating surfaces. The specified triac has a mounting tab which is electrically isolated from all of its terminals. When using a substitute device without an insulated tab it will be necessary to mount it by means of a nylon nut and bolt and to use a mica insulating washer.

Fig. 14 shows the layout inside the box and the details of the connections to the plugs, shown from the solder side of each plug. It will be necessary to shorten the specified group-boards a little before they will fit in the box. About 400mm of 3 core 13A mains cable is used to connect the housing to each projector plug. The third core of the cable can be pulled out leaving a hole large enough to take the four 0.4mm dia. wires that connect to the slide change mechanism, the power supply and earth. Inside the box the conductors from each composite cable are connected to tags on the group-board. From the group-board stout wires are connected to the $T_1$ and $T_2$ connections of each triac while the cores of the multi-way connection to the control box are also terminated on the appropriate tags. Make sure that the earth wire from each of the projectors is connected through to the chassis tag and that the screen of the multi-core cable is connected to this tag also.

It is not easy to solder the thick conductors of the load carrying cable to the pins of the projector plugs and it may be helpful to make the parallel connections between pins first using a piece of stiff wire (a resistor lead, for example). The heavy duty cable cores are then stripped back for only a short distance (approx. 4mm) and fanned out a little before
Interior wiring

being butt jointed to the stiff wire link which provides a large enough area to form a good soldered joint.

**MAIN CONTROL CIRCUIT**

The whole of the electronics is mounted on a single printed wiring board whose layout and component overlay are shown in Figs. 19 and 15. As a result the circuit is very easy to assemble even for the beginner or for someone whose main interest lies in photography! Install a few components at a time, working from one side of the board inserting the components and bending back their leads so that they do not drop out when the board is inverted. Continue in this way mounting all the wire-ended discrete components before others are inserted. R4, the power supply dropper resistor, gets fairly hot and should be stood away from the board by putting a U-bend in its leads.

Mount the skeleton preset potentiometers and sockets for the integrated circuits making sure that they are held securely home whilst soldering. The specified cermet preset potentiometers should not be replaced by the cheaper s.r.b.p.-based types which have inferior mechanical and electrical characteristics. Use of sockets for the i.c.s is not a luxury—it is very difficult indeed to unsolder all 14 or 16 leads of a suspect “chip” without damaging the device or the board (or both), and it is very discouraging to undertake the task only to discover that it was not the i.c. that was causing the problem. Sockets allow easy substitution tests as well as ensuring that the devices are not damaged by excessive heat during soldering.

Finally, insert pins from the copper side of the board into the holes provided for off-board connections and push them firmly home using a hot soldering iron before fixing them with a small quantity of solder. In the same way that i.c. sockets are not essential to the project these pins can be omitted, but they make it much easier to make connections to the board without causing damage, and they make it possible to attach and remove external wires once the board is firmly mounted in the box.

**TRANSFORMER**

The pulse transformers, T101 and T102, are very easy to make and should not deter anyone from undertaking the project. Wind 100 turns of 38 swg wire on to one half of the sectionalised bobbin and twist the free ends of the wire together for a short distance to prevent them from unwinding. Repeat the operation for the secondary winding using 10 turns of 28 swg wire in the other half of the bobbin. Now put the bobbin into one half of the pot core, line the other half of the core up on top and clip the whole assembly to the mounting board with the ring and clips as shown in Fig. 18. Solder the protruding wire ends to the pins on the base according to the layout in Fig. 15—the sense of the windings is not important as the triac will turn on with either positive or negative pulses applied to its gate. To prevent vibration and noise from the transformer when in use dip the whole assembly into household polyurethane varnish, giving it a good shake to remove surplus fluid on removal, and leave it to dry for 24 hours. Finally give the windings a check for d.c. continuity and insert the transformer into the printed wiring board before carefully soldering it into place.

**THE BOX**

First mount the two sockets SK1 and SK2 at the back of the box after carefully making the cut-outs. The DIN socket SK1 is used to interconnect with the
tape recorder while the multi-way D-type socket, SK2, carries the connections to the triac housing. Fig. 20 shows the numbering of the socket connections from the interior of the box to assist in wiring. Solder leads of suitable lengths to the socket pins before mounting the printed wiring board in the box using four 3mm holes drilled to align with the mounting holes on the board. Group the wires neatly together and solder them to the appropriate pins on the board making sure that you leave enough wire to allow the board to be removed from the box to assist with later fault finding and debugging.

Fig. 16 shows the drilling details for the front panel. Mount the components where shown being careful not to damage the front surface of the panel and wire up the controls as shown in Fig. 17.

Group the wires from the front panel together remembering to leave enough wire to allow the panel to be removed for access.

When all the soldering is complete insert IC1-5 in their sockets noting that they do not all lie the same way round. It is very easy to insert an i.c. the wrong way round or to trap a pin underneath it so check carefully to avoid some tricky fault finding later.

**AUDIO LEADS**

The correct terminations for the DIN plug connection to the tape recorder are shown in Fig. 20 in which the left hand channel of the stereo pair has been chosen to carry the dissolve control tone. The connections to the plugs at both ends of the lead are identical. For right hand channel operation wire up the plug using pins 4 and 5 in place of 1 and 3 respectively. If phono connections to the tape recorder are required wire up one DIN plug as shown and terminate the two free wires at the other end with standard phono plugs.

**MODIFYING THE PROJECTORS**

There are probably as many variations on the basic electrical circuit of a projector as there are manufacturers of this type of equipment so it is not possible to give modification instructions in great detail. We show in Fig. 21 the circuit diagram of a typical projector together with the modifications needed to enable it to work under control from the slide dissolve unit.
Fig. 19. Printed circuit board for Diamatic
The first and most obvious of the modifications involves interrupting the lamp circuit and bringing it out to a suitably placed D-type socket for connection to the triac housing. Also brought out to the socket is a connection in parallel with the slide change switch and a connection to the transformer secondary which completes the power supply circuit for the control electronics.

Not so obvious are the suppression components shown connected across the two solenoids. The change solenoid (SOL1) operates every time the change relay contacts make in the control unit and the slide direction solenoid (SOL2) will also operate if the direction switch on the projector remote control is set to "reverse". On release of the change relay the back e.m.f. across both of the solenoids causes arcing across the relay contacts which can interfere with the audio channel and disturb the operation of the control circuit. Suppression components are fitted across the coils of both the solenoids to prevent this problem.

First it is necessary to establish whether the solenoids involved (in many projectors there will be only one) are powered from an a.c. or d.c. supply. In the example shown (which is of a real projector) SOL1 is d.c. operated while SOL2 is powered by unrectified a.c. Across the d.c. solenoid we may connect a normally reverse biased rectifier diode that will conduct during the reverse swing of the back e.m.f. thereby preventing an arc from developing. This treatment is not possible for an a.c. solenoid so in this case a series combination of R/C is used to damp the back e.m.f. and reduce the intensity of the arc.

For operation as a normal projector without the dissolve control unit in circuit a dummy plug which shorts together the interrupted lamp connections is inserted in the multi-way socket and slide change is controlled in the usual way from the projector remote control.

![Fig. 20. Plug and socket connections](image)

Constructors who build the triac into their projectors can revert to normal operation by connecting a resistor in series with the switch between T2 and gate of the triac. With the switch open operation of the lamp circuit is controlled by the triac trigger pulses but when the switch is closed the triac is held in its conducting state and the lamp remains at full brightness.

SAFETY

An earth connection is shown in the circuit diagrams which connects the 0V rail and all metalwork to mains earth via the projectors. It is important that this connection is made even if the projectors are double-insulated and do not have a ground connection because the control circuits and hardware are not protected by the double-insulation and could therefore become live in the event of a fault in either projector. If a two-core mains lead is fitted to either or both of the projectors replace it with a three-core 3A cable and connect the earth lead through to the control equipment via the multi-way connector as shown in the diagrams.

Do not rely on an earth connection made via audio equipment—if a hum loop results when separately earthed audio equipment is used remove the connection between the board (pin H) and the DIN connector (SK1, pin 2) to alleviate the problem but remember to replace it if isolated equipment is used at a later date.

ADJUSTMENTS

Only four adjustments are needed before the unit can be used. The object is to adjust the control circuit of each projector so that the lamp is just extinguished at one extreme of the range of the dissolve control knob and just at maximum brilliance at the other. This ensures that there is no "dead space" at either end of the control and that maximum brightness is achieved with no annoying residual image on the screen at the other extreme. Referring back to Fig. 3 we see that a projector is at maximum brilliance when its control voltage just reaches the bottom of the ramp signal (approximately -2V). The lower extreme of the ramp is fixed for both projectors by the common bias (set by R29/D9) to which C101 is discharged. Because this level is fixed it is necessary to adjust the control voltage at each end of its range to make certain that the bright projector is just at its brightest point. This adjustment is made with VR1 and VR3 which set the voltage seen by the wiper of VR2 at each end of its travel (Fig. 6).

Having set up the bright end of the range for each projector it is necessary to ensure that they just turn off at the other extreme of their range. A projector lamp is just extinguished when its maximum control voltage just exceeds the positive tip of the ramp. As we have already fixed the two extreme values of the voltage we must now adjust the peak value of the ramp at the dark end of the range for each projector. The adjustment is made by VR101 (VR102) which...
varies the current generated by the source which charges C101 (C201) and therefore affects the slope of the ramp.

**SETTING UP**

The setting up procedure is as follows. First connect the two projectors to the triac housing via the heavy duty cables. It does not matter which projector is connected to each of the two cables as, although power is drawn from only one of the two projectors, both are wired up to supply power when connected to the appropriate lead. Next plug the multi-core connection from the triac housing into the control box, which should be switched to record with all preset adjustments set to mid-range, and switch on the projectors. Check that operation of the dissolve control fades from one projector to the other although the adjustment of the lamps at each end of the range will almost certainly be wrong. With the control to the extreme of its travel at which projector A should be bright adjust the preset VR3 anti-clockwise until the projector will go no brighter and then reduce its setting until the lamp dims just perceptibly. Now increase the setting a little to reach maximum brightness. Set the dissolve control to its other extreme (B bright) and repeat the procedure using VR1 for the other projector. The adjustments of VR1 and VR3 interact so it will be necessary to repeat this sequence of events with the control set alternately at each end of its travel three or four times until no perceptible difference is found from one adjustment to the next.

When the bright end of the range is correct set the dissolve control to make A dark and adjust the current source preset VR101 until A is just extinguished. The best way of making this adjustment is to project a slide onto a screen in a darkened room and to adjust the preset until the image can just no longer be seen. When the setting is made in this way the projector lamp will be left with a dull orange glow which keeps it warm and speeds its response to rapid changes. Repeat the adjustment for projector B using VR201; the current source presets do not interact so it is only necessary to make one adjustment for each projector at opposite extremes of the dissolve control.

When the adjustments are complete check that the slide change control works at both ends of the dissolve control range, that the “twinkle” control swaps over the states of the two projectors and that the “superimpose” button forces them both to illuminate at half power. Finally, with the dissolve control set to either end of its range and with no audio input switch to play and check that the signal loss detector operates forcing both the projectors to switch on as if the “superimpose” button had been pressed.

You are now ready to make your first slide dissolve programme.

**FREQUENCY SETTING**

The adjustments already described are all that are required if the same unit is to be used both to record and to play your audio-visual presentations. Because the same VCO is used both during recording and during playback no adjustment of the VCO output frequency is needed. If, as may happen in a club for instance, different units are used for recording and playing back it is necessary to ensure that all the VCOs have the same brightness/frequency characteristic. R15 and R16 control the frequency of the VCO at the upper and lower extremes of its control range. In order to make several units compatible with one-another it will be necessary to replace these resistors with pre-set potentiometers, possibly mounted so as to be accessible through the rear of the box.

In order to set up a group of units they should first be adjusted individually in the manner described in the previous section. One of the units is then nominated as “master” and its variable R15 and R16 set to mid-range. The output of this unit is then connected to each of the “slave” units in turn so as to carry out the adjustment of their VCO frequencies. With the “master” set to record and the “slave” set to play the master control potentiometer is set to the end of its range at which projector A is bright. R16 of the “slave” is then adjusted until its A projector is just at full brightness. R15 is next adjusted to set the brightness of “slave” projector B with the “master” control at the other extreme. The whole procedure must be repeated three or four times until no variation between successive adjustments is detected as the frequency setting controls will interact with one-another.

**MAKING A RECORDING**

The best recording technique to use will depend on the type of tape recorder involved. The output from the dissolve unit occupies one complete track of an audio tape recorder so “those readers who, like the authors, do not possess a multi-track machine, will have to use one track of their stereo tape deck and record only mono sound. This is a limitation of course but the impact of a fully synchronised dissolve programme more than makes up for a lack of accompanying stereo sound.

Using a two-head machine (many cassette recorders are of this type) it will be necessary to record both the sound and the slide control tone simultaneously. The sound will first be assembled on an auxiliary tape machine if a number of sources (e.g. disc, tape, microphone) are to be mix together and then played into the master recorder while the slide sequence controls are operated. With a relatively simple sound programme (e.g. disc only) it is possible to record sound and vision directly without the need for an extra tape recorder.

Three-head machines often allow you to play the contents of one track whilst recording on the other. In this case the sound programme can first be built up on one track, from a number of sources if required, and the visual control signal can later be added to the other track whilst listening to the sound.

Before making a recording it is vital to draw up a script indicating exactly how the intended sequence of dissolves, twinkle etc. relates to the sound track. It is also helpful to practice by running through the programme several times.
to check on timings and to learn to anticipate the operation of the controls.

To make a recording arrange the projectors so that their images are superimposed and load the slides alternately into each magazine with a black slide as the first in each set so that the screen is dark whichever projector is illuminated. With the black slide in each projector gate switch to record and adjust the dissolve control so that the projector that will show the first slide is dark, the other fully illuminated. Now switch on the tape recorder at least 30s before the first slide is due to appear and after about 15s press the slide change button to remove the black slide from the gate and replace it with the first one to be projected. When the slide is to appear fade it in with the dissolve control and as soon as it is fully illuminated press the change button to bring the second slide into the gate of the dark projector. Continue in this way alternately operating the dissolve control and the change button until the sequence is completed. It will probably be necessary to insert a black slide as the last in each projector so that the screen remains dark at the end of the presentation.

REPLAY
A smooth, efficient and unruffled beginning to a show adds greatly to the overall effect that it has on even the most uncritical of audiences so fumbling with projectors, wires and controls is best done before the viewers arrive. The signal loss detector helps by allowing you to superimpose the images from the two projectors at half power simply by switching to "play" without an audio input applied. When the images are set correctly load the slides into the two projectors (making very sure that the right magazine has been loaded into each projector) and bring the first (black) slide into the gate of each. Wind the tape to a position just after the beginning of the slide control tone and connect the output of the recorder to the control unit which is switched to "play".

When the moment arrives switch on the projectors and turn off the room lights. Now start the tape recorder and enjoy the show which will begin by first bringing a slide into the gate of the dark projector and then fading it up on to the screen.

We apologise for the omission of joint authorship and qualifications in Part 1.

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Energy Saving

Among all the claims and counterclaims for energy saving systems, sane or mad, it is refreshing to find a few hard facts and figures based on actual field experience.

The Italian company Telettra has recently published some details of a 2,000 mile national route network of microwave links they have engineered in co-operation with the New Guinea PTT Administration. The first links went in seven years ago and, taking advantage of the newest technology which allowed an extremely low power consumption of only 30W, the equipment was originally powered from dry cells needlessly. The equipment, which allowed an extremely low power consumption, was brought up to date and the repeaters are now powered from solar cells with a secondary battery to service the secondary cells and clean the batteries.

Later expansion of the system also brought an up-date and the repeaters are now powered from solar cells with a secondary battery to service the secondary cells and clean the batteries, but over a five year period the cost of ten replacement sets of dry batteries is saved.

Drawing on this experience together with the falling cost of solar cells Telettra now say that the capital cost of a solar powered system breaks even with a diesel generator installation for local power up to 100W. In service the savings come from a nil fuel bill and no maintenance costs for diesel equipment. One of the great advantages of independent local power is that the equipment cabins can be sited anywhere. No approach roads are needed as would be the case for regular delivery to the site of diesel fuel, or the provision of overhead power lines or both.

Fine! But how about locations where temperature variations are such that the equipment needs an air conditioned environment? Conventional air-conditioning burns up more power than the equipment itself. Telettra says the answer lies in a new form of shelter exploiting the thermal characteristics of the materials from which it is constructed and the few watts of heat dissipation in the equipment itself. There are no moving parts and by changing the materials a passively conditioned shelter can be made to iron out temperature fluctuations in either tropical or arctic environments. For large installations this change can be enhanced by natural circulation of fluids in a closed circuit.

Augustine’s Law

Norman R. Augustine, vice president technical operations, Martin Marietta Aerospace Corporation, following the example of Professor Parkinson, has established his own set of Laws. Augustine’s are based on observation of trends in his own industry and projecting them into the future. The US defence budget increases yearly but so does the cost of tactical aircraft, the latter at a much greater rate. Extrapolating the figures Augustine suggests that by the year 2054 the total defence budget of the United States will buy only one tactical aircraft. Similarly, that before the tricentennial the US Government will employ more government workers than there are workers. None-sense, of course, but with just that little grain of truth which makes you sit up and think.

Augustine ruefully reflects that in World War 2 all the technology was developed, -built and applied and the war was won in just half the time it takes to develop a new military system today.

How Big?

GEC may be Britain’s largest private employer (about 184,000 employees) as well as one of the best managed and consistently profitable. And annual turnover is now a healthy £2,500 million. But, as GEC management point out to their staff, there are much bigger fish in the sea. US General Electric (no connection) has a major share of the turnover and Siemens of West Germany over three times. Matsushita and Toshiba of Japan are both much larger in turnover than GEC while French Thomson-Brandt and Brown Boveri of Switzerland and Germany are nudging from behind only barely short of GEC’s sales performance.

Direct comparisons are, however, difficult because such conglomerates (including GEC) have different interests. GEC, for example, unlike US GE, does not make any engines or own coal mines. A more valid comparison is to try to separate out the various activities. Yet when we do this there is another shock. The whole of GEC’s activities in electronics, automation and telecommunications accounts for only one fifth of group turnover. Take out the business in traffic lights, telephone exchanges and industrial automation and you might guess that in ‘pure’ electronics GEC is about level on turnover with Racal whose business is almost totally in professional electronics.

This is not to disparage GEC, clearly a powerful force in electronics world-wide, but it does impress us with the problem of comparability and that, after all, from this perspective some of the smaller British firms are relatively larger than we imagined.

It is now ten years since GEC swallowed up English Electric and AEI. Turnover was then less than £900 million. Today’s £2,500 million turnover is achieved with 50,000 fewer employees, reflecting a mix of factory productivity gains and price inflation. Annual salary per employee is now averaging nearly £4,000, not far short of four times the 1970 figure which worked out, by present standards, at a lowly £21-80 per week—but you got more for your money in those days.

BPO Split

Apart from predictable adverse comment from union spokesmen on the postal side of the business, the Government’s decision to split the present BPO into two corpora-
tions was generally welcomed. PO telecommunications can now romp ahead doing their own thing, and doing it well. Most people, users only of the domestic network, are unaware of the international aspects of the business, or of the immense capital sums involved.

Two recently announced projects are examples. TAT 7, due in service by 1983, will provide another 4,200 submarine cable channels between the UK and the USA. Britain has a 22 per cent share of the £100 million cost and STC will manufacture in the UK the 2,700 miles of the cable at a cost of £30 million. Another £100 million project is INMARSAT providing by the mid-80s satellite communications for shipping. The BPO has an 11 per cent share in the project which will have its HQ in London. Yet another dish aerial is to be constructed at the Goonhilly complex to accommodate the new service. The BPO of course also has a major share in INTELSAT and is pressing ahead with international sales of the Prestel viewdata service.

Under the new arrangement, home and business subscribers will be able to use terminal equipment of their own choosing or, if they so choose, provided it has no adverse technical effect on the public network. With the BPO monopoly of supply broken, there will be intense competition for the business, providing a real challenge for home producers to exercise initiative. They have about two years in which to prepare. Failure means handing the bulk of the business to the Far East.
No.3 AMMETER

Conventional moving iron ammeters usually offer poor calibration, whilst transient response is severely impaired due to the damping needed to prevent overshoot. These ammeters are often difficult to install since they require heavy duty leads (30A or more) from the battery.

The instrument described overcomes these limitations and provides linear response over a range of typically ±25A. Furthermore, the displayed current range is adjustable, thus permitting the user to preselect the actual range of indication to suit his particular needs. The module is basically a voltage measuring device with a high input impedance.

PRINCIPLE OF OPERATION

The usual arrangement of connections to a vehicle battery is shown in Fig. 1(a). A heavy duty copper braid links the negative terminal of the battery to the vehicle chassis. This earth strap has a very low resistance, typically 0.002Ω or less. The equivalent circuit of the battery connection, showing the earth strap resistance, is given in Fig. 1(b). The voltage drop developed across the earth strap resistance, R, is directly proportional to the current flowing in it. Furthermore, the polarity of this voltage will change according to whether the battery is being charged or discharged. The obvious disadvantages are that the resistance of the earth strap will vary from car to car, and the voltage developed is very small, typically 20mV for a current of 10A. Hence, in order to interface with the standard LM3914 display circuit, additional amplification is required, and the gain must be made variable to allow for variation in earth strap resistance from one vehicle to the next.

The obvious solution is to use a simple operational amplifier arrangement. There is, however, a problem associated with the fact that the input voltage (developed across the earth strap) varies in polarity about OV (chassis potential). This is overcome by using a FET as a common source amplifier. See Fig. 2. The output voltage developed across the drain load resistor, R_D, depends upon the drain current, I_D, and Fig. 3 shows how the drain current varies with the gate-source voltage, V_GS. By suitable choice of source resistor, R_S, the drain current will increase and decrease about a steady value according to whether the battery is being charged or discharged. Again, by appropriate choice of values, the drain voltage is made to be approximately half the supply voltage, and thus it will interface correctly with the operational amplifier stage which follows. The effects of supply voltage and temperature variations are reduced by using a balanced differential arrangement as shown in Fig. 4. An input protection circuit is necessary in the event of the earth strap ever becoming disconnected, since the excessive gate-source voltage would damage TR1. VR1 allows the circuit to be balanced and compensates for any difference in FET characteristics.

The complete circuit of the Ammeter is shown in Fig. 5. Input protection is provided by R3 and D1–D2. This ensures that the maximum input voltage excursion at the gate of TR1 is 600mV in either polarity. R5 and D13 provide a regulated supply for the differential stage and VR2 sets the voltage gain of the operational amplifier stage. D14 is used to remove the d.c. level from the output of the operational amplifier and allows correct interfacing with the display driver, which requires a 0 to 5V input signal. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible signal at the input of IC2 over the desired current range.
Fig. 1. (a) Conventional car battery connections; (b) Equivalent circuit of the battery earth strap

Fig. 2. Simple common source amplifier using an n-channel FET

Fig. 3. Mutual characteristics $I_D/(V_{GS})$ of an n-channel depletion mode FET

Fig. 4. Practical realisation of Fig. 2

Fig. 5. Circuit diagram of the Ammeter
CONSTRUCTION
Two constructional examples are described. Individual constructors will most likely exercise their own preference as to the mechanical assembly of the instrument. The p.c.b. pattern is shown in Fig. 6 with the corresponding component layout given in Fig. 7. The printed circuit board is recommended for use when the instrument is for dashboard mounting in a rectangular “instrument pod”. An alternative layout which uses 0.1 inch matrix stripboard is shown in Fig. 8. This method of construction is more appropriate when the instrument is to be of the hand-held type.

The pod mounted version uses standard 0.2 inch i.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The MODE link in both layouts has been shown in the recommended DOT display position. The i.e.d.s may be colour coded to suit the constructor’s preference and suggested colours are red for the five left-hand diodes (indicating discharge) and green for the five right-hand diodes (indicating charge).

TESTING AND CALIBRATION
Before installation it is recommended that the instrument is “bench checked” using the circuit in Fig. 9. This provides a variable input voltage of up to 100mV of either polarity. It thus simulates the approximate range of voltages that will appear across the earth strap, and constructors can check ...

**COMPONENTS . . .**

**Resistors**
- R1, R2, R9 3k3 (3 off)
- R3 10k
- R4 220k
- R5 680
- R6, R8 1k (2 off)
- R7 470
- R10 27 ½W 5%
- R11 2k2

All resistors ½W 5% unless otherwise stated.

**Potentiometers**
- VR1 4k7 miniature skeleton pre-set
- VR2 100k miniature skeleton pre-set

(Use horizontal pre-sets for PCB mounting, vertical for Veroboard mounting.)

**Capacitors**
- C1, C2 2µ2 25V tantalum (2 off)

**Transistors and Diodes**
- TR1, TR2 2N3819 (2 off)
- TR3 2N3053
- D1, D2 1N4148 (2 off)
- D3–D12 10 off i.e.d.s—size and colour to suit
- D13 BZY88 C5V1
- D14, D15 BZY88 C5V6 (2 off)
- D16 1N4001

**Integrated Circuits**
- IC1 741
- IC2 LM3914

**Miscellaneous**
- Printed circuit board or stripboard
- Moulded case as appropriate
that the circuit functions correctly before wiring to the vehicle. With the 1k variable resistor set to mid-position, VR1 should be adjusted so that D7 just extinguishes and D8 just becomes illuminated. Moving the variable in one direction should cause the green i.e.d.s (D8 to D12) to illuminate successively and in the other direction the red i.e.d.s (D3 to D7) should illuminate successively. VR2 should be adjusted so that the whole range is covered.

The instrument can now be fitted to the vehicle. Care should be taken to connect the input leads correctly (otherwise a reverse indication will result) using a length of two core cable which terminates at either end of the earth strap. Calibration in the vehicle can then follow, but it will first be necessary to know the power or current requirements of one or more items connected to the vehicle's electrical system.

With no electrical accessories operating and the ignition off, VR1 should be adjusted for centre zero indication as before. Now assume, for example, that two headlamps, each rated at 60W, are illuminated together with side lights and rear lights accounting for a further 60W. The total power from the battery (assuming that the engine is not running and no other accessories are connected) will be 180W, which corresponds to a current of 15A. (In the example we have assumed that the battery is man enough to stand up to this load—in practice the terminal voltage of the battery would probably fall a little from the nominal 12V.) It is now merely a question of adjusting VR2 so that the third red i.e.d. from the centre, D5, is illuminated (assuming calibration is 5A/LED or ±25A). If a different calibration is required it is simply a matter of adjusting VR2 accordingly.

The setting of VR1 should now be checked once again and the car started. A momentary full scale discharge indication will be given as the starter motor is engaged. The charging indication should be checked. On most cars this will be between 5 and 15A. The following table gives a rough guide of the current consumption of various items:

<table>
<thead>
<tr>
<th>Item</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidelights</td>
<td>3A</td>
</tr>
<tr>
<td>Rear stoplamps</td>
<td>5A</td>
</tr>
<tr>
<td>Rear screen heater</td>
<td>10A</td>
</tr>
<tr>
<td>Radio/cassette</td>
<td>less than 1A</td>
</tr>
<tr>
<td>Fan</td>
<td>3A</td>
</tr>
<tr>
<td>Interior light</td>
<td>1/2A</td>
</tr>
</tbody>
</table>

The basic temperature sensing arrangement is shown in Fig. 1. The base-collector voltage is fixed; a resistor is included in the emitter lead and, provided that the supply is included in the emitter lead and, provided that the supply and bias voltages remain constant, VBE gives an indication of the temperature of the transistor junction. An improved arrangement is shown in Fig. 2 where two transistors are connected.
in a differential configuration. This is important in reducing the effects of supply voltage variation which in a vehicle can be as much as 25%. If the circuit is exactly balanced, with R1 equal to R2 and identical transistors, the output voltage will be zero, provided that the two transistors are at the same temperature. Any difference in temperature will cause an imbalance in the circuit and a corresponding output voltage. Ideally TR2 should be closely maintained at a constant temperature, however in practice the interior temperature of a vehicle is usually regulated to a comfortable and fairly constant level (between 20 and 25°C) by the driver. The temperature sensor, TR1, is mounted at some convenient point on the engine block and thus is kept at the working temperature of the engine.

Fig. 3 shows the practical realisation of Fig. 2. A Zener diode is used to stabilise the base-collector voltages of TR1 and TR2. The emitters of TR1 and TR2 are connected to the differential inputs of an operational amplifier. This responds to the difference in the two base-emitter voltages. The operational amplifier also provides the additional voltage gain necessary for interfacing with the display module. VR1 provides a means of balancing the circuit and compensating for any mismatch in transistor characteristics.

The complete circuit of the engine temperature indicator is shown in Fig. 4. The gain of the operational amplifier stage is made adjustable by means of VR2 and, since the output of the stage is at about half-supply potential (approximately 5V), a Zener diode, D2, is used to remove the d.c. level before the signal is applied to the display driver, IC2. By suitable adjustment of VR1 and VR2 it is possible to produce a compatible 0 to 5V signal at the input of IC2 over the desired temperature range.

CONSTRUCTION
As with the other instruments in this series, two constructional examples are described. Fig. 5 shows the printed circuit track pattern and Fig. 6 the corresponding component layout recommended for use in a dashboard instrument for mounting in a rectangular instrument pod. The alternative layout using 0.1 inch matrix stripboard which is suitable for a hand-held instrument is shown in Fig. 7. The pod mounted version uses standard 0.2 inch i.e.d.s whereas the hand-held instrument uses smaller TIL209 type devices. The wire MODE link in both layouts has been shown in the recommended Dot display mode. The i.e.d.s. may be colour coded,

Fig. 1. Base-emitter voltage varies with temperature of transistor junction

Fig. 2. Differential configuration to reduce the effects of supply and bias voltage variations

Fig. 3. Practical realisation of Fig. 2

Fig. 4. Circuit diagram of Engine Temperature Gauge. Note: D2 should be BZY88 C4V7
COMPONENTS

Resistors
R1, R2 10k (2 off)
R3, R7 3k3 (2 off)
R4, R6 1k (2 off)
R5 470
R8 27 Ω
R9 2k2
All resistors 1W, 5% except where stated.

Potentiometers
VR1 10k, min, skel, pre-set
VR2 100k, min, skel, pre-set
(Use hor. pre-sets for p.c.b. mounting, vert. for stripboard mounting.)

Capacitors
C1, C2 2μF, 25V tantalum

Transistors and Diodes
TR1, TR2 BCY70
TR3 2N3053
D1 BZY88 6V2
D2 BZY88 4V7
D3-D12 I.e.d.s to suit (10 off)
D13 BZY88 5V6
D14 1N4001

Integrated Circuits
IC1 741
IC2 LM3914

Miscellaneous
Printed circuit board or 63 x 40mm of 0.1 inch stripboard
Moulded case as appropriate

and suggested colours are red for the two I.e.d.s on either extreme and yellow for the others. Hence a red "warning indication" will be given when the engine temperature is outside the range 20°C to 80°C.

CALIBRATION

Calibration is quite simple and, if necessary, can be carried out without the aid of a thermometer. VR1 should be used to set the low temperature indication of the display and VR2 to adjust the range of display. An approximate calibration temperature of 0°C can be obtained using a cupful of crushed ice which is just on the point of melting. The temperature sensor, TR1, should be placed in the ice taking care not to immerse the leads. VR1 is then adjusted until the extreme left hand I.e.d., D3, just extinguishes (leaving the rest of the display blank). TR1 should then be placed in a cupful of water that has just been boiling, again taking care not to immerse the leads. This will produce a temperature of around 90 to 95°C. (Do not use a kettle since the steam produced can cause condensation around the transistor leads.) VR2 is then adjusted so that the extreme right hand I.e.d., D12, is illuminated. The procedure should be repeated, again adjusting VR1 at one end of the range and VR2 at the other. The calibration can, of course, be checked using an accurate thermometer if available. Having completed the calibration, the instrument is ready for fitting to the vehicle.

CONNECTION TO THE VEHICLE

The temperature sensor, TR1, should be either bonded to the engine block using epoxy adhesive or held in place by a small metal clamp. The metal case of the transistor is connected to the collector and may thus safely be earthed to the chassis of the vehicle. Care should be taken to insulate the transistor leads and ensure a sound mechanical termination. A short length of three-core cable should be used to connect the temperature sensor to the instrument pod. Alternatively, a length of two-core screened cable may be used in which case the earth/collector connection is the screen itself.
THE dwell angle of the contact breaker cam is of great importance to engine performance, particularly at higher rev's. The dwell angle is the angle through which the cam turns while the contact breaker points remain closed and depends upon the angular separation of the cam lobes on the distributor shaft, and the maximum gap between the points. It must be sufficiently large to enable the soft iron core of the ignition coil to become magnetically saturated to provide a good spark, yet not so large as to cause over-dissipation. Too small a dwell angle will result in a low spark voltage, and poor combustion. This may be caused by:
(a) The contact breaker gap being too large.
(b) The cam being excessively worn.
(c) The cam and shaft bearings being excessively worn.

Large dwell angles will result in overloading of the capacitor and burning of the contact breaker points at low speeds. Too large a dwell angle is usually due to the gap of the contact breaker being set too small.

The correct dwell angle for a particular vehicle will be found in the workshop manual. Generally, the dwell angle is usually slightly less than two-thirds of the angle between the cam lobes. In a 6-cylinder distributor, for example, the cam lobe separation is 60 deg and the dwell angle is about 36 deg (comparable figures for a 4-cylinder unit are 90 deg and 52 deg, respectively).

MEASUREMENT OF DWELL ANGLE
Measurement of the contact breaker dwell angle is most easily accomplished by observation of the voltage waveform across the contact breaker points. An idealised representation of this waveform is shown in Fig. 1(a).

A straightforward method of measuring dwell angle requires only a moving coil d.c. voltmeter and a calculator. The mean value of the waveform in Fig. 1(a) is given by:

$$V_{\text{mean}} = \frac{V_s \times \text{Angle between cam lobes}}{\text{Dwell angle}}$$

Fig. 1. (a) Breaker points voltage waveform. (b) Points condition; (c) Timing angles; (d) Duty cycle

Fig. 2. Circuit diagram
The values of $V_{\text{mean}}$ and $V_s$ may be measured at the two ends of the ignition coil primary winding. The moving coil movement will average the waveform and the dwell angle may then be found from:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{V_s - V_{\text{mean}}}{V_s}$$

This technique is tedious when repeated measurements are required.

Ideally, dependance upon the variable value of $V_s$ should be eliminated, allowing a simple scaled meter to be used, whereby the duty cycle of the waveform, rather than the voltage is measured. The dwell angle is then:

$$\text{Dwell angle} = \text{Angle between cam lobes} \times \frac{100\% - \text{Duty cycle}}{100\%}$$

The calibration now depends only upon the angle between the cam lobes. This meter works on duty cycle and displays dwell on a scale which may be calibrated to 90 deg, 60 deg or 45 deg for distributors with 4, 6 or 8 cam lobes, respectively.

**CIRCUIT DESCRIPTION**

The circuit diagram is shown in Fig. 2. The contact breaker voltage waveform is sampled at point "B", and then filtered by $R_1$, $C_1$ and $R_2$. The filtered signal is applied to the non-inverting input of op. amp. $IC_{1a}$, which is arranged as a voltage comparator. The combination of $R_3$ and $D_1$ sets the switching threshold such that the voltage at point "B" must exceed approximately 1 volt to cause the output of the comparator to go "high".

**COMPONENTS . . .**

<table>
<thead>
<tr>
<th>Resistors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_1$, $R_3$, $R_5$</td>
<td>10k (3 off)</td>
</tr>
<tr>
<td>$R_2$</td>
<td>22k</td>
</tr>
<tr>
<td>$R_4$, $R_7$</td>
<td>1k (2 off)</td>
</tr>
<tr>
<td>$R_6$, $R_{10}$</td>
<td>2k2 (2 off)</td>
</tr>
<tr>
<td>$R_8$</td>
<td>3k3</td>
</tr>
<tr>
<td>$R_9$</td>
<td>27 $\frac{1}{2}$W</td>
</tr>
<tr>
<td>All $\frac{1}{2}$W 5% unless otherwise stated</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$, $C_3$</td>
<td>10n ceramic (2 off)</td>
</tr>
<tr>
<td>$C_2$, $C_4$, $C_6$</td>
<td>10µ/16V elect (3 off)</td>
</tr>
<tr>
<td>$C_5$</td>
<td>4µ/7/10V elect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transistors and Diodes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_1$</td>
<td>1N914 or similar</td>
</tr>
<tr>
<td>$D_2$, $D_4$</td>
<td>1N4001 (2 off)</td>
</tr>
<tr>
<td>$D_3$, $D_15$</td>
<td>BZY88 CS5V6 Zener (2 off)</td>
</tr>
<tr>
<td>$D_5$--$D_{14}$</td>
<td>L.e.d.s to suit physical requirements (10 off)</td>
</tr>
<tr>
<td>$TR_{1}$</td>
<td>2N3053, BFY50 or similar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrated Circuits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$IC_1$</td>
<td>LM324</td>
</tr>
<tr>
<td>$IC_2$</td>
<td>LM3914</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripboard or p.c.b. Moulded case</td>
<td></td>
</tr>
</tbody>
</table>

*Fig. 3. Printed circuit layout (actual size)*

*Fig. 4. Component overlay*

*Fig. 5. Alternative stripboard layout*
The comparator output is a rectangular waveform limited to the output saturation levels of the op amp, which in this application are approximately 600mV and \( V_{\text{sup}} = 1.2 \) volts for the "low" and "high" states respectively. The dependence of the "high" level on the supply voltage is eliminated by the clipper circuit, R4 and D3, and the result is a signal between the levels of 600mV and 5-6 volts.

The average value of the signal at point "D" varies linearly between 600mV and 5-6 volts as the duty cycle varies between 0 and 100%. This average value is developed at point "E" by the integrator formed by R5 and C4, and is subsequently buffered by IC1d to minimise loading effects. The 600mV d.c. offset is removed by D4, and the voltage across R6 varies from 0 to 5V as the duty cycle at the input varies from 0 to 100 per cent to correspond to dwell angles from maximum (angle between the cam lobes) to zero, respectively.

The time constant of the display response is determined by the integrator circuit of R5 and C4. The remainder of the circuit comprises the standard display module.

**PRACTICAL DETAILS**

The constructional details for the dwell meter closely follow those outlined for the earlier instruments in the series. A p.c.b. design is shown in Fig. 3, with a corresponding component layout in Fig. 4. A stripboard layout for a hand-held test instrument is shown in Fig. 5.

Both instrument variants are shown wired for dot mode display. The display scale should be calibrated 90°-0°, 60°-0°, 45°-0° for 4, 6, 8-cylinder distribution units respectively. The connections for use are the same as those for the tachometer (November), and are summarised again in Fig. 2. A higher resolution display of the dwell angle may be obtained by the use of additional display driver devices, described later.

**HAZARD WARNING & CASCADING...**

There are many occasions when it is imperative that the driver receives an immediate warning that all is not well under the bonnet. The two techniques described below illustrate methods of producing hazard warnings in sharp contrast to the normal indication given by the instrument concerned. The examples provided should enable constructors to modify any of the instruments previously described in the series for added hazard warning indications. The enthusiastic constructor will doubtless wish to further exploit the many features of the LM3914 and, in this case, the suggestions given will merely provide a starting point.

**MODE SWITCHING**

An obvious method of attracting the driver's attention to an instrument operating in Dot mode is to change the display to Bar mode whenever a pre-determined level is exceeded. In practical terms this involves switching the display mode input (pin 9 of the LM3914) electronically, and since the particular I.e.d. illuminated relates to the input level, it is possible to sense the voltage across the I.e.d. concerned and use this to activate an electronic changeover switch. If the voltage at the input of the standard display module (pin 5 of the LM3914) were to be increased slowly from 0 to 5V, and the last I.e.d. used for setting the display into Bar mode, then the display would operate in the normal Dot mode until the last I.e.d. became illuminated, at which point the display would change to Bar mode. In practice any one of the I.e.d.s in the display it is possible to turn off the display by reducing this current to zero. The circuit of Fig. 2 shows a simple arrangement for flashing the display whenever D8 is illuminated. The falling potential at the cathode of D8 when it first becomes illuminated is applied, by means of C1 and R2, to the reference output of the display driver. R3 is included to ensure that D8 becomes extinguished along with the other I.e.d.s in the display when the display is momentarily turned off. The LM3914 is programmed to produce a constant current in each of its I.e.d. loads and hence the additional resistor in series with D8 does not affect its brilliance. With the component values given the circuit operates at a rate of approximately 90 flashes per minute with a duty cycle of around 30%. It is important to note that, because the reference output is used to modulate the display, the top end of the resistive divider chain feeds the non-inverting inputs of the ten comparators within the LM3914, must be supplied from a separate regulated supply. This can conveniently be derived from the supply rail which feeds the I.e.d.s (nominally 5V) however, since Bar
mode is employed and a relatively high current is drawn from this rail, it is recommended that the simple discrete component series transistor regulator used with the standard display module be replaced with a conventional 5V integrated circuit regulator.

Where the flashing circuit is to be fitted to an existing circuit board it is recommended that the extra components are assembled using a small piece of stripboard. The regulator should be fitted with a suitable heatsink (19°C should be adequate) and capacitors C2 and C3 should be fitted as close as possible to the pins of the regulator. The existing transistor series regulator arrangement should be disabled by removing the transistor and associated components from the board. It will also be necessary to modify the board wiring around pins 6 and 7 of the LM3914. R1 and R4 can conveniently be incorporated on the existing board and five connecting wires will be necessary.

**DISPLAY RESOLUTION ENHANCEMENT**

The basic display module described in this series makes use of a display consisting of 10 I.e.d.s. It is often desirable, however, to know the value of the measured parameter to finer limits than can be read from the basic display module. This means that a greater number of I.e.d.s must be used, for example, to display 0-6000 r.p.m. in steps of 200 r.p.m. requires 30 I.e.d.s.

The design of the LM3914 integrated circuit means that the display is conveniently increased in multiples of 10.
EXTENDED DOT MODE DISPLAYS

The "chaining" of display devices to provide an extended Dot mode display employs some as yet unused characteristics of the Mode Select Amplifier in the LM3914. The Mode Select Amplifier looks at three inputs to decide whether to show a Dot display, a Bar display, or a Dot display using multiple LM3914 devices. The three inputs to the Mode Select Amplifier are from pin 9 (mode), pin 3 (V+), and from pin 11 (D9); the last two being connected internally.

Holding the mode pin to within 20mV of the voltage at pin 3 will cause a bar graph to be displayed. A dot mode display will appear if pin 9 is 200mV or more below the voltage at pin 3. If the mode pin is 900mV below the voltage at the anodes of the I.e.d.s, D10 will be turned off. This last feature is exploited in the extended dot mode displays to be discussed and is used to turn the last I.e.d. of one LM3914 off when the first I.e.d. of the next device up the chain is turned on.

The circuit diagram for a 30-I.e.d. dot mode display module is shown in Fig. 3. The I.e.d. current is set by the value of the resistors R, to a value given by:

\[ I = \frac{12.5}{R} \]  
(R is typically 1 kΩ)

The full-scale calibration of the display module shown depends on the exact value of the 5 volt rail, i.e. the full-scale value is set by the voltage at pin 6 of the LM3914 in module 3. A 22k resistor is also required in parallel with D9 in modules 1 and 2 to ensure correct operation of the Mode Select Amplifiers.

A 20-I.e.d. display may be constructed by omitting module 2 from the circuit of Fig. 3, and making direct connections A-a, B-b, C-c, D-d, E-e, and F-f. Alternatively, the display may be extended beyond 30 I.e.d.s by breaking the links at A, B, C, D, E, and F, and inserting additional modules of type 2 as required.

EXTENDED BAR MODE DISPLAYS

Bar graph displays of 20 or more I.e.d.s are relatively simple to build. All that is required is that the mode pin of each LM3914 is connected to pin 3 of the same LM3914. The circuit diagram for a 30-I.e.d. bar graph display module is shown in Fig. 4.

As with the extended dot mode display, the full-scale input voltage for the module is set by the voltage at pin 6 of the LM3914 in module 6. The power dissipation of the regulator for the anode supply to the I.e.d.s requires careful consideration. A stable 5-Volt output is required, with the regulator capable of dissipating the surplus power associated with a full-scale display. For example, a 100-I.e.d. display with \( R = 1 \) kΩ would involve a regulator dissipation of 8.75 watts when operated from 12V supply, (the individual I.e.d. current would be 12.5mA). It is recommended, therefore, that an integrated circuit regulator be used as shown in Fig. 4, and that adequate heat-sinking arrangements be made.

Displays of 20 I.e.d.s should omit module 5 from the circuit given in Fig. 4, and links should be inserted at G-g, H-h, I-i, J-j and K-k. For displays of more than 30 I.e.d.s, the links should be broken at G, H, I, J, and K, and additional modules of type 5 inserted as required.
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... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Compukit
Sir—Some time ago I think you asked for reader comments and I would like to say that in my view PE has improved very considerably over the years and particularly in recent times.

But I have a moan! The Compukit articles, who are they aimed at, the expert or the amateur? Right at the start the writer lists the amateur as a potential user, but the articles are written using computer jargon (the writer says much as much in one place) which is pretty well unintelligible to the beginner in the computer world, however expert he may be in general electronics. In saying, this I am not referring to the BASIC dialect but to words such as “string function” (on page 43 of the pull-out, it is stated that a string can be 0 characters long which seems to have no meaning, and whence 2557), “the memory defaults,” “arrays,” “truncated integers,” etc., and does the average amateur know his Boolean algebra?

With reference to the pull-out itself, does this refer particularly to the Compukit or to BASIC in general?

May I refer to the “Microprocessor Evaluation System” article in the May issue of PE in which the writer states several times that 377 octal is 255 binary, but 377 octal is equivalent to 255 decimal, there are no 2s and 5s in the binary system. As the writer makes the statement several times he presumably means something by it, but what? Lastly, to the beginner in the computing world (and that includes me) the charts on pages 20, 21 and 22 are pretty well unintelligible to the beginner in the computing world. Thank you for your comments. This is a selection from our postbag.

A. Bray, Potters Bar.

Recompense!
Sir—Re your correspondence page in October issue and the article on CB. There is no doubt in my mind that most, if not all of this, is triggered off by people who wish to block CB imports. I have had a life-long interest in radio and have made no concerted effort to study, and yet recently I saw a paper used at the May RAE exam and could have passed it. This would give me access to equipment designed for 144MHz costing less than the £260 quoted in Mark Sawicki’s article. Study Morse for a few weeks and I can transmit world-wide! Much more interesting and just as useful in emergencies as CB probably is. In the States, I am told, (CB) is abused more than used.

I suppose that the Government will eventually give in, they usually do, but if they take the soft option, 27MHz, then they are morally bound to recompense modellers financially, who have to change their equipment. I am not, by the way, an RC modeller.

T. D. Ray, Derby.

Schottky
Sir,—In “Semiconductor Update” in September’s issue of Practical Electronics, R. W. Coles states “There will be other new TTL families from manufacturers such as Fairchild…”. A few months ago Texas Instruments announced their AS and ALS range of advance TTL families. To date, only one part is obtainable, the 74ALS74.

One year ago, Fairchild announced fast: “Fairchild Advanced Schottky TTL”. This range was not only announced several months before competing products: it is also considerably easier to obtain. Already the simple SSI building blocks are available, and MSI multiplexers, registers, counters and bus drivers are either available or will shortly be announced.

Fast is fast: 3ns per gate at one fifth the power of high speed standard Schottky. A technical description of fast technology has already been published in Electronics, March 1979, pp. 111.

J. Summers, Fairchild.

Champ
Sir,—In the conclusion of the CHAMP series you mentioned possible further articles on programming or hardware designs, but nothing has been printed yet.

There must be many PE readers who have constructed CHAMP and have information to exchange.

I would be glad to exchange with any CHAMP enthusiasts hardware ideas, problems and even the occasional program.

J. Coyne, BFPO 17.

CHAMP has been rather overtaken by new technology but it is not our intention to neglect those who have built it and we would welcome small programmes and hardware ideas for publication and for exchange to other CHAMP users—Ed.

P.E. COMPONENT STANDARD

Typical examples:

<table>
<thead>
<tr>
<th>Resistance</th>
<th>Now</th>
<th>Before</th>
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<tr>
<td>3.9kΩ</td>
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<td>1MΩ</td>
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<tr>
<td>2.2Ω</td>
<td>2.2Ω</td>
<td></td>
</tr>
<tr>
<td>0.47μF</td>
<td>0.47μF</td>
<td></td>
</tr>
<tr>
<td>470pF</td>
<td>470pF</td>
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<td>4700μF</td>
<td>4700μF</td>
<td></td>
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<tr>
<td>4.7μF</td>
<td>4.7μF</td>
<td></td>
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<tr>
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<td>47μF</td>
<td></td>
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<tr>
<td>2.2μF</td>
<td>2.2μF</td>
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</tbody>
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<tr>
<th>Inductance</th>
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<tr>
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</tr>
<tr>
<td>2.6mH</td>
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<td></td>
</tr>
<tr>
<td>1mH</td>
<td>1mH</td>
<td></td>
</tr>
</tbody>
</table>

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THE unit to be described will display directly the cost of a telephone call, taking into account the time of day, distance called, and length of time of a call. The unit can also be used to total the cost of several calls.

At the time of writing, the Post Office charges three pence for each unit of time of the duration of a telephone call. For a long distance call (over 56km) at peak rate, each ten seconds will cost three pence. A local call at peak rate costs three pence for two minutes. Table 1 gives the current rates (cost codes) presently charged by the Post Office.

For example with the instrument set to cost code (a) it will add three pence to the display every ten seconds.

CIRCUIT

Fig. 1 gives a block diagram of the system used. The period timer is a monostable with a timing period set for the appropriate cost code—10s, 15s, etc. The negative edge of the output pulse is fed to both the unit timer, which is also a monostable, and, in turn, the cost oscillator. The timing pulse of this is used to gate the cost oscillator.

The duration of this pulse and the frequency of the oscillator are chosen such that only thirty oscillations occur before the gating pulse stops the oscillator. These thirty pulses are fed to the counter/display system, and cause a 3 to be displayed. The unit timer pulse is also fed back to retrigger the period timer, and start again the sequence of events.

IC1 contains two monostable oscillators (Fig. 2). IC1a is used to provide the period timing pulse. The length of this depends on which resistor R3—R11 is switched into the circuit and on the value of C3. VR1 is used to provide a control voltage to pin 3 which is used to make a fine adjustment to the timing pulse period. The length of this pulse is altered by VR2.

The output pulse is then fed to pin 12 of IC2. This is a four NAND gate CMOS chip. Three of these gates are connected as an oscillator. The oscillations are fed to pin 9, and only emerge at pin 11 of the gate if pin 12 is at logical 1, which is for the duration of the unit timer pulse.

<table>
<thead>
<tr>
<th>Table 1: Cost Codes</th>
<th>Time in secs. for 3p. Costcode is in brackets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak Rate</td>
</tr>
<tr>
<td>Local</td>
<td>120 (f)</td>
</tr>
<tr>
<td>Up to 56km</td>
<td>30 (c)</td>
</tr>
<tr>
<td>Over 56km</td>
<td>10 (a)</td>
</tr>
</tbody>
</table>

The negative edge of the pulse is fed back via C5 to retrigger IC1a. C4, R13 and C5, R12 are used to provide short input triggering pulses, since these must be of shorter duration than the output pulse, which would not be the case if the pulses were fed directly to the inputs.

S2 is a double pole switch arranged such that S2a is on when S2b is off. In this mode pin 4, the reset of IC1 is grounded and the output pin 5 is low. Switching S2b on immediately gives a negative pulse to pin 8 IC1b which triggers the monostable so that the instrument immediately displays the first unit of cost, and then proceeds to cost the rest of the call.

TIMING PERIODS

The values of C3 and R3—R11 are chosen to give a timing period of 10 seconds per 100k (using VR1 for a final calibration). Therefore to obtain the timing periods 10, 15, 30, 45, 60, 120 and 180 seconds, resistors of 100k, 150k, 300k, 450k, 600k, 1.2M and 1.8M, respectively are required.

Fig. 1. Block diagram
30k resistor is obtained by two 150k in series and a 470k resistor is used instead of a 450k resistor, leading to a 5 per cent error in this timing interval. However, for domestic use this is not significant. Also R8 will need to be 620k. Varying VR1 changes all timing periods by the same percentage.

In the event of changes in telephone charges VR2 will recalibrate the unit cost of a call. Any changes in this period costing may be done with VR1 or else resistor changes may be required. This however is a simple job.

IC3 is a National CMOS MM 74C925 four digit counter/latch/driver, internally multiplexed. IC5 is a CA3046 chip containing five identical transistors, four of which are used to drive the display digits. The display is a TIXL306 calculator display with either four or six digits. Only four are used in this project.

The pulses from the oscillator are clocked into pin 11 of IC3 where they are then counted and displayed on IC4. S4 is depressed to zero the reading on the display.

The power supply regulation circuit is fairly simple and straightforward giving a line voltage of about five volts.

COMPONENTS

IC5 may be substituted by an LM3086, which is a pin for pin equivalent. IC4 may be substituted by any display if the appropriate adjustments are made to the printed circuit board. All that is required is that the segments a-g and digits be connected to IC3 as shown. Individual 0-3 in. displays may be used also. Again the constructor will need to make his own modifications.

The specified display fits into a 16 pin DIL socket making the mounting simple. It is recommended that DIL sockets be used for all the i.c.s, especially for the 74C925. Being CMOS it can be easily damaged by static electricity.

CONSTRUCTION

Figs. 3 and 4 give the printed circuit board and component layout. The display is mounted in a DIL 16 pin socket arranged on its edge, such that the display is perpendicular to the board. Bend the socket pins round 90° and solder them into the holes drilled in the board. Stiff wire is used to connect the remaining pins of the display to the board.

Drill the front panel of the case to take the switches. Cut a window in this panel suitable for viewing the display. Red clear plastic can be used as a filter. This can be glued to the inside of the panel.

S3 is mounted on the lid of the box. R3-R11 are soldered directly onto the terminals of this switch. The battery, if used, is stuck on the underside of the lid using a double sided sticky mounting tab. The printed circuit is held to the base using two screws into the mounting studs. The lettering on the box can be done using Letraset. To avoid extra circuitry for controlling the decimal points, the unwanted decimals are blanked off using a felt tipped pen.
CALIBRATION
VR2 must first be adjusted so that the display increments by thirty each time. Switching S2 from stop to start will increment the display and speed up the calibration process.
Switch to cost code a, and adjust VR2 until the counter increments every 10 seconds. This roughly calibrates the period timer. Then switch to position g, and readjust VR2 so that the counter increments every three minutes. The unit is now calibrated.

TROUBLE SHOOTING
If the unit doesn't work on switching on, check power supply voltage and wiring. Also check the i.c.s are inserted the right way round.
If the four digits of the display light and S4 will zero any random number displayed when the instrument is turned on, then IC3, IC4, IC5 will be functioning. Attention can then be turned to the remaining circuitry. Remove IC1 and the display should count continuously. Switching on/off may be necessary to start the oscillations. If the oscillator is working, attention can then be turned on IC1. Make sure that VR1 is not set to either end of its travel, and check the voltages on the various pins of the i.c.

USING THE INSTRUMENT
Switch on, set cost code. Put S1 to stop, press S4, then put S1 to start when the call starts. At the end of the call put S2 to stop.
The cost will then be displayed. If another call is to be made do not turn off the instrument. Press to start and the cost of this call will be added to the last call. The instrument could be permanently left on if required to total the cost of all calls (up to a limit of £9.99). However, a mains adaptor would be imperative in this case.
MANY of the letters sent to Micro-Bus are from owners of a Science of Cambridge Mk14, the low-cost microcomputer system based on the SC/MP micro, and six of this month's seven topics were submitted by readers who own such a system.

OSCILLOSCOPE DISPLAY

The following ingenious video display makes it possible to display text or graphics on an ordinary oscilloscope. It was designed for use with a SC/MP micro, but is equally suitable for use with other micros. The circuit and program were submitted by Adrian Dickens of Leicester, and what follows is based on his description:

“The idea for the display is not revolutionary, but because the hardware costs under £1, it will enable anyone with a suitable microcomputer and an oscilloscope to experiment with a video display. In the prototype, 2048 bits of data stored in RAM are displayed as a matrix of 64 x 32 dots. Although the quality of the display leaves something to be desired, it is possible to display four lines of eight or nine legible characters each.

DISPLAY OPERATION

“The complete circuit of the cheap video display uses only two CMOS integrated circuits and a few resistors; see Fig. 1. The program of Fig. 2 drives the oscilloscope display, outputting data from the extra RAM space in the Mk14 microcomputer, locations 0000-00FF, as a stream of bits to the display circuit. Data from each memory location is output from the extension register using the serial input/output instruction 'SIO'. If the extra RAM is not present, the 1024 bits stored in 0F80-0FFF can be displayed instead. In this case the oscilloscope should be triggered by the Q9 output from IC1, and the program will have to be modified slightly.

When the program has been loaded into the Mk14, and the user is about to press 'GO', flag 1 will be low so the reset on the counter sets all the Q outputs low. If the program is now set in motion the counter is incremented for each bit output, and whenever a '1' appears at the serial output from the MK14 the resistor chain is pulled low via IC2a. This in turn causes a dot to appear in the relevant position on the oscilloscope display. When all of the 2048 bits have been displayed the necessary trigger pulse appears at the Q10 output.

One improvement available to readers who own an oscilloscope with an X input would be to build another resistor chain using Q5 to Q10 and use this to deflect the beam from left to right, instead of relying on the internal timebase of the oscilloscope to do this.”

EXTRA DISPLAY DIGIT FOR Mk14

The Science of Cambridge Mk14 microprocessor kit is supplied with a nine-digit display, but only eight of them are connected. The following simple modification, discovered by Mr. R. G. Aucotte, makes it possible to use the ninth digit:

“Only two wires are needed; one on the back of the printed-circuit board from pin 10, IC13 (DM7445) to the second of the two spare holes under the left-hand side of the display when viewed from the component side. The other wire links the same point on the board to terminal number 2 on the display (numbered left to right); this connection may already be present on later Mk14s.

The pattern of segments displayed by the monitor on the ninth digit will be determined by the contents of location 0F08, and since
how the Mk 14s display can be multiplexed from a cassette interface system, submitted by Colin C. Tredwell of London, which displayed the message bytes, and the extension register display digits; P1 points to the display and P2 the message to the addresses for the nine repeated copying the nine segment codes for how the Mk 14s display can be multiplexed AUTOMATIC OFFSET

Colin C. Tredwell of London, which displayed oFF3 GEED GFEC 3FXPPC oFEA (TES 98E8 or.) 0490 .EDE c9FF;ow 02 (TD8 40, FD6 0FDI 9CE4 .FCC CIPF cRCA 9921 OFBE 94FC OF24 OF20 OF1F)

except that where instructions require a dis-

assembling" programs is calculating the offsets for program-counter relative jumps and addressing operations. The "offset calculator" program of Fig. 4, submitted by Mr D. Love of Swansea, eliminates the need to make these calculations by hand.

"The 'offset calculator' makes all the calculations automatically in one pass, thus speeding up writing programs and making them more likely to be free of errors. To use the offset calculator, programs are written as usual except that where instructions require a displacement, the low byte of the destination address is inserted as the second byte of the instruction instead of the displacement. The offset calculator makes the calculation when it passes over the program.

0F1F COUNTER
0F20 B81F LOOP: DLD COUNTER
0F22 9020 JMP LOOP
0F24 A0 STOP CHARACTER FOR OFFSET CALCULATOR

In the example of a program which loops around, decrementing a counter the address of the program to be processed (0F20 in this example) is put in OFF9, OFFA so that the monitor will set up P1 for us. Then the offset calculator program is run from 'ENTER', and it will stop when it encounters 'A0'. It will have altered the program to:

0F20 B8FE
0F22 90FC

and the program is now ready to run."

PROGRAM OPERATION

"The SC/MP instruction set can be divided into three basic types:

1) Single byte instructions
2) Double-byte immediate or indexed instructions
3) Double-byte instructions with displacement.

The offset calculator is only concerned with the third category, so it must differentiate between them. All single-byte instructions are positive and so are easily identified, and double-byte displacement instructions end in either 'O' or '8', the only exceptions being 'JP' (94) and 'JZ' (9C). Note that jumps and memory-reference instructions require different offsets, as illustrated by the example given above, and this is dealt with at 'INC' by incrementing the displacement for memory-reference instructions. Displacements are reduced in the range -128 to 127 since the program

So writes Mr N. E. H. Fielden of Suffolk, and to remedy the situation he has written a routine for SC/MP to simulate the JSR and RTS instructions of other micros such as the 6502; see Fig. 7.

A list of the subroutine addresses is stored in memory pointed to by P2. The appropriate one is selected by the value received in the accumulator by the stacker routine. Thus the calling program contains: 'LDI n, XPPC 3' (C4 nn 3F) as the equivalent of 'jump to subroutine'. The subroutine address is taken from locations P2+n (high byte) and P2+n+1 (low byte). The calling address is saved in a stack using P1, which should initially point to the top of a free area of RAM. Return is achieved using 'JMP 17(3)' (93 17) which causes a jump to the stacker routine at 'LDI n, XPPC 3'.

Pointers P3 should be set to the address 'EXIT' (0B00 in this case) before use. The routine is fully relocatable, so it can be put anywhere convenient in memory without modification. This version is fairly simple; it does
MARKET
PRESTEL TESTING THE INTERNATIONAL MARKET

BUSINESSMEN in seven countries will soon be able to take part in an international trial of Prestel, the British Post Office's world-leading viewdata system which gives users access to computer information banks by means of a simple TV type display terminal.

Invented at the Post Office Research Centre this system has already put Britain ahead of any other country in the mass marketing of electronic information. Now following the start of the world's first public viewdata service in London on March 27 Britain will score another world first when it begins experiments with an international viewdata service later this year.

The trial is designed to identify the kind of information today's globe-trotting businessman, or government official, needs to know but which is often difficult to get quickly. With a Prestel international service it will be instantly available, literally at the user's fingertips.

The trial will be open to selected users in the UK and up to six countries-Australia, German Federal Republic, the Netherlands, Sweden, Switzerland, and the United States. It will offer a wide variety of up-to-the-minute business information drawn from many parts of the world-prices in the world's premier stock markets, currency exchange rates, schedules for the world's major airlines, the latest shipping news, as well as a variety of specialist information such as commodity prices, economic analyses and company management information.

The decision to go ahead with the trial follows a six-month evaluation of the potential market for such a service carried out for the Post Office by Logica Limited. This firm has now been commissioned to assist in implementing the trial which is expected to last one year. During the trial, a decision will be taken regarding a full scale service.

Already discussions are under way with firms who might provide information needed for an international databank, part of which could be multi-lingual. Parallel talks are due to start soon with TV set manufacturers about supplying the few hundred terminals needed for the trial. The telecommunications authorities of the other countries involved are being invited to discuss the Post Office's plans.

The trial service will be using a dedicated Prestel computer in London which will become available after the full public service goes live in London.

News Briefs

FALLING MAN DISPLAY

The last in this month's series of applications for the Mk14 is a program donated by Nick Toop, designer of the Science of Cambridge VDU Module, to demonstrate some of the graphics possible with this VDU. The program generates a display of a man falling through space with his arms raised, and then landing with his arms lowered, see Fig. 8. He is then joined by three similar men, and the cycle repeats indefinitely. The animation is generated in half of the screen, 32 of the 64 possible rows, and uses the Mk14's extra RAM at OB00 for the display area. This memory is mapped to the display in rows of 64 dots, 8 bytes per row.

PROGRAM OPERATION

The falling-man program, Fig. 9, makes clever use of auto-indexing to keep it as short as possible. The bit patterns for the two positions of the man are stored after the program at "MAN". Each row of the man consists of 16 dots, specified by two bytes, and the whole man comprises 15 rows. The program writes the man to the display a total of 19 times, each time shifting the man down by one row to give the appearance of falling. For the first 15 sweeps of the man the picture of the falling man is used, and for the last 4 sweeps the standing man is used.

The resulting animation is pleasingly realistic, and should inspire owners of suitable systems to attempt more ambitious displays, such as a man walking across the screen.

EIGHT EIGHTS WINNERS

The winners of the Eight Eights competition, presented in the August Micro-Bus, were: Mr D. Caballero of Ramsgate, Mr J. M. Brinton of Cheltenham and Mr E. Vynek of Alleur, Belgium.
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text. Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

HAVING constructed the audio-millivoltmeter featured in the June '76 edition of PE, I discovered that circuit noise and main's hum caused a permanent deflection on the meter that was unacceptably large on the lowest range. To cure this I devised this circuit.

IC1 has unity gain and acts as a buffer amplifier for the input signal across R1. The signal is then fed through one of the voltage-dividers to IC2, which amplifies it and provides frequency compensation. The signal then passes to IC3 which duplicates it across R4 and so produces a low-distortion half-wave rectified signal across R5 (it is important that R20 = R21 and that D1, D2 and D3 are identical). The rectified signal is d.c. and is amplified by IC4 to drive the meter. The gain of this stage is varied by VR2, allowing calibration, and the meter is zeroed by VR1. D4 protects it from damage.

The input impedance of the circuit is governed by R1, one megohm was found to be satisfactory. The frequency response is virtually flat up to and beyond 100kHz, depending on the value of C2 which affects the frequency compensation of IC2. The circuit measures a.c. signals from 1mV to 1V in seven ranges using a 100µA f.s.d. meter with 0-3 and 0-10 scales.

The circuit is very sensitive and care should be taken in its construction and housing; all signal carrying leads, the selector switch, the input socket, and any sources of main's hum should be properly screened. Kevin Cameron, Melrose, Roxburghshire.
The introduction of the General Instruments, AY-3-8500 i.c. has produced a large number of almost identical tele-games circuits. It was while seeking some degree of variation from these circuits, while still maintaining the use of the AY-3-8500, that the following circuit was evolved, to introduce a certain amount of randomness to the game. In this way differences in ground texture (ball speed variation) and slight mis-hitting (angle at which the ball leaves the bat is uncertain) can be represented.

The circuit operation is very simple; consider the top section used for ball speed variation. Two slow oscillators are built around two NAND Schmitt triggers operated in the inverting mode. The speed of the oscillators is 0.3 Hz and 1 Hz using the quoted values. The resistor in series with the gate is to help protect the gate from switch on surges. The two oscillators are then gated via IC2a to produce random pulses.

A SPDT centre off switch (S2) replaces the S2 in the original game. It can be seen that with S2 in position A the output of IC2c will be high, thus IC2bd will be low, giving a high ball speed. Similarly, with S2 in position C, IC2bd will be high, and so the ball speed will be low. However, with S2 in position B, both IC2c and IC2bd are enabled thus giving the random transitions at the output of IC2bd. The AY-3-8500 uses 100 kilohm pull up resistors, and although one gate drive will cope with the current drain, two may be used in parallel to ensure adequate speed.

An identical circuit is used to change the rebound options between 2 and 4 angles.

The circuit may be much simplified, by using only one oscillator and one drive gate, the circuit could then be built around one quad NAND Schmitt, but the full random nature is not available. It should also be possible to obtain speed changes every time a rebound occurs by using a monostable and latch on the sound output to alter the speed.

The connection to pins 5 and 7 of the AY-3-8500 may be made at the original switch points.

The oscillator gates must be Schmitt to ensure oscillation and the capacitors should be Tantalum types.

I. C. Lare,
Northwich,
Cheshire.
DC/DC VOLTAGE MULTIPLIER

Shown is an astable, symmetrical multivibrator working at about 1,000Hz. It has the special feature, that the ordinary collector resistors are replaced by p.n.p. silicon transistors. Even using small transistors, the output has a low impedance. When using supply voltages lower than 5-6 volts the base protection diodes may be omitted. It is advisable to use transistors with a nominal Ic maximum two or three times the input current; they need not match exactly.

The multivibrator has been tested with small power transistors BC328 as TR1-TR2, and BC338 as TR3-TR4. The base diodes are ordinary small signal silicon types. The circuit works well with power transistors too: p.n.p. 2N3955, n.p.n. 2N3055 and base diodes 1N4001. With these it is necessary to decrease the base resistors and to keep the frequency, increase the capacitors proportionally.

It might seem unusual to use this type of converter instead of the popular transformer coupled type, which has somewhat higher efficiency, but this needs less space and is light weight. Thanks to the present cheap, high quality semiconductors, the total result is better than one might expect.

The circuits are interesting to the experimenter, and could certainly be improved. The examples in the tables tell the rest of the story.

P. Poulsen, Odense, Denmark.
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PRTICAL ELECTRONICS December 1979
This circuit is for an experimental hexadecimal keyboard for use with National Semiconductor's SC/MP microprocessor. Using four popular TTL i.c.s it represents an interesting example of the hardware/software trade-off in MPU systems. If built with one of the surplus calculator-style keyboards advertised regularly in P.E., total cost should be under £5. Use of 74LS series TTL is recommended.

It comprises a 7493 4-bit counter clocked by Flag-0 of SC/MP, feeding a 74154 4-16 line decoder. Outputs from this decoder go to the 16 keys of the keyboard, whose common line is debounced via a 74121 monostable. SC/MP increments the counter by putting Flag-0 high. One of the 16 decoded lines corresponding to the resultant 7493 binary output now goes low. Suppose the key on that line is now depressed, causing the output of the 74121 to go high and an interrupt on the SC/MP. The MPU responds by halting the counting sequence, and by putting Flag-1 low to latch the 4-bit (hexadecimal) code using a 7475. Outputs of the 7475 are connected to the four least significant bits of SC/MP's data bus, which it now reads and stores after rotating right four times. The sequence is now repeated to get another hexadecimal character, which is added to the first to produce a single 8-bit byte. This can now be stored in a memory location pointed to by a Pointer Register; the Pointer Register is now incremented and the whole process is repeated to obtain the next byte.

A greater understanding of the above process may be obtained by studying the flowchart shown left.

N. Rushton, Northwood, Kirkby.
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<td><strong>SEIKO MEMORY BANK</strong></td>
<td>Calendar watch M304. Hours, mins., secs. Month, day, date in 12 or 24 hour format all indicated continuously. Monthly calendar displays month, year and all dates for any selected month over 80 year period. Memory bank function. Any desired dates up to 11 can be stored in advanced. 3 year battery life. Water resistant. Metac Price</td>
<td>£79.50</td>
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<td>Chiming Alarm, plus chrono. Hours, mins., secs., date, day, 24 hour chronograph, 1/10th secs., laptime, back light. Stainless steel, mineral glass.</td>
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<td><strong>SEIKO Calculator Watch</strong></td>
<td>Full specification calculator with memory, plus multi function whach. Hours, mins., secs., date, day, am/pm, backlight. Automatic calendar. Long life battery.</td>
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<td>Elegant slim line. Stainless steel bracelet. Fully adjustable. Hours, mins., 10 sec second hand, am/pm. Month, date, day, Auto-calendar programmed for 28th day in Feb. Accuracy per month 15 secs, Battery life approx 15 months.</td>
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<td><strong>CASIO F-200 Sports Chrono</strong></td>
<td>Attractive Mans watch in black finish with mineral glass. Hours, mins., secs., am/pm, Month, date. Optical alarm. Auto-calendar set 28th Feb. Stopwatch working range 1 hour. Units 1/100 sec, Mode, Net time/lap time/1st-2nd place times. Accuracy approx 15 secs per month. Battery 2 month.</td>
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<td>**BELTIME Chronograph (B-function)</td>
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<td><strong>BELTIME Multi Alarm</strong></td>
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<td>M36</td>
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<td><strong>CASIO CALENDAR 200</strong></td>
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<td>£56.00</td>
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  - 0.01. 033..33 2.8p. .022. -047mf 0.068, .1mf 1. 5p. .01, .033. .33 2.8p. .022. -047mf
  - 15, .25, .5.
  - 1, 2, 3, 5 Amp quickblow 1p. anti-surge
  - MURATA TRANSDUCERS. 40KHz., REC/SENDER 01.110 pair.
  - 5% 3W 0.015, 5% 0.033, 5% 0.1, 5% 0.25, 5% 0.5.
  - 1.19. output 3/43/6/7/8/9/12V 800ma (2 .66.
  - 4/95p, 6" 15 watts 8 ohms adjustable bracket t5.26p.
  - 0.01. 033..33 2.8p. .022. -047mf 0.068, .1mf 1. 5p. .01, .033. .33 2.8p. .022. -047mf
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### ROMS

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### BAUD RATE GENERATORS

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<tr>
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<td>BC212A</td>
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<td>4v7 Zener</td>
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<td>3K Presets</td>
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<td>TBA800</td>
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