For SAFE keeping
— fit this
CAR BURGLAR ALARM

Also inside... Your INDEX for Volume 13
<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
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<tr>
<td>±1000μF</td>
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<tr>
<td>±1000μF</td>
<td>1μF</td>
<td>10.00</td>
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Complete kit including UHF/VHF Modulator and the PCB £3.95 incl. VAT (45p p&p).

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TV Games demonstartion at our stand. Send £5 for further details.
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Our January issue will be on sale Friday, 9 December, 1977
(for contents see page 245)
This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

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& DISPLAY

TWO YEAR
GUARANTEE

illustration shows GXL Centaur System

These systems feature full mixing for two decks tape & mic with monitoring facilities – override and are supplied complete with sound to light + sequencer, display, speaker leads etc.

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MONO SYSTEM

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Similar in appearance to the Centaur and complete with loudspeakers and leads.

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Carriage on all disco systems
(Included in H.P. Prices)

10% Deposit Terms
On All Orders
Over £150 – 12 or 24 Months – Low Interest

D.I.Y. MODULES FOR ALL DISCO/P.A. AMPLIFIERS

| Module No. | Power | Price
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>S6308 30W</td>
<td>8 ohms</td>
<td>£9.95</td>
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<tr>
<td>S6604 60W</td>
<td>4 ohms 50V</td>
<td>£13.25</td>
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<tr>
<td>S608 60W</td>
<td>8 ohms 65V</td>
<td>£14.25</td>
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<tr>
<td>S1204 120W</td>
<td>4 ohms 75V</td>
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<tr>
<td>S1208 120W</td>
<td>8 ohms 95V</td>
<td>£21.00</td>
</tr>
<tr>
<td>S2404 240W</td>
<td>4 ohms 95V</td>
<td>£29.50</td>
</tr>
</tbody>
</table>

D.I.Y. Kits 50% Discount, 30%–20%, 20% – 10%, Full Colour/Open Circuit proof input sensitivity 240 mV to suit most mixers – D.C. & Output Fused.

TOP QUALITY COMPONENTS THROUGHOUT

COMPLETE LIGHTING CONTROL AT YOUR FINGERTIPS!

| Feature | Price
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Lighting Control Unit Mk II</td>
<td>£44.50</td>
</tr>
<tr>
<td>4K Sequencer + Sound Light + Dimmers</td>
<td>£10.90</td>
</tr>
<tr>
<td>Automatic Level Integrated Logic</td>
<td>£6.50</td>
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<tr>
<td>Circuitry</td>
<td>Panel £9.50</td>
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<tr>
<td>Three Channel Sound to Light</td>
<td>£29.75</td>
</tr>
<tr>
<td>3KW 1-240V input – master</td>
<td>£19.75</td>
</tr>
<tr>
<td>Plus channel controls</td>
<td>Panel £9.50</td>
</tr>
</tbody>
</table>

STROBE UNITS
Pro-Strobe 4-6 Joules £37.50
Super Strobe 2-3 Joules £22.50
Proc-Strobe has external trigger facility.

PROJECTORS – PLUTO –
CHOICE OF WHEEL/CASSETTE

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>P10O 150W Tungsten</td>
<td>£37.50</td>
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<tr>
<td>P500 100W G.I.</td>
<td>£89.50</td>
</tr>
<tr>
<td>P250 250W G.I.</td>
<td>£22.50</td>
</tr>
</tbody>
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PIEZOELECTRIC HORNs only £7.50
YES! – only £7.50
(As fitted to our package PA system)
Direct from Motorola Inc., USA at an 
UNBEATABLE PRICE

Strobe tubes B/W £8.50
ICR Vynide 50° wide £3.50
Kickerproof Grille 24° wide £3.25
Kick Resistant Grill 50° wide £3.25
FULL RANGE OF RE-AN PRODUCTS IN STOCK
SEND FOR OUR BROCHURE NOW!!

DISCO MIXERS – COMPLETE OR MODULAR

| Feature | Price
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Mono or Stereo</td>
<td>£22.50</td>
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<tr>
<td>Stereo module</td>
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<tr>
<td>Panel</td>
<td>£9.95</td>
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<tr>
<td>Kit of leads/sockets etc.</td>
<td>£5.50</td>
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FEATURES INCLUDE:


SPARES & ACCESSORIES – LOUDSPEAKERS & CABINETS

<table>
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<tr>
<th>Item</th>
<th>Price</th>
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<tr>
<td>Rope Lights – Red or Multicolour</td>
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<tr>
<td>Melos Echo Chamber</td>
<td>£59.00</td>
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<tr>
<td>Headphones</td>
<td>£7.50</td>
</tr>
<tr>
<td>Rope Light Controller for up to 120 Reel £30.00</td>
<td>£8.90</td>
</tr>
<tr>
<td>Sirens: English Police, USA Police, &amp; Fire</td>
<td>£8.90</td>
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<tr>
<td>Destroyer</td>
<td>£22.80</td>
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<tr>
<td>Magnetic Cartridge Equalisers</td>
<td>£3.50</td>
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<tr>
<td>Bulgin 8 way lighting plug/socket</td>
<td>£1.90</td>
</tr>
</tbody>
</table>

100 Watt Chassis Loudspeakers 12’’ £23.50
18” £47.50

(Add £1.50 per item)

(As fitted to our package PA system)

Direct from Motorola Inc., USA at an
UNBEATABLE PRICE

Unusual items required 48hrs – 30kHz rated
75W/8 ohms 150W/4 ohms use two per 100W amplifier – Full instructions supplied.
**AND**

**PACKAGE P.A. SYSTEMS (2 Year Guarantee)**

Complete with PIEZO horn columns fitted with 100 watt units (100 watt system illustrated)

**100 Watt £145**
Deposit £19.70
12 Months £13.78 or 24 Months £17.73

**200 Watt £225**
Deposit £28.80
12 Months £21.58
24 Months £29.01

These systems come complete with a Four Channel Amplifier, Leads etc. The 200 Watt system features Twin 100 Watt drive units in each cabinet.

**ALSO ILLUSTRATED:**
Melos Echo Unit £59.00 Boom Stand £15.50 Electret Mic ECM81 £19.95* Floor Stands £9.90 EM507 Mic* £15.00 Phasers £19.80

**D.J.Y. MODULES FOR P.A. SYSTEMS Mono or Stereo**
Make your own mixer — Mono/Stereo — up to 20 channels with these, easy to wire modules — Available as PCB’s or assembled on panels.

<table>
<thead>
<tr>
<th>Modules</th>
<th>Mono PC</th>
<th>Mono C/W panel etc.</th>
<th>£8.95</th>
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<tbody>
<tr>
<td>Mixer (Monitor)</td>
<td>Stereo PC</td>
<td>Stereo C/W panel etc.</td>
<td>£12.50</td>
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<tr>
<td>(One only per system)</td>
<td>Stereo PC</td>
<td>Stereo C/W panel etc.</td>
<td>£8.95</td>
</tr>
<tr>
<td>Power supply for up to 20 channels</td>
<td>£9.50</td>
<td>Blank panel</td>
<td>£1.00</td>
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Send for free brochure for complete specification

**Saxon AP100 Amplifier £45**
Four mixing inputs — 100W into 4 ohms
Wide range bass & treble controls + master — Twin outputs

**Saxon 150 Amplifier £59**
Four mixing inputs — 100W into 8 ohms
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Dimensions: 15" x 18" x 5½".

An alternative version is available without the pick-up arm and lifting device, incorporating a larger walnut/plastic cover, enabling most high quality, pick-up arms to be used.

Dimensions: 15" x 18" x 7½". BD 103 Alternative unit without arm and lifting device.

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Manufacturers of Connoisseur Sound Equipment, Connoisseur Works, Atlas Mill Road, Brighouse, West Yorkshire HD6 1ES
Telephone: Brighouse (0484) 712 142, Telex: 517144 Sugden G,
Telegrams & Cables: Connoisseur Brighouse.

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BUILD A SUSTAIN UNIT EQUAL TO THE BEST COMMERCIAL MODELS.
COMPLET KIT - £7.95
ALL HIGH QUALITY COMPONENTS AS SPECIFIED.
DESIGNER APPROVED.

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Tuner £4.99
Gloss fibre PCB, printed with component locations £9.60
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PE DIGITAL VOLTOMETER (APRIL 1977)
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Complete set of all semiconductors for the P.E. DVM including I.C.'s, transistors, diodes, displays, regulator, etc. £20.50*
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Complete set of resistors, incl. attenuator resistors £1.00*
Complete set of capacitors incl. 200µf/p power supply £1.60*

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Complete set of semiconductors £2.30, High quality glass fibre p.c.b. £1
POSTAGE AND PACKING 15p per order. Orders over £5 post free. All devices are top grade, brand new and to full manufacturer's spec. We do not sell seconds or rejects. Send S.A.E. for our data sheet and price list. Prices do not include VAT—add 8½ to items marked*, and 12½% to all others.

DAVIAN ELECTRONICS (MAIL ORDER ONLY)
13 Deepdale Avenue, Royton, Oldham OL2 6XD

Practical Electronics December 1977
HY5 Preampifier

HY30
15W into 8Ω

HY50
25W into 8Ω

HY120
60W into 8Ω

HY200
120W into 8Ω

HY400
240W into 4Ω

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to appropriate pins. The internal volume and tone circuits merely require connection to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation; low noise; low distortion, high overload; two simple combined for stereo.

APPLICATIONS: hi-fi, discos, guitar and organ; public address

SPECIFICATION: Input: magnetic pick-up 300V, turntable 100V, microphone 10mV, auxiliary 3–100mV; input impedance 47kΩ at 4kHz. Outputs—tape 100V², main output 500V², AVC 0.5%. Tone Controls—volume 12dB at 1kHz, bass ±12dB at 1kHz. Distortion—<1% at 1kHz, signal/noise ratio 60dB. Overload—3dB on magnetic pickup. Supply Voltage—110V.

Price £5.22 = 65p VAT. P. & P. free

HY5 mounting board B.1. 4p + 6p VAT. P. & P. free

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heat sunk, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion, open and thermal protection, easy to build.

APPLICATIONS: updating audio equipment, guitar practice amplifier, loudspeaker, audio equipment.

SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—<1% at 15W. Input Sensitivity—10kHz 45kHz at 3dB. Frequency Response—10kHz -3dB.

Price £5.22 = 65p VAT. P. & P. free

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: low distortion; integral heatsink; only few connections; 7 amp output transistors; no external components.

APPLICATIONS: medium power hi-fi systems, low power discos, guitar amplifier.

SPECIFICATION: Input Sensitivity—500mV Output Power—60W R.M.S. into 8Ω. Load Impedance—>1Ω. Distortion—<0.5% at 60W at 1kHz. Signal/Noise Ratio—50dB. Frequency Response—10kHz—45kHz —3dB. Supply Voltage—25V Size—125 x 80 x 25mm

Price £6.82 + 52p VAT. P. & P. free

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion; integral heatsink; load line protection; thermal protection; five connections; no external components.

APPLICATIONS: Hi-fi; high quality discos; public address: monitor amplifier; guitar and organ

SPECIFICATION: Input Sensitivity—500mV Output Power—120W R.M.S. into 8Ω. Load Impedance—>1Ω. Distortion—<0.5% at 120W at 1kHz. Signal/Noise Ratio—50dB. Frequency Response—10kHz—45kHz —3dB. Supply Voltage—25V Size—140 x 10 x 65mm

Price £15.84 + 107p VAT. P. & P. free

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: thermal shutdown: very low distortion, load line protection, integral heatsink; no external components.

APPLICATIONS: Hi-fi, discos, monitor, power series, industrial, public address.

SPECIFICATION: Input Sensitivity—500mV Output Power—120W R.M.S. into 8Ω. Load Impedance—>1Ω. Distortion—<0.5% at 100W at 1kHz. Signal/Noise Ratio—50dB. Frequency Response—10kHz—45kHz —3dB. Supply Voltage—25V Size—144 x 50 x 65mm

Price £23.32 + 11.87 VAT. P. & P. free

The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4Ω! It has been designed for high power discos or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown: very low distortion; load line protection; no external components.

APPLICATIONS: public address, disco, power series, industrial.

SPECIFICATION: Output Power—240W R.M.S. into 4Ω. Load Impedance—>1Ω. Distortion—<1% at 240W at 1kHz. Signal/Noise Ratio—45dB. Frequency Response—10kHz—45kHz —3dB. Supply Voltage—110V Input Sensitivity—500mV. Size—144 x 50 x 85mm.

Price £32.17 + 12.75 VAT. P. & P. free

POWER SUPPLIES: PSU50—suitable for two HY30s £3.22 + 65p VAT. P. & P. free. PSU100—suitable for two HY50s £6.42 + 125p VAT. P. & P. free. PSU500—suitable for one HY500 £125.65 + 11.01 VAT. P. & P. free. PSU3000—suitable for one HY500 £325.10 + £31.45 VAT. P. & P. free

I.L.P. Electronics Ltd., Crossland House, Nackington, Canterbury, Kent CT4 7AD

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Please debit my Access account □ Barclaycard account □

Account number
Name and Address

Signature
### Panel Meters

#### 4in Range

<table>
<thead>
<tr>
<th>Size (4 x 3 x 1 in)</th>
<th>Value</th>
<th>Price</th>
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<tr>
<td>0-50uA</td>
<td>1307</td>
<td>£0.50</td>
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<tr>
<td>0-100uA</td>
<td>1306</td>
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<tr>
<td>0-200uA</td>
<td>1304</td>
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<tr>
<td>0-500uA</td>
<td>1303</td>
<td>£0.50</td>
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#### 2in Range

<table>
<thead>
<tr>
<th>Size (2 x 1 x 1 in)</th>
<th>Value</th>
<th>Price</th>
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<tbody>
<tr>
<td>0-50uA</td>
<td>1306</td>
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<tr>
<td>0-100uA</td>
<td>1304</td>
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<tr>
<td>0-200uA</td>
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### MR2P Type

<table>
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<tr>
<td>0-50uA</td>
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<tr>
<td>0-100uA</td>
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### MINIATURE BALANCE/TUNING METER

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<tr>
<th>Size (23 x 22 x 26mm)</th>
<th>Sensitivity</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>Value</td>
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### Balance/Tuning

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<tr>
<td>Value</td>
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### MIN. LEVEL METER

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<tbody>
<tr>
<td>Value</td>
<td>200uA</td>
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### Vu Meter

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<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
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### Mini Multi-Meter

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<th>Size (60 x 24 x 90mm)</th>
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<tbody>
<tr>
<td>Value</td>
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### Transistors

#### Brand New—Fully Guaranteed

<table>
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<tr>
<th>Type</th>
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<tr>
<td>C300</td>
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<tr>
<td>C301</td>
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<tr>
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</tr>
<tr>
<td>2N104</td>
<td>£0.10</td>
</tr>
</tbody>
</table>

### 74 Series TTL ICs

**Full Specification Guaranteed. All Famous Manufacturers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
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<tr>
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<tr>
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### CMOS ICs

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<tr>
<td>74HC20</td>
<td>£0.05</td>
</tr>
<tr>
<td>74HC40</td>
<td>£0.05</td>
</tr>
<tr>
<td>74HC41</td>
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### Linear ICs

<table>
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<tr>
<th>Type</th>
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<tr>
<td>74HC12</td>
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<tr>
<td>74HC20</td>
<td>£0.05</td>
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<tr>
<td>74HC40</td>
<td>£0.05</td>
</tr>
<tr>
<td>74HC41</td>
<td>£0.05</td>
</tr>
</tbody>
</table>

### Newnes Technical Books

- **No. 229** Beginners Guide to Electronics
  - Guide to Electronic Circuits
  - Price £2.25

- **No. 230** Beginners Guide to Transistors
  - Price £2.25

- **No. 231** Beginners Guide to Televisions
  - Price £2.25

- **No. 234** Beginners Guide to Colour Television
  - Price £2.25

- **No. 235** Electronic Circuits
  - Price £1.80

- **No. 236** Electronic Components
  - Price £1.80

- **No. 237** Printed Circuit Assembly
  - Price £1.80

- **No. 238** Transistor Pocket Book
  - Price £3.00

- **No. 225** 110 Thyristor Projects using SCR and Triacs
  - Price £2.50

- **No. 227** 110 COS/MOS Digital IC Projects for the Home Constructor
  - Price £2.50

- **No. 226** 110 Operational Amplifier Projects for the Home Constructor
  - Price £2.50

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- Transistor Data - 1974
- Modern Electronic Component Values
- RCA Handbook of Radio Equipment for Amateurs Revised
- RCA Manual of Electronic Circuits for the Radio Amateur
- Boys and Beginners Book of Practical Radio and Electronic Projects
- Second Book of Electronic Projects
- Pocketbook Handbook of Radio and Television Reception
- Guide Chart of Radio Electronic Semiconductor and Logic Booklets
- Practical Repair and Restoration of Colour TV
- Pocketbook of IC Audio Pre-amplifier and Power-amplifier Construction
- 300 Most Useful Germanium, Silicon and Zener Diodes
- 50 Preliminary Using Relays, DC/AC and TRACS
- 50 (PET) Food Effect Transistor Projects
- Electronic Circuits for Model Railways
- Audio Enthusiasts' Handbooks
- Solid-State Power Supply Handbooks
- Radio Enthusiasts' Transistors
- 1000 Power Transistors for Beginners
- Ceramic and Solid State High-Fi and Audio Components
- Practical Sound Reproduction of High Fidelity
- A Practical Introduction to Digital IC's
- A Practical Guide to High Power Audio
- Resistors Colour Code Data Calculator

#### SUPER UNTESTED PAKS

<table>
<thead>
<tr>
<th>PAK No.</th>
<th>Order</th>
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<tr>
<td>MCP 1</td>
<td>24</td>
<td>$0.50</td>
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#### LINEAR PAKS

- Manufacturers' "Fall-Out" which include Functional and part-Functional Units. They are classified as "out-of-stock" from the makers. They are very difficult to obtain, and it is best to order through experienced suppliers.
- Order No. 9221 - $1.50

#### 74 SERIES PAKS

- Manufactures' "Fall-Out" which include Functional and part-Functional Units. They are classified as "out-of-stock" from the makers. They are very difficult to obtain, and it is best to order through experienced suppliers.
- Order No. 9221 - $1.50

#### VERBOARDS PAKS

- VBO - 190, 240, 260 1000 vac. sizes. All 1-N pin, medium.
- VBO - 200 1600 vac. sizes. 2-N pin.
- Order No. 1886 - $0.80

#### ELECTRICAL PAKS

- A range of packs each containing 18 first quality, mixed value transistors, electrolytics, E.C.I. values, assorted capacitors, etc.
- Order No. 1881 - $0.80
- Order No. 1882 - $0.80
- Order No. 1883 - $0.80
- Order No. 1884 - $0.80

#### C280 CAPACITOR PAK

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- Order No. 1004 - $0.80

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### TEAK or Perspex Case

| NON ALARM | £12.50 |
| ALARM    | £15.50 |

### Delta

6x1 23Jin x 3in

All prices include VAT and P & P.

### Features
- 4 LED digits (in high red)
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- Indication
- Matte frequency accurate
- Easy to build

### Accessories Included
- Beautiful real wood case or perspex: White, Black, Red, Blue and Green
- Fuses to indicate power cut

### Non Alarm Complete Kit including case, £12.50
- Ready built, £14.50
- Module kit without case, £3.50

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- 9 minute 'Snooze'
- Simple setting
- Complete kit including case, £15.50
- Ready built, £17.00
- Module kit excluding case, £13.00
- Ready built, £13.50

### Timer Facility
- Sleepwatch use to 3 min. 59 sec. extra 50p.

### Excellent Value - Guaranteed
- £87.38

### Displays
- FD050: 50-pin LED. £1.19 each; for £6.68. 10B: 5430Q, 6pin LED 4x £4.32. STL52: pin 18 green £1.45. (£4.45)
- CLOCK CHIPS: 5028N. Alarm 1224-hour 4 digit, £5.67
- 5028N Calender clock, 1224-hour 4 digit Alarm £4.22
- 6x2 clock/cal, £10.00

### Recreational Battery Set
- Super Value: £8.95, includes 4xAA (1-V2)
- Nickel Cadmium batteries (batteries £1.08 each). 3x6/6v switch Universal Main Adaptor with plug connections, most batteries (separately £3.75)

### Electronic Door Bell
- Warner tone. Runs off 2PS £3.40

### Payment with order to

**BARON** (P/B)

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**FM Tuner Front End**

- RM82 8000 FM/L.C. £1.40
- 20 Watt Zenner Diodes 7.5V, 8.2V, 8.8V, 11V, 16V, 18V, 22V, 24V, 27V, 32V, 35V 123 each, 45p each
- 100 Watt Zenner Diodes 18V, 33V, 57V. 100V 10 each

### Audible Alarm System

- Transformer and LC. 12 volt working made for select bell
- Alarm mantas. £5.95

### Volt Switch.

- 6x2 Rotary Switch, 2pin
- £2.44

### Photo Sockets

- Single 90°, Double 110°, Triple 110°, Quad 20p
- Flat 2 pin mains sockets £1 each on drill or 8ins systems 2 for a row. 15p

### Loudspeakers

- 23, 8 ohm. 15watt. £3.75
- 70 volt 1500 watt. £9.50
- 150 watt PA. £13.95

### Microprocessors

- 2006. £1.87
- 1096, £2.25
- 1616. £4.00

### Power Transistors

- Exclusive 2N2907. £8.25
- 2N2907 400, 8011 40p each. £1.16
- £19.75

### NPN Silicon Phototransistor 2K11 20A Darlington Type 20p.

### Opto-Isolators IL-74 with data.

### Texas Transistors Type TIP114 70/40. £1.89 each

### VHF Power Transistors

- £12.50 each

### Ununions

- 75T4. Each £2.25
- 75T5. Each £2.15
- 75T6. Each £2.25

### Programmable Ununions D1226, 20, 900280.

### Miniature JF. 300, 200 V. ELECTROLYTICS 10 for £8p.

## FM Tuner Front End

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- 75T6. Each £2.25

### Programmable Ununions D1226, 20, 900280.

### Miniature JF. 300, 200 V. ELECTROLYTICS 10 for £8p.
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Practical Electronics December 1977
KITS FOR SYNTHESIZERS, SOUND EFFECTS

COMPUTER SETS include all necessary resistors, capacitors, transistors, processors, memories and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these may be bought separately. Fuller details of kits. PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by Phonocites.

PHOTOCOPYs of the P.E. texts for most of the kits are available—prices in our lists.

P.E. MINISMONGIC No. 2 SYNTHESIZER
A portable mains-supplied Miniature Sound Synthesizer, with keyed circuits. Although having slightly fewer facilities than the large P.E. Synthesizer the functions offered by this design (he has got small size and versatility. Consists of 25 vol. VCAs, 10 envelope generators, 2 voltage-controlled amplifiers, keyboard hold and control circuits, oscillator and detector, ring modulator, noise generator, output amp and mixer. Power supply Set of basic component kits from £12-71
P.E. SYNTHEISER (P.E. Feb. 73) to Feb. 74) The well acclaimed and highly versatile large-scale manual Sound Synthesizer consists with keyboard circuits. Other circuits in our lists may be used with the Synthesizer, for example, notably P.E. Minismongic Phasing Unit: Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal and Overdrive. Fuzz, Tremolo and Wah-wah units.

The basic units: PSU, 4 volume VCAs, 2 ramp generators, 2 outputamps, sample hold, noise generator, switch amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists. Set of basic component kits from £8-53
Set of printed circuit boards from £13-29
1. The Synthesizer Keyboard Circuits (can be used without the Main Synthesizer) include an independent modified 10-control envelope shapers and additional PSU. Full details in our list.
Set of basic component kits £7-98
Set of printed circuit boards £17-86

GUITAR EFFECTS PEDAL (P.E. July 75) Modulates the attack, delay and filter characteristics of an audio signal not only from a guitar but from any audio source. Produces different delay, cut-off and feedback characteristics for sound effects units in your range. Circuit does not duplicate effects from the Guitar Drums unit. Each set is designed for a particular instrument and so can be modified for other instruments.

Component set with special foot-operated switches £7-95
Stencils to enable component set with panel mounting switches £4-98
Printed circuit board £1-43

SOUND BENDER (P.E. May 74) A multi-purpose sound controller, the functions of which include distortion, echo, chorus, tremolo, voice-alteration styles, automatic faster and frequency-modulator. Component set for above functions (except SWs) £7-64
Printed circuit board £1-61
Optional audio installadional Audio Modulator, the use of which, in conjunction with the above component set, can produce " Dub " rhythms. Component set (incl. PCB) £8-98

PHASING UNIT (P.E. Sept. 73) A compact but effective manually controlled unit for introducing the " phasing " sound into live or recorded music. Component set (incl. PCB) £2-67

PHASING CONTROL UNIT (P.E. Oct. 74) For use with the above Phasing Unit to automatically control the rate of phasing. Component set (incl. PCB) £4-48

SOPHISTICATED PHASING AND VIBRATO UNIT
A slightly modified version of the circuit published in " Electronic Musician " March 1976, and includes manual and automatic control over the rate of phasing and vibrato.
Component set (incl. PCB) £2-69
Printed circuit board £2-39

WAH-WAH UNIT (P.E. Apr. 78) The Wah-Wah effect produced by this unit can be controlled manually or by an internal automatic control. Component set £1-55

AUTOWAH UNIT (P.E. Mar. 77) Produces complex wah-wah and swept-pedal sounds each time a new note is played. Component set (incl. PCB) £2-37
Component set and PCB, with panel switches £4-83

POST AND HANDLING (UK): Orders under £20 add 25p plus VAT, over £25 add 50p plus VAT. Keyboard £2-00 plus VAT. Order includes spare components for compensation against loss or damage in post. Add 35p in addition to above post and handling.

BRITISH: E.I., B.P.O. and other countries are subject to Export postage rates.

P.E. JOANNA (P.E. May/Sept. 75) A five-octave electronic piano that has switchable alternative existing of Hohner-style piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.
Main power supply, tone generator, 61 envelope shapers, volume and p.e.a. amplifiers.
Component set (incl. loudspeaker) £11-92
Printed circuit board £2-34

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77) A modified and extended version of the circuit published. Details in list.

SEE OTHER PAGE FOR KEYBOARDS. AND OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED

P.E. SYNCHRONOME (P.E. Mar 76) An accented beat electronic metronome, providing, triple, quad and quadruple times with full control over the rate.

TAPE NOISE LIMITER
Very effective circuit for reducing the noise floor in most tape recordings. All kits include PCBs

VOLATILE CONTROLLED FILTER (P.E. Dec. 74) Part of the P.E. Minismongic now released as an independent module. Component set (incl. PCB) (Order as Kit 6-51) £8-22

RING MODULATOR (P.E. Jan. 75) Part of the P.E. Minismongic now released as an independent module. Component set (incl. PCB) (Kit 8-51) £5-90

NOISE GENERATOR (P.E. Jan. 75) Part of the P.E. Minismongic now released as an independent module. Component set (incl. PCB) (Kit 60-7) £3-35

SOPHISTICATED POWER SUPPLIES
A wide range of mains voltage and low noise power supply kits is available—details in our lists.

MICROPHONE PRE-AMP (P.E. Apr. 77) Component set (incl. PCB) £3-78

VOICE OPERATED FADE (P.E. Dec. 73) For automatically reducing music volume during " talk-over " particularly useful for Disco work or for home-movie shows. Component set (incl. PCB) £3-77

DYNAMIC RANGE LIMITER (P.E. Apr. 77) Automatically controls sound output to within a preset range. Component set (incl. PCB) £4-58

EXPIRED ORDERS are welcome, though we advise that a current copy of our brochure is not to be ordered.

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.
Mailing address: Practical Electronics, South End, Sidcup, Kent DA14 6EH

236 Practical Electronics December 1977

mail order and c.w.o. only sorry but no callers please

Please note: This text is a snapshot of the content on a page. For a more detailed or interactive experience, use the full PDF version.
PHOTOGRAPHS in the advertisement show two of our units containing some of the P.C. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LEFT-Side-stand 16/17in. square with all-U.K. reserve for free hit pencil.tubes, components, PCBs, kits and other components.

OVERSEAS- enquiries for list: Europe- send 20; other countries- send 40.

KEYBOARDS AND CONTACTS

Korean-All keyboards as required for many published circuits, including the P.E. Joanne, P.E. Minimot and P.E. Synthesiser. The manufacturers claim that these are the finest moulded plastic keys available. All keys are C to G. The keys are plastic, spring-depressed and mounted on a robust aluminium frame.

3 Octave (F, mid 56-3, 4 Oct (all notes) E3-86), 5 Oct (all notes) E3-75.

Contact assemblies for use with above keyboards: Single-pole change-over (type SP) as for P.E. Joanne and P.E. Minimot. Two-pole normally-open make-break (type DP) as for P.E. Joanne. Special contact assembly (type SN) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minimot and the P.E. Joanne simultaneously thus avoiding the cost of more than one keyboard. See our list for other contacts.

Contact

<table>
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<tr>
<th>Type</th>
<th>3 Octave Set</th>
<th>4 Octave Set</th>
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<td>SP</td>
<td>£2.95</td>
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<td>DP</td>
<td>£5.95</td>
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<td>£7.31</td>
</tr>
</tbody>
</table>

PRINTED CIRCUIT BOARDS are available with the above contacts and thus eliminating most of the interwiring required, are available. Details in text 2.

MORE NEW KITS!

NEW RHYTHM GENERATOR

NEW automatic drum generator extended version of the P.E. 1974 design and including new automatic rhythm programme selector.

TUNE-PROGRAMMABLE SEQUENCER

IPE (Nov. 77) The new module unit currently being published.

FORMANT SYNTHESIZER

IPE (Oct. 1977) Very sophisticated music synthesizer suitable for the professional whoormaker and for whom cost is secondary to performance.

GUITAR SUSTAIN UNIT

IPE (Oct. 77) Details in text. Please send for free leaflet.

SOUND-TO-LIGHT (P.E. Aurora) (P.E. Apr.-Aug. 71)

A simple but effective sound-frequency converting device capable of operating 3 lamps each of approximately 70 watts. Includes power supply, necessary light switching. Component set (incl. PCB) £11.95

DISCOBRITE (IPE Nov. 78)

Discobrite lightshow controller giving a choice of sequential, random, or full strobe mode of operation. Basic component set £18.95

Printed circuit board £2.45

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The unit has comprehensive built-in controls so that you can not only select the 'tune of the day' but the volume, tempo and envelope decay rate to change the sound according to taste.

Not only visitors to the front door will be amazed, if you like you can connect an additional push button for a back door which plays a different tune!

This kit has been carefully prepared so that practically anyone capable of neat soldering will have complete success in building it. The kit manual contains step by step constructional details together with a fault finding guide, circuit description, installation details and operational instructions all well illustrated with numerous figures and diagrams.

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CHROMATRONICS

15 December 1977
THE WAY THINGS GO

As the year approaches its end a little rumination may not be amiss. Around 1967 Practical Electronics was but a few years old and we were all still busily engaged in exploring the uses of the transistor, when the integrated circuit became generally available and started to alter the pattern of circuit design. Today we find ourselves in a somewhat parallel situation to the late 1960s, with the microprocessor now marking the latest revolution in the far from placid history of electronics.

As would be expected, microprocessors have made their initial impact in the industrial and the Service areas, and only just now are these devices beginning to appear in consumer products. Amongst the very first of this kind is a 24-tone door chime. (The designer is in fact a past contributor to this magazine.) To follow, we are promised intelligent toys and combination door locks, according to one speaker at a recent Texas Instruments Seminar. Hurrah for technology! Yes, we will not be surprised if some eye-brow-raising greets these disclosures.

We can also make a disclosure. Amateur-inspired combination lock circuits have been an editor’s embarrassment ever since TTL chips became cheap and abundant. Like several other popular circuit ideas, they had more worth as design than in any real-life use. Looking back, it is amusing to recall that P.E. has in the past been accused by a few individuals of encouraging the alleged “frivolous” use of electronics. Evidently, if this is done on a large enough scale and turns into profitable business, the frivolity can be overlooked! The real truth is that, paradoxically, the more advanced the technology the easier it becomes to apply it to what some might consider trivial or frivolous purposes. Thus does electronics perform as a major conditioner of all our affairs.

At this particular moment one certainly gets the impression that microprocessor makers are still groping around for ways to use their latest wonder devices. Large and potentially valuable areas have indeed been marked out for attention. One such is the motor car industry, but to fully implement the use of the latest in electronics in a non-electronic industry is bound to take time.

Various smaller-scale developments are happening of course, often on a modest budget, perhaps in rather unprenentious laboratories. Some examples came to light during the SERT Symposium last September. It became clear that cash constraints and the inability to purchase the very latest in parts are no deterrent to enthusiasm among dedicated workers, especially if the goal is something really worthwhile and of likely benefit to mankind, as for example in the medical field.

Serious amateur experimenters are kindred spirits to these professional “loners” and will also have their contributions to make in this latest area of our technology. Here it might be pertinent to say that the biggest memory and the fastest word are not necessarily the best for every purpose. The Mini has not been rendered obsolescent by the TR7.

NON-CRYSTAL BALL

From the present, a peep into the future. What will be the next milestone in electronics?

The award of the Nobel Prize for Physics to Sir Nevill Mott (shared with two American physicists) for work on amorphous materials at Cambridge naturally reawakens interest in the use of non-crystalline materials, particularly glass, as the basis for a new generation of semiconductor devices. Low cost is the chief virtue of glass as a semiconductor and one possible application relates to solar cells. It is being suggested that amorphous solar cells could change the whole situation making direct generation of electricity from solar radiation a perfectly economic operation.

SWITCHING OFF

At this point our crystal gazing must stop: quite finally unfortunately, so far as the present writer is concerned. To explain this a change to the first person now seems in order.

After guiding the destiny of PE since its inception I now have reluctantly to relinquish my editorship. This is due to the relocation of our editorial offices to Poole, Dorset. It is especially sad to part at this very time since PE has now become number one in its field in the UK.

These thirteen years have been exciting, stimulating and rewarding. A great number of contacts have been made with members of all sections of the industry, with advertisers, and with contributors. I have been fortunate in that many of these have become more than just business associations; friendships have been made which I greatly value.

There is of course that far larger band of readers with whom I have always felt a strong rapport despite no direct personal contact. To these unseen tens of thousands who have supported Practical Electronics throughout the years (including the critics) I am conscious of my indebtedness. For it is in the end the readers who make a magazine. Our task is to try and meet their needs. I can only hope that in the aggregate we have succeeded.

Also leaving Practical Electronics will be colleague David Barrington who has worked with me continuously since the pre-launch period in early 1964. He has been a key figure in the compilation of every issue, and his varied feature writing responsibilities included Market Place. Dave will join our associate publication Everyday Electronics which I will continue to edit from our London Offices.

So now, cherio. FRED BENNETT.
If you've ever had to leave your car in a "shady" area of town, and you are only too aware of how little opposition the average car lock presents to a thief, then you probably will have promised yourself a burglar alarm one day. It's not just a question of your car being stolen, but you could come back to find your "in-car" music centre missing, and even a simple system is a good deterrent while there are still other vehicles around without protection.

This automobile burglar alarm is triggered by the door operated courtesy light switches, causing pulsation of the horn and headlights, and features exit and entry time delays with the on/off switch hidden somewhere to hand inside the car. The alarm unit itself is fixed in a convenient location somewhere under the bonnet.

CIRCUIT OPERATION

The circuit diagram of the alarm is shown in Fig. 1. With the latch (TR1 and TR2) in the "off" state (TR2 collector low), Timer A is disabled via D2, and the relay is not energised so that the car headlights and horn are off. When the latch is in the "on" state, Timer A is allowed to oscillate, thereby repetitively energising and de-energising the relay, and thus the horn and headlights.

The latch toggles from the "off" to the "on" state when triggered by any of the door switches, except for a short interval after power is applied to the circuit via the hidden switch, when Timer B holds the latch off while the driver vacates the vehicle.

When S1 is closed, C1 begins to charge through R6, at which time the output of Timer B is high, biasing TR2 on, irrespective of the state of all door switches. While TR2 is on, C4 is prevented from charging, and the output of Timer A is high, de-energising the relay. During this interval, the warning light mounted on the dashboard is illuminated to indicate that it is safe to open the car door.

After about 17 seconds (1.1 × C1 × R6), the voltage across C1 reaches the threshold level of Timer B, and the output goes low, releasing the latch and turning off the warning light to indicate that opening the car door will now trigger the alarm.

When one of the door switches is operated (closed) by opening the door, even momentarily, the latch toggles from "off" to "on", so that TR2 collector is high. This allows C4 to charge through R7 and R8. After about 18 seconds (1.1C4 [R7 + R8]), the voltage across C4 reaches the threshold level of Timer A and the output goes low, energising the relay.

At the same time, C4 begins to discharge through R8 and the timer pin 13. The discharge period lasts for about 11 seconds (0.7 × C4 × R8), until the voltage across C4 falls to the trigger level of Timer A. At this point the timer output goes high, de-energising the relay. Also, the timer discharge pin (pin 13) is now disabled, so that C4 begins to charge once more through R7 and R8.

The charging period this time lasts for about 12 seconds (0.7C4 [R7 + R8]) before discharging proceeds as before, so that from now on, the relay is repeatedly energised and de-energised for periods of 11 and 12 seconds respectively.

During the 18 second interval, between the latch being triggered by the door switch and the relay first being energised, the circuit can be de-activated by opening S1. This allows the car owner to enter the vehicle and turn off the power before the horn and headlights operate.

The capacitors C1 and C4 must be low leakage types, otherwise the threshold levels of the timers will not be reached. The remaining components are not critical.
Fig. 1. Burglar Alarm circuit diagram. For positive earth vehicles, D1 is replaced by a 100kΩ resistor which goes to the base of TR1

COMPONENTS...

Resistors
R1, R2, R7 10kΩ (3 off)
R3, R4, R5, R6, R8 10kΩ (5 off)
All resistors ±W min carbon

Capacitors
C1, C4 150μF/15V solid tantalum (2 off)
C2, C3 0.01μF ceramic (2 off)
The tantalum capacitors must be low leakage (<0.01μA/μF)

Transistors
TR1, TR2 BC108 (2 off)

Integrated Circuits
IC1 556 Timer

Diodes
D1, D2 1N914 (2 off)
D3 1N4001

Miscellaneous
Single sided p.c.b. 58 x 66mm
P.c.b. pins
S1 on/off toggle switch
F5 500mA fuse and 20mm holder
Relay, 12V/110Ω, 2 pole c/o, 10A contacts (Doram)
Diecast box 114 x 55 x 89mm
Terminal block, 7-way
Grommet, 8mm (2in)
P-clip, size N2
Warning lamp, 12V/2.2W. (An LED could be used in series with a 680Ω resistor)

Fig. 2. External wiring arrangement for positive earth vehicles
The details shown for wiring up RLA are only correct for the Doram type 72-722-0 relay.

Fig. 3. Printed circuit for Car Burglar Alarm

Fig. 4. Component layout of Burglar Alarm board. The spare pad (marked X) is for the "positive earth" modification.
CONSTRUCTION

The unit comprises a small p.c.b. (which is shown in Fig. 3), a suitable relay, and a seven-way terminal block, all housed in a diecast aluminium box which is mounted under the car bonnet. Firstly the p.c.b. should be assembled following the diagram of Fig. 4, and then the metalwork should be carried out.

Four holes are drilled through the base of the box to accommodate the p.c.b. mounting screws. These screws will be independently fastened with nuts to form studs over which the p.c.b. can be placed. They will also act as spacers to separate the board from the base of the box. Fixing holes for the relay should be drilled, and also for the terminal block, and one further hole for the grommet through which the interconnecting leads will enter.

A final four holes are necessary for the self tapping screws which will secure the whole unit to the car. This means that the unit has to be screwed down with the lid off, and the lid subsequently replaced. Make sure that these drillings are situated where there will be plenty of room to introduce a screwdriver once the "bits and pieces" are installed inside the box.

A robust case with tight fitting lid was chosen in preference to a plastics type because the environment inside an engine compartment is pretty hostile. The box will have to stand up to vibration, corrosive elements, and severe heat variations. The unit should be screwed together tightly, using shakeproof washers wherever possible. Good soldering is also necessary.

CONVERSION TO POSITIVE EARTH

The unit as shown in Fig. 1 is designed for negative earth cars, but it can readily be adapted for positive earth vehicles. See Fig. 2.

In this case the positive terminal of the unit (A) is connected directly to earth, instead of S1, and the negative terminal of the unit (E) is now connected to S1, which continues on to –12 volts.

The same p.c.b. and components are used, with the exception that D1 is replaced by a 100kΩ resistor, and an extended pad (marked X in Fig. 4) is provided for this larger component, which goes to the base of TR1 instead of its collector. This is so that the latch can still be triggered by the door switches which are generally connected to earth, and which will give a positive voltage in this case.

The horn and headlight relay contact connections are similar to those for a negative earth system, except that now the horn connection inside the unit (RLA1 pole) is connected to the positive rail instead of the negative one, and the headlights (terminal block C) are connected to negative supply instead of the original +12 volts.

The warning light will still be connected between terminal block points G and E, but since point E is no longer earth, all wiring relating to this lamp will need to be insulated from the car chassis.

POINTS TO CHECK

The wiring details given in this article are based on certain assumptions, but the following points should be verified before wiring up the unit: That the headlamp bulbs, and door switches return directly to the chassis, irrespective of the polarity of the system; and that the horn returns to "Line" and not chassis, i.e. +ve for a negative earth vehicle, or –ve for a positive earth vehicle.

These checks can be made with a simple multimeter, or even a small 12 volt bulb, and the internal relay can be rewired to compensate for any variations encountered. **

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To the newcomer to electronics causes of failure in equipment can be baffling and frustrating without an awareness of troubleshooting procedures. This series affords an opportunity to acquire skills to remedy.
In this second and final part describing the 128 note sequencer, details will be given for constructing the three sub-assemblies making up the unit together with testing procedures and patching examples for use with a synthesiser.

POWER SUPPLY

The power requirements for the sequencer are positive five volts at about 200mA and five volts negative at a very low current for the 741 op amp. The circuit for this is given in Fig. 7 and provides both regulation and stabilisation for the two lines.

Constructional details for realising this are given in Fig. 8 which shows the majority of components mounted on a 76 × 54mm printed circuit board. When assembled both this and the transformer are mounted on a simple angled aluminium sub-frame. The p.s.u., main and counter display boards should be mounted on the baseboard adjacent to the control panel.

MAIN BOARD

The p.c.b. and component layout for the circuit of Fig. 2 is given in Fig. 8. Here i.c. sockets are used throughout to obviate the possibility of chip damage in assembly. They also facilitate the replacement of i.c.s.

When this board is assembled all i.c.s apart from the RAM should be inserted. This will enable the clock oscillator, counter and D-A converter to be checked for correct functioning.

First the control panel is made up from a piece of 135 × 235mm aluminium. This should be drilled and cleared to suit the components shown annotated in the photograph.

The Letraset legends were layed on a black paint background and then secured with a clear polyurethane spray.

After this preparation and finishing the control components should be fitted and wired according to Fig. 10 to the main board.

DIGITAL READOUT OF COUNTER

It was found when operating the prototype sequencer that it was often helpful to know what position in the memory had been reached when writing in a tune. It was considered that a full numerical display of the counter state was not necessary, and should greatly increase the cost of the unit. Fig. 9 shows an alternative arrangement which was used in the prototype. In this the binary number at the memory address inputs of IC3 is displayed on seven l.e.d.s, driven via buffer transistors.
Fig. 8 (top). Showing component layout and p.c.b. for main components of power unit and (below) component board and etching details for the main circuit (Fig. 2)
Fig. 9. Circuit of counter and prototype Veroboard layout

Fig. 10. Interwiring and component layout for control panel

On the prototype unit this circuit was assembled on a 45 x 55mm 0-1in matrix Veroboard (Fig. 9) and fixed with two screws and bushes to the control panel so that all the l.e.d.s are visible via cut-outs from the front.

To check circuit functioning set the "Stop/Run" switch to "Run" and apply power. With a voltmeter or oscilloscope examine whether the clock oscillator is producing pulses and the correct binary count appears at the l.e.d. "Count" display.

Set the "Stop/Run" switch to "Stop" and check that depressing a key causes the counter to step, and also that it causes a pulse to appear at pin 1 of IC4.

Still with the MCM6810 out of circuit, connect the D-A output to a synthesizer v.c.o. Adjust the offset control VR2 (Fig. 2) until the sequencer output is zero with no keys depressed. Now adjust the gain control VR3 so that playing consecutive octaves on the keyboard produces the correct pitch change in the v.c.o. (It may be necessary to adjust the value of the feedback resistor R23 to obtain the correct pitch span.)

If all is correct so far, switch off the power and insert the MCM6810.

On reapplying power, a random series of notes should be sounded by the v.c.o. when the clock is running. Pressing the "Erase" switch while running the clock at a fast speed will clear the memory. The sequencer is now ready for use.

PROGRAMMING THE SEQUENCER

A certain amount of practice is needed to programme the sequencer correctly, the user should familiarise himself fully with the working of the device before attempting to write complicated tunes into the memory.

The operating procedure is as follows:

1) Clear the memory by running the clock at a fast speed with the "Erase" button held down.
2) Select "Stop" with the "Stop/Run" switch.
3) Press the counter "Reset" button.
4) Set the "Reset Read/Write" switch to "Write".
5) Write the required notes in by depressing the appropriate keys (go fairly slowly to avoid mistripping the circuit). If a note is to be held for more than one beat, the key should be pressed more than once.

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If the envelope trigger outputs are being used, the trigger button (1 or 2) should be pressed at the same time as a key whenever a trigger pulse is required.

(6) When the last note of the tune has been written in, hold the "Reset Write" button, and press the last key again.

(7) The tune is now ready to be played. Reset the counter, put the "Reset Read/Write" switch to "Read" and select "Run". The tune should now be played through the synthesiser v.c.o.

**USING THE SEQUENCER**

Even when used with fairly simple synthesisers, the sequencer is capable of producing quite startling results. Some typical patching arrangements are shown in Fig. 11. The sounds produced by Fig. 11(d) are extremely entertaining if the two v.c.os are tuned to a musically related interval.

![Fig. 12. Demonstrating a simple tune for the sequencer](image)

**COMPONENTS . . .**

<table>
<thead>
<tr>
<th>P.S.U.</th>
<th>Resistors</th>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1: 150Ω ±1W</td>
<td>C1: 1000μF 25V elect</td>
</tr>
<tr>
<td></td>
<td>R2: 4.7kΩ ±1W</td>
<td>C2: 470μF 25V elect</td>
</tr>
<tr>
<td></td>
<td>R3: 0.47μF</td>
<td>C3: -</td>
</tr>
</tbody>
</table>

**Semiconductors**

- D1-D4: Bridge rectifier (2A, 200V) (R.S. Components)
- D5: BZX58-51 51V, 1.3W Zener (R.S. Components)
- IC1: 7805 5V, 1A regulator (R.S. Components)

**Transformer**

- T1: 6-0.6V 250mA mains transformer

**L.E.D. COUNTER**

*(Optional to main board)*

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24-R30: 1kΩ (7 off)</td>
<td>TR4-TR10: BC184 (7 off)</td>
</tr>
<tr>
<td>R31-R37: 100kΩ (7 off)</td>
<td>D91-D97: TL209 (7 off)</td>
</tr>
</tbody>
</table>

**KEYBOARD**

- 49 note keyboard C to C
- 4 s.r.b.p. strips 169 x 51mm for mounting contact blocks
- Contact blocks type GB2 (49 off)

*(All keyboard items available from Maplin Supplies)*

---

Fig. 12 demonstrates how a simple tune can be played. Here each bar is divided into 12 beats, a close approximation of the dotted notes is given by using the 1st, 3rd, 4th, 6th, 7th, 9th, 10th and 12th beats only. By writing trigger pulses only on the accented beats the impression is given of a separate bass and melody line being produced by only one oscillator!

It is interesting to note that this tune only uses 25 positions in the memory, less than a fifth of the unit's capacity!

It must be realised that this is a very simple example; the full capabilities of the sequencer are really only limited by the imagination of the user.

**EXPANSION**

More ambitious constructors should have no difficulty expanding the unit in a number of ways, for example, two or more memories could be connected in series to give longer sequences. Alternatively, two memories could be paralleled to provide more outputs (two tunes could be played at once!).

Even in its basic form, the 128 note sequencer is a very useful addition to a synthesiser, making possible effects and sounds that are very difficult to produce manually.
MICRO-BUS

Compiled by DJD.

This is the second of a new regular feature covering all aspects of microprocessors and minicomputers. Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

TIME-CODE CLOCK

In the past the only type of clock which did not need to be set to the correct time was the sundial; other clocks are at best only as accurate as the last time they were set. However since 1974 when the National Physical Laboratory started transmitting a high-accuracy time code, it has been possible to design an electronic clock which automatically sets itself to the correct time within a minute of switching it on!

The output from the PLL drives an LED which should flash at 1 Hz when a signal is being received, and the two inputs to the MC6820 Peripheral Interface Adapter (PIA) in the microprocessor system. One input is a conventional input and the other is a latched control unit.

The clock was tested on a Motorola D2 kit, which uses a 6800 MPU, and the complete program is shown in Fig. 3. This could easily be modified for use

The signal is transmitted from Rugby on M.S.F. 60kHz. A 100-millisecond break in the carrier occurs every second (and on some half-seconds), and each minute the time and date are transmitted in a binary coded decimal format, see Fig. 1. Designs have appeared which used logic gates to read and decode the information but these needed a large number of integrated circuits and much wiring.

An alternative approach presented here is to do all the decoding by software using a circuit based on a microprocessor; in this case the only parts needed, apart from the microprocessor system, are the receiver section and interface as in Fig. 2. This would therefore make an ideal system clock for a microcomputer. The receiver is built around an NE567 phase-locked loop (PLL) tone decoder whose frequency is set to 60kHz by VR1. When a frequency within about 14 per cent of this is present at its input, it drives the output low. A ferrite-rod aerial tuned to 60kHz feeds a two-stage amplifier which brings the signal up to the 25mV needed to drive the PLL. The aerial should be placed at least 2 ft away from the receiver to minimise pick up from the PLL, and the wire connecting them should be screened.

In the prototype the front-end was built from a kit supplied by D. W. R. Higginson Limited, Bristol Road, Sherborne, Dorset, DT9 4EF, for £14.08 (incl. VAT), and this included a pre-aligned aerial (available separately).

Fig. 1. Format of the encoded time and date information transmitted at the start of each minute

Fig. 2. (a) Block diagram of the NE567 phase-locked loop tone-decoder integrated circuit used in the receiver

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suitable

Fig. 0008

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Fig. 0008

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with other micros. As it stands the program uses the display routine in the D2 kit JBUG monitor to display the time; when executed the program first causes an arbitrary number to be displayed (and this flickers at one-second intervals due to the time taken by the interrupt service routine) and then each minute the display is updated to the new correct time as the time code is received.

The program is entered at BEGIN and this first section initialises the PIA, making CA1 an interrupt input, and puts the address of the interrupt-service routine ISR into the pseudo interrupt-vector at A000; on interrupts this is picked up by the monitor and used as a jump address.

The interrupt mask is then cleared, and control transferred to the main program; in this case OUTDS, the display routine which refreshes the 7-segment displays in the D2 kit.

On the rising edge of every pulse from the receiver an interrupt is generated and the routine ISR is called. This routine is only concerned with minute pulses, so it reads the input pulse after 30 milliseconds and returns to the main program if it is still high. Otherwise it updates the seven locations at DIEA with the decoded information, and it does this as follows:

The program delays a further 35 milliseconds to the centre of the first data bit and then reads bits at 10 millisecond intervals into the correct location at DATA. The number of bits to be shifted into each location is different (see Fig. 1) and is given by the number in the corresponding element of the array BITs. All the delays are generated by the subroutine DELAY which counts down the index register X, and in systems with different clock rates the delay parameters will have to be altered accordingly.

To convert from G.M.T. to the more familiar B.S.T. the program adds the summertime bit to the number of hours. Finally, for testing purposes, the routine UPDATE uses subroutines in JBUG to clear the displays and load the new hour and minute counts into the display buffer. Note that although the date and parity information are not displayed they are available in the array.

**DATA**

As well as making an ideal source of the time and date in an existing microcomputer system, a time-code clock could be constructed using a dedicated microprocessor with the program stored in ROM. It would be a simple matter to extend the program to date display, error-checking (using the parity bits), seconds, an alarm, and time-controlled switching of circuits. All things considered, the sundial does not have much going for it any longer!

**MICRO PLAYS CHESS**

The "Chess Challenger" pictured below is a new microprocessor-based game that is being imported from the States, and it is currently on sale here for about £150. It is a remarkable example of how micros have crept up on us, and most people who have played against it are amazed that such a serene-looking wooden case contains a machine that can produce strong opposition to their moves.

The Chess Challenger microprocessor-based chess playing game

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Fig. 3 Program for the 6800 which reads and decodes the time and date information from the receiver section and displays the time on the displays in the D2 kit

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The player enters his move at a keyboard, to the right of the chess-board, and the machine gives its reply on a four-digit seven-segment display. The moves are entered as the co-ordinates of the two squares involved (in what is unfortunately the opposite of standard algebraic notation) e.g. FROM 4b TO 4d. The “EN” key then enters the move and the machine replies in about two seconds.

It is worth noting that the machine performs no move checking, so any piece may be moved to any square that is either unoccupied or else occupied by an enemy piece; it is up to you to not to cheat! This has the side-effect of making it possible to set up mid-game positions, albeit in a rather tedious way.

AN EXCELLENT PARTNER

The special moves of castling and en-passant captures are dealt with by means of the “DM” double-move key. This prevents the machine from replying to the next move entered, so it enables you to move more than one piece in one turn. The machine will castle at the first opportunity, and it sometimes castles through check; in this event it is necessary to move its king and rook back and ask it to move again, and it will not attempt another castling. It does not capture en-passant. If a player's pawn reaches the back line it is promoted to a queen and you cannot ask for an under-promotion. However, it neglects to promote its own pawns, and in one game played against it where it could have forced a victory it left its pawn unpromoted on the last line.

The machine announces “check” by an i.e.d., and when mate says “I lose” with an other. A useful additional feature is the possibility of interrogating the current board position piece by piece to verify that the pieces are set up correctly.

At first sight the machine plays a good game, and it certainly never misses a trick if one is immediately possible. However, it only performs a static evaluation of the current position and does not look ahead at all. In other words it will fail to spot a mate in two, unless it happens to choose the key move for other reasons. Despite this the algorithm it uses to choose what it considers to be the best move is well-designed so that nine times out of ten it actually does come up with one of the better moves. When for some reason it gives a bad move its opponent usually remarks that “it failed to see what was going on”, it cannot spot long-term plans and, by the same token, does not form long-term plans. This is a common failing of all but the most sophisticated of chess programs.

Out of a number of games played against it by players of ordinary to club standard it won about one-third. The shortest mates are spectacular if unrepresentative, but they illustrate the machine’s blind spots and two are given below:

<table>
<thead>
<tr>
<th>Pete Christian</th>
<th>Chess Challenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>1. 5b–5d</td>
<td>5g–5e</td>
</tr>
<tr>
<td>2. 4a–8e</td>
<td>7g–7e</td>
</tr>
<tr>
<td>3. 7a–6c</td>
<td>8g–8f</td>
</tr>
<tr>
<td>4. 6N5e (xP)</td>
<td>7h–6f</td>
</tr>
<tr>
<td>5. 8e–6g (xP)</td>
<td>1 LOSE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geoff Walker</th>
<th>Chess Challenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Black</td>
</tr>
<tr>
<td>1. 5b–5d</td>
<td>5g–5e</td>
</tr>
<tr>
<td>2. 2a–3c</td>
<td>2g–2f</td>
</tr>
<tr>
<td>3. 6b–6d</td>
<td>5e–6d (xP)</td>
</tr>
<tr>
<td>4. 4b–4d</td>
<td>3h–2g</td>
</tr>
<tr>
<td>5. 5b–4d</td>
<td>7g–7e</td>
</tr>
<tr>
<td>6. 6a–3d</td>
<td>6h–5g</td>
</tr>
<tr>
<td>7. 6c–5e</td>
<td>6g–6f (??)</td>
</tr>
<tr>
<td>8. 4a–8e (ch)</td>
<td>5h–6e</td>
</tr>
<tr>
<td>9. 8e–6g</td>
<td>1 LOSE</td>
</tr>
</tbody>
</table>

The widespread availability of inexpensive hardware for the storage and playback of computer programs is seen as a key requirement in the development of the domestic television receiver into a computer system for use by all the family as a TV games centre and programmed learning and information terminal.

The possible range of programs is unlimited. By plugging a suitable cassette program into the cassette deck contained in the TV Game, the linked television could be transformed into a scientific or business microcomputer in which every stage of calculation is displayed on the TV screen. Alternatively, language tapes could be made available combining on-screen text with the spoken word.

Program Cassettes for Home TV Terminal

**General Instrument Microelectronics Ltd and EM1 Tape Ltd have jointly developed an inexpensive method of storing computer data for home use, using conventional audio cassette tapes and a standard audio cassette mechanism or deck.**

The technique, for which patents have been obtained, permits the storage of 1-6 million bits of data on each side of a conventional C-60, 30-minute per side cassette and offers one hundredfold increase in storage capacity in comparison with ROM microcircuit cartridges, at one quarter of the price. Moreover the technique allows voice and digital data to be stored on the same cassette.

The game is based on the 8080A micro, the Intel-designed 8-bit device descended from their 8008 and currently the most widely used microprocessor. The program and keyboard/display interface routines are stored in a 2K byte ROM, and for the board position and other variables there are 3K bytes of RAM. As the photograph shows, it forms a very compact unit, this being made possible by supplying the transformer as a separate unit.

This machine is an excellent partner for average players who want some rapid and accurate opposition to help them improve their game, and it will certainly get one past the stage of leaving pieces unprotected. Unfortunately, while you are improving, the machine stays at the same level making the same mistakes. Perhaps with this in mind the makers offer to upgrade the game for an additional £50 by replacing the chip. Then the upgraded game can be set to play at one of three strengths, and at level 3 it searches to a greater depth and takes up to 30 seconds per move. For those who do not play chess the makers say that a “Backgammon Challenger” is in the pipeline, and who can guess what else may be on the way?

**FERRANTI 8-bit D/A CONVERTER**

The ZN425E is the cheapest monolithic 8-bit D/A converter currently available despite its excellent specifications, and as an added bonus it contains an 8-bit binary counter so that it can be used as the basis of a simple A/D converter. It was specified for the digital waveform generator in the previous Micro-Bus and can be obtained from S.D.S Components Ltd., Hillesden Industrial Estate, Gunstore Road, Portsmouth for £3/78 (inc. VAT) plus 65p postage.

**A few tapes of the program for a “Bulls and Cows” game are still available from P.E.** (see October issue).
SAILS IN THE SUNSET

The now rejected system of photon propulsion for the spacecraft which will be used to rendezvous with Halley's comet has caused some people difficulty. In fact the same principles apply to this system, which uses photon wind for the propulsive medium, as to the normal sailing dinghy. The incident radiation would be reflected by the sail and the resultant energy would urge the vehicle in the same manner as the wind on Earth. It is, of course, necessary to take into account the action of gravitational and centrifugal forces.

However, it could be intriguing to plot a course with its necessary tacking when moving towards the sun. It might not be so facetious if it was suggested that the variations in the medium and the strength of the radiation might lead to the use of the planets as buoys.

SPACE SHUTTLE

Now that the space shuttle has entered both the vocabulary of the public at large and the world as a whole, it is to be hoped that a new look will appear on the space scene. Since there will be much that other countries can aim for at a much lower budget, it is foreseeable that many more missions will be required than envisaged in the first plans.

The rate at which mission time has already been taken up, it would seem that the second and third shuttles are already justified. Indeed, the natural reaction to the September disaster for the second Voskhod may accelerate this.

It must be very apparent now that the way to economic stability in the space programmes is via a maximum use of these new methods. The horizons are so wide that the accusation of "money wasted on wrong things" can be easily disposed.

The implications for industry and further employment is very considerable particularly in light metal raw materials. These are to be thought of in terms of millions of tons. So much indeed is required that every country in the world can benefit where process industries are working.

CHEAP SOLAR CELLS

One of the greatest needs of solar development is the requirement of cheap solar cells. It would not require any more money spent on development to increase efficiency for the quantities needed would be so great that a very rapid lowering of price would result.

While the last little fraction of efficiency is required for space missions, this does not apply to earth based equipment. The difference in cost for a low grade cell is very great and other alternatives of basic materials could now be investigated.

The same reasoning applies to space projects where the shuttle is used. The weight that can be raised to orbit is so great in comparison to a single launch, that larger quantities of solar cells can be used. Here again the economic law applies. It is better and cheaper to use a large number of less efficient units which will in the end exceed the installed equivalent power.

THERMEOLECTRIC DEVICES

So far as earth based units are concerned, attention might also be given to thermoelectric devices. Used in cylindrical reflectors the area of activity is of sufficient extent for continuous lines of such devices to be used without overheating.

For example, a two metre by one metre sheet of aluminium will give a very high concentration of heat over a plane of 500 centimetres. For the "do it yourself" enthusiast it may be extended cheaply using simple angles instead of a parabola-cum-cylinder arrangement. A simple corner reflector will serve very well if slightly modified. Two sheets of aluminium, two metres by one metre, set longways will provide one square metre of concentration with a gain of four to one. In fact a complete unit such as this, with preheating from the distributed "lost heat", can make a very efficient garden unit to supplement the household heating.

The last few sentences may be thought to be far removed from space, but is really so? Does not the new space age offer such spin-off facilities? The same techniques can be moved from one discipline to another to make the maximum use of resources. Many years ago it was suggested that a large reflector arranged in orbit could not only supplement the heating of the Earth but that also it could be arranged to act as a second moon. Such a project is hidden within the compass of present technology.

The moving of the large gravity pulled structures and the associated equipment into space would reduce many costs and enable many devices on Earth to be reduced considerably in dimensions. Is it so fanciful to see the Earth controlled from its outer environs?

Certainly, if all nations took part in such a future programme there would be automatic control of attitudes. There would be so much for everyone to do that common interest could lead to common citizenship. Such a situation would indeed make horizons boundless. Not least of the benefits would be a wrist telephone which put everyone in touch with everyone else. Perhaps it is better to leave the subject there for the moment.

JUPITER

There seems to be a number of people who have been somewhat dismayed by the interpretation of Prof. McNally's report about the Jovian planet. Within the last several weeks there have been many questions as to whether Jupiter is to be a second Sun. It is unfortunate that when these ideas take hold of public imagination a whole crop of pseudo science appears.

It has been known for a very long time that Jupiter gives out more heat than it receives. This in no way justifies a statement that it will grow hotter and hotter to reach a state of concentrated gravity condition to raise temperatures to fission level. Indeed, application of the inverse square law will settle any fears of a new "Sun" within the lifetime of the one already sustaining the Earth and its people.

At the distance of Jupiter from the Sun, nearly 500 million miles, a much smaller fraction of the Sun's heat per square mile of the planet is received than that received on the Earth.

The Pioneer results, in any case, have established the reigning temperature very definitely. A great deal of heating up would be required to bring it to a hospitable level. The projected mission into the atmosphere of the planet will bring forward much needed data to enable assessments to be made in these matters.

That Jupiter is a remnant of the original nova is gaining ground now. This would seem to be a logical explanation of Jupiter's size and effect in the solar system. Its effect on the Sun is considerable because the centre of rotation of the Sun and Jupiter is some 30,000 miles inside the photosphere. The inevitable result is a disturbance of the atmosphere of the Sun.
POCKET MULTIMETER
A new, high accuracy, personal digital multimeter from Sinclair Radionics is now available in the UK at £29.95 plus VAT.

Claimed to be less than one-third the price of existing 3½ digit meters, the PDM35 fits easily into a coat pocket, brief case or tool kit.

Using an adaption of the old Oxford calculator cases (to save cost), the PDM35 will measure a.c. and d.c. voltage to an accuracy of 1 per cent of reading. Also d.c. current can be measured to the same accuracy. The resistance range is up to 20 megohms. Range selection is by a slide switch as against the usual rotary type.

There is no provision for a.c. current measurement as Sinclair claim their investigations show little demand for this facility.

A brief technical specification is as follows: D.C. Volts (4 ranges) 1mV to 1000V at 1 per cent ±1 count, 10MΩ input impedance; A.C. Volts (40Hz–5kHz) 1V to 500V at 1 per cent ±2 count, mean reading r.m.s. (calibrated); D.C. Current (6 ranges) 1mA to 200mA at 1 per cent ±1 count, maximum resolution 0.1mA; Resistance (5 ranges) 11Ω to 20MΩ at 1.5 per cent ±1 count, also provides 5 junction-test ranges.

Additional extras include an a.c. adaptor for 117V 60Hz or 220/240V 50Hz, carry case and a 30VμA probe.

For addresses of nearest stockists of the PDM35 digital multimeter readers should write to Sinclair Radionics Ltd., Dept P.E., London Road, St. Ives, Huntingdon, Cambs, PE17 4HJ, although most good component shops and some stores will have stocks.

MUSICAL DOORBELL
No doubt most readers will already heard of the Chroma-Chime, claimed to be the world’s first microprocessor controlled electronic doorbell manufactured by Chromatronics.

This product is now available in kit form for the enthusiasts who want to build their own units. The kit comes complete with all parts including the microprocessor chip, printed circuit board and a comprehensive assembly manual.

At £18 inclusive of VAT and postage the Chroma-Chime will certainly make a novel gift to add to the Christmas shopping list. Further details and kits can be obtained from Chromatronics, Dept P.E., Coachworks House, River Way, Harlow, Essex.

We hope to give a more in-depth report on the Chroma-Chime kit in the near future.

TAPE/RECORD CARE
With the price of tapes and records on the increase each month, it would seem that BASF have taken the ideal opportunity to launch their Checkpoint record and tape care accessories.

Being their first venture into record accessories, they have produced special gift packs containing such items as cleaning fluid, record cleaning arm and strobe speed check discs. For the cassette recorder there’s a cassette tape head cleaner and even an inspection mirror.

Apart from complete record and tape care kits all Checkpoint accessories are available separately in special bubble packs.

Prices of the BASF Checkpoint accessories vary from £1.94 for a complete record and cassette case kit to 30p for a record cleaning cloth. All units are available from most audio shops and some big stores.

DIFFICULT COMPONENTS
Readers who are experiencing difficulty in obtaining the Radiospares switches for the “Digital Multimeter”, published in our October issue, will be pleased to know that Sparks Developments are able to meet their requirements.

They are also able to offer a low cost alternative to the 1 per cent high stability resistors required for the input divider chain. By using two resistors for each of R20–R26 allows the use of preferred resistance values from the E12 range.

Sinclair PDM35 digital multimeter

Also, by utilising the spread in values of a sample of components, a pair of resistors can be selected by measurement to obtain a final value very close to the ideal value.

They are prepared to supply a complete set of resistors R20–R27 to make up the input divider chain to an accuracy of 1 per cent. In addition they will supply printed circuit boards for the project with the necessary modifications to accommodate the extra resistors.

All enquiries should be addressed to Sparks Developments, Dept P.E., 53 North Street, Melbourne, Derbys, DE7 1EZ. A stamped addressed envelope should be enclosed with any enquiry.

GOOD-BYE
This is a very sad occasion for me to have to say goodbye to all readers of P.E., having been responsible for “Market Place” since the first issue.

This is due to a management decision that the magazine would benefit by a move to Poole, Dorset. Even though the Editor and myself, who first started Practical Electronics way back in 1964, feel that this is a sad move for the magazine.

Not being able to make this move West the Editor, Fred Bennett, and myself are having to relinquish our positions on Practical Electronics at a time when the efforts of all the P.E. Team have now made it No. 1 in its field in the U.K.

For myself it is particularly sad as I am the sole Editorial staff member of the Practical Group of magazines who worked with and was trained by the late P. J. Cann, the originator of the Practical.

I should like to take this opportunity to thank all my friends at our Printers, my colleagues on P.E. (particularly Dave Tillierd and Peter Mew of Advertising), our Advertisers and my close friend Gordon Gould who gave us an exciting and rewarding 13 years.

Finally, I hope that all readers of P.E. will continue to give the magazine the support it deserves.

Dave Manning
... TWO-DAY COURSE
Sponsored by PE

SYSTEM DESIGN
with MICROPROCESSORS
Organised by INTERPROJECTS Limited
Technical Services

JANUARY 6 and 7 1978
9 a.m. to 5 p.m.

at the INSTITUTION of ELECTRICAL ENGINEERS
SAVOY PLACE LONDON W.C.2

Conducted by D. ZISSOS
Professor of Computer Science University of Calgary Canada

An intensive two-day course aimed to enable practising engineers, technical managers and hobbyists to design and implement their own microprocessor systems using methods that require no specialist knowledge of electronics or programming other than a basic knowledge of logic.

Professor D. Zissos is an established authority on logic design, on both sides of the Atlantic. He has written numerous books and articles on the subject. Professor Zissos is also a practicing design consultant known for his pragmatic approach, with several projects to his credit.

Registration
The course is of limited enrolment and applicants will be dealt with strictly in order of receipt of completed coupon and remittance.

Fee: £45 (plus £3.60 VAT) includes a book "Problems and Solutions in Logic Design" by D. Zissos and comprehensive lecture notes.

The proceedings will be opened by Professor C. Turner, King's College, London.

Please make the following reservations for the 2-day course System Design with Microprocessors.

Signature

Name
Address Home/Company

Delegates name
1.
2.
3.
4.

Enclose cheque/PO £ at £45 plus £3.60 VAT each. Payable to Interprojects Ltd.
MAIL BAG

The most distressing feature of being a columnist in 1977 is the occasional mail which arrives from young people seeking an entry into the electronics industry. The writers are generally out of work or in some dead-end job. Can I help? Would I please supply names and addresses of firms who have vacancies, give introductions. They are sad letters to receive, reflecting the high level of unemployment in our society, especially among school leavers.

Regrettably, I have to point out that while sympathising with the plight of my correspondents, it is no function of PE to act as an employment agency although, of course, we are always glad to receive letters from readers and give what advice we can.

It seems to me that career expectations are much higher today than they used to be. Young people are encouraged to believe that jobs will be found for them, whereas, we of an older generation were brought up to help ourselves and be far more self-reliant. We had to be prepared to work long hours for very little pay if this meant getting experience and a foothold on the bottom rung of the ladder.

Any sort of job would do to get a start and provide a chance to prove yourself. But if you fall down on the job, then it was a week’s notice and you were. My first job in electronics was as a junior service engineer at a local radio dealer for which I got £1.25 for a 48-hour week and no extra pay for overtime. It was a start on the road to becoming a qualified engineer.

Those were the bad old days of hire and fire, long hours and low wages, but those days offered the opportunity of getting a start, however humble. Today there are so many rules and regulations that employers are much more reluctant to take on any but the obviously best youngsters. Greater job security would seem to have limited the job opportunities.

The other great change is in the electronics industry itself. It is still a great growth industry but not in the numbers of people employed. If we look back to the first generation of electronic computers we find that the original ENIAC computer developed in the United States and completed just over 30 years ago used 18,000 valves and consumed 100KW of power.

It seems laughable today but just think of the employment it provided. All those valves, valveholders, resistors, capacitors, the millions of interconnections all wired by hand and laboriously soldered, joint by joint. Even when they got it going it needed an army of trouble-shooters to keep it on stream.

The fact is that today an unskilled operator pushes an I.S.I. module into a printed circuit board and passes it to a flow-soldering machine and in less than a minute has wired up as many as 5,000 components and the board works first time and keeps on working. And today, the chances are that even the testing of the board after assembly will be done on automatic test equipment by a semi-skilled operator.

This hard fact was brought home forcibly to me when I was looking over the last set of GEC accounts. This year’s record profits and turnover were achieved with less people employed. The UK work-force in 1976 was 166,000 people. Today it is 100,000 less. By no means is this reduction entirely due to things like I.S.I. but it does show the trend resulting from mechanisation and automation and modernisation.

If we look at Racal Electronics Group we find turnover in 1976 of £50 million generated by 4,187 people. 1976 saw a huge leap forward to £79 million generated by 5,028 people. This year’s turnover was £122 million with 5,373 people. Note that turnover has more than doubled with only a 25 per cent increase in employment in the past two years. In the past year alone, turnover was up 53 per cent and yet the Group employed only just over 300 more people.

All is not lost however for the bright young person. Technology-based companies are still looking for talent. Last year GEC spent £150 million on R and D. So my advice to keen youngsters is to get qualifications as quickly as they can. An O.N.E. will not guarantee a job but it will impress an employer that the applicant is career-minded and not just a job-hunter.

PRICE BREAKTHROUGH

After the National Enterprise Board took a big stake in Sinclair Radionics everything seemed to go quiet, unusual for such a publicity-conscious concern. Then there was that sudden spate of press advertising for Sinclair calculators and now the big breakthrough in instruments.

To market a digital multi-meter with a price tag of under £30 was a bold move. But such a price is only possible if the instrument can be produced in great volume. The DM2 had done well with over 25,000 units sold but the new smaller and cheaper PDM35 will do even better as it started off with firm orders for 20,000 from the USA alone.

Among the cost-cutting economies to get price down without sacrificing performance were the use of an adaptation of the Oxford calculator case as a housing, thus saving on tooling costs, and a precision resistor network on a single thick film circuit.

The designer of the DM2, John T. Nicholls, has also designed the PDM35. As head of Sinclair’s Instrument Division he is already looking ahead to a range of instruments to be introduced to the international market in 1978. I understand that an up-market model will be an auto-ranging 4½ digit instrument but it is also hinted that there will be some down-market instruments as well. Sinclair Radionics is aiming to be the world’s largest manufacturer of digital multimeters, at least in volume of instruments, by mid-1978.

Meantime, I can reveal that production of Sinclair’s tiny t.v. set is rapidly expanding and although the bulk of production is ear-marked for the United States market it is expected to be available in the UK by Christmas.

SIGNS OF THE TIMES

Selling information can be just as profitable and far less risky than selling products. But while some people talk, others get out and sell. Oil-rich Libya has just given Marconi Communications Systems Ltd its biggest ever single order, worth £9 million, for updating the radio facilities at Benghazi and Tripoli airports.

The capacitor manufacturers, Advance Filmcap, has changed its name to Gould Components Ltd., reflecting its change of ownership to the US Gould Corporation. I think it unlikely that the Advance name will be dropped from instruments but one never knows.

The Co-op has signed up for another £4 million worth of ICL mainframe computers. This is the biggest single order the ICL has ever taken and raises Co-op purchases from ICL in the past 18 months to £6 million.
Logic Probe LP-1

It's compact.
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It identifies High, Low, or Intermediate levels, open pulsing nodes.

It enables you to trace logic levels, pulses and logic sequences through complex digital circuits.
It detects pulses as short as 50 nsec and stretches them to ½ sec for easy observation.

Try the LP-1 and you won't know how you ever managed without it!

How it works
You just clip the probe leads to the circuit power supply, setting the 'Logic Family' switch to DTL, TTL or CMOS (CMOS position also covers HTL).

Touch the probe's tip on the node you're investigating and the LP-1 lights up to show you exactly what you've got. The LED marked 'Hi' comes on for logic state 1 (High) and 'Lo' comes on for logic state 0 (Low).

The third LED, marked 'Pulse', shows the dynamic signal activity at the node under test. Set the switch to 'Pulse' and pulses as narrow as 50 nanoseconds are stretched to ½ second. Single-shot and low rep. rate pulses are clearly shown — you can't do that even with a fast CRO! High frequency pulses up to 10 MHz will make the 'Pulse' LED blink continuously at 3 Hz; and with asymmetric signals, the 'Lo' LED will come on for duty cycles under 30%, and 'Hi' for those over 70%.

Another useful feature is 'Pulse Memory'.

Put the probe tip on to a node, switch to 'MEM' and the next logic change-positive or negative — or the next pulse edge, will cause the 'Pulse' LED to come on and stay on, until reset. Meanwhile, 'Hi' and 'Lo' LEDs continue to function as usual. No other probe or logic checking device gives you all that!

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The balconies remained empty in the Grand Hall of Olympia for what used to be called the Audio Fair, where just under ninety stands barely filled the main floor.

The exhibition ran from September 12 to 18, and giving lectures during that period at the Wireless World stand was John Logie Baird himself! This lifesize model of the inventor, with his blank wax face animated by a sound synchronised movie projector, was chillingly convincing, as he (if?) told of his early experiments in television. Although numerous big names in hi-fi were present at the exhibition, their interest rating seemed "pushed over" in favour of such things as calculators, alternative uses for television, digital watches and clocks, including an i.e.d. clock radio from SI Electronic (UK) for under £20. The show was of no real interest to organ or synthesiser fans.

INTELLIGENT TURNTABLE

There was a chance to see and operate the new ADC Accutrac +6 Turntable, and this gave a good example of the subservient microprocessor's ability to please, because this deck, which is expected to retail at around £150 inclusive of cordless remote control, can play up to six l.p.s using touch-switch activated "hands off" servo mechanisms which really do treat the records with loving care. There can be no mishaps, and the records are not dropped brutally on to the platter.

What is more, the system can be instructed to play any combination of tracks in any order. The microprocessor stroboscopically controls the turntable speed, and seeks out the selected recordings with an infra-red "eye" mounted in the cartridge, which counts the smooth unmodulated gaps between tracks. ADC are keen to point out that this is a true hi-fi class deck, and not a mere gimmick. The circuit blueprint for the Accutrac +6 measures nearly 5m by 6m, most of which is on a 2.5mm mos chip!

CORDLESS HEADPHONES

Listening to recordings with headphones is generally accepted as being more satisfying than using loudspeakers, but nobody likes tripping over wires. For this reason Beyer Dynamic developed their infra-red cordless system. The ISS 76 Stereo Transmitter (there is also a mono version), along with the DT444S headphones incorporating infra-red receiver, will set you back about £190, but if you have your own headphones, you can buy a discrete plug-in type receiver for about £30.

The transmitter can take an audio signal from any source, and the infra-red output is semi-directional, therefore needing some walls around to "bounce" the signal.

INFORMATION BY TV

Much activity was centred on television, providing an opportunity to try out the CEEFAX and ORACLE teletext systems for one's self, but by far the most impressive t.v. data service to use was that of Viewdata, both from simplicity of operation and the potential usefulness of point of view.

Unlike other systems, the PO's Viewdata communicates via telephone lines and is completely user interactive. If the required page number is not known, you simply call up the general index, and select a suitable heading by entering its number. A more appropriate index will then appear, and further selection through this "family tree" of pages will bring you to anything from a Which Report on a particular freezer to an airline ticket booking facility. You could find the nearest golf course to your Summer holiday location, complete with fees and opening hours.

The services possible are endless; it simply depends upon which organisations feed their information into the system. For example, a motoring organisation could provide a diagnostic service. If your car will not start on a cold morning, by answering "yes/no" type questions, the most likely fault would be displayed.

As yet there is only a pilot service, and a full public service is not envisaged until the early 1980s. Because of this, there are no conversion modules which will instantly give your t.v. Viewdata capability, and a set designed for this additional facility would probably cost an extra £80.

MARKSMANSHIP BY TV

Anyone expecting to hear the roar of tank battles and dog fights at the t.v. games stands would have been disappointed, for with the odd uninspiring exception, only the "blipping" of the usual ball games could be heard.

Along with these games, Interton Electronic were showing the rifle range option of their Video 3001 multi-games (colour) unit, with which, for an extra £20 on top of a basic £52, you can plug in the V300 Rifle and aim at a spot of light bouncing around the screen, or call for the target to fly past in clay pigeon style. No scores appear on the screen (for obvious reasons) and the plastics "shooting iron" gets flooded by daylight, so the game has to be played in a darkened room.

OTHER INTERESTS

The show was by no means all about hardware, and among the other activities were live music performances at the theatre, with an open invitation to make private recordings, and which included a demonstration by the BBC Radiophonic Workshop. There were lectures by various hi-fi experts too.

A cinema showed films of all kinds, one of which, produced by the BBC, gave an insight to local radio behind the scenes. The London Broadcasting Company (LBC), local radio, were indeed present, and transmitting live from Olympia throughout the show, whilst a few stands away, the BBC were busily receiving experimental transmissions of Proms concert music for live demonstration in Matrix H Quadruphony.

The new base of this exhibition may not please the hi-fi buff, but will undoubtedly provide greater scope for imagination in the future.
LOW COST MICROPROCESSOR APPLICATIONS

The Third Session included papers dealing with Low Cost Store on Audio Cassettes, an MPU System for the Entusiast or Small Laboratory, and Microprocessors in Education. The presenter of the last paper enthused over US minicomputers, which are available in this country either as complete machines or in kit form, recommending these for students and hobbyists alike.

COMMERCIAL APPLICATIONS

Session 4 was devoted to commercial applications; these included a microprocessor system which has replaced a conventional pneumatic logic control system in a factory air conditioning plant with a claimed 70 per cent energy saving; a system for monitoring and controlling commercial greenhouse environments; and a microprocessor control system for tele-phone coin boxes. The latter has been developed by Post Office Research to replace existing relay logic systems. The tremendous scaling-down of hardware (and of the circuit diagrams) was demonstrated with illustrations of the existing relay equipment and its probable successor. It is of interest to learn that the Post Office started on this project in 1972 before the first commercial microprocessor had become available.

SOPHISTICATED SYSTEMS

Session 5 was devoted to advanced and unusual uses of microprocessors and included two papers relating to medical applications. Assuredly there is an exciting and socially important role for microprocessors in the field of medicine. An example is a microprocessor-based foetal monitoring system devised to overcome the disadvantages of the normal chart recording bedside monitoring box, which has been in use for many years. The system described has been used successfully for monitoring patients in the labour ward of a maternity hospital, and has been well received by hospital staff.

The second medical application provided an example of computer assisted learning, a technique which has become well established for education and training in a wide range of subjects. The project described is a training equipment for patients undergoing haemodialysis treatment with artificial kidney machines. The haemodialysis Simulator/Trainer incorporates an Intel 4040 together with an alphanumeric display unit.

SYMPOSIUM PAPERS

Reprints of all the papers presented at this symposium are available in a single volume comprising some 200 pages. This publication is available to Practical Electronics readers at the specially reduced price of £7.00 which is inclusive of postage and packing. Orders, with remittance, should be sent to the Secretary, 1977 MPU Symposium (Dept P.E.), S.E.R.T. 8-10 Charling Cross Road, London WC2H 0HP.

This reviewer for example was disappointed to find no mention of Messrs. Colpitts, Hartley, Cockcroft or Walton, Foster or Secarl, or Wien in the truly an understate slight to these gentlemen and their contributions to classic circuitry.

Under Transistors and Semiconductor Devices we find Esaki and the tunnel diode, also Ovshinsky and the amorphous semiconductor. But absent is Dr. Carl Zener.

What is an electronic invention? The author himself discusses this tricky definition in the Preface. One could also enquire exactly what is entitled to be referred to as "electronic". Surely not the Phonograph or Gramophone? Yet this invention of Mr. Edison's in 1877 is given a place. There are further examples of equipment or devices which taken on their own have no claim to be considered electronic, they are commonly accepted as so nowadays because in their modern form they are an integral part of some electronic amplifying or control system.

These points of criticism are in fact a kind of compliment to this book, for they demonstrate the fascinating nature of its contents and the thoughts they set going in the reader. The author invites additional data, for possible inclusion in a further edition. It is to be hoped that this work undergoes further research and expansion for it could be the basis of a badly needed central reference source in the field of electronics. But it will require revising and expanding at least once a year!
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AN INTRODUCTION TO MICROCOMPUTERS: VOLUME 1—BASIC CONCEPTS
By Adam Osborne

This is an expanded version of the chapters forming the first half of an earlier edition of An Introduction to Microcomputers which sold 30,000 copies in the USA. The book deals with microcomputers on two levels. Firstly it contains a very clear description of the general concepts of computing—binary arithmetic and boolean algebra—and explains how a typical microprocessor operates. It comes into its own, however, in the later chapters which cover such subjects as input/output and memory addressing, and provide answers to questions like "what is the difference between cycle stealing and simultaneous DMA?" and "why do few microprocessors provide indirect memory addressing?". In dealing with the internal logic of the microprocessor the chip slice is explained, and the book concludes with the compilation and discussion of a hypothetical instruction set.

The book is well illustrated with diagrams clearly drawn and in a uniform style (not just extracted from manufacturers' data as is unfortunately sometimes seen), and a novel technique of dividing the text into sections of boldface type, for fundamental facts, and lightface, for explanations in greater depth, makes the book useful as a reference source. All in all it provides well written, authoritative, and very readable explanations of most aspects of microcomputer design.

D.J.D.

A PRACTICAL INTRODUCTION TO ELECTRONIC CIRCUITS
By M. H. Jones

An excellent up-to-date text book practically orientated and using well-known circuit devices as illustrations throughout. Explanations are clear and to the point, uncluttered by unnecessary delving into non-essentials. There is no excessive recourse to mathematics. Component values and pin connections are given in the circuit diagrams so that the readers can follow out the author's recommendation to prove by practice.

For Dr. Jones is, as he tells us in the Preface, a staunch believer in learning by constructing and experimenting.

One chapter is devoted to thermionic valves and the cathode ray tube otherwise the book concentrates on solid state devices. The function of bi-polar, field-effect, power and other discrete devices is explained and such devices are then shown in typical applications. Integrated circuits received full attention. The 741 is the most frequently used linear example. One chapter on logic, counters and timers introduces digital i.c.s—TTL, the 555 timer and alternative forms of logic such as MOS and CMOS.

All the well-known circuit building blocks seem to be covered including one of fairly recent introduction, the bucket brigade. This makes the book a good work of reference apart from its main purpose as a textbook for those who have already some knowledge of simple circuits and who wish to progress with a serious study of the subject. A Practical Introduction to Electronic Circuits deserves to become a standard work for the hobbyist and student.

F.E.B.

STARTING AND RUNNING A SMALL BUSINESS
By Alan Sproston

130 pages, 210 x 135mm. Price £3.95

The component retailing business offers plenty of examples of "The Small Business". It is appropriate therefore that a book on this subject should come from the pen of one who has established his own highly successful component business, well-known in the constructor field. Mr. Sproston's experiences as an entrepreneur have not been limited to electronic components but he has in the past been involved in several different business ventures.

Drawing freely upon all of this wide background the author has written a book that is enjoyable to read and imparts helpful information to the would-be proprietor. The author explains the problems every owner faces and from his own experience offers sound and valuable advice, interlacing the hard facts of business life with amusing anecdotes and humorous asides. In this free and entertaining approach he has been aided andabetted by Jack Pountney, Art Editor Practical Electronics, who has provided this book with amusing illustrations.

F.E.B.
PART FOUR

Now that we have examined the circuitry of the CHAMP main board, and the details of its interface with the control panel and keyboard, we are in a position to move into the construction phase. This month we will consider the assembly of the main board, the design and construction of the power supply module, and the assembly of the plinth which supports the main board, and houses the power supply module.

STRIPBOARD LAYOUT

The CHAMP main board consists of a piece of 0.1in matrix Veroboard measuring 304.6 × 165mm (12 × 6.5in). This is an unusually large size for Veroboard, and if you intend to build CHAMP PROG it may be wise to buy two sheets at the same time, because of course CHAMP PROG uses the same type of board.

The board layout and the required track breaks are shown in Fig. 4.1 and Table 4.1. Before working on the board we would recommend chamfering the edges where they slide into the self adhesive card guides, because these guides grip very firmly and this can hamper board removal later.

As far as possible, the Veroboard component geography is similar to the circuit layout of Fig. 2.3, and although there are some differences, constructors should have no difficulty in finding their way around. Notice in particular that the program memory data and address buses, and the four bit m.p.u. bus are each represented by parallel runs of Veroboard copper track. This arrangement is costly in board space, but is more than made up for by the added convenience when wiring up and trouble shooting, and it provides a layout which can be related to the circuit diagram very easily.

SOCKETS

On the prototype board all i.c.s were mounted using Soldercon socket strips. This technique is strongly recommended for three reasons:

(a) Sockets are essential in MOS systems because of the damage which can occur if an LSI chip ever has to be removed.

(b) Soldercon pins are the cheapest way of providing sockets.

(c) Soldercon pins have the advantage that wiring up can take place between the i.c. pins instead of just outside the i.c. pins, as would be necessary with "raft" type sockets. This is a big help when using 0.6in wide chips, and allows maximum use of available board space.

The disadvantage of Soldercon pins is that they are not much good when repeated insertions or withdrawals of the chip is necessary.

This is not a problem with the CHAMP integrated circuits, but the interfacing sockets (SK1–8) certainly will get well used, and consequently conventional low profile 16-way d.i.l. sockets should be used in these positions. It is also possible that constructors of CHAMP PROG will find themselves regularly swopping 4702A chips around on the CHAMP board, and in this case 24-way low profile sockets could be substituted in the IC18 and IC19 positions, although this has not yet been found necessary on the prototype.

You may have noticed that the prototype board sports an extra 28-way Soldercon i.c. socket in the top right-hand corner. This was installed in the prototype to allow
TABLE 4.1.
Track cut positions to be made on CHAMP Veroboard

<table>
<thead>
<tr>
<th>Row</th>
<th>Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>BN-BF, BB-AV, AR-AJ, T</td>
</tr>
<tr>
<td>6</td>
<td>AD-W</td>
</tr>
<tr>
<td>9</td>
<td>BN-BE, BB-AU, AR-AJ, T, R-H</td>
</tr>
<tr>
<td>11</td>
<td>AD-W</td>
</tr>
<tr>
<td>14</td>
<td>BN-BF, BB-AV, AR-AJ</td>
</tr>
<tr>
<td>15</td>
<td>V-H</td>
</tr>
<tr>
<td>16</td>
<td>BN-AS, AE-AB, D, E</td>
</tr>
<tr>
<td>19</td>
<td>AR-AJ, AA-X</td>
</tr>
<tr>
<td>20</td>
<td>W</td>
</tr>
<tr>
<td>23</td>
<td>V-H</td>
</tr>
<tr>
<td>24</td>
<td>BP-AT</td>
</tr>
<tr>
<td>29</td>
<td>BP-BD, V-H</td>
</tr>
<tr>
<td>31</td>
<td>BA-AT, Y</td>
</tr>
<tr>
<td>35</td>
<td>P-H</td>
</tr>
<tr>
<td>36</td>
<td>BC-AT</td>
</tr>
<tr>
<td>38</td>
<td>P-H</td>
</tr>
<tr>
<td>39</td>
<td>BC</td>
</tr>
<tr>
<td>40</td>
<td>BB-AT, BD</td>
</tr>
<tr>
<td>41</td>
<td>BC</td>
</tr>
<tr>
<td>43</td>
<td>R-H</td>
</tr>
<tr>
<td>45</td>
<td>BD-AT, AH, AF</td>
</tr>
<tr>
<td>46</td>
<td>V, T</td>
</tr>
<tr>
<td>48</td>
<td>R-H</td>
</tr>
<tr>
<td>49</td>
<td>BA-AT</td>
</tr>
<tr>
<td>53</td>
<td>R-H</td>
</tr>
<tr>
<td>55</td>
<td>BE-AT</td>
</tr>
<tr>
<td>57</td>
<td>X-H</td>
</tr>
<tr>
<td>61</td>
<td>BE-AT</td>
</tr>
<tr>
<td>66</td>
<td>X-H</td>
</tr>
<tr>
<td>67</td>
<td>BE-AT</td>
</tr>
<tr>
<td>69</td>
<td>AA-U, R-H</td>
</tr>
<tr>
<td>72</td>
<td>AA-H</td>
</tr>
<tr>
<td>73</td>
<td>BD-AT</td>
</tr>
<tr>
<td>76</td>
<td>AA-H, AB</td>
</tr>
<tr>
<td>78</td>
<td>BD-AT</td>
</tr>
<tr>
<td>81</td>
<td>R-H</td>
</tr>
<tr>
<td>82</td>
<td>AA-T</td>
</tr>
<tr>
<td>83</td>
<td>BD-AT</td>
</tr>
<tr>
<td>86</td>
<td>AA-T, R-H</td>
</tr>
<tr>
<td>87</td>
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</tr>
<tr>
<td>88</td>
<td>BD-AT</td>
</tr>
<tr>
<td>91</td>
<td>AA-U, S-H</td>
</tr>
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</tr>
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<td>94</td>
<td>F, E, D</td>
</tr>
<tr>
<td>95</td>
<td>AA-L</td>
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<td>96</td>
<td>K, J, H</td>
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<tr>
<td>100</td>
<td>H, D</td>
</tr>
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<td>105</td>
<td>H, D</td>
</tr>
<tr>
<td>106</td>
<td>BD-AT, E</td>
</tr>
<tr>
<td>109</td>
<td>AA-U</td>
</tr>
<tr>
<td>111</td>
<td>BP-BF, T-N</td>
</tr>
<tr>
<td>112</td>
<td>AB-U, M-D</td>
</tr>
<tr>
<td>115</td>
<td>BN-BF, AS-AJ</td>
</tr>
<tr>
<td>116</td>
<td>BP, AB-U, N-D</td>
</tr>
</tbody>
</table>

Fig. 4.1. Basic CHAMP board layout. Wiring details of CHAMP complexity cannot be superimposed on this diagram and so for full assembly of this board reference to Fig. 2.3 should be made.
the future addition of an 8251 USART or 8253 programmable interval timer chip to the CHAMP board, should it be desirable. With hindsight we consider it unlikely that most constructors would require these facilities, and therefore suggest that this area is left uncommitted.

WIRING UP

It is not possible to produce a comprehensive interwiring diagram for Veroboard circuits of this complexity, but with combined use of Fig. 2.3, Fig. 4.1, and the board photographs, interconnection wiring should be fairly straightforward for the experienced constructor. In the prototype yellow KYNAR wire was used for all the logic wiring, and this is very highly recommended for the following reasons:

(a) Kynar is very fine and therefore avoids the "Spaghetti" effect which can occur with p.v.c. insulated wire.
(b) Despite its small diameter, KYNAR has a very tough insulation which is nevertheless easy to strip.
(c) KYNAR is silver plated which helps you to avoid dry joints and assures you of high integrity interconnections.

The disadvantage of KYNAR is that it seems to be difficult to find in amateur suppliers' catalogues at the moment. It is widely used in the electronics industry for its primary purpose of wire-wrapped joints and is available from R.S. Components, but if you are unable to secure any, be sure to substitute the very finest single strand p.v.c. wire you can find.

GETTING IT TOGETHER

Once the board has been cut to size and the edges chamfered, track breaks can be made, which conform to Table 4.1.

The Soldercon pins and d.i.l. sockets should be soldered in position first, to provide a reference framework for the discrete components and the interwiring, but the bandolier strip to which the Soldercon pins are attached should be left in place until construction is complete, as this will help prevent any distortion or loss of pins during soldering. The exact order in which the discrete components

**COMPONENTS . . .**

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</tr>
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<td>Capacitors</td>
</tr>
<tr>
<td>2 off 0.1µF</td>
</tr>
<tr>
<td>3 off 0.47µF</td>
</tr>
<tr>
<td>2 off 1000µF</td>
</tr>
<tr>
<td>2 off 1000µF</td>
</tr>
<tr>
<td>3 off 3300µF</td>
</tr>
<tr>
<td>Semiconductors</td>
</tr>
<tr>
<td>2 off L005</td>
</tr>
<tr>
<td>1 off 7915</td>
</tr>
<tr>
<td>2 off</td>
</tr>
<tr>
<td>Switches</td>
</tr>
<tr>
<td>4 off s.p.d.t.</td>
</tr>
<tr>
<td>4 off c/o</td>
</tr>
<tr>
<td>2 off n.c.</td>
</tr>
<tr>
<td>2 off n.o.</td>
</tr>
<tr>
<td>1 off d.p.s.t.</td>
</tr>
<tr>
<td>Miscellaneous</td>
</tr>
<tr>
<td>T1 0–12 0–12V, 25VA winding</td>
</tr>
<tr>
<td>PL2 Mains chassis mounting plug</td>
</tr>
<tr>
<td>3 off 4mm</td>
</tr>
<tr>
<td>1 off 16-pin</td>
</tr>
<tr>
<td>1 off</td>
</tr>
<tr>
<td>8 off 2mm</td>
</tr>
<tr>
<td>3 off 4mm</td>
</tr>
</tbody>
</table>

**CONSTRUCTOR’S NOTE**

The large sheets of Veroboard can be obtained from A. Marshall (London) Ltd. A suitable transformer for T1 can be obtained from Doram, order code: 66-150-6, or RS Components, order code: 207-051.

Card guides for the CHAMP main board may also be obtained from Doram, order code: 68-337-1.

The breadboard (EXP300) is available from Continental Specialties Corporation (UK) Ltd., Spur Road, North Feltham Trading Estate, TW14 0J.

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and the interwiring are added, is best left to individual preference, but of course, the MOS chips should not be plugged into their places until construction is complete, to prevent accidental damage. The last component to be mounted should be the DEAC stack, and in fact it might be wise to add this only after the circuit has been checked with power applied.

The power connections to the board are made via three wander plug terminated flying leads, and these are made with p.v.c. insulated flexible wire soldered to terminal pins inserted in the CHAMP board power bus tracks. Terminal pins are also used to provide the keyboard power, and two are situated adjacent to SK3 for this purpose, wired to +5V and 0V respectively.

The 16-way interconnection jumpers from SK7 to SK8, and from SK1 to the front panel socket can ideally be made up using ribbon cable, and 16-way plugs of the penetrating "no solder" variety such as those made by T & B Ansley, which was the method used in the prototype. The main problem with these components is availability; putting them together was found to be easy even without the special tools made for the purpose, and much more convenient than making soldered connections. An alternative to the ribbon cable system is to use d.i.l. "header plugs" with soldered multiway cable, a more tedious but perfectly sound solution.

### POWER SUPPLY CIRCUIT

The CHAMP power supply is designed to provide sufficient current to power the main board, the CHAMP-PROG board, and any reasonable combination of interface circuitry on the breadboard socket. The specification therefore calls for a +5V supply at 1A, and a -10V supply at 750mA. In practice these current specifications have been comfortably exceeded.

The circuit of the power supply module is shown in Fig. 4.2, and as can be seen, the design is fairly conventional, using fixed voltage regulators to set the output potential and provide the necessary high quality regulation. The positive supply uses two L005 devices in parallel to meet the current requirement, but there is no reason why LM309Ks should not be substituted directly if available. The LM309K will also provide a higher current capability if this should be necessary, although to take full advantage of this, the bridge rectifier would have to be changed to a 4 amp unit to prevent overheating.

A negative regulator from the 79 series is used to provide -10V but since -10V units are not available, a 15V device (the 7915), is used with its common terminal referenced to zero volts, but to the +5V output from the L005s.

This configuration works well with no compromise of the short circuit protection provided in the regulator.
POWER SUPPLY LAYOUT

The power supply is built as a module which can be tested independently of the other CHAMP components, and which can be removed easily from the plinth as and when necessary. The module uses the aluminium back panel of the plinth as its main structural component and also as a heat sink for the regulators and transformer. The large electrolytic smoothing capacitors are supported by an aluminium tray which rests on the bottom panel of the plinth for stability, and for the sake of neatness, some of the circuit interconnections are provided by a printed circuit board which mounts on a bracket also attached to the back panel.

Figure 4.3 shows the overall arrangement and the connections required, and this should be compared with the photograph of the unit assembled in the plinth. The printed circuit board layout is shown in Fig. 4.4, although 0.15in matrix Veroboard or even pin-board could be used instead if p.c.b. making is not your area of interest.

The only thing to remember when wiring up the unit, is that wire of sufficient diameter to handle the currents involved should be used, and that all terminals conducting mains voltage should be properly insulated. It is of course essential that all exterior metalwork be connected to the mains earth to prevent any danger of electric shock, and CHAMP should always be used with a 13 amp plug fitted with a 2 amp fuse.

PLINTH CONSTRUCTION

The plinth design has been simplified as far as possible so that construction is straightforward, but as you can see, the appearance of the finished unit is very pleasing to the eye. Materials and dimensions are given in Figs. 4.5 and 4.6.

The first step is to cut the plywood parts to size, and it is important at this stage to ensure that the two plinth side members are identical. This is achieved by clamping the sides together with G clamps, or binding with tape before finally trimming both to size. On the inside bottom edge of the sides, mark a line equivalent to the thickness of the bottom panel, and similarly on the inside rear edge, mark a line equivalent to the thickness of the back panel, and finally, on the front edge draw a line equivalent to the thickness of the front edging strip.

The plywood runners should be cut to fit inside these marks, and then pinned and glued in position with a woodworking adhesive such as Evostick Resin W. If a large illuminated mains on/off rocker switch like the one in the prototype is used, it will probably be necessary to truncate the left-hand plywood runner to provide the necessary clearance for the switch body. The bottom panel, when cut to size, should have a number of air holes drilled in it to allow for convection cooling of the power supply module, whereupon it can be primed and glued to the sides and the front edging strip.

It is a good idea to temporarily attach the aluminium back panel at this stage, so that the plinth is properly aligned while the glue hardens. The aluminium top panel or cover should be carefully cut to size, and all the...
Fig. 4.5. Top/front panel of CHAMP unit

Fig. 4.6. Back-plate: The hole for P1 is cut to suit whichever type of plug used. Corner holes are drilled for No. 8 woodscrews. Base: The large holes are for air cooling. Guide brackets: Four holes are drilled to suit either pop rivets or screws.
necessary component locating and fixing holes drilled and deburred. The bend in the cover can be produced fairly easily, even without a bending machine, if the following procedure is followed:

(i) Mark the bend line in pencil.
(ii) Clamp the panel to a workbench with the aid of a stout straight edge, with the pencil mark aligned with the straight edge.
(iii) With another stout straight edge press evenly down on the panel, bending it only a few degrees at a time.
(iv) Remove the panel often and check it against the plinth until the desired angle is obtained.

The cover should now be screwed to the plinth and the edges trimmed before the L shape brackets and card guides are bolted (or pop-riveted) into position (see Fig. 4.6).

It is a good idea to use the CHAMP main board as a jig while finally positioning the card guides prior to fixing, to ensure that the board is not too loose or too tight when assembly is complete.

FINISH

A lot of care was taken over the finish imparted to the CHAMP prototype, and we feel that the results achieved justify the small amount of extra effort involved. When the "fit" of the plinth components is satisfactory, the cover should be removed and the plywood base given two or three coats of aerosol primer. Allow the primer to dry and sand down to a fine surface between coats. A top coat of a suitable colour can then be applied; in the case of the prototype, a metallic cellulose paint was used, with attractive results.

The cover should be rubbed down all over with wet and dry paper or fine Emery to provide a good "key" for the primer which is applied, and as before, apply two or three coats. A contrasting metallic finish was chosen as the top coat, and several light coats should be applied until a good finish is achieved.

Before the outlines and lettering are applied to the cover, the paint should be allowed at least two days to harden off to prevent damage to the finish. The outlines are first pencilled in with the aid of a soft pencil, then inked over with either drawing ink or a spirit based felt tipped pen. (Do not use a water based ink, or the lines will run when varnish is applied.)

All necessary lettering is applied with Letraset, or a similar dry transfer technique, before the application of a coat of clear polyurethane varnish to give a durable protective finish.

ASSEMBLY

When the plinth is complete, the front panel components can be fitted and wired up as in Fig. 4.7. The use of a 16-pin d.i.l. socket as a termination adds to the modularity of the design, but is not strictly necessary. Terminal pins and soldered connections could be used instead if desired.

The ribbon cable, or loom, from the front panel is taken through the large hole in the cover to appear under the main board, so that it can be unobtrusively mated with the appropriate d.i.l. socket.

The power supply module should be thoroughly tested in isolation before the main board is plugged in, and it is wise to do comprehensive voltage checks on the main board before any chips are plugged in. It will not be possible to get CHAMP to run properly at this stage because the keyboard has not been described, and the CHAMP firmware will not be available, but if desired, the clock chip can be plugged in and the clock and reset waveforms checked with an oscilloscope, as can the SYNC pulses emanating from the 4004 CPU chip.

NEXT MONTH: Keyboard design and construction
The alarm circuit shown in Fig. 1 can save the embarrassment of a flat battery due to forgetting to turn off the side lights. The alarm will sound for about five seconds after the ignition is switched off, so if the lights are needed for parking the alarm is eventually silent. This circuit is designed for negative earth cars. For positive earth vehicles, p.n.p. transistors would have to be used, and the capacitors and ZS170 diodes reversed.

The circuit can be built on a piece of stripboard. It is then connected to the car earth, and to the lighting and ignition switches as indicated in Fig. 1.

If the RS Components type audio alarm is used, which has an average current of 60mA and peaks of 1A, then a high current transistor should be used for TR3.

When both lights and ignition are on, TR2 is on, which holds TR3 off. Also TR1 is on because C1 is charged up. When the ignition is turned off, TR2 turns off, and is temporarily kept off by TR1 being on for five seconds by the charge on C1. When this charge decays, TR1 goes off and TR2 switches back on, thus inhibiting the alarm.

The circuit works very well, and gives a short sharp reminder to turn off the lights.

A. J. Buxton, Stockport, Cheshire.
The circuit in Fig. 1 was intended as a rear light bulb failure indicator for cars, but could be used for any light source monitoring. Numerous designs for this purpose have appeared over the years, but this is probably the simplest method possible (and should therefore be the most reliable), having only three components.

The l.d.r. (R2) is mounted in a convenient position within the lamp housing, with the active face directed towards the filament. When the bulb is illuminated, R2 has a low resistance thereby short-circuiting the l.e.d. which consequently remains off. If, however, the bulb blows, the resistance of the l.d.r. rises causing the voltage across D1 to increase sufficiently for it to light up.

The circuit as shown, is for a 12V negative earth system. For positive earth vehicles, reverse the l.e.d., and for 6V systems reduce R1 to 470Ω. In any case, the warning circuit should be wired on the correct side of the on/off switch to ensure that no current consumption takes place while the lights are turned off. If there is insufficient room within the lamp housing for the l.d.r., a small hole can be drilled through the reflector, angled towards the filament, and the l.d.r. mounted behind it.

G. H. Lucas.
Leicester.

Although this circuit was designed for the six digit common anode display of a CT7001 digital clock i.e. it could be modified for use with other types of seven segment display.

Zero blanking in the tens-of-hours digit is normally achieved by using the circuit shown in Fig. 1. The count here is either 1 or 2, depending upon whether a 12 or 24 hour display is used. At segment f it is possible to detect the presence of a zero, and suppress the display.

However, to blank the zeros in tens-of-minutes and tens-of-seconds where the count climbs to 5, two segments have to be used, and segments c and e are selected, as it is only in a zero format that both of these segments are active at the same time.

In Fig. 2, a 7432 OR gate is used to detect a zero. The output of the gate connected to the digit driver will only be low when the inputs connected to segments c and e are both low. As this only happens when a zero is present, all other figures from 1 to 5 will be displayed, while a zero which requires both segments, will be inhibited.

Only one gate is required, as the output is fed via diodes to the tens-of-minutes and tens-of-seconds digit drivers.

G. Ballantyne.
Clydebank, Dunbartonshire.
**Polarity Protector**

The home experimenter can all too easily destroy expensive components at the anxious moment of trying out a circuit, by hastily applying reversed polarity to the supply input.

Time and money can be saved by simply fitting a bridge rectifier to the circuit, as shown in Fig. 1. Polarity of the applied power is now unimportant. The sacrifice made for the benefit of this precaution is that a volt or more will be lost across the rectifying diodes, but more often than not, this voltage loss will be inconsequential.

**Logic Probe**

Having seen many different types of TTL logic probes advertised in magazines varying in price from £5-£25, I was prompted to design this circuit which has many of the features of a probe in the £9-£12 range, yet it only costs about £1 to build.

The circuit, (Fig. 1) was built onto an old "Fat" ball point pen tube, which had flying leads for +5V and 0V connections.

When A is at 0 the output of ICl is at 1, so I.E.D. D3 is on, indicating the "low" state.

When A is at 1 because of the inverter, ICl pin 5 is at 0, so the output of ICl is at 1 and D4 is on, indicating a "high" state.

D1 and D2 are included to protect the circuit against wrong polarity.

R1 is chosen to give correct operating current for D5.

J. Scott Patterson,
East Lothian.

**Battery Condition Indicator**

This circuit was built to replace an expensive meter in a radio control transmitter.

The NiCad battery used is nominally 12 volts, with a maximum of nearly 14V when fully charged. When discharged, the cell voltage should not fall below 1 volt; that is, 10 volts for the battery.

The circuit of Fig. 1 is a Schmitt trigger operating an I.E.D. indicator. The reference voltage is provided by the 5-6V Zener diode, and hysteresis is set by the ratio of R4 and R5 to about 1 volt. The trip voltage is set by the ratio of the potential divider resistors, R2 and R3. For accurate setting, R3 could be replaced by a variable resistor. When the battery falls to 10 volts the output of ICl goes low and turns off the I.E.D. which remains off until the battery rises to at least 12 volts again. The total cost is very much less than the cheapest meter.

A. Langton,
Aberdeen.
Last month it was seen how the position indicator signal handled the situation of repeated internal colours with both "P" and "I" correct entries. The final section of the scoring logic, dealing with the cases where there are repeated internal colours with only "I" correct entries, is to be considered this month, together with the display logic.

**THE RESET LOGIC**

The existence of this logic was mentioned last month and rather than to now undertake a full operational description the approach will be to illustrate its action with a series of actual examples.

The basic function of this logic is highlighted by the example shown in Fig. 5.1. Below is shown a sequence of events executed by the machine in response to the colours of this example.

1. Enter First Red
   - C1 C2 C3 C4 = 0
   - S1, S2, P1 = 0

2. Enter Second Red
   - C1 C2 C3 C4 = 1
   - S3, S4 = 1

3. Enter Third Red
   - C1 C2 C3 C4 = 1
   - S5, S6 = 1

4. Enter Fourth Red
   - C1 C2 C3 C4 = 1
   - S7, S8 = 1

(2)-(4) no further change of status (except for clearing of "S"s).

---

**Table 5.1**

<table>
<thead>
<tr>
<th>Slave Status</th>
<th>Reset functions</th>
<th>A Flip Flop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Status</td>
<td>R1, R2, R3, R4</td>
<td>J1, J2, J3, J4</td>
</tr>
<tr>
<td>S1 R1 S2 R2 S3 R3 S4 R4</td>
<td>J1, J2, J3, J4</td>
<td></td>
</tr>
<tr>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 0 1 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 0 1 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 1 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 1 0 1</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 1 1 0</td>
<td>0 0 1 0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>0 1 1 1</td>
<td>0 0 1 1</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>1 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<tr>
<td>1 0 0 1</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>1 0 1 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>1 0 1 1</td>
<td>0 0 0 0</td>
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<td>1 1 1 0</td>
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<td>0 0 0 0</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
</tr>
</tbody>
</table>

Don't care condition

---

It is seen that I0, I2, I4 are all set, giving an incorrect score of three white key pegs. It is the function of the reset logic to reset two of these flip flops and produce the correct score of one white key peg. By convention I2 and I4 are reset with I1 retained. The truth table for this and all other examples of reset logic operation is shown in Table 5.1. The final two columns of this table will be discussed a little later.

In the example just considered "S" flip flops S3, S5 and S7 were all set by a single entry, corresponding to a slave status of 0111 in the truth table, which shows that I2 and I4 are to be reset to logical zero (R2 = R4 = 1).

These resets are enabled by clock pulse C1C from the comparison counter, and there are two reasons why this must be so. Firstly, by the time C1C appears all flip flops will have been clocked and given time to set, and secondly,

---

*[Mastermind is the registered trade mark of Invicta Plastics Ltd]*

---

Fig. 5.1. Example showing the need for the reset logic

<table>
<thead>
<tr>
<th>X CODE</th>
<th>B</th>
<th>R</th>
<th>R</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>W</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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Practical Electronics December 1977
had a "P" correct entry been made the PI signal would have gated clears to any "I" and "S" flip flops also set by the entry, prior to the appearance of C. If more than one "S" flip flop has remained set by the time C appears, it is known that only "I" correct entries have been made and the reset logic can therefore be enabled.

The slave status 1111 can never occur, since in this situation one entry would be "P" correct (1111 means that the entry is correct for colour with all internal colours and so must be correct for position with one of them), and all slaves would be cleared prior to C.

IC48 and 49, shown in Fig. 5.2, are used to implement these reset functions.

The "A" Flip Flops

The example of Fig. 5.3 will be used to demonstrate the requirement for two more flip flops. The sequence of events is summarised below.

1. Enter Red
   C - C
   C

2. Enter Red
   C
   C
   Slaves cleared
   P sets - I1, S1 therefore cleared and inhibited via gate 2 of reset level 1. PI goes high
   C - C
   S1, I1 and S2, I2 set and promptly cleared by PI
   C
   No action (no slaves remaining set)

3-4. No change

Only P1 remains set and an incorrect score would be indicated. What has happened is that P1 in (2) clears I1 which was retained in (1) by the reset logic, reducing the score by one white key peg. Had the reset logic been organised to clear I1 and I2 and retain I3 instead there would still be input combinations that would be wrongly scored.

The solution to this dilemma is to use conditional deletions or clears, and the "A" flip flops are used to indicate whether or not a clear is conditional. No detailed description of these flip flops is to be given and their operation is illustrated by way of example, see Fig. 5.3 and the sequence of events below.

1. Enter Red
   C - C
   S2, I2; S2, I2 and S3, I3 set
   C1 and I2 reset by reset logic. A2 set to indicate that I1 was conditionally reset

2. Enter Red
   C
   C
   Slaves cleared
   P sets and clears and inhibits I2 and S2. PI high
   C
   S2, I2 set. PI line is inhibited from clearing S3 and I3 by A3 = 0 at input to gate 3 of reset level 2
   (see Fig. 4.1)
   C
   I3, S3 set and promptly cleared by PI
   C
   No action (only S3 set)

3-4. No change

The score is now the correct score of one black and one white key peg. If flip flop A1 serves for I1 in a similar fashion, no example is to be given for this case.

The set conditions for the "A" flip flops are shown in the last two columns of Table 5.1. The entries of K (from

Fig. 5.2. The reset logic circuitry

The reset modes are as follows:
(a) I1—cleared by "reset logic";
(b) I2—cleared by PI (clear and inhibit function);
(c) I3—cleared by PI enabling "reset level 2"

As explained in the text, the score given here is incorrect, and so necessitating the use of the "A" flip flops.
Fig. 5.4. The "A" flip flop and associated logic. Locations for i.c. pin outs are also listed

CLEARING THE "A" FLIP FLOPS

Both these flip flops are cleared by the reset signal R\textsubscript{1a}, but A\textsubscript{1} is additionally cleared via IC45. The reason for this is that unless A\textsubscript{1} is cleared as soon as it has served its purpose it can in certain circumstances incorrectly inhibit the PI line from clearing I\textsubscript{1}.

A type SN7473N dual JK flip flop is used for A\textsubscript{2} and A\textsubscript{4}, shown in Fig. 5.4 together with the set and reset logic, ICs 43; 44, 46 and 47; and 45b respectively.

DISPLAY LOGIC

Conventional display logic is employed using two SN7447N seven segment decoder drivers coupled to a type DL727 dual seven segment i.e.d. display (see Fig. 5.5). This display must only be enabled when the final results are available from the scoring logic. For this reason signal N from IC20, the entry counter, is taken to the BI/RBO (Blanking input/Ripple blanking output) of both drivers, so that these are only enabled following the fourth entry made, and until such time as a subsequent deduction is commenced. Signal N is buffered by IC19 and 27 before being taken from board one to board two.

Fig. 5.5. Circuity for the display logic

Strictly the BI/RBO should be used in conjunction with an open collector gate, but in this application the internal output is disabled by ensuring that the RBI never assumes the value of logical zero.

Limiter resistors are necessary between the decoder and the displays. Do not use values of resistance below approximately 180 ohms in an effort to achieve greater brightness from the displays. (A value of 330 ohms, as given in the list of components, was used for these resistors in the prototype).

CONSTRUCTION

The remaining section of the scoring logic is wired on the main board (Board 1), with i.c. positions as shown in Fig. 5.6. As usual, all wiring is carried out using single cored wire on the top side of the board, reference being made to the circuit diagrams of Fig. 5.2 and 5.4 as appropriate.

Remember that an i.c. should be carefully positioned and orientated on the board before any of the copper tracks are broken and any connections made.

The display circuits are wired onto Board 2. The details of this board are given in Fig. 5.6. One important point to remember here is that the DL727 display is viewed through the cut-out on the peg board. It is therefore a very wise precaution to check that the final position of this display on Board 2 lines up exactly with this cut-out when the board is mounted in the casing. The display itself should be mounted using, for example, solder-con pins.
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PRactical Electronics December 1977
In the test schedule last month it was suggested that temporary connections be made between pins 9, 6 and 3 of IC34 and 0V in order to perform worthwhile testing. Do remember to remove any such connections before proceeding with this month’s construction!

**FINAL TESTING**

The ultimate test of any piece of equipment is to connect it up and try it! The scoring may be checked by monitoring the internal X codes and comparing the achieved scores with those expected from appropriately chosen combinations of inputs. Advantage may be taken of any occurrences of repeated X codes to verify that the reset logic and “A” flip flops are performing correctly.

Remember that fault tracing may be expedited by slowing down the internal clock as described in part three. To help those who do meet with problems a list of likely oversights is given below.

- **(a)** Check i.c. power connections—these are easily missed!
- **(b)** Make sure that you have not forgotten to solder in any i.c. pins.
- **(c)** Check for shorting Veroboard tracks.
- **(d)** Forgotten any Veroboard breaks?

Finally, it may be mentioned that there is a golden rule with non-operative TTL built systems: Always suspect your wiring first and the IC last!

![Component layout for the display logic. A photo of the prototype is shown above. For assembly details Fig. 5.3 should be referred to.](image_url)

**COMPONENTS . . .**

**Semiconductors**
- IC43 SN7473N
- IC44 7400
- IC46–47 7420 (2 off)
- IC48 7454
- IC49 7410
- IC40–29 7447 (2 off)
- IC50 DL727 l.e.d. display (Litronix)

**Resistors**
- R1 – R25 330Ω
- R26 1kΩ

**Miscellaneous**
- Veroboard 0.1in matrix
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2N5045/6/8/7 24p
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Sound Transmission by Infra-red Light

A new multi-channel infra-red sound transmission system has recently been demonstrated in this country. The Sennheiser Introsport System designed and manufactured in West Germany by Sennheiser is a large-scale development from the cordless headphones system for domestic hi-fi equipment first introduced at the Berlin Audio Fair 1975. Equipment is available for up to nine channel operation.

The demonstration was arranged by Hayden Laboratories Limited, of Chalfont St. Peter, Bucks, the U.K. distributors, and took place at Shopperston Film Studios. The whole of one stage area was saturated at high intensity from a number of strategically placed i.r. radiators (aerials). Each infra-red power radiator contains a bank of diodes and the power stage electronics. An automatic level setting amplifier ensures a low distortion radiation at maximum power.

The transmitter contains the exciter circuits of the multi-channel unit and the power supply for up to eight power radiators. A high frequency carrier is frequency-modulated by the audio signal. The transmitter output feeds the active radiators, where the emitted infra-red light is amplitude-modulated by the carrier. A special connection cable contains a coaxial lead for the r.f. signal and two d.c. supply leads for the power radiators.

The receiver is incorporated in the headset. This is fitted with a channel selector switch and houses standard batteries mounted on the headset, facing forward, is the infra-red receiving diode. Reception is not entirely dependent upon direct line-of-sight with the radiators, since the i.r. radiation is reflected from light-coloured walls and objects, and so a strong field can be built-up within the room or hall. The number of radiators required depends upon the area to be covered and the reflection nature of the surrounding surfaces. The system’s only limitation is that it cannot function in bright environments (over 3000 ft candles).

Using the standard headset PE’s representative found that excellent reception was obtainable anywhere within the stage area, a fall-off in signal and increase in background noise being experienced when the wearer closely approached the dull-coloured distant walls, but a sheet of polystyrene of about $1\text{ metre square}$ was sufficient to restore the reception to normal. The system is stated to be ideal for conference halls, factories and other large, moderately well-lit areas. Since solid surfaces are opaque to infra-red no radiation “leaks” out of the enclosed area, thus the infra-red system has great possibilities for “security sensitive” applications.

No licence is required for this type of wire-less communication.

DIGITAL REACTION TIMER (November 1977)

The p.c.b. conductor layout in Fig. 2 does not show the necessary copper cladding extension around the fixing holes, which allow the stiff copper wire p.c.b. anchors to be soldered. This omission should be catered for. Also, the fixing holes themselves need not be as large as indicated in Fig. 3.

Points Arising
V.H.F. AIR CONVERTER KIT
Build this converter kit and secure the overall band by placing it by the side of a radio tuned to medium wave or the long wave band and spanning as shown, in the instructions supplied free with all sets.
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Complete kit of parts including construction plans.
Total building costs £6.60 Ins. 80p

ELECTRONIC CONSTRUCTION KITS

E.C.K. 2
Sell Contents Multi-Band V.H.F. Receiver Kit 5 transistors and 3 diodes. Push pull output, 3in loudspeaker, gain control. 7 section chrome plated telescopic aerial, V.H.F. tuning capacitor, gain control, power switch, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. Power fully assembled and tested with 5 volt P.P. & Ins. £13.99 Battery. Complete kit of parts including carrying strap, Building instructions and operating Manual.
Ins. P. & P.
Case enclosure kit if required £1.99 Ins. P. & Ins.

E.C.K. 4
Transistor, receive wavebands, MW, LW, Trifilar Band. 3 Short Wave Bands, Receiver Kit. With 3½in x 3½in loudspeaker. Push pull output stage, gain control, and rotary switch. 7 transistors and 4 diodes. 6 section chrome plated telescopic aerial. Ultrasonic ready wound ferrite rod aerial, tuning capacitor, resistors, capacitors, etc. Operates from a 6 volt P.P. & Ins. battery (not supplied with kit).
Complete kit of parts £7.95 P.P. and Ins. 90p

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- 4 Transistor Push/Pull Amplifier
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All parts including Case and Plans.
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Input stages on front panel. Output 1000VA from 250VA per channel, R.M.S. Very attractively finished. 

Harversonic Special Amplifier & Power Pack.

### Specifications
- **Power Output**: 1000VA from 250VA per channel, R.M.S.
- **Input Sensitivity**: 1mV into 2K (for use with line level etc.).
- **Input Impedance**: Various options available, contact for details.
- **Output Stages**: 2 per channel, R.M.S.
- **Power Pack**: Available for each channel.

### Special Offers
- **Mains Supply Kit**: Includes mains lead, fuse, and instruction booklet.
- **Output Stage**: Incorporates high-fidelity integrated circuit amplifiers with built in short term thermal over-load protection. All components including output transistors, crossover filter, heat sink, control volume, volume control, etc. will be mounted on a large metal plate. For detailed specifications contact your nearest stockist or refer to catalogue.
- **Price**: £115 per pack.

### Harversonic Stereo 44

A solid state stereo amplifier chassis, with an output of 4 x 40w with -6dB crossover. These amplifiers are based on a high frequency integrated circuit amplifier with built-in short term thermal overload protection. All components are mounted on a large metal plate. Suitable for use in any Hi-Fi system. For detailed specifications contact your nearest stockist or refer to catalogue.

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- £240 per pack.

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### Harversonic Super Sound 10 + 10 Watt Hi-Fi Amplifier Kit

A ready first-class kit-in-a-box amplifier kit. Comes with 14 transistors including Silicon Transistors in the first stage, on each channel, on an over-burn noise wax with improved Miniature Transistor. Includes protection circuit with a loudspeaker and speaker output stages for speakers in 10 x 10 channel R.M.S. Frequency response: 100Hz - 15KHz. Bass booster circuit, to 1500Hz. Full power bandwidth: + 15dB - 10-15KHz. Bass booster circuit, to 1500Hz. Two channel outputs. Very high bandwidth over mini-amp. Power requirements: 30V at 10A overall size 90mm x 25mm x 30mm x 60mm x 12mm x 200mm x 250mm.

### Price
- £150 per kit.

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### Price
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Practical Electronics, December 1977

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HEAT SINKS

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