Low-price robots from POWERTRAN

- hydraulically powered
- microprocessor controlled

The UK-designed and manufactured range of Genesis general purpose robots provides a first-rate introduction to robotics for both education and industry. With prices from as low as £470, even the home enthusiast can aspire to his own robot.

Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.

The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

All Genesis robots are available either ready-built or in kit form. The latter provides not only extra economy but also valuable additional training as an assembly project.

HEBOT II Turtle-type robot

For a little over £100, HEBOT II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoid-operated pen to chart its moves. Touch sensors, coupled to a shell return data about its environment to the computer enabling evasive or exploratory action to be calculated. The robot connects directly to an I/O port or, via the interface board, to an expansion bus of a ZX81 or other microcomputer.

HEBOT II
Weight 1.8kg
complete kit with assembly instructions £95
Interface board kit £11

MICROGRASP

A real programmable robot for under £300! Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about its base and there is a motor driven gripper. All five axes are motor driven and four of these are servo-controlled giving positive positioning. The robot can be controlled by any microcomputer with an expansion bus - the Sinclair ZX81 being particularly suitable.

MICROGRASP
Weight 8.7kg, max lifting capacity 10kg
Robot kit with power supply £215.00
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ZX81 peripheral/RAM pack splitter board £3.50

GENESIS S101
Weight 29kg, max lifting capacity 1.5kg
5-axis model (kit form) £525
5-axis complete system (kit form) £817

GENESIS P101
Weight 34kg, max lifting capacity 1.8kg
6-axis model (kit form) £750
6-axis complete system (kit form) £1050

GENESIS P102
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6-axis system (kit form) £1476

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OUR JUNE ISSUE WILL BE ON SALE FRIDAY, MAY 4th, 1984
(for details of contents see page 15/4 of Micro-file)
*The instruments featured on the front cover were kindly loaned to us by the House of Instruments, Global Specialties Corporation and Maplin Electronic Supplies

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  - 1 - VP37 Module. 1 - 25 volt 2 amp transformer.
  - 1 - 90/20V 2amp Meter. - 1 - 2 amp 2 amp Panel Meter.

**BI-PAK**

- Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods delivered the same day. Remember you must add VAT at 19% to your order. P&P charge is £1.50 per box for 1st Class or £2.50 per box for Includes p&p on 2nd class.

**BI-PAK**

- Send your orders to Dept: FES BI-PAK PO BOX 2 WARE HERTS. SHOP AT A BALEY'S ST. WARE STREET. TERMS CASH ON ORDER SAME DAY DELIVERY. ACCEPTED. Bi-Pak BARGAINS = VAT + 7.5% VAT + 7.5% PER ORDER POSTAGE AND PACKING
MKS MAINS TIMER

- MKS 1 ELECTRONIC THERMOSTAT (60 MIN) to 1 °C
- MKS 2 AUTOMATIC TIMER 1 to 100 hours
- MKS 3 ADJUSTABLE 24-7 TIMER
- MKS 4 PROPORTIONAL

TEMPERATURE CONTROLLER

- Senses fixed temperature to within 0.5°C
- Use with MKS 3 for time regulated switching

HOME CONTROL CENTRE

- THIS KIT ENABLES YOU TO CONTROL UP TO 16 DIFFERENT APPLIANCES
- Each to different coded pulses in the mains wiring
- Enables decoding by special receivers anywhere in the house.
- The transmitter can be controlled manually or by the computer interface.
- Enables you to make your coffee in the morning or anywhere in the house on and off at preset times once programmed.
- Switches any appliance up to 300W at 2400V

COMPONENT PACKS

PACK 1: 1 each of a, b and c 10 sets
PLACE ORDER AS XK 102 £15.50

PACK 2: 1 PCB Electronics, EXP 1 to 55 with 5 A.C. Outputs and 5 Power Supplies £20.95
PLACE ORDER AS XK 103 £25

PACK 3: 2 PCB Electronics, EXP 1 to 55 with 10 A.C. Outputs and 10 Power Supplies £41.00
PLACE ORDER AS XK 104 £45

PACK 4: 2 PCB Electronics, EXP 1 to 55 with 15 A.C. Outputs and 15 Power Supplies £60.95
PLACE ORDER AS XK 105 £65

HOME LIGHTING KITS

- These kits contain all necessary components and instructions.

DVM/ULTRA SENSITIVE THERMOMETER KIT

- New design based on the LM335 (lm335
- New circuitry based on ZN414 IC
- Includes PCB, wound transformers

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- 15 basic controllers with 16 ranges
- 16x 3-position rotating selector switches
- Ranges 1-16
- 16x 3-position rotating selector switches
- Output 750mA
- Fits in a 19" rack or on a wall

MD1000K

- This unit can be used for directional sounding, aspect at night, etc.
- Remote control enables you to vary the output power and the direction of output
- Controls up to 4 lamps

24 HOUR CLOCK/ APPLIANCE TIMER KIT

- Switches any appliance up to 2KW
- Kit contains 3-5x1250 K, 0.5 A.D. display, mains supply, relays, LEDs, switches and instructions.

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You will do the following:

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

A tutor is available to whom you can write personally at any time, for advice or help during your work. A Certificate is given at the end of every course.

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The Latest In Hi-Tech Test Equipment

**25-Range 20,000 Ohms/Volt Folding Multitester**

£19.95

- 90-120-150-180° Hold-Position Hinge
- Folds Into Compact Case With Wrist Strap

Features include fuse and surge-absorber protection, banana-type probe jacks and 4" 3-colour mirrored meter with automatic shunt protection (when folded shut). DC Volts: 0 to 1200. AC Volts: 0 to 1200. DC Current: 0-60µA, 3-30-300 mA. Resistance: 0-2-20-200k-2 megohms (centre scale 24). dB: -20 to +63 dB. Requires "AA" battery.

**Compact 3¼-Digit, 16-Range Multimeter**

£34.95

- Fused and Overload Protected
- Diode Check Function For Testing Semiconductors
- Measures 5½/16 x 3½ x 1¾"x 17/16"


**Digital Logic Probe With Tone and LED Indicators**

£12.95

- Overload and Polarity Protected

The fast way to "peek inside" TTL, LS and CMOS digital circuits. Colour-coded LEDs indicate high, low or pulsed logic states (up to 10 MHz). Simultaneous tone output frees your eyes - really speeds up testing. Minimum detachable pulse width: 50 ns. 36" leads with clips obtain power from circuit under test. Low current drain. With instructions and user's tips.

**Transistor Checker Tests In Or Out of Circuit**

£9.95

- Indicates Relative Current Gain
- With Coded Test Leads and Instruction Manuals

Makes Go/No-Go tests on small-signal and power types and allows you to match similar transistors. Indicates relative current gain, "opens" and "shorts". Tests in or out of circuit. Has a front panel socket plus hook-clip leads for in-circuit tests. Requires "AA" battery.

**Archer™ Voltage Inverter**

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- For Cars, Trucks and Imports

Compact voltage inverter means you can easily connect and use your 12V DC equipment in vehicles with 12V DC positive ground or 6V DC negative ground electrical systems. For radios, CBs, and tape players. Gives up to 3A. Fused.

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Tandy

Technology

Practical Electronics May 1984
We are unable to offer any advice on the industry to hobbyists. Even though PE can claim to show a great deal of interest in selling come as something of a shock.

Unfortunately many suppliers do not show a great deal of interest in selling to hobbyists. Even though PE can claim to show a great deal of interest in selling come as something of a shock.

We have attempted to do their marketing job for them and give readers basic information on the products available. Thankfully these comments do not apply to all companies. You will find some multimeter advertisements in this and other issues of PE and we commend these advertisers to you. They obviously want your business and are prepared to do something about it.

Next month we continue this theme in our pages with a look at oscilloscopes, p.s.u.s, function generators and logic probes. We are sorry to say that by the time you read this it will be too late to get any further material in. If your company has been missed may we suggest that you make sure we are aware of your products and PE readers know where to get them in the future!

Changing tack slightly may we urge you to make sure you continue to buy the product you are reading. It is normal for us to start getting requests for back numbers just after the summer months, when some readers have been away and missed an issue, only to find that it contained an important feature or project. While we are pleased to supply back numbers, the quantity available is limited and you pay more for them (see foot of this page). So please save yourself all the hassle by placing an order for a regular copy with your newsagent—they will hold them for you while you lie on the beach in some exotic part of the world. Most newsagents also deliver them when you return, and want to catch up on technological innovations.

Of course, if supply of issues is a regular problem, we can offer you a subscription which will ensure your issue is posted to you every month (details at the foot of the page). Just to keep you interested we are planning features or projects relating to the following subjects during the summer months: photography, hi-fi, test gear, fibre optics, radio astronomy, computing, robotics and alarm systems.

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

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

Back Numbers and Binders
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas a.p. Please state month and year of issue required.

Binders for PE are available from the same address as back numbers at £6.50 each to UK or overseas addresses, including postage, packing and VAT where appropriate. State year and volume required.

Subscriptions
Copies of Practical Electronics are available by post, inland for £13, overseas for £14 per 12 issues, from: Practical Electronics, Subscription Department, IPC Magazines Ltd., Room 2816, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment for subscriptions can also be made using any credit card and orders placed via Teledata. Tel. 01-200 0200.
HEAVY-DUTY CASSETTE

It is estimated that, even at home, a recorder coupled to a computer may go through more cycles of operation in a month than a recorder used only for audio does in a year. Commonsense companionship for a micro with a busy operator comes in the shape of this 'heavy-duty' recorder from Bell and Howell.

Unlike the majority of cassette recorders used for data transferral, the 3179CX is based on a recorder designed specifically for use in schools. The unit is aimed at the BBC machine, primarily but is compatible with other personal computers.

The machine incorporates an internal electret microphone and an external microphone socket. Two headphone sockets are provided for private study, as well as a socket for remote control of the drive motor by the computer. In addition to conventional fast-forward and rewind a 'cue and review' mode is incorporated: This allows fast-forward or rewind to be done with the 'play' button depressed so that playback begins immediately the wanted section of the tape has been found.

Other features include auto-stop at both ends of the tape and mains or battery operation. Recording whether computer or audio can be done with either manual or automatic level control. For computers requiring a higher output from the recorder when loading such as the ZX Spectrum, the signal is taken from one of the headphone sockets. From these up to 4V is available from 'volume control' adjustment. The case, mechanism and circuit boards are exceptionally hard wearing and shock resistant. A full list of micros compatible with the 3179CX is unfortunately not yet available. However, owing to the high output it is expected that most micro users will have little trouble with compatibility. The unit is expected to retail at around £39.95 inc VAT. For further information contact Brian Watkinson, Bell and Howell, Alperton House, Bridgewater Road, Wembley, Middx. HA0 1EG. (01-902 8812).

UK Sales Boom

The buoyancy of electronic equipment production in the UK was reflected in substantially increased demand for semiconductors in 1983, says the Electronic Components Industry Federation.

On the basis of ECIF returns and after fair allowances for the imports and production of others, it is calculated that the 1983 UK market for semiconductors attained a size of £600M, which is equivalent to a growth of 41% over 1982. It has now doubled in size in the last 4 years, with continuous growth throughout the recent recession.

The Federation predicts that 1984 will see a growth of 38% in integrated circuits and 12% in discrete devices.

Beyond this the expectation is for 1985 to see further growth and the UK semiconductor market reaching a size of £1 billion for the first time.

SONIC-ALARM

New from Riscomp, and complementing their existing range of modular alarm systems, is the 'stand alone' ultrasonic intruder detector kit, the CK 5063.

This unit generates an ear-piercing alarm signal in excess of 110dB when triggered. Although designed as a 'stand alone' unit, an external bell or siren can be connected. Simple soldering and assembly is all that is required along with a mains supply on completion.

A 'hold' position on the key-switch allows for 'walk-testing' the area to be protected. The PowerBreaker range is incorporated as well as a selectable entrance-delay, exit-delay and fixed alarm time are incorporated as well as a selectable entrance-delay. A 'hold' position on the key-switch allows for 'walk-testing' the area to be protected.

Normally retailing at £42.55 inc VAT this kit is available on special offer in this issue of PE priced £37.95 inc VAT (see page 34).
ABLA TIVE ETCHING

Laser etching, with all its promise in medical and photolithographic applications, suffers from the disadvantage of heating side effects, or charring. The photograph shows this (cut on the left) where a conventional visible infra-red laser was used.

The cut on the right was made using a new technique called ablative photodecomposition, and developed by IBM at its Thomas J. Watson research centre. It is seen how a laser can be made to cut biological or polymeric substances without heating up the surrounding material. The breakthrough takes advantage of a phenomenon of far-ultraviolet laser, which features an intensity threshold that, if exceeded, will eject molecules from the area, taking with them excess energy that would otherwise have been absorbed by the surrounding material (hence the term 'ablative').

In biological and dental applications, unprecedented accuracy can be achieved because the geometry of the cut is controlled entirely by the shape of the light beam.

The lower photograph shows a scanning electron micrograph of commercial plastic film etched to a line width of five microns, demonstrating the technique's potential in the photolithographic fabrication of integrated circuits.

In recent weeks the PE office has received several suppliers' catalogues which may be of interest to readers.

Greenworld's Components and Equipment Catalogue (64 pages), the post-paid price of £1 is redeemable with a coupon against subsequent purchases, 70p to callers at: 442 Milbrook Road, Southampton SO1 0HX (0703 772501). Marshall's Component and Equipment Catalogue (56 pages), costs 75p to callers or £1 post-paid (UK) £1.50 (Rest of World) from: 85 West Regent Street, Glasgow G2 2QD (041-332 4133).

Countdown...

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

Life (Fire protection) April 9-13. Olympia. S
Laboratory April 11-12. New Century Hall, Manchester. E
Tectronica April 16-18. Earls Court, London. T
DEC user May 15-17. Cunard Int. Hotel, Hammersmith, London Q1
Micro City May 15-17. Exhibition Complex, Bristol. F3

Leeds Electronics July 3-5. University. E
Networks July 3-5. Wembley Conf. Ctr., London. O
Laboratory Sept. 4-6. Barbican, London. E
Building & Home Improvement Sept. 25-30. Earls Court, London. M

Optocoupler/7500V isolator requiring only 1mA input, is MOC8100.
New series of high speed, single supply, quad op amps known as the MC34074 series run from 3 to 44V (±1.5 to ±22V). Bipolar. 4.5MHz gain bandwidth product.
New dual port memory unit (8-bit HCMOS) is MC68HC34.
3A voltage regulator series in voltages from 5V-24V, with up to 2% o/p voltage tolerance (A suffix) is MC787T00 series.
Motorola European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes.

Silicon News Corner

Motorola introduces dual-chip, ultrafast rectifiers in TO-220 package to replace two axial lead 3A devices which normally require hand soldering to a heatsink. These switchmode rectifiers are MUR605CT, MUR610CT, MUR615CT & MUR620CT.
• 100MHz infrared fibre-optic emitter MFOE 1201 & MFOE 1224.
• Four new r.f. power TMOS f.e.t. transistors for low band linear applications, are MRF148, MRF150 @ 30W & 150W respectively, and MRF138, MRF140 @ 30W & 150W respectively, the former being 50V, the latter, 28V.

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实践活动 五月 1984
MULTIMETERS

A multimeter is one of the most essential pieces of test equipment for the hobbyist. This buyer’s guide has been designed to show you a selection of the meters currently available. Although it cannot cover all the models it should at least put you on the right road to the type of meter you require. Please note all the prices are inclusive of VAT but not p&p. Only one supplier is listed for each meter but many of the models are available from more than one source.


The new AVO 1000 Series of analogue testers feature a breakthrough in design.

A slot in the handle is the key to simple lead stowage, but that's only one aspect of our breakthrough. This series, designed and built in Britain, also features top entry leads with right angled fittings, moulded channels to contain spare prods and clips; easy-to-read analogue scales; simple range selection, a separate battery and fuse compartment and a handy tilt stand. The specification is equally outstanding.

The AVO 1001, for instance, offers voltage testing to 1kV (a.c. and d.c.), current up to 1A d.c. and resistance up to 2MΩ.

See your usual distributor for further information and a demonstration. Chances are you'll want to drop it into your toolbag right away. Which is fine, we've designed them for precisely that.
**MULTIMETERS**

**Model:** Hitachi VR3525. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 2000mV–750V (4 ranges). Current a.c./d.c. 200µA–10A (5 ranges). Resistance 200Ω–20MΩ. **Special Features:** Autoranging. Diode test. Continuity. Temp. –20°C to +70°C. **Price:** £120-75. **Supplier:** Reltech Instruments, New Road, St. Ives, Huntingdon, Cambridgeshire PE17 4BG. (0480 63570).

**Model:** Fluke JF73. **Ranges:** Voltage d.c. 0–1000V. Voltage a.c. 0–750V. Current a.c. 0–10A. Current a.c. 0–10A. Resistance 0–32MΩ. **Special Features:** Digital and analogue. Autoranging. **Price:** £74-75. **Supplier:** Electroplan Ltd., PO Box 19, Orchard Road, Royston, Herts SG8 5HH. (01763 41171).

**Model:** AVO 2001. **Ranges:** Voltage a.c./d.c. 100µV–1000V (5 ranges). Current a.c./d.c. 0.1A–10A (6 ranges). Resistance 0.1Ω–20MΩ (6 ranges). **Special Features:** Continuity. Diode test. **Price:** £98-21. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex. (0799 24922).

**Model:** Pantec PAN 2001. **Ranges:** Voltage a.c./d.c. 100µV–1000V (5 ranges). Current a.c./d.c. 0.1A–10A (6 ranges). Resistance 0.1Ω–20MΩ (6 ranges). **Special Features:** Capacitance 1pF–20µF. Square wave generator 15Hz–15kHz. Temp. –50°C to +150°C. **Price:** £113-85. **Supplier:** Electronic & Computer Workshop Ltd. (0245 262149).

**Model:** Fluke 8026B. **Ranges:** Voltage d.c. 200mV–1000V. Voltage a.c. 200mV–750V. Current a.c. 2mA–2A. Resistance 2000–20MΩ. **Special Features:** Diode test. Conductance: 2ms–200ns. **Price:** £207-00. **Supplier:** Electroplan Ltd., PO Box 19, Orchard Road, Royston, Herts SG8 5HH. (01763 41171).

**Model:** ALT/Al KD305. **Ranges:** Voltage d.c. 0–1000V (4 ranges). Voltage a.c. 0–750V (2 ranges). Current d.c. 0–10A (4 ranges). Resistance 0–2MΩ (4 ranges). **Price:** £32-20. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

**Model:** Miselco Electro Super. **Ranges:** Voltage a.c./d.c. 100mV–1000V (9 ranges). Current a.c./d.c. 100µA–6A (8 ranges). Resistance 0–1MΩ (13 ranges). **Special Features:** dB scale. **Price:** £56-00. **Supplier:** Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ. (01-352 1897).

**STEREO TUNER/AMPLIFIER**

4 wave-band stereo tuner/amplifier by GEC NEEDS 110/240 V 2-way speaker outputs<br>10 + 10 watt stereo amplifier outputs for PJ tape kit/no. Supplied as low assembly unit. Easy to connect. (UK £22.95)

**CASSETTE MECHANISMS**

Film counter, manual, record and erase heads, subwoofer. etc. Brand new available. (UK £5.95)

**DIGITAL MULTIMETERS**

Hand Held Models:<br>**Earth**<br>**AC/DC volts**<br>**DC amps**<br>**AC/DC volts**<br>**AC/DC volts**<br>**AC/DC volts**<br>**AC/DC volts**<br>**AC/DC volts**<br>**AC/DC volts**

**TURBO 111**<br>**2500**<br>**2400**<br>**1800**<br>**1100**<br>**840**<br>**600**<br>**40**<br>**25**

**ADJUSTABLE PROTECTORS**

20kV a.c. & d.c. (over £100.00)

**Audio Electronic Shop**

39-41 Edgware Road. London. W2 4QG

- **STEREO TUNER/AMPLIFIER**
- **CASSETTE MECHANISMS**
- **DIGITAL MULTIMETERS**
- **TURBO 111**
- **ADJUSTABLE PROTECTORS**

**ASYTECH UHF MODULATORS**

776kHz.2W power output. (£3.50)

**MULLARD MODULES**

IU/1115 £15.00 11111 £10.00 (11111 £25.00)

**PRESST ADAPTOR**

3-card kit with test leads (£4.95)

**CHERRY ADAPTOR KEYPAD**

16 button pads (£4.25)

**MODERN CARD**

80 key, ABC, USA, general purpose, etc. (£11.95)

**WIRY KEYBOARDS**

40 + 40 user definable keys (P £8.85)

**GRODOS**

Exclusive Special: Purchase compact hall effect 64 keys plus 5 function keys with Presst ADAPTOR for £3.50. Incl. all definable, steel frame all facilities (UK £6.00)

**HIGH VOLATAGE METER**

Direct reading D.C. & A.C. (P £25.20)

**DIGITAL CAPACITANCE METER**

P £39.95

**TRANSISTOR TESTER**

Meter reading: NPW & PHD & leakage & resistance (P £32.95)

**OSCILLOSCOPES**

**SCF 110** Single Trace (UK £25.00)

**SCF 230** Two Trace (UK £50.00)

**SCF 50** Four Trace (UK £100.00)

**STANDARD OSCILLOSCOPES**

**SCF 110** (UK £35.00)

**SCF 230** (UK £70.00)

**SCF 50** (UK £140.00)

**STANDARD OSCILLOSCOPES**

**SCF 110** (UK £45.00)

**SCF 230** (UK £90.00)

**SCF 50** (UK £180.00)

**THermal MATRIX**

**NEW LOW PRICE**

- **COMPLETE WITH FULL HANDBOOK. 3 ROLLS PAPER**
- **FULL ACCESSORIES**
- **20kW V a.c. & d.c.**
- **STANDARD OSCILLOSCOPES**
- **HAND HELD MODELS**
- **PRESST ADAPTOR**
- **CHERRY ADAPTOR KEYPAD**
- **MODERN CARD**
- **WIRY KEYBOARDS**
- **GRODOS**
- **HIGH VOLATAGE METER**
- **DIGITAL CAPACITANCE METER**
- **TRANSISTOR TESTER**
- **OSCILLOSCOPES**
- **STANDARD OSCILLOSCOPES**
- **THermal MATRIX**

**TWO FABULOUS OFFERS FROM ALCON**

**SUPER 20**

20kV a.c. & d.c.

A SUPER PROTECTED UNIVERAL MULTIMETER

Unbreakable, with automatic protection on all ranges but 10A.

**ONLY £33.50**

incl. VAT, P&P, complete with carrying case, leads and instructions.

This special offer is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £20.00.

**SUPER TESTER 50**

50kV V a.c. & d.c.

A 39 ranges – fool-proof – multimeter with protective diodes, quick acting 1.25A fuse and resettable cut-out. PROFESSIONAL SOLUTION TO GENERAL MEASUREMENT PROBLEMS

**ONLY £36.30**


The best instrument for the workshop, school, toolbox, TV shop and anywhere accurate measurement is needed quickly and simply.

**Accuracy:**

d.c. ranges and 1% a.c. 3% (off.s.d.)

39 ranges: a.c. 1.0V, 3.0V, 3.0V, 10V, 30V, 100V, 300V, 1000V; d.c. 1.0µA, 10µA, 30µA, 100µA, 1mA, 10mA, 30mA, 100mA, 1A, 10A, 30A; a.c. V 10V, 30V, 100V, 300V, 1000V; a.c. 1mA, 10mA, 30mA, 100mA, 1A, 10A, 30A; α: 0.05° – 50°, 0° – 50°, 0° – 25°, 5°, 10°, 20°; 5°, 10°, 20°; 5°, 10°, 20°

Dimensions: 105 × 130 × 40mm.

Details of these and the many other instruments in the Alcon range, including multimeters, components measuring, automotive and electronic instruments, please write or telephone:
**Model: ISI DM3350. Ranges:** Voltage d.c. 0-1000V (4 ranges). Voltage a.c. 0-600V (2 ranges). Current a.c./d.c. 0-10A (2 ranges). Resistance 0-2MΩ (5 ranges). **Special Features:** Autoranging. Continuity. **Price:** £51-75. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

**Model: Beckman T90. Ranges:** Voltage d.c. 200mV-1000V (6 ranges). Voltage a.c. 0-600V (2 ranges). Current d.c. 200μA-2A (5 ranges). Resistance 200Ω-20MΩ (6 ranges). **Special Features:** Diode test. **Price:** £49-96. **Supplier:** Beckman Instruments Ltd., Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU. (021-742 7761).

**Model: Anders AMM301. Ranges:** Voltage d.c. 60mV-300V (7 ranges). Voltage a.c. 6V-600V (5 ranges). Current d.c. 0-03mA-600mA (4 ranges). Resistance 0-2MΩ (4 ranges). **Special Features:** dB scale. **Price:** £29-33. **Supplier:** Anders Electronics Ltd., 48-56 Bayham Place, Bayham Street, London NW1 0EU. (01-387 9092).


**Model: ALT/AI KD25C. Ranges:** Voltage d.c. 0-1000V (4 ranges). Voltage a.c. 0-500V (2 ranges). Current d.c. 0-200mA (2 ranges). Resistance 0-2MΩ (4 ranges). **Price:** £27.60. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

**Model: Keithley 175. Ranges:** Voltage d.c. 200mV-1000V (5 ranges). Voltage a.c. 200mV-750V (3 ranges). Current d.c. 200μA-10A (6 ranges). Current a.c. 200μA-10A (6 ranges). Resistance 200Ω-200MΩ (7 ranges). **Special Features:** Autoranging. μP operated with memory (100 readings). IEEE bus. **Price:** £396.75. **Supplier:** Keithley Instruments Ltd., 1 Bolton Road, Reading, Berkshire RG2 ONL (0734 861287).

MULTIMETERS


Model: Fluke '73'. Ranges: Voltage d.c. 320mV–1000V. Voltage a.c. 3.2V–750V. Current a.c./d.c. 32mA–10A. Resistance 0–32MΩ. Special Features: Auto-ranging, additional linear display feature. Price: £74.75. Supplier: Electroplan Ltd., P.O. Box 19, Orchard Rd., Royston, Herts. SG8 5HH. (0763 41171).


Model: Trio DL-705. Ranges: Voltage a.c./d.c. 1mV–1000V. Current a.c./d.c. 10µA–200mA. Range option, semi-auto-ranging. Price: £123.91. Supplier: Superfast Electronics Ltd., P.O. Box 201, St Albans, Herts. (0727 62171).
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PRICES (Inc. adaptor/charger, P & P and VAT)

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BIMCASES 1000 Series. ABS. Guides for vertically mounting PCB's, binadaptors for horizontal mounting.

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- Bimump 27W £7.75
- Bimump 27W £7.75
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BIMSALES

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This month’s Digital Project is devoted to the construction of a versatile signal source which will be invaluable for use in testing and fault diagnosis of digital circuits. The Logic Signal Generator provides four outputs which are fully TTL compatible. These consist of complementary square wave signals at both the nominal frequency (f) and at twice this value (2f). A fifth, variable amplitude, output of 1V peak maximum is also available. This output has a nominal 50 ohm impedance and is ideal for applications such as the calibration and general testing of both analogue and digital circuits.

The Logic Signal Generator unit uses low-cost readily available components and is assembled on a single-sided p.c.b. As with all of the projects in this series, power for the Logic Signal Generator is derived from the separate regulated d.c. supply module which was described in the March issue of PE.

CIRCUIT DESCRIPTION

The complete circuit of the Logic Signal Generator is shown in Fig. 1. A Schmitt inverter, IC1f, forms a simple square wave oscillator where the frequency of operation is governed by switch selected capacitors, C1 to C7, together with the series combination of VR1 and R1. The capacitor values are selected to produce seven decade frequency ranges, and VR1 provides a continuously variable adjustment of the output frequency over a range of a little more than 10:1, thus ensuring a small overlap between switched ranges.

It should be noted that, although the output of this simple form of TTL oscillator has acceptably fast rise and fall times, the mark to space ratio is typically around 1:3. For most applications it is desirable to achieve as near unity a mark to space ratio as possible. In the Logic Signal Generator this is achieved by applying the oscillator output to an edge clocked bistable stage. Such a stage reacts solely to either the falling or the rising edge of its clock input, depending upon the particular i.c., and thus will generate a near perfect square wave regardless of the duty cycle of its input.

The oscillator output is buffered by means of IC1e and then taken to the JK bistable, IC2a, arranged as a binary divider with both J and K inputs taken to logic 1. The output of IC2a thus consists of a square wave of near unity mark to space ratio at exactly half the frequency of its clock input. Complementary outputs, Q and Q, are taken to inverters, IC1b and IC1a, respectively. These gates act as buffers and help to minimise effects associated with loading at the output. A second bistable stage, IC2b, follows the first. This further divides the signal frequency to provide complementary outputs via IC1c and IC1d.

The Q output from IC2b is applied to the source follower stage, TR1. This provides a low impedance output which is adjustable in amplitude by means of variable and pre-set resistors, VR2 and VR3 respectively. Distributed supply decoupling is provided at h.f. by means of C8 and C9 and at l.f. by means of C10.

SPECIFICATION

| GENERAL | Square, unity mark to space ratio. |
| Frequency: Seven switched ranges covering: | |
| 1 | 0-3Hz to 3Hz |
| 2 | 3Hz to 30Hz |
| 3 | 30Hz to 300Hz |
| 4 | 300Hz to 3kHz |
| 5 | 3kHz to 30kHz |
| 6 | 30kHz to 300kHz |
| 7 | 300kHz to 3MHz approx. |

TTL OUTPUTS

Four fully TTL compatible outputs: f_out, f_out, 2f_out, and 2f_out.

VARIABLE OUTPUT

Single output at f_out continuously variable in amplitude to 1V peak maximum. Output impedance nominally 50 ohm.
CONSTRUCTION
The Logic Signal Generator is built on a single-sided p.c.b. measuring approximately 120 x 70mm, the copper foil layout of which is shown in Fig. 2. The corresponding component layout on the top surface of the p.c.b. is shown in Fig. 3. Interconnections from the p.c.b. to the output sockets, potentiometers and power supply are all made via 0-1" matrix p.c.b. connectors, the wiring scheme for which is shown in Fig. 4.

Components should be assembled on the p.c.b. in the following sequence: d.i.l. sockets, p.c.b. connectors, links, resistors, capacitors, f.e.t., and rotary switch. Note that, unlike all of the other components, this last mentioned item is mounted on the copper track side of the p.c.b. Once assembly has been completed the underside of the p.c.b. should be carefully checked for solder splashes, bridges bet-

<table>
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<tr>
<th>COMPONENTS . . .</th>
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<td><strong>Resistors</strong></td>
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<tr>
<td>R1: 100</td>
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<tr>
<td>R2: 4k7</td>
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<tr>
<td>R3,R4,R5: 1k (3 off)</td>
</tr>
<tr>
<td>VR1: 1k carbon potentiometer</td>
</tr>
<tr>
<td>VR2: 100 carbon potentiometer</td>
</tr>
<tr>
<td>VR3: 100 miniature horizontal skeleton pre-set</td>
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<tr>
<td>All resistors 0.25W 5% carbon</td>
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<tr>
<td><strong>Capacitors</strong></td>
</tr>
<tr>
<td>C1: 470µ 10V elect</td>
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<tr>
<td>C2: 47µ 25V elect</td>
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<tr>
<td>C3: 4µ7 63V elect</td>
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<tr>
<td>C4: 470n polyester</td>
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<td>C5: 47n polyester</td>
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<tr>
<td>C6: 4n7 polystyrene</td>
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<td>C7: 470µ polystyrene</td>
</tr>
<tr>
<td>C8,C9: 4n7 ceramic (2 off)</td>
</tr>
<tr>
<td>C10: 100µ 16V PC elect</td>
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<tr>
<td><strong>Semiconductors</strong></td>
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<tr>
<td>TR1: VN66AF</td>
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<tr>
<td>IC1: 7414</td>
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<tr>
<td>IC2: 7473</td>
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<td><strong>Miscellaneous</strong></td>
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<td>P.c.b.: 14-pin d.i.l. sockets (2 off)</td>
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<td>4-way 0-1&quot; p.c.b. plug and socket (2 off)</td>
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<td>5-way 0-1&quot; p.c.b. plug and socket</td>
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<td>1P 7W p.c. mounting rotary switch</td>
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<td>2mm sockets (5 off: 4 red, 1 black)</td>
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<td>BNC socket</td>
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Fig. 1. Circuit diagram of the Logic Signal Generator

Fig. 4. Wiring interconnections
ween adjacent tracks, and dry joints. Finally, the i.c.s may be inserted in their respective holders, taking care to ensure the correct orientation of each device. Constructional details of the enclosure and off-board wiring have not been given since this will undoubtedly be a matter of preference for the individual constructor. Constructional details of a suitable power supply module were given in the March issue of PE.

**TESTING AND CALIBRATION**

Two commonly available items of test equipment are required in order to fully test and calibrate the Logic Signal Generator. These are an oscilloscope (preferably a dual beam type) and a digital frequency meter. Calibration should initially be carried out with the unit switched to range 4 (300Hz to 3kHz), VR1 set to maximum (fully anti-clockwise). The Y1 input of the oscilloscope should be connected to display $f_{out}$ and the timebase should be adjusted to display two to four cycles of this waveform. The Y2 input should then be connected to each of the other TTL outputs in turn, and the correct frequency and phase relationship should be checked by reference to the Y1 display. The amplitude of each of the TTL outputs should also be checked and this should be in the range 3.5V to 4.5V.

The oscilloscope Y2 input should now be connected to the variable output and VR3 adjusted until the amplitude of output signal is exactly 1V. Finally, the digital frequency meter should be connected to the variable output and VR1 adjusted for a reading of exactly 1kHz. The scale fitted to VR1 should then be marked appropriately at this and at other suitably chosen frequencies. This completes the testing and calibration of the Logic Signal Generator and the unit is now ready for use.
The popular sustain effect for electric guitars is obtained using a form of compressor. Units of this type have fast attack and decay times so that they can respond with suitable rapidity to changes in the dynamic level of the signal from the guitar, and the compression characteristic gives an almost constant output level. This retards the fast attack each time a note is played, but the normal decay characteristic is eliminated, and a virtually constant volume level is maintained for the duration of each note. As a result, the normal, almost percussive sound of an electric guitar is modified to give a sound which is more like that of an organ.

Sustain units can be rather more complex than one might expect, and can have problems with noise levels. The noise results from the high gain that must be used to maintain the output at a suitable level once the input signal has substantially decayed. The gain (and noise) are at a maximum when there is little or no input signal, which, unfortunately, is when the noise is most noticeable.

This design is based on just one active device, and good noise performance is obtained by including a noise gate at the output. A useful additional feature is the ability to produce a good fuzz effect using the unit.

**NE571**

The integrated circuit used in the unit is an NE571. This device is primarily intended for noise reduction systems where one section is configured as a 2 to 1 compressor and the other is used as a 2 to 1 expander. A straightforward 2 to 1 compression characteristic would give a reasonable sustain effect, but would be less than ideal. With this type of compressor any change in the input signal level gives only half as much change in the output level. For example, boosting the input signal by 20dB (10 times) would give a rise in the output level of only 10dB (about 3 times). This greatly restricts the dynamic range of the output signal, but ideally a sustain unit should give an almost constant output level from any input signal of adequate strength, and an effective dynamic range of only a few dBs.

The block diagram of Fig. 1a shows the standard NE571 compressor configuration. $R_a$ to $R_d$ are bias and feedback resistors, but due to the inclusion of decoupling capacitor $C_c$, there is no negative feedback at audio frequencies, and the operational amplifier exhibits its full open loop voltage gain. However, there is a second feedback path through $C_d$, $R_e$, and the gain cell. The latter is a form of voltage controlled resistor, and the greater the control voltage it receives, the lower its resistance. The control voltage is provided by the rectifier circuit, and this is driven from the output of the circuit.

Therefore, as the input signal is increased, the output level rises, giving increased control voltage to the gain block, which in turn provides more negative feedback. This feedback reduces the voltage gain of the amplifier, so that the rise in output level is limited, and the required compression is obtained.

There is an alternative form of compressor, and it is possible to reconfigure the NE571N to perform in this alternative mode. The block diagram of Fig. 1b shows this arrangement.

This is in most respects the same as the original set-up, and the only difference is that the rectifier circuit is driven from the input, not from the output. Previously, the output level of the circuit had to increase by a certain amount if there was a rise in input level, as some rise in output level was needed in order to increase the control voltage to the gain block and give a reduction in gain.
MUSIC PROJECT

In this design, the second configuration is not the case. An increase in the input amplitude reduces the gain of the amplifier, and the compression effect is independent of the output level. Low input levels have no significant effect on the gain block as the control voltage that is generated is too small, but above a certain threshold level a rise in input level causes a reduction in gain that stabilises the output at a constant level. In practice, there tends to be some variation in the output amplitude, but this can be kept to no more than a few dBs with careful circuit design, and the NE571N works well in this configuration.

EXPANDER

The NE571N can operate as an expander using the arrangement shown in Fig. 1c. Here the gain of the amplifier is determined by the negative feedback network which is formed by Ra, the gain cell, and Rd. The lower the resistance of the gain cell, the higher the circuit gain.

The rectifier is driven from the input of the circuit, and the higher the input level becomes, the larger the control voltage and gain of the amplifier. This gives the 2 to 1 expansion characteristic.

In theory, using an expander of this type at the output of the circuit would give a high level of noise reduction without impairing the sustain effect. With only the noise output from the sustain circuit there would be only a low input level to the expander, and it would consequently have a low level of gain. In fact, it would provide considerably less than unity gain, and the noise would be attenuated. With a reasonably high signal level applied to the input of the sustain circuit, a high output level is produced, and the expander therefore has a comparatively high level of gain, so that the signal from the sustain circuit receives a degree of amplification.

As stated earlier, in practice there is a small variation in the output level of the compressor as the input signal is increased above the compression threshold level. The expander would tend to exaggerate these variations and reduce performance. This problem can be overcome by using a less extreme expansion characteristic, but one which still gives sufficient expansion to give a useful degree of noise reduction. Resistor Re provides a bias to the gain block which boosts the minimum gain of the circuit and gives a reduced amount of expansion. Strictly speaking, the circuit is an expander rather than a noise gate, as it does not simply gate the input signal on and off, but an expander used in this single-ended noise reduction role is often referred to as a noise gate.

A typical input/output characteristic of the sustain unit is shown in Fig. 2. As can be seen from this, a 40dB increase in the input signal (10mV to 1V) is compressed to a change in output of only about 3 to 4dB.

THE CIRCUIT

The full circuit diagram of the unit is shown in Fig. 3, IC1a is used in the compressor/sustain circuit and the expander/noise gate is based on IC1b. These closely adhere to the configurations of Fig. 1b and Fig. 1c, but some of the resistors shown in these diagrams are integral components of IC1 and do not appear in Fig. 3.

Switch S1 is a (foot operated) bypass switch which enables the effect to be easily switched out. Switch S2 can be used to switch out the smoothing capacitor in the rectifier circuit of the compressor so that the input signal modulates itself. This produces severe distortion that gives quite a good...
"fuzz" effect. The attack and decay times of the circuit need to be short, due to the rapid changes in the dynamic level of the input signal, but smoothing capacitors C6 and C11 must not be made too small or distortion performance suffers. It is, therefore, a matter of choosing values which give a good compromise between response time and distortion levels.

Potentiometer VR1 and its associated components enable the distortion performance of the compressor to be trimmed for optimum; VR3 is the distortion trim control for the expander. The gain of the circuit might be excessive for some guitars, and VR2 enables the gain of the compressor to be reduced by supplying a bias to the gain block; VR4 is the output level control.

Power is obtained from a small (PP3 size) 9 volt battery, and the current consumption is typically only about 3.5 milliamps. Switch S3 is the on/off switch, and this can be a set of isolated make contacts on the input socket, JK1.

CONSTRUCTION
A diecast aluminium box is ideal as the housing for a guitar effects unit, as boxes of this type provide screening against electrical noise and are very tough. Bear in mind that bypass switch S1 is a heavy-duty push-button type that is foot or toe operated, and that a simple folded aluminium box might not be able to take the sort of stresses to which the unit will inevitably be subjected. A 150 by 80 by 50mm diecast aluminium box was used as the case for the prototype.

The two controls and two sockets are mounted on the front panel of the unit, which is one of the 150 by 50mm sides of the case. With effects units it is common for the on/off switch to be part of the input jack, so that the unit is automatically switched on and off when the guitar is plugged into the unit and disconnected from it. This is usually very convenient in use, but an ordinary jack socket and separate on/off switch can obviously be used if preferred. A jack socket having isolated d.p.d.t. contacts is specified for JK1 merely because a socket having a single make contact does not seem to be available. No connections are made to most of JK1's tags.

Details of the printed circuit board are shown in Fig. 4. The NE571 is not one of the cheapest integrated circuits, therefore it is advisable to use a (16 pin) d.i.l. i.c. socket for this component. Fit Veropins to the board at the places

Fig. 3. The complete circuit diagram of the sustain unit

![Circuit Diagram]

**COMPONENTS . . .**

**Resistors**
- R1, 9: 18k (2 off)
- R2, 8: 68k (2 off)
- R3, 4: 27k (2 off)
- R5: 10M
- R6: 22k
- R7: 390k
- VR1, 2, 3: 22k min skeleton pre-set (3 off)
- VR4: 4k7 log carbon

All fixed resistors are 0.25W 5% carbon.

**Capacitors**
- C1, C2, 13: 100μ 10V axial elect
- C3, 5, 8, 12: 100n ceramic (2 off)
- C4, 10: 4μ7 63V axial elect (2 off)
- C6: 10n polyester
- C7: 4μ7 63V radial elect
- C9: 10μ 25V axial elect
- C11: 100n polyester

**Semiconductors**
- IC1: NE571

**Miscellaneous**
- S1: d.p.d.t. heavy-duty press-button switch
- S2: Rotary on/off type switch
- S3: Part of JK1
- JK1: Standard jack socket with isolated d.p.d.t. contacts
- JK2: Standard jack socket
- B1: 9 volt PP3 size

Diecast aluminium box, 150 x 80 x 50mm; printed circuit board; PP3 battery connector; two control knobs; Veropins; 16 pin d.i.l. IC socket; wire, etc.
where connections to the off-board components will be made. Once the board and wiring have been completed, the printed circuit is mounted in the case, and it simply slides into the set of guide-rails nearest the rear of the unit. There is plenty of space for the battery to one side of S1. It is advisable to fit a set of cabinet feet to the unit so that it does not slide around when S1 is operated.

**ADJUSTMENT AND USE**

The guitar is connected to JK1 using a standard screened jack lead, and the output from JK2 is coupled to the guitar amplifier in the same way. Initially, all three preset potentiometers should be adjusted to a roughly mid-way setting. Using S1, it should then be possible to switch the sustain effect in and out, and with the effect switched in it should be possible to adjust the output level using VR4; this is adjusted so that the general volume obtained is much the same at both settings of S1. It is possible that a very high output guitar pick-up might give a slightly higher output than the sustain unit can provide, and the volume control of the guitar would then have to be backed-off slightly.

Potentiometers VR1 and VR3 are adjusted empirically to obtain optimum distortion performance. It is not essential to use sophisticated test equipment when doing this, and these presets can simply be adjusted to minimise audible distortion on the output. It is much easier to do this using a reasonably pure sinewave input rather than the signal from a guitar, but obviously any settings that give satisfactory results in practice can be used.

If the unit is used with a high output guitar, results will probably be better if VR2 is adjusted in an anti-clockwise direction. This reduces the gain of the circuit, which is otherwise almost certain to be excessive. A low output guitar will probably necessitate adjustment of VR2 in a clockwise direction to give a boost in gain. Otherwise, only a weak sustain effect is likely to be obtained. Really it is just a matter of using trial and error to find the setting which gives the best subjective results.

A point which has to be borne in mind when using any sustain unit is that it effectively boosts the gain of the guitar amplifier when the output of the guitar is at a low level. This increases the risk of problems with stray feedback, pick up of mains hum, etc., although in this case the built-in noise gate helps to minimise the risk of such problems.
THIS design provides gain control of sine, triangle and square waves via an op-amp buffer. It has a TTL output for logic applications, and gives digital readout accurate to ±1Hz. No switched ranges are used, the potentiometer giving a 1000:1 sweep range, and for this reason a multiturn pot is specified to enable accurate settings to be made easily. The unit is mains-powered, giving +12V and +5V.

**Fig. 1. Circuit of signal generator**

**HOW IT WORKS**

The heart of the signal generator is the ICL8038 voltage controlled oscillator with the following excellent features: low frequency drift with temperature, low distortion and high linearity, wide operating range (possible 0.001Hz to 300kHz), variable duty cycle from 2%-98% etc. The three waveforms are available simultaneously at pins 2, 3 and 9.
### COMPONENTS...

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<td>VR5, VR6</td>
<td>100k min preset</td>
</tr>
<tr>
<td>VR7</td>
<td>100k lin (with S1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>C1-3</td>
<td>100n</td>
</tr>
<tr>
<td>C4</td>
<td>47p</td>
</tr>
<tr>
<td>C5</td>
<td>27p</td>
</tr>
<tr>
<td>C6</td>
<td>2200µF 25V elect</td>
</tr>
<tr>
<td>C7,8</td>
<td>0-22µF 25V tant</td>
</tr>
<tr>
<td>C9,10</td>
<td>0.22µF 25V tant</td>
</tr>
<tr>
<td>C11-13</td>
<td>10µF 15V tant</td>
</tr>
<tr>
<td>C14</td>
<td>5-65p trimmer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>D.p.s.t.</td>
</tr>
<tr>
<td>S2</td>
<td>3-way rotary</td>
</tr>
<tr>
<td>S3</td>
<td>S.p.d.t.</td>
</tr>
<tr>
<td>S4</td>
<td>S.p.s.t.</td>
</tr>
<tr>
<td>XL1</td>
<td>5-24288MHz crystal</td>
</tr>
<tr>
<td>F5</td>
<td>250mA fuse and holder</td>
</tr>
<tr>
<td>SK1</td>
<td>BNC socket</td>
</tr>
<tr>
<td>SK2</td>
<td>Phono socket</td>
</tr>
<tr>
<td>Display bezel</td>
<td></td>
</tr>
<tr>
<td>5-digit CA multiplexed display (GL9R03)</td>
<td></td>
</tr>
<tr>
<td>Centurion DX1 case</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0-12V, 0-12V, 3VA p.c.b. mounting transformer</td>
</tr>
</tbody>
</table>

### Fig. 2. Main board assembly

The symmetry of the waveform can be affected by the external resistors on pins 4 and 5, and those readers who would like to vary the duty cycle to produce, e.g. short pulses or sawtooth waveforms, may like to experiment with these components. The frequency of the generator is a direct function of the voltage on pin 8, so by varying the potential divider formed by VR1, VR2, VR3, it is possible to obtain a 1000:1 sweep (i.e. 20-20,000Hz with the values selected). The presets are used to set the top and bottom limits. However, to obtain this sweep the voltage across R2 and R3 must decrease to nearly zero. This requires the highest voltage on pin 8 to exceed that at the top of R2 and R3 by a few hundred millivolts, and so D1 is included to lower the effective supply to the 8038. IC3 is included as an output buffer, and provides gain control by means of the potential divider at pin 3. The two presets on pins 1 and 12 minimise sine wave distortion, and according to the Intersil data it should be possible to reduce the distortion to 0.5% by adjusting these.

A split power supply is used because it enables all the waveforms to move symmetrically about 0V. The square wave is not committed, and so R4 is used as a load resistor. This output is also linked to two inverting gates of the 4049 which, being powered from the 5V line, gives a TTL compatible square wave signal available at the output terminals, and is used for the digital display.
An ICM725 is used being the simplest means of providing frequency readout. It drives a 4½ digit CA display directly with the CA line to 5V, but needs its store, reset, and gating pulses in a specific sequence, and this is done by IC4.

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This gives a 1s gate (0.1s if pin 11 is connected to 5V) to give readings of Hertz, and IC2 inverts the count inhibit output to provide the gating input to the 7225. For readers who wish to use a CC display (possibly the miniature FND357), the 7225 can be replaced with the 7236, though the data sheets specify this as a device for driving vacuum fluorescent displays, it will also drive the CC type. The pinout is exactly the same as the 7226 except that pin 5 should be grounded and pin 35 (at present connected to OV) should instead be connected to +5V. Otherwise simply connect the display segments as shown, and the CA line to 5V. The power supply is straightforward and consists of a 3VA, 0-12, 0-12V transformer arranged in a 12-0-12V centre tapped configuration. The secondary a.c. is then rectified and smoothed before being regulated by IC6 and IC7 to give ±12V controlled by VR7. This line also feeds the 5V regulator which supplies IC2, 4, 5. This line is not switched because it would have meant that VR7, incorporating only a two-pole switch, could not be used. It is therefore made to power the mains supply on.

CONSTRUCTION

The project uses two p.c.b.s, details of which are given in Figs. 3 and 4. Mount the power supply components, making sure that the regulators are inserted the right way round. The 7805 is mounted on the rear panel.

After checking, attach a mains lead, switch on and make sure that +12V and 5V appear at the 'out' pins. If all is well, switch off, and disconnect the mains before proceeding with the oscillator section. All sets of holes are provided on the p.c.b. for C4 depending on whether polystyrene or silver and dialled before being regulated by IC6 and IC7 to give ±12V controlled by VR7. This line also feeds the 5V regulator which supplies IC2, 4, 5. This line is not switched because it would have meant that VR7, incorporating only a two-pole switch, could not be used. It is therefore made to power the mains supply on.

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mica is selected. This component needs to be of high stability to minimise frequency drift. Use Veropins for all interconnections to the p.c.b., and set all the presets to mid travel. Apply power and check, preferably with a scope, that the correct waveforms appear, and that adjusting the various presets causes some alteration to them. Check the TTL output on pins 15 and 12 of IC2 (one of them being an inversion of the other). Varying VR7 should alter the peak-to-peak level coming out of IC3 pin 6. Again if all is well, switch off, and insert the components associated with the digital readout. The digits are connected with ribbon cable to make possible fault-tracing easier. By monitoring pins 2, 13, 14 of IC4 it should be possible to see the count inhibit pulse switching at a 1Hz rate, and the reset and store pins producing short negative going pulses. Connecting pin 11 of IC4 to +5V will reduce the gate time to 0.1s, speeding up any change in reading, but this does reduce the resolution to 10Hz, and this can be included via a toggle switch if desired.

If everything is working satisfactorily, the p.c.b. can be bolted to the base panel of the Centurion DX1 case. It is a very tight fit, but the result is a neat compact unit.

A ten-turn pot was used for VR2 to make resolution easier but the author chose not to include a ten-turn dial, being superfluous with a digital readout. The display incorporates a bezel to improve the appearance and hide possible ragged edges. Drill two holes in the rear panel for the strain relief bush and mains fuse.

After a final check the unit can be calibrated by adjusting trimmer C14 with reference to a reliable source, but in practice it was found that setting it to mid travel was accurate enough for all but the most demanding purposes. VR5 and VR6 are adjusted to give a good shape to the positive and negative peaks of the sine wave, whilst VR4 alters the duty cycle, most easily set using the square wave output. VR3 is then adjusted to give a reading of 20kHz and VR1 a reading of 20Hz. These presets interact and repeated adjustments are necessary. Note that above 20kHz, the c digit will remain lit, and give misleading results, so the prototype was set with a top limit of 19500 to avoid confusion. When these adjustments are complete, the case can be screwed together, and any front panel markings, e.g. Letraset, added. If readers are concerned about the buffer being a d.c. amp, it can easily be modified to one of the standard a.c. op-amp configurations.

---

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**National Exhibition Centre, Birmingham**

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We have now covered most of the common 8 and 16 bit multi-chip processor families, followed by their single-chip cousins, and the time has now come to take a look at the few remaining processors which either did not fit readily into those earlier categories or were not widely available when the series began.

In March we looked at the single-chip 8070 family, and I highlighted the uninspiring microprocessor track record of its manufacturer, National Semiconductor, which despite some very good ideas had not been able to shake the market stranglehold enjoyed by the Intel, Zilog, Motorola, "big-three". In the next two file articles we are therefore going to examine two other, fairly new, devices from the National stable which are expected by their sponsor to break the existing mould and to turn the "big-three" into the "big-four". See what you think!

First let's look at the National NSC800, an interesting 8 bit multi-chip design which is already beginning to take-off well in the expanding market for battery operated microprocessor systems where its low power CMOS technology gives it an instant advantage.

It all started with the development by National of a new CMOS processing technology which combined, for the first time, the functional density of NMOS with the low power requirements of CMOS. National called this technology P2CMOS, and set about the task of designing a new processor to make use of it.

In order that they might capitalise on their new technology as quickly as possible, before everyone else could catch up, National decided not to face the certain delays involved in a brand new architecture, but to use an existing architecture instead. The trouble was, National did not have a suitable 8 bit NMOS processor of their own since their indigenous 8060 (SC/MP) design was becoming obsolete and their other 8 bit processor, the 8080A, was just a second source to the Intel design which itself was well past its prime. National therefore examined all the offerings of their competitors and decided that the impressive success of the Zilog Z80 and its powerful instruction set was the act they wanted to follow. Unfortunately, they also felt that the un-multiplexed Z80 bus structure was not as neat as that of the multiplexed Intel 8085, and so they decided to use their P2CMOS technology to demonstrate that you can have a cake and eat it too, by building a CMOS Z80 with an 8085 bus interface. The NSC800 was born!

Of course there were CMOS microprocessors already available, particularly the RCA 1802, but these early devices had to pay quite a price for their low power consumption and suffered from low operating speeds and a primitive architecture. By having the capability to put the Z80 register and instruction set inside a package using the efficient 8085 bus interface, running at the full 8085 clock rates of up to 4MHz and with a low power consumption to boot, National felt they were bound to produce a winner.

To back up the impressive capabilities of the NSC800, National also designed two multi-function P2CMOS peripheral chips based on the Intel 8155 and 8355 devices, to allow the design of a multi-chip system with 2K of ROM, 128 bytes of RAM, 42 I/O lines and two 16 bit programmable timers, but needing only three 40 pin chips.

The NSC800 and its support chips have been available for about 2 years now, and success has certainly been achieved to the extent that the National device has ousted the RCA 1802 from its position as the foremost CMOS processor, and has won ready acceptance in battery powered applications thanks to its powerful architecture and its ability to run the vast library of available 8080 and Z80 software, including the ubiquitous CP/M operating system.

Promising as this may be however, the NSC800 is unlikely to make National's fortune. For a start, the NSC800 is several times more expensive than the NMOS Z80, making it a natural choice only for battery powered applications, which taken together are a relatively small fraction of the total microprocessor market. Secondly, other manufacturers, particularly in Japan, have now introduced their own CMOS versions of both the Z80 and the 8085 microprocessors, and these have the great advantage that they can be plugged straight into an NMOS Z80 or 8085 socket, often with little or no circuit change. The NSC800 cannot be used in this way, and is therefore mainly specified for brand new projects where its special blend of Z80 and 8085 features can be used to advantage.

We therefore have to ask ourselves whether National have got it wrong again, by designing an admittedly superior product which in the end will be less successful than microprocessors which are simpler and therefore less expensive.

Only time will tell, but after reading more about the technical features of this excellent chip I am sure you will agree with me that National do at least deserve to succeed!

REGISTERS

The NSC800 has an almost identical register set to that of the Zilog Z80, which in its turn consists of a superset of the 8080/8085 registers. Register names remain the same as those used on the Z80, and anyone used to that processor, or even the earlier Intel 8080, will feel immediately at home with the NSC800.

Like the Z80, the NSC800 has two separate general purpose register banks each containing the AF, BC, DE and HL register pairs, and it has the usual 16 bit index registers IX and IY in addition to the Stack Pointer and the Program Counter. You may remember that the Z80 also had two unique 8 bit registers, and R, which provided the base address of the Interrupt vector table and a dynamic RAM refresh counter respectively. These have been retained on the NSC800 with the R register now having a modification to enable it to provide a full 8 bit count value rather than the 7 bit count of the Z80. This is the only obvious difference between the register sets of the two processors, and it confers the useful ability to refresh the newer 64K bit DRAM chips which have become a problem for the Z80 since it is only directly able to refresh 16K bit devices unless additional external hardware is used.

As I pointed out on File Sheet 3, the Z80 has a more comprehensive register set than any of the other 8 bit multi-chip processors, and the NSC800 is therefore very well endowed in this respect.

The flags in the F register are also identical to those of the Z80, and consist of the familiar Carry, Add/Subtract, Parity/Overflow, Half Carry, Zero, and Sign bits.

INSTRUCTION SET

The NSC800 has all the 8080 instructions and, thank goodness, they all use the same mnemonics (for this reason we have not shown the instruction set here) so that any Z80 based machine with an assembler can easily be used to produce object code for the National processor.

Like the Z80, the NSC800 instruction set contains all of the 8080 instructions too, although as before, most mnemonics have been changed so that compatibility exists only at the object code level. The two additional 8085 instructions, RIM and SIM, which manipulated the Interrupt Mask and provided a serial I/O facility are missing from the NSC800 set however, and this is because the two serial I/O lines of the 8085, SID and SOD, have been sacrificed to provide the new NSC800 pin functions Refresh and Power Save.

Although the RIM and SIM instructions are not available, some functions of the additional Interrupt Mask Register of the 8085, which provided individual status and enable flags for the three fixed
GENERAL
The use of low power CMOS technology combined with an 8085 bus structure and the full Z80 instruction set makes the NSC 800 a unique and interesting processor. This device has become very popular for battery powered applications, but due to a higher price tag than that enjoyed by NMOS processors and some recent competition from CMOS pin compatible versions of the Z80 and 8085 it may not turn out to be the great success that National had hoped for. It is without a doubt however the most powerful 8-bit CMOS processor available and is ideal for "few-chip" battery powered systems.

REGISTERS
The NSC 800 register set is identical to that of the Z80 except that the refresh counter register (R) is 8 bits (rather than 7 bits) long. This allows easy interface to the 64K RAM chips now available.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8)</td>
<td>(8)</td>
<td>(8)</td>
<td>(8)</td>
<td>(8)</td>
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</tbody>
</table>

INTERRUPT VECTOR INDEX REGISTER IX INDEX REGISTER IX REGISTER INDEX
MEMORY REFRESH ALTERNATE SET
MEMORY

June 1984

INSTRUCTION SET AND SOFTWARE
The NSC 800 uses the full Z80 instruction set with no additions or deletions, and uses standard Z80 mnemonics so that any Z80 based system can be used for software development. It is upwards compatible with the 8080 and 8085 at the object code level apart from the two 8086 special instructions RIM & SIM. It is fully compatible with the 0/0M 0.5 and therefore has access to a very large software library.

PERFORMANCE DATA

<table>
<thead>
<tr>
<th>NSC 800</th>
<th>Z80</th>
<th>8085</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEMORY ADDRESS RANGE:</td>
<td>64K</td>
<td>256</td>
</tr>
<tr>
<td>I/O ADDRESS RANGE:</td>
<td>A11</td>
<td>A11</td>
</tr>
<tr>
<td>CLOCK FREQUENCY:</td>
<td>2.5MHz</td>
<td>2.5MHz</td>
</tr>
<tr>
<td>POWER SUPPLIES:</td>
<td>+3 → +5V</td>
<td>+5V</td>
</tr>
<tr>
<td>INTERRUPTS:</td>
<td>INT NMI</td>
<td>INT NMI</td>
</tr>
</tbody>
</table>

*NOTE: 4 MHz VERSION ALSO AVAILABLE*

BENCHMARKS

<table>
<thead>
<tr>
<th>NSC 800</th>
<th>Z80</th>
<th>8085</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD REGISTER TO ACCUM</td>
<td>16.4μs</td>
<td>16.4μs</td>
</tr>
<tr>
<td>OUTPUT ACCUM TO PORT</td>
<td>4.8μs</td>
<td>4.8μs</td>
</tr>
<tr>
<td>MOVE FROM MEMORY TO MEMORY</td>
<td>6.4μs</td>
<td>6.4μs</td>
</tr>
</tbody>
</table>

SUPPORT CHIPS
THE NSC 800 PERIPHERAL CHIP FAMILY IS MODELED ON THAT OF THE 8085 AND INCLUDES THE NSC 830 ROM, I/O (LIKE 8335) AND THE NSC 810 RAM, I/O, TIMER (LIKE 8155) BOTH IN LOW POWER CMOS, Z80 AND 8080 PERIPHERALS CAN ALSO BE USED IF REQUIRED.

MANUFACTURERS

ORIGINATOR: NATIONAL SEMICONDUCTOR

2ND SOURCES: SMC, EUORTECHNIQUE
vector interrupts, have been retained in the NSC800 via a special 4 bit Interrupt Control Register (ICR). This register is unique to the NSC800 and has the following pin based instruction word format: OOBH. Anyone who is familiar with the 8085 will soon find that the NSC800 RST A, B and C interrupts which are intended to be similar to the RST 5.5, 6.5 and 7.5 of the 8085, are in fact quite different in some respects, so be careful!

There is no need for me to examine the NSC800 instruction set in detail, since this was done quite adequately in the Z80 file article. It is not a good idea to say that the useful as a host development system, the instruction words, BCD Shifts and Block Moves are all alive and well. Since all the instructions are the same you would expect the addressing modes to be the same too, although National have put their stamp on things by renaming the Extended mode of the Z80 as the Direct mode, which is an improvement, I suppose.

SOFTWARE

With full 8080 and Z80 compatibility there is definitely no shortage of software for the NSC800 since it can share the huge existing library built up for those processors over the years. The CP/M disc operating system provides the easiest gateway to this library, although whether it is likely that the low power advantages of the NSC800 could ever be fully appreciated in a system which uses a couple of floppy disc drives is quite another question!

More important perhaps, is the possibility of using an existing Z80, or even a personal computer as a host development system for battery powered NSC800 target systems. Almost any Z80 system with an assembler and a PROM programmer could be used, including the humble Sinclair Spectrum, but a system with floppy discs and running the CP/M DOS would be ideal.

So far as I am aware, there are no personal computers which actually use an NSC800 CPU, but this is only of academic importance to the programmer.

INTERFACING

The NSC800 is not pin compatible with either the Z80 or the 8085, although it most closely resembles the latter. Some of the 8085 pins which have similar functions on the NSC800 have been renamed by National to confuse the enemy, so that TRAP becomes NMI and Ready becomes Wait. Some other pins have changed not only their names but also their functions. In the 8085 two pins with the previously mentioned advantage of an 8 bit refresh address being provided on the multiplexed bus. The PS input pin is unique to the NSC800 and complements the low power operation of the CMOS processor by invoking a very low power standby mode in which the processor clock is suspended to reduce consumption. Since it is intended that the processor itself should control this pin in most circumstances, it would seem more appropriate to provide this function via a special instruction rather than by external hardware, but in its present form it does also provide the useful facility of a single step mode when driven by a couple of external latches.

The PC/MOS technology of the NSC800 conforms to several other advantages in addition to low power consumption. Instead of the usual rigidly imposed 5 volt power supply voltage, the NSC800 can operate over a 3 to 12 volt range and does not need tight voltage regulation. Noise immunity, too, can be better in CMOS systems, and the low internal heat dissipation makes it possible for some NSC800 versions to be specified for the very wide ambient temperature range of −55 degrees C to +125 degrees C.

The 8085 bus structure is already a good choice for the NSC800 since it multiplexes the 8 low order address bits with the data bus to save a separate address latch since the two special I/O devices coded NC810 and NC830 contain internal demultiplexing circuitry for this purpose.

The NC810 is a 40 pin P2CMOS device which features 128 bytes of static RAM, 22 parallel I/O lines and two programmable 16 bit timer/counters. In most respects this device is similar to the 8155 from the 8085 family but it differs in having two timer counters instead of one, each having superior features to the single 8155 unit.

The NSC830 is also a 40 pin P2CMOS device, but in this case containing 2K bytes of masked ROM and 22 I/O lines. Masked ROM is of no use for low volume applications of course, but there is a companion device, the NSC831, which only has the I/O lines. Unfortunately there is no EPROM version equivalent to the 8755.

The NSC800 is particularly well endowed with interrupt inputs and modes, inherited from both the Z80 and the 8085 and providing a high level of compatibility with both devices.

There are four fixed vector interrupts, NMI, RSTA, RSTB and RSTC, all of which result in a direct vector to locations in low memory. NMI is of course non maskable, but the other three can be individually masked by clearing the appropriate bit in the Interrupt Control Register (ICR), or collectively masked by issuing a DI (Disable Interrupts) instruction. The NMI interrupt input is edge triggered but the others are level sensitive, while the control this pin in most circumstances, it would seem more appropriate to provide this function via a special instruction rather than by external hardware, but in its present form it does also provide the useful facility of a single step mode when driven by a couple of external latches.

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In addition to the fixed vector interrupts there is a single multi-mode interrupt INTR, which operates in the same way as the Z80 input of that name. This input can be set up by the program instructions IM0, IM1 and IM2 to respond in one of three different modes depending on the system configuration and the peripheral devices.

In Interrupt Mode 0 the single multi-mode interrupt INTR is the simplest mode since it turns the general purpose INT pin into an additional fixed vector input making a new total of five. This is the most useful mode for many all-CMOS systems, since as far as I can discover, there is no CMOS equivalent to the 8259, and there are no CMOS equivalents to the Zilog peripherals either.

Interrupt Mode 2 is the most powerful mode since in this case the INTA output is used to read a single byte vector from the interrupting device which is subsequently concatenated with the contents of the I register to form a 16 bit pointer into a 128 entry vector table which can be located anywhere in memory. Unfortunately, the external logic required to generate the appropriate response is quite complex, and neither of the two National peripherals (NSC830 and NSC831) have the necessary facilities to support this mode, a surprising omission. Perhaps National intend (or intended) to produce an interrupt controller which supports this facility, but without it the only easy way to use Mode 2 is to choose NMS Zilog peripheral chips such as the P10 and CTC devices.

Although National have not produced many CMOS LSI peripheral devices for the NSC800, they have performed much better in the provision of CMOS "glue" ports, since a useful range of gates, decoders and latches is available, all fabricated in P2CMOS.

APPLICATIONS

The NSC800 should be considered for all battery powered microprocessor applications since it offers a powerful architecture and instruction set, an excellent bus structure, and all the low power advantages of CMOS technology. If the need is to convert an existing NMOS8085 or Z80 system for a low power application, however, it may be easier to use one of the pin compatible CMOS versions of those processors (80C88, 80C89) which are now becoming available.

If the intended application is to be mains powered, then it is unlikely that the NSC800 could be considered cost effective unless the reduced cooling requirements or the particular attractions of a Z80 architecture and an 8085 bus are dominant factors.

A better try National, but perhaps you should listen more closely to the market research team rather than allow those bells-and-whistles engineers to call the shots!
A dynamic light sequencer using an EPROM for light pattern memory, allowing preset light shows to be initiated at the touch of a button. This robust, 4-channel unit also features "shimmer dimmer" for kinetic dance floor effects, and sound triggered effects. Zero voltage switching extends the life of the display lamps.
Napoleon designated the British as a nation of shopkeepers. Les thought it was Hitler, but I forgave him because he’s a young man who probably didn’t care much for history as a hobby—he why too led up with electronics. But if Napoleon wasn’t right, isn’t it time we did something about changing that image? It is laudable to be an efficient supplier. But it is even more laudable—and essential to ensure our economic future—that we should be a good salesman as well.

My goodness, Les. You have thrown the cat among the pigeons.

* * *

Electronics and its applications knows no bounds. Hotelier Peter Rudd, according to reports reaching my ears, is offering cut-price weekends at his Norfolk establishment for chronic snorers. Apparently he is prepared to give them accommodation in a special (sound proof?) wing, where their nocturnal snoring will be monitored and measured by night porters equipped with decibel meters. And there will be prizes for those generating the most ear-splitting row.

He goes even further than that, if my informant is to be believed. To ensure that the participants are worked up to maximum pig-noise capacity by night, he takes them on daytime visits to the neighbouring villages of Great and Little Snoring.

But it is clear that this lively inn-keeper is setting a trend which could spread. What about a similar facility for those who are prone to talking in their sleep? It is a well-known fact that the truth, the whole truth and nothing but the truth tends to emerge during mutterings in the wee small hours and it is important that this soul-baring should be harnessed in a constructive way. So why don’t Mr. Rudd organise weekends for those with something on their minds? In the secure atmosphere of his hotel they would be able to babble away to their heart’s content and purge their systems of what could otherwise be a death blow to marital harmony.

Whether such revelations should be taped by the prowling porters is quite another matter. But certainly a playback session—with immediate destruction of the recordings afterwards—would be a much more entertaining diversion than Monopoly.

* * *

Here’s an odd remark attributed to Patrick Cody, managing director of STV, when announcing his company’s plans. He’s quoted as saying “we specialise in entertainment. We make no pretence or apology for that.”

Now, what did the gentleman mean? Surely, entertainment is what people are paying out their pounds for. So why should anyone pretend anything else? And why should an apology be forthcoming for a pledge to deliver the goods the client rightly looks forward to? As Alice said: “Curiouser and curiouser...”
2532 EPROM PROGRAMMER...

**FOR AROUND £8**

INCE the Vic 20 ROM board described in Part 1 of this series is designed to accommodate 2 x 2532 EPROMs, it was decided that there was little point in building a complex programmer for use with the Vic 20, even though it is possible to use 2716 EPROMs. Further to this, the falling cost of the 4K ROM is conducive to adopting it as a standard instead of the 2716. The programmer described here uses the minimum of components required to fulfill the necessary operations needed to test, read, program and verify a 2532 EPROM, instructions to the operator and other functions being carried out under software control. Unlike most microcomputers, the Vic 20 has address and data lines available at the expansion port, cutting the components count of the EPROM programmer by several costly i.c.s.

**EPROM PROGRAMMING**

When "clean" every bit in the memory matrix of an EPROM is set high and since these are presented on the screen of a computer in bytes, each byte has the Hex value FF (1111 1111). To program the EPROM, some of the bits are brought low to logic "0". The Hex value CA would be represented by the bit pattern 1100 1010. In order to bring the required bits low, a high voltage pulse of 50ms duration has to be applied to the bit in question. This is carried out by first of all applying a high (25V) voltage to Vpp (pin 21) and then applying the 50ms pulse at CE (pin 20) when pointing to the particular memory bit to be brought low. This is carried out sequentially throughout the 4096 bytes (32768 bits) contained in the 2532.

Programming is carried out in four stages. The first function of a programming sequence should be to check that the EPROM is clear, i.e. all bits set high. This is carried out in the Read mode. The second stage sets the programmer circuit to Program mode. Next is the actual programming, consisting of comparing with a 4K byte section of RAM bit by bit and bringing bits low where required. The third stage compares, or Verifies the programmed EPROM with the RAM section, indicating any bits left high that should have been brought low and listing them, before announcing that the operation is finished. Finally the EPROM board is returned to the Read mode before removal of the EPROM from its socket. Reading EPROMs is similar to Verification. For those possessing Vicmon, this has a facility built in. Because of the vast quantity of information being processed, it is usual to program in machine code, the whole sequence described above taking between 3 to 5 minutes for a 2532. Again, those who have Vicmon will find many subroutines in this package that they can use.

A typical programming sequence would follow these lines:

1. **(a)** Set Prog/Read switch to Read – Check
2. **(b)** Insert EPROM in socket – Check pin orientation
3. **(c)** Has Data been entered into RAM – Check
4. **(d)** Define Start and End of RAM area – Check
5. **(e)** Define Start and End of ROM area – Check
6. **(f)** Will total RAM fit into ROM?
7. **(g)** Check that ROM is clear. All bytes set at FF Hex
8. **(h)** Check that EPROM space is free of Data held in RAM
9. **(i)** Set Prog/Read switch to Prog. Apply 26V to Vpp
10. **(j)** Program – output bit pattern to start address – toggle CB2, 50ms pulse
11. **(k)** Output bit pattern to Start + 1 – toggle CB2
12. **(l)** Repeat until program count is complete
13. **(m)** Set Prog/Read switch to Read
14. **(n)** Verify that Data in EPROM is same as Data in RAM
15. **(o)** If correct – End
16. **(p)** If not, List Bytes that do not agree
17. **(q)** Do you want to re-run from (i)?
18. **(r)** If Yes, go to (i), otherwise – End
19. **(s)** If Verification now correct – End

EPROMs can be checked for "clear" by verifying with a RAM area set to FF Hex. They can be Read by POKEing Data into RAM instead of comparing as at the Verification stage. Note that the RAM address is not usually the address where the EPROM will normally reside when in use.
ERASING EPROMs

The transparent window on the upper surface of an EPROM is normally covered with an opaque label to protect it from extraneous UV light present in daylight and household fluorescent lighting. This label is removed and the window cleaned thoroughly. The EPROM can then be erased by exposure to a 2357A wavelength ultra violet light held approximately 1 inch from the transparent window for around 20 minutes. For those who wish to construct their own unit, the Philips TUV 15W tube is suitable. This replaces an ordinary 15” fluorescent fitting and can be bought for around £10. Care must be taken to ensure that the unit is sealed in a light proof case to prevent the emission of UV light that is harmful to the eyes and hands. Commercial units are fitted with press to make switches in the lid to ensure automatic cut-off when the lid is removed.

CIRCUIT DESCRIPTION

Because the basic Vic 20 has insufficient RAM on board, it is essential that it is fitted with a mother board and at least a 3K expander card before a 4K EPROM can be programmed. The board described in this part of the series is intended for insertion into the end socket of the mother board described in Part 1 (Oct. 83), but this does not prevent it being used with other models of motherboard.

Two power supply lines are required by the programmer, +5V to power the on board devices and a +25V supply used in the programming mode. The +5V supply is present at the Vic 20 edge connector on the mother board, whilst the +25V can be derived from batteries or mains. Indeed, it is suggested that batteries should be used until the unit is suitably cased to ensure isolation from the mains voltages at the transformer. Provision is made for connections to a battery supply, 4 x PP3 in series, or a similar arrangement, at the terminals of C1. In this case the transformer, rectifier bridge (BR1), C1 and C2 should be omitted.

When the 30V-36V d.c. supply is turned on it is present at the collector of TR3, which forms part of the regulated power supply. D2 is a 27V Zener diode and the supply voltage across R4, D2 causes the Zener to conduct, holding the base of TR3 at 27V. This, in turn, because of the voltage drop across the base/emitter junction, produces approximately 26.4V at the emitter and Vpp. At the same time, +5V is removed, turning off the red I.e.d. and also TR1. TR2 is now biased by R3 and turns hard on, its collector falling to OV. This has the effect of shorting out D2 and pulling the base of TR3 to ground potential. TR3 is turned off, as is the green I.e.d. and only +5V reaches Vpp through D4. For those who might like extra indicator I.e.d.s, provision is made for monitoring the 30V signal at BR1 via R6 and yellow D5.

DPDT switch S1 is used to switch between Program and Read modes. This switches off the +5V supply to the base of TR2 and the same time selects CB2 (User Port) for Read mode or a RAM/ROM block (Expansion Port) for Program mode. This switches off the +5V and this is provided from the edge connector supply by way of D4 simultaneously with the removal of the 26V level. TR1 and TR2 provide noiseless switching of the Vpp supply. When in Program mode, red indicator I.e.d. D1 is turned on and the base of TR1 is connected to the +5V rail through R2, turning it hard on. This produces OV at its collector and the base of TR2, turning TR2 off. Its collector is now at 27V, that produced by the turning on of the Zener diode. As described earlier approximately 26V reaches Vpp. In Read mode, the +5V is removed, turning off the red I.e.d. and also TR1. TR2 is now biased by R3 and turns hard on, its collector falling to OV. This has the effect of shorting out D2 and pulling the base of TR3 to ground potential. TR3 is turned off, as is the green I.e.d. and only +5V reaches Vpp through D4. For those who might like extra indicator I.e.d.s, provision is made for monitoring the 30V signal at BR1 via R6 and yellow D5.

Construction

Construction is on a double-sided glass fibre p.c.b., measuring 11 x 14cm. Holes are drilled in the following sizes:

- Transistors, Zener, 1N4148: 0.8mm
- D.I.L. socket, I.e.d.s, resistors, capacitors: 1mm
- Bridge rectifier, transformer, mains lead: 1.3mm
- DPDT switch, holes to retain mains lead: 2mm

The board is uncomplicated as far as artwork is concerned, and for those who wish to draw their own boards with etch resist pen, it is suggested that holes are drilled first by using a photo copy or tracing of the pattern taped to the p.c.b. as a guide. The holes are then used as reference points for drawing lines. The bar joining the edge connectors is used in an electro-gold-plating process, but the thin lines are useful as a guide for drawing the edge connector bars.

**Fig. 7.1. Circuit diagram**
THE VIC 20 SERIES . . .

Part 1 (Oct. 83) Motherboard, 8K RAM, 8K ROM expansions
Part 2 (Nov. 83) L.e.d.s & switches simulator
Part 3 (Dec. 83) B-channel low voltage output driver board
Part 4 (Jan. 84) Mains voltage output driver, control line input interface
Part 5 (March 84) Two stepper motor drivers
Part 6 (April 84) ADC/DAC board
Part 7 (May 84) EPROM Programmer

It may interest constructors of the stepper motor interface to know that the SDB520 i.c. is available from: Astrosyn (UK) Ltd., Old Outhouse, New Rd., Chatham, Kent ME4 4QJ. 0634 915175.

The above, and the following are also sources of stepper motors: Stewart of Reading, 110 Wykeham Rd., Reading, Berkshire RG6 1PL. 0734 68041.

In all construction work where no p.c.b. holder is available, it is advisable to start by mounting the lowest lying components first, in this case resistors and diodes. Always fit resistors with tolerance bands in the same direction. Ensure polarity is correct with diodes, cathode being indicated by a broad band for the Zener, D2 and by the coloured bands for D4. Since the anode of D4 is used as a through the board link it must be soldered on both sides of the board.

The screw holes on each side of the miniature DPDT switch are not required, so they should be snipped off and filed to make the board neater. It might be necessary to bend the tags slightly, but a few types were examined and all were 0.15" pitch as provided on the board. Care should be taken with the l.e.d.s as they can be destroyed by very little overheating. Do not insert beyond the lugs approximately 1/" from the l.e.d. and use crocodile clips or a pliers as a heat-sink on this section whilst soldering. The cathode of a l.e.d. is mostly indicated by a flattened side. Provision is made for a yellow l.e.d. as an indicator that the mains power is on. This was omitted from the circuit diagram because it is likely that it might be enclosed when shrouding the mains supply.

The long leads cut from the rectifier bridge make ideal pins for linking pins 20 and 21 of the socket to the underside of the board at the pads provided. A length can also be used to connect pin 20 CE by S1 to the edge connector Block selected. The programmer will use the lower 4K of a block, but if an 8K or 16K RAM pack is in use there must be RAM
at BLOCK 1 for the BASIC program to use and for storage of the data to be burnt into ROM. If most of the programming functions are to be carried out in machine code, these routines can reside in the onboard RAM. Capacitor C1 provides smoothing at the power supply, and whilst it is necessary to have an electrolytic with a working voltage of 50V to 63V, the capacitance value is not critical, 220µF being a suitable minimum value. Two holes are provided at the positive end because of varying shapes and sizes. For the use of the programmer in schools, where mains supplies are not allowed, batteries can be connected at points A, positive and B, negative. Four PP3 batteries in series make a suitable supply and these should last for years. Three PP3 are not sufficient as the supply must be above the Zener voltage (27V). If difficulty is experienced in buying PP3 connectors, these can be made from expended batteries.

The mains supply must be shrouded at the transformer for the safety of operator and equipment. Since it is necessary to raise the rear end of the programmer to the height of the mother board, a spacing block made from an audio cassette case is ideal for starters.

Capacitors C2 and C3 are included for noise suppression and may not be needed.

Connection of CB2 is to pin M on the User Port. The author identified this with a marker and connected up with a small croc-lead, insulated at the top side of one end with tape.
TESTING

Carry out visual check for short or open circuits. Without connecting the board to the computer, check that the 26V supply is reaching pin 21 of the socket. This is done by applying +5V at edge connector segment 21 and 0V at 22. Vpp, pin 21 should now change from +5V to 26V as Switch 1 is changed from Read to Program.

Without the 25V supply and with the board inserted into the expansion socket send alternating “high” and “low” signals from CB2 (37147) to pin 20, CE. Note: CB2 is mentioned because it produces an accurately timed square-wave pulse. However, for initial tests, by entering POKE 37138,225 set DDR user port for outputs and alternating I/O Register POKE37136,255 and POKE37136,0 an ON/OFF signal can be sensed at any segment from C to L.

If BLOCK 3 has been selected and a Vicmon chip is available, it should run from the programmer set to Read. Otherwise a programmed 2532 or 2716 can be inserted and Address and Data lines checked with the routine in Table 7.1.

The decimal value of the data at each location is scrolled up the screen. If contents of EPROM are known, this can be verified. If no EPROM is available, test Address and Data lines with a logic probe, analogue multimeter, or 'scope.

This completes tests that all functions necessary for programming and reading EPROMs are working correctly.

This is also the completion of the series on Expanding the Vic 20. The author wishes to thank all readers who have taken an interest in the series and wishes them success in their efforts at construction and application of the interfaces. It has been a challenge, to design low cost interfaces of original design that really work, and it is hoped that the notes that accompanied each part have helped newcomers to electronics, from computing, to understand a little of the functional problems associated with interfacing.
Fig. 7.5. Flowchart is a guide to the software required to check that an EPROM is fully erased

Table 7.1. 2532 or 2716 EPROM check routine

10 L = 24576: REM Start address BLOCK 3
20 PRINT PEEK(L): REM Display decimal value at start address
30 L = L + 1: REM Move up to location 24577
40 GOTO 20: REM Repeat for consecutive addresses

Fig. 7.6. Flowchart is a guide to the software required for EPROM programming

---


PHILIPS N1700 V.C.R., working and with tapes. £75 o.n.o. Tel: Poulton (0253) 88141. Mr. N. K. Basquill, 48 Whiteholme Drive, Carleton, Poulton-le-Fylde, Lancashire FY6 7PP.

UK101, fully expanded, £65. 8" disc drive with interface for above £220. Both together for £225. Danny Fellows, 26 Westbourne Avenue, Emsworth, Hants. Tel: (0243) 5548.

METRIX Wobbulator Type 210. Range 5-220 MHz: for L.F. alignment: switchable bandwidths with CCTP data. £10. W.H.Y. Mr. B. French, 162 St. Bernards Avenue, Louth, Lincolnshire LN 11 8BH.

APPLE II Europlus 2 Drives NEC 12" Monitor. Basic Pascal Pilot Lap Discs. Excellent condition. £650. P. G. Boud, 23 Cranbrook, Manor Road, Twickenham, Middx. Tel: (894) 4429.

NEWBRAIN A with manuals and latest book "Getting more from your Newbrain". Immaculate. £170 o.n.o. Allan Trainer, Hunters Moon, Riverside Drive, Esher, Surrey KT10 8PG. Tel: Esher 63209.
GAIN CONTROLLED PREAMPLIFIER (SL 6270C)

The range of signal levels which can be obtained from modern microphones is very large indeed, varying from a few microvolts to several hundred millivolts. The differences in sensitivities of the microphones account for some of this signal range, although for any specific type of microphone the difference in signal level produced by a whisper several metres distant and a shout directly adjacent to the microphone is vast; ratios of thousands to one are typical. Because of the practical constraints of audio system design, we need to provide the means to control the gain of microphone amplifiers, such that the system can be optimised for most circumstances in which the microphone is likely to be used.

The majority of audio systems have manual adjustment of microphone level, allowing the owner or operator of the system to decide on the optimum gain setting at any given moment.

Some form of automatic control, on the other hand, is an attractive concept in simpler systems. While such an arrangement may lack sufficient quality or sophistication for very high fidelity audio, it is ideal for such applications as cassette recorders, public address equipment, intercoms, etc. The Plessey SL 6270C gain controlled preamplifier (sometimes known as a Voice Operated Gain Adjusting Device, or VOGAD) is a very easy and economic way to provide such an automatic gain control facility. Fig. 2 shows a block diagram of the i.c.

The pre-amp has a balanced low impedance input, specifically designed to match low impedance microphones with an impedance of 300 ohms (typically) or less. The microphone MUST be a.c. coupled to the inputs, hence the use of C1 and C2. The output of the pre-amplifier is fed via an internal 680 ohm resistor, and the external capacitor C3 (to ensure a.c. coupling between stages), to an inverting main amplifier, the output of which is fed to the automatic gain control (AGC) detector. The output of this, in turn, is fed back to the gain controlling input of the pre-amp via an internal 2k resistor. Hence, if a large signal is generated by the microphone, the AGC 'loop' turns the gain of the pre-amp down, and if a small signal is generated the AGC loop turns the gain of the pre-amp up. As a result of the constantly changing gain of the preamplifier, the main amplifier output level tends to remain constant.

AGC PARAMETERS

Normally, the i.c. will be required to respond very quickly to large input signals, decreasing the pre-amp gain to minimise overload of the input stage. When the signal from the microphone drops to a low level again the AGC is allowed to increase the gain, but only relatively slowly in case other large signals are about to be generated. Without this slow 'decay' the system can sound very unpleasant, with a 'sucking' or 'pumping' effect on the audio signal as the gain is constantly changed. The time taken to turn the gain down after receipt of a large signal is known as the 'attack' time, and is determined by the value of C4. It approximates to:

- Attack Time = 0-4ms per microfarad.

For a 47uF capacitor, this gives a 20ms attack time. The 'decay' time is the time taken to
usually made quite large in value to ensure a flat frequency response, so these are approximately 3.4 kHz. The values of C1 and C2 can also be altered to change these time constants.

Input signals of up to several tens of microvolts are amplified normally by 52 dB (typically), as indicated in the specification of Fig. 1. As the level increases, the AGC action gradually takes over, to eventually hold the output at a nominal 90 mV (for a 6 V supply) over an input range of over 50 dB. Reducing the main amplifier gain will reduce both the dynamic range of the system and its sensitivity. Connecting an external resistor between pins 7 and 8 will reduce the gain; for a 1 kΩ resistor the reduction will be 20 dB. Values of external resistors less than 680 ohms are not advisable. Full AGC action comes into play at around 1 mV for the standard circuit and 8 mV with the external 1 kΩ resistor fitted. Fig. 3 shows a graph of input vs. output for the i.c.; note that there is some compression of the dynamic range of the system and its levels will be the norm, where the distortion is considerably less than 1%.

Finally, care must be taken with the inputs to the i.c. These should normally be ac coupled; if dc coupling is used the resistance between pins 4 and 5 must be less than 10 ohms. The inputs are arranged differentially to suit balanced microphones, although unbalanced signals can also be accommodated. Because of the low input impedance, crystal or ceramic microphones supplied with many cheap cassette recorders, however, can often be ideal.

Although a wide range of supply voltages can be tolerated, the supply itself must remain constant in voltage during operation of the circuit. The AGC circuit is dependent on the supply voltage; change that voltage, and the AGC will clamp the output at a different level from the nominal 90 mV specified at 6 V supply. Hence, any ripple on the supply will modulate the output, and could lead to instability. Although the specification of Fig. 1 paints a pessimistic view of the distortion performance at higher input levels, the lower levels will be the norm, where the distortion is considerably less than 1%.

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PRACTICAL CONSIDERATIONS

There are many factors which affect the operation of this i.c. in practical systems. The first of these is frequency response; the SL 6270C has an open loop response of several megahertz, but it is normally intended for use in speech bandwidth systems. The frequency response is primarily defined by C3 and by a capacitor connected between pins 7 and 8 (C7 in Fig. 4). With the circuitry shown, and the values of 1 μF and 4 nF for C3 and C7, the bandwidth is approximately 240 Hz to 3 kHz. The values of C1 and C2 can also affect the frequency response, so these are usually made quite large in value to ensure that only C3 affects the lower frequency limit.

Although a wide range of supply voltages can be tolerated, the supply itself must remain constant in voltage during operation of the circuit. The AGC circuit is dependent on the supply voltage; change that voltage, and the AGC will clamp the output at a different level from the nominal 90 mV specified at 6 V supply. Hence, any ripple on the supply will modulate the output, and could lead to instability. Although the specification of Fig. 1 paints a pessimistic view of the distortion performance at higher input levels, the lower levels will be the norm, where the distortion is considerably less than 1%.

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APPLICATIONS CIRCUIT

The circuit diagram of a "baby alarm" is shown in Fig. 4; basically a one-way intercom used to monitor a child in a distant room. IC1 is an SL 6270C set up as previously described. C7 ensures stability by rolling off the gain of the main amplifier of IC1 at high frequencies. D1, R2, C5, and C6 decouple the power supply to IC1. Without this, the power amplifier, IC2, modulates the supply rails sufficiently to cause instability in the system. R3 is included to provide a small offset at pin 5 with respect to pin 4, again helping to prevent internal instability within IC1.

POWER AMP

IC2 is a simple power amplifier in a standard configuration. Note that the 'M' package (i.e. TBA 820M) should be used, since the TBA 820 has a different package type, incompatible with the given layout in Fig. 5. R6 and C14 provide bootstrapping, C13 provides frequency compensation, C11 reduces the effects of supply ripple, and C15 decouples the loudspeaker. C12 and R5 form a "zobel" network, which helps to ensure stability when driving into reactive loads, and R4 sets the gain of the power amplifier, decoupled by C10. Finally, VR1 controls the gain of the system, and C9 decouples the power supply.

The circuit is designed to be powered by a 9 V battery for safety and convenience, via D2 to protect against incorrect connection. Any type of loudspeaker will suffice, although its impedance should be at least 4 ohms, and preferably 8 ohms or more. A 0 V feed for the microphone is provided if required for screening, etc. The microphone should be connected between the two inputs as shown, or between one input and 0 V, in which case the unused input should be taken via its input capacitor to 0 V. (Never connect pin 4 or 5 directly to 0 V; always use a capacitor.) No heatsinking is normally required for IC2. In the interests of stability, it is strongly urged that the layout shown in Fig. 5 is closely adhered to. If the circuit still oscillates, and it isn't because of simple "howlround" or acoustic feedback, try increasing the values of C6 and C9, change R2 to 330 ohms, and try a new battery in place of the old one. Note that all capacitor values are shown at 25 Volt rating; in practice, 16 volt types are equally acceptable.

![Fig. 3. Graph showing input against output (unbalanced input)](image)

![Fig. 4. Circuit diagram of the Baby Alarm](image)
In use, the microphone is normally placed in the child's room, and is connected via screened cable to the unit in the required room; usually this is a kitchen, lounge, or parents' bedroom. The AGC action ensures that the child can be clearly heard, whether he or she is quietly complaining or shouting the house down! If required, the unit can be operated with the microphone local to the circuitry, and the speaker remote, although the volume will have to be preset, of course. The SL 6270C will find many uses in public address, tape recording, and simple telecommunications projects. It can be obtained from Watford Electronics, and the TBA 820M can be obtained from Cricklewood Electronics Ltd., 40 Cricklewood Broadway, London NW2 3ET.

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ET

Convergence was a fashionable catchphrase a few years ago. It foresaw a coming together of discrete electronic technologies to provide powerful integrated systems. The most obvious outcome is Information Technology (IT) which integrated display technology, telecommunications and data processing to spawn a whole new sector of the electronics industry, of which more later.

In the defence field a newly fashionable in-phase is Emerging Technology (ET) which is viewed by some military experts as a miracle alternative to theatre nuclear weapons. It has always been accepted that NATO forces would be outnumbered in manpower, tanks, guns and aircraft in the event of conflict. As a last resort to prevent catastrophic defeat it would be necessary to use tactical nuclear capability with the consequent risk of escalation to full rather than limited nuclear war.

It has also been argued that numerical advantage of men and materials of the potential enemy ought to some extent be counterbalanced by higher efficiency and technological superiority in one's own forces. ET would stretch this notion to its fullest extent. The brute force of the enemy would be blunted by super-sophisticated weapons of the conventional type.

It sounds good news for the industry. The giants in the defence sector such as Ferranti, GEC, Plessey and Racal together with dozens of smaller companies all stand to gain by a new impetus towards even more advanced systems. Again we see convergence, to integration in a single system of sensors for target acquisition, data processing for analysis, and terminal guidance for liquidation of threat.

Much of the technology is already available and is, in fact, in service. An example is Thermal Observation and Gunnery System (TOGS) being fitted to Britain's Chieftain and Challenger tanks. TOGS provides the ability to detect, track and engage targets by day or night in any weather without disclosing one's own position. At longer range there are precision guided munitions for artillery, and airborne stand-off weapons with fire-and-forget terminal guidance. Data processing is already commonplace in all the armed services in operational, logistical and administrative duties.

In a sense ET has already emerged but its supporters want it to emerge even more. The danger could come from over-sophistication and misplaced confidence in reliability. And while the push-button war might be effective in large set-piece battles, technical superiority was ineffective against a peasant army in Vietnam, remains so in Afghanistan and would be equally so in any brush-fire conflicts involving infiltration, fifth-column support and street fighting.

Whatever the military merits, ET is a short-term political winner. If it led to a nuclear freeze the anti-nuclear doves would be mollified without damaging the morale of the hawks. My own guess is that the nuclear option will be maintained but not expanded while ET will receive a modest boost. But much will depend on the attitude of the new leaders in the Soviet Union and the result of the presidential election in the United States.

IT

Whereas ET for defence is of relatively low volume and very highly priced, the reverse is true for IT where high volume production and tumbling prices is now the name of the game.

That the great publicity drive for IT has been a staggering success is high-lighted in the nominations for this year's TOBIE Awards. The winners, chosen by ballot among readers of Electronics Times, are to be announced at the All Electronics Show Dorchester Ball on May 2.

Acronym composers at Imperial College must have had quite a struggle to arrive at ALICE (Applicative Language Idealised Computing Engine), an advanced computer nominated in the 'Research Achievement' category. Her distinctive feature is a high degree of parallel, as distinct from serial, processing to give very high operating speeds. ALICE uses the Inmos transputer.

Competing against ALICE are Project Universe, an expanded form of local area networks and an array processor which enables robots to 'see' what they are doing and perform more intelligently. These are a sprinkling of the 21 TOBIE contestants but the general thrust is clear. Every product or system is aimed at higher speeds, lower costs, greater productivity. In short, the regeneration of British industry or, from another viewpoint, a further threat to jobs.

But the IT revolution does provide extra work and more jobs. There is plenty of investment and new job opportunities in Scotland's Silicon Glen and reports from the United States suggest a strong black market in some semiconductor devices. Delivery times have lengthened from a few months to a year and some short-supply items are said to be commanding as much as 20 times their list value. Speculative buying in the hope of big profit on re-sale is suspected. Monolithic Memories is but one firm with record order books who are monitoring all incoming orders to determine whether speculators might be distorting their usual projection of future demand. But MM have concluded that order growth is genuinely through demand.

Big Sister

Social conscience is a burden made even heavier when, after a quick check, I discovered that the Nexus home is nothing less than sexist. The total number of male plugs on my household and workshop appliances outnumber the demure female sockets with which they mate by over three to one.

A ridiculous assertion, of course, but no more silly than many calls for sexual equality from the Equal Opportunities Commission. In terms of numbers, electronic equipment manufacturers have always employed far more women than men, albeit in repetitive assembly work. But if we look in the R & D labs, at installation and commissioning engineers, and at management, males are predominant.

This year's WISE (Women in Science and Engineering) campaign hopes to get more girls in at professional level. At present of all our chartered engineers only one in a hundred is female. Of the new generation of engineering undergraduates at universities only 8-6 percent are female, in polytechnics only 3-2 percent.

Of course these figures cover all engineering disciplines. In electronics there is every reason to suppose that a better balance will be achieved naturally. The possibility of positive discrimination is unhealthy and I feel sure that thinking feminists would prefer employment by merit rather than by quota. So it's really up to the girls themselves. Electronics is a natural for them, the opportunities are there and they only need to work hard at it to increase their numbers. Equal opportunity has existed for years and a Big Sister to force the issue is totally unnecessary.

The Old and the New

Professor Eric Laitwhaite, famous for his work on magnetic levitation, has always contended that nature is more skilled at engineering than man. In fact he gets much of his engineering inspiration from the study of evolution, the continuous refinement of living structures over millions of years.

His example reminds us that we should never dismiss or discard earlier work. For instance the 'new' design of satellite communications aerials now being installed at Ealing and Madley don't use the conventional geometry. Instead they use the Gregorian, found to be more efficient in smaller sizes of dish. The principle is exactly that developed for an optical telescope by James Gregory, a Scottish mathematician who lived in the 17th century.
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RF KEY-FINDER

European patent item 089667, from Thomas William Nyiri of San Marino, California is a quaint idea with interesting possibilities. The idea is to track down lost keys, purses and wallets by fittng them all with a miniature receiver that produces an audible or visible signal when triggered by a transmitted search signal. Fig. 1 shows the transmitter, which will usually be a handheld battery powered gadget like a TV remote control. Chip 3 produces an r.f. signal on either CB or model-control frequencies. Encoder 4 chops the signal in a pre-arranged code. When the first stage of the receiver shown in Fig. 2 picks up a signal of correct frequency it triggers f.e.t. 9 to switch battery power 10 into the rest of the receiver. Decoder 12 distinguishes between random CB or model transmissions and a wanted search signal. It outputs to amplifier 13 and sound or light generator 14. The idea, of course, is to make the receiver small enough to attach to whatever it is you think you are going to lose. By using different transmission frequencies, or codes, one transmitter can search independently for several lost objects. The patent is rather short on detail but if the gadget could be made cheaply and small enough it would undoubtedly sell to anyone who routinely loses their car keys five minutes before they are due to leave home.

WRIST-WATCH THERMOMETER

A new British patent application 2118307 from the Citizen Watch Company of Tokyo suggests that wrist-watches with thermometers built-in may be the next consumer gimmick. A combined watch and thermometer can easily log temperature over a pre-set period of time, storing averages and maximum and minimum values. The snag, say Citizen, is finding an electrical element to measure temperature that is cheap, accurate and reliable. Thermocouples, for instance, are too expensive. A thermistor, a resistor which changes value with temperature, is cheap but difficult to use because the resistance changes value exponentially. Complicated circuits are needed to provide a linear readout. Citizen, in this very lengthy and detailed patent, explain how linearity may be quite simply achieved by using the thermistor to control the frequency of an oscillator circuit.

Fig. 1 shows a CR oscillator circuit, with thermistor 1, capacitor 2, two CMOS inverters 3 and 4 and CMOS NAND gate 5. A control signal G is applied to input P1. When signal G is low CR oscillator is switched off. When signal G goes high, CR oscillates to produce pulse signal F1 at terminal P2 of frequency determined by resistance R of thermistor 1. The temperature value can be derived from the pulse rate, but correction is needed to compensate for the non-linear change of resistance. Fig. 2 shows the circuit. The CR oscillator of Fig. 1 is shown at 6, receiving control signals G from circuit 7 and outputting oscillator pulses to frequency divider circuit 8. The division ratio of circuit B is varied according to the cumulative number of pulses counted at 10. Variations in the ratio are set at 9 to compensate for the exponential characterist of the thermistor. So the total pulse count at the end of a fixed time interval is directly proportional to temperature and is displayed at 11.

Readout will usually be on an LCD which also displays time. Citizen say that this circuit can be manufactured at "very low cost" and with a memory it is possible to arrange for ambient temperature to be measured and memorized at a fixed time each day, along with maxima and minima. The temperature readings taken can also be used to generate temperature compensation data for the clock circuits, to improve time-keeping accuracy.
ARE TODAY'S ELECTRONIC COMPONENTS LIKE THE DINOSAUR—TOO LARGE TO SURVIVE?

It is common knowledge that all electronic components, no matter what shape or size, have leads protruding from them... isn't it? After all, how else can they be soldered to a printed circuit board?

The answer to this question is investigated here, and it reveals a direction in equipment manufacture which is not common knowledge. A new technique is emerging; it's called SMA (Surface Mounted Assembly), and with it grows an army of leadless components called SMDs (Surface Mounted Devices). This development was spawned by the electronics industry in the face of fierce competition, and its urgent need to reduce assembly costs. In fact, components as we know them today will not allow further miniaturisation. Conventional devices represent a dead end.

SURFACE MOUNTED DEVICES

Leadless, surface mounted capacitors and resistors, commonly (and confusingly) called "chips", consist of small rectangular packages. These are of either plastic or ceramic construction, and are metallised at each end. Diodes, although they have a more recognisable body, also have metallised ends instead of leads, and all these devices are soldered by their metallised ends, directly to the top surface of the p.c.b.

SMDs have numerous advantages. They are smaller (allowing typically twice the p.c.b. packing density of conventional components), they are cheaper to use in end-product terms, and they are more reliable. Also, the absence of wire leads eliminates the radiating antenna effect that downgrades high frequency/switching performances in conventional components.

A high-performance car radio might comprise well over 500 components, and with such numbers it is easy to see why the SMD's high packing density and low profile appeals to forward-looking equipment manufacturers. Circuit board assembly costs can be as much as 50% lower than those for conventional "inserted" devices, so Mullard claims. The claim that SMDs are very much more reliable is nothing to do with their fabrication technology, but because they do not have to have leads or tags added, and because no lead-bending or cropping takes place during assembly—stages which frequently cause damage.

The Mullard SMD product line already covers some 80% of all component types which, according to the company, account for nearly all potential applications in the emerging digital era.

Who knows, in fifteen years' time, the hobbyist may need a magnifying glass and tweezers to handle components; components which it is already known, will be too small to accommodate printed values or colour codes. The development engineer too, will be forced into modular applications, rather than a breadboard approach to design. What else might the hobbyist one day need? A pot of glue!

GLUE?

The "pick-and-place" machinery used in automated SMA has to include a method of making the devices stay put until soldered. For without leads passing through to the other side of the p.c.b., these tiny devices would slide around during conveyance to the soldering station. The answer is glue. The pick-and-place must first daub a spot of glue on the underside of each component to be mounted, or drop a spot of glue on the p.c.b. itself. These special epoxy adhesives have been developed for short cure time (the boards are passed through an oven prior to soldering) and adequate viscosity.

SURFACE MOUNTED ASSEMBLY

At the heart of the pick-and-place assembly machine is the "pipette". The Mullard system comprises a mechanical jaw for clamping the component to be placed (the terms "place" and "insert" have a sharp distinction now that leadless devices exist). The pipette also incorporates a vacuum sensor which uses an embodied microphone to verify the presence of the component being handled.

These production machines are extremely fast, and may be software or hardware controlled. Reliability is higher here too, it is claimed. A run of 100,000 component placements before a single error occurs is quoted by Mullard as typical, this being 10 p.p.m. as opposed to an often quoted error figure of 1000 p.p.m.

SMDs are supplied on reels of tape containing blister packs, and partial standardisation is already achieved in this area. Real-estate savings to the manufacturer are considerable, too. SMA machinery occupies far less factory floor space.

Surface-mounting transistor
TERMINOLOGY
Over the last three or four years these new phrases have crept into the electronics press: "leadless chip carriers", "surface mounted devices" and "SO" devices. The "SO" package for i.c.s was defined by Philips (Mullard's parent company) back in 1967, and it then stood for "Swiss Outline", although the contemporary interpretation is "Small Outline".

At one time the surface mounted device and the leadless chip carrier were envisaged as exclusively the same thing, but in practice it will be found that surface mounting i.c.s have tabs on them for soldering. The same applies to transistors, although passive components are without leads.

MULLARD
As the reader may have begun to suspect, Mullard has a major involvement in this development. As the UK's largest electronics component manufacturer, its activity in the area of SMD and SMA equipment manufacture virtually represents Europe's only horse in this race, in which Japan looks set for an unassailable lead (the Japanese are said to be producing 6 billion surface mounted resistors a year). Whilst it is not too surprising to learn that in Japan 40% of all electronic equipment already makes use of the technology, nor that Europe is only just beginning to look seriously at it, it is surprising to find reports that the US is still further behind. Now, at least, a source of expertise and hardware, from the devices themselves through to the automatic placement machinery is, in the shape of Mullard Ltd., available in Europe.

MCM III is a hardware-automatic placement machine accommodating up to 12 placement heads. A typical handling capacity is 200,000 component placements per hour. Photograph courtesy of Mullard Ltd.

The unique pipettes of the Philips MCM range of automatic SMD placement machines

These boards fulfill identical functions. Generally, SMDs require only a third of the board space needed by conventional components. Photograph courtesy of Mullard Ltd. P.c.b. drilling is entirely eliminated

Examples of Mullard range of SMDs, including "chip" resistors, diodes, SOT package transistors, and i.c.s. All these miniature "chip carrier" outlines conform to international standards

A closer look at the SO transistors and diodes
SOLDERING

One of the first questions to spring to mind when looking at a board full of SMDs is, how are they production-soldered when the connections, and the devices, are on the same side? The assembled p.c.b.s shown to the press by Mullard were wave-soldered in the conventional way, but of course the components, it was explained, are designed to survive the wave of solder too. An interesting, and obvious outcome of all this, is that a p.c.b. can be double-sided in terms of both copper tracks and components!

New techniques in wave-soldering have had to be developed because, for example, the components tend to cast a "shadow" in the wave, possibly leaving themselves unsoldered at one end.

COST FACTORS

It is all very well the electronics industry concentrating progress on the integrated circuit; moving from MSI to LSI to VLSI etc., but i.c.s apparently account for around only 5% of the total equipment cost in current designs. Interconnect components (approximately 30 passives for each i.c. on average), on the other hand, are reported to account for nearly 25%. Mullard's specialists point out that if the trend towards miniaturisation, lower cost and failure rate, remains focused on i.c.s, a disproportionate cost relationship will soon arise.

It is obviously now necessary to develop the SMD, which, incidentally, was originally devised by the hybrid manufacturing industry for mounting on the surface of substrates, to rationalise equipment costs in the future. Moreover, new products will be possible only because of SMA — portable video equipment already depends heavily on the technique.

FUTURE

The development is important to industry now, the hobbyist later. But then, a glance through a late sixties copy of PE will reveal life at the dawn of the i.c. Not that long ago really, and later. But then, a glance through a late sixties copy of PE will reveal life at the dawn of the i.c. Not that long ago really, and then the quarter of a billion SMDs worldwide.

Industry sources suggest that by next year one-quarter of all equipment manufactured will contain SMDs. Another five years, and this figure will be one-half, which represents around 100 billion SMDs worldwide.

BAZAAR

MARLIN Cassette System, 30W amplifier with speakers, built but requires inter-board wiring. Uncased. £80. P. Rains. 3 Warwick Close, Knutsford, Cheshire WA16 8NA. Tel: (0565) 2958.

SCOPE Gould 05245A 10MHZ Dual trace hardly used. Probes instr. manual £130. Tel: 0202 886943/887240. R. Tarling, 35 High Street. Wimborne, Dorset BH21 1HR.

WANTED manual for Solatron Scope Model CD 1014.2. J. McAlmon, 7 The Meade, Chorltonville, Manchester M21 2EA Tel: (061) 2714.

ZX-81 16K RAM, Programs manuals and leads. Open to offers. Tel: Egremont (0946) 81521. Graeme Hodgson, 20 Chaucer Avenue, Orjill. Egremont, Cumbria CA22 2HB.

AVO DA. 116 Digital Multimeter. Hardly used. £65 o.n.o. Buyer collects. B.E. Hull, 21 Courtenay Road, Wantage, Oxon. OX12 7DW. Tel: Wantage 3372.

BUY: Acom Atom disc pack or controller card. Send details to: Tony Dale, 30 Cuffs Road, Christchurch, B. New Zealand.

ZX-81 16K with assembler, MCTT monitor, forth, toolkit, flight simulator. £55. Tel: 051-608 8617. D. Stephenson, 311 Woodchurch Road, Birkenhead. Merseyside £42.8P.

HALL effect K/Board 83 keys parallel ASCII output metal framed p.c.b. New, unused. £35 inc. (0782) 550684. N. Smith, 31 Meadow Avenue, Wetley Rocks, Stoke-on-Trent ST7 8D.

HI-RES graphics board for use with UK101 wanted. Preferably the kind produced by CUA, Hans-Petter Naa, 2450 Rena, Norway.

TELEQUIP 43 CRO with manual. Offers. 01-977 1549. John Petherick, 41 Somerset Road, Wantage, Oxon. OX12 7BT.

SMDs sprang from the hybrid industry. This is the IRDC1732 12-bit hybrid resolver and Inductosyn™-to-digital converter (for digital representation of angular or linear measurement). Photograph supplied by Analog Devices Ltd.

These SO i.c.s, launched by Texas Instruments less than a year ago, are shown compared to their d.i.l counterparts. They take up one-third of the board space, and are available in alternative packages to many of TI's more popular i.c.s. These SO packages started life at 1-6 times the cost of their conventional alternatives, but may already be on a price parity.

Industry sources suggest that by next year one-quarter of all equipment manufactured will contain SMDs. Another five years, and this figure will be one-half, which represents around 100 billion SMDs worldwide.
THE ISAAC NEWTON TELESCOPE

British astronomers are celebrating 'first light' at the new observatory which is being constructed on the island of La Palma, one of the Canary Islands group. The Isaac Newton 2.5-metre telescope, currently the largest optical telescope that Britain has, is now operational. It is one of a trio of British telescopes now being installed at La Palma; they are being funded by the Science and Engineering Research Council (SERC). These telescopes form the core of a new International Observatory. The official name for the installation is the 'Observatorio del Roque de los Machachos.'

The Isaac Newton telescope was first installed at Herstmonceux, Sussex at the site of the Royal Greenwich Observatory in the late sixties. In the 1970's it was decided by the SERC that the best place for the telescope would be in the northern hemisphere and in 1979 entered into an international agreement with Spain, the United Kingdom, Denmark and Sweden to build telescopes on the Spanish site at La Palma. As part of this agreement Spain was to provide a road to the peak, staff accommodation, power and telephone lines. In return the Spanish astronomers are guaranteed 20 per cent of the observing time. Also to share are the Dutch who are to have 20 per cent of the time on the three British telescopes. The Irish are also partners and would have 27 nights per year on the one-metre telescope.

The two telescopes presently installed are a one-metre and the Isaac Newton. The third telescope is the William Herschel which has a primary mirror diameter of 4.2 metres, the mirror has just been completed at Grubb Parsons, the famous telescope manufacturers based in Newcastle-on-Tyne. This will be operational in 1986 on La Palma. There are other telescopes at the observatory. The Swedes have installed a 0.6-metre reflector and a solar telescope. There is also an Anglo-Danish transit circle for accurate star positioning.

The new telescopes on La Palma will establish the United Kingdom's leading role in optical astronomy and so complement the world-leading position it holds in most of the major branches of astronomy. This applies especially to radio, infra-red, X-ray and theoretical research. For more than three centuries now the Royal Greenwich Observatory has been a centre of excellence in astronomical research. Originally its purpose was to study the position and apparent motion of the stars. These observations were required to ascertain the longitude on the Earth and Time measurement data.

Since the end of the last century activities were widened to include astrophysics and much ground has been covered since. Indeed several volumes would be needed to give even notes of the work done. It was the inevitable expansion that finally led to the need for the Isaac Newton telescope. The changing emphasis finally led to the transfer of the Royal Greenwich Observatory from the Admiralty to the Science and Engineering Research Council in 1965. Later the Observatory was transferred to Herstmonceux Castle, Sussex. It has of course retained the title of Royal Greenwich Observatory. This extended the telescope facilities throughout the whole of the astronomical community.

The results have been quite outstanding, the extended facilities have helped to develop some of the world's most sensitive detectors of light for use on telescopes, providing a continuity of development that university research departments cannot always maintain. Of the contribution to astrophysics of course there is a formidable record. In recent years astrophysicists have become interested in objects which are very faint optically. Much of this work has appeared in Spacewatch. Many have been found by radio astronomy, satellites and probes. Sometimes this is because the sources, such as quasars, are so far away or because they are so faint, the optical telescope constantly needs updating.

Of course most observations of very dim objects have to be carried out using large telescopes. Many of the observations have been made with telescopes in the USA and in Australia. An Anglo-Australian telescope is based in New South Wales. There is still work to be done by large Earth-based telescopes but they must be at suitable sites. The particular demands that are determined by the nature of the research must be observed if the results are to be valid. The telescope has confirmed the accuracy of data gathered on Earth. With the aid of the sophisticated techniques available to Earth-based telescopes, whose sensitivity has been enhanced thereby, there is the benefit of extra-terrestrial back-up.

The 4.2-metre William Herschel telescope was designed for La Palma. This telescope has special light detectors which have been supplied by the Royal Greenwich Observatory and will ensure a sensitivity second to none. This is one of the reasons that the SERC are funding this project. The decision to make this site available to all researchers, from anywhere in the world, is the truly democratic way of knowing more about our place in the Universe.

It is to this end also that the new large infrared telescopes have been funded. These have the Island of Hawaii as their site. The parent organisation of the large infrared instrument, the Royal Observatory of Edinburgh, has already shown its worth and has also demonstrated how the techniques of remote control can be such that the researcher does not have to be present at the telescope site. The control and remote viewing can be done from the comfort of the home station. Much of this has been described in detail in previous issues of Spacewatch. The other telescope at Hawaii is the 'millimetre-wave' telescope. This will help to resolve the unexplored area of the spectrum between infra-red and radio wavelengths.

EXTRA-TERRESTRIAL OBSERVATION

It is necessary to make proper reference to the extra-terrestrial activity. The observations from the Earth are complemented by instruments above the atmosphere. This covers a whole new field because the absorption by the atmosphere is no longer an obstacle. The SERC has supported the researchers in universities. This has been put into effect at Leicester University and University College, London. These two have contributed very well as pioneers in X-ray astronomy.

British astronomers have also a large stake in satellites investigating the Universe in the infra-red and ultra-violet. This was the IRAS and the International Ultraviolet Explorer. The data from IRAS, which has now ceased its mission, will take a decade to analyse.

On the interpretive side university astronomers and researchers of the RGO and the ROE are keeping the UK at the forefront in theoretical astronomy especially cosmology which deals with galaxies today and more recently the black holes. So the new International Observatory will take learning into the next century.

THE WILLIAM HERSCHEL TELESCOPE

This was named after the Musician/Astronomer. He was the remarkable man who in 1781 discovered the planet Uranus. Of course originally it was called Herschel, after its discoverer. His skill as a telescope maker was quite exceptional. The telescope that bears his name in commemoration is very much larger than those which he made. The present telescope has a primary mirror which is a metre in diameter. It is the third largest in the world. So the man who should be called the father of observational cosmology will be honoured again in tribute by the users of this instrument. The exceptional viewing site together with the use of the most modern light detectors will give this telescope the advantage over others. Although its mirror is smaller than those of the American or Russian telescopes it will be able to see farther than either.

The telescope itself, which was once the only step between the observer and his target, has use intermediate apparatus for research purposes. Again modern techniques dispense with the human being and give the human a more accurate picture of what is taking place. This instrumentation is superior indeed to the human. It does however furnish data which enables the human to think with reliable 'known' information. So it is now possible to determine a situation without the need to 'see' directly. Fortunately it is possible to expand a good deal about these techniques, they will be explained more fully in a forthcoming issue of Spacewatch.

Frank W. Hyde
WE shall begin this month with a practical example of the use of J-K bistables and logic gates in the form of a traffic lights simulator. For simplicity we shall only concern ourselves with the most basic form of traffic lights once encountered at road works, i.e. those which consist of two lights only; red and green. This is a system with which most of us are all too familiar.

Even so, it is worth reminding ourselves of the sequence of events in such a system.

Let us assume that the traffic lights are labelled TL1 and TL2. The sequence of operation of the lights should follow the pattern:

<table>
<thead>
<tr>
<th>TL1</th>
<th>TL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

In fact there will be two lamps fitted in each traffic light unit. If we refer to these separately as TL1(red), TL1(green), etc. and use 1 to denote 'light on' and 0 to denote 'light off', we arrive at something which is more akin to a truth table as shown in Table 8.1.

<table>
<thead>
<tr>
<th>TL1</th>
<th>TL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

There are two things to note from this:

1. The red and green lamps in either traffic light are always complementary. Thus:
   
   TL1(red) = TL1(green)
   
   and
   
   TL2(red) = TL2(green)

2. The sequence of operation consists of four distinct states repeated over and over again.

For the purpose of this example we shall assume that each state occupies the same time interval. In practice, and dependent upon the traffic flow and separation of the traffic lights, this may not be the case. In any event, we shall require a clock in order to define our basic unit of time, i.e. the time interval for any one of the states in the sequence. The clock can take the form of any one of the several circuits previously described but, for convenience, we shall use the clock oscillator provided within the Logic Tutor. This will give us a basic time interval (clock period) of approximately 1 second: long enough for us to see what is happening, but far shorter than would be acceptable in practice!

The four logic states, corresponding to those shown in the Table 8.1, can be generated by two J-K bistables in conjunction with some additional logic. The J-K bistables operate as binary dividers (as discussed in Part Seven), and the additional logic is used to decode the bistable outputs (Q1 and Q2) into the required logic 1 and logic 0 states to activate the four lamps: TL1(red), TL1(green), TL2(red), and TL2(green). The basic arrangement of the logic control system is shown in Fig. 8.1.

The four states produced by the two bistables will follow the normal binary counting sequence. If the bistable outputs are labelled Q1 (LSB) and Q2 (MSB) we arrive at the sequence:

<table>
<thead>
<tr>
<th>Q2</th>
<th>Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Combining this sequence with the truth table which we saw earlier gives the complete truth table shown in Table 8.2. Here we have shown 'inputs' from the simple binary counter and 'outputs' required from the decoding logic. Now we are confronted with the problem of what must go into the decoding box!

### Table 8.2. Complete truth table

<table>
<thead>
<tr>
<th>Q2</th>
<th>Q1</th>
<th>TL1</th>
<th>TL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 8.1. Truth table for the Traffic Lights

Table 8.2. Complete truth table

Fig. 8.1. Basic block schematic of the traffic light simulator
If we concentrate on the green lamps only (remember that the red lamps are always the opposite) we can readily develop the Boolean expressions from the truth table:

$$TL1(green) = Q1 \cdot Q2$$

$$TL2(green) = Q1 \cdot Q2$$

The red lamps are simply the complement of the above:

$$TL1(red) = \overline{Q1} \cdot \overline{Q2}$$

$$TL2(red) = \overline{Q1} \cdot \overline{Q2}$$

Again, concentrating on the green lamps initially, TL2(green) can be generated very easily by applying the Q1 and Q2 outputs to an AND gate.

For TL1(green), however, we will require Q1 to be AND'ed with Q2. Happily, this is no great problem since our J-K bistable provides us with a 0 output! We can now, tentatively at least, sketch out the logic arrangement of our traffic lights controller, adding inverters between the red and green outputs. This arrangement is shown in Fig. 8.2.

Rather than use a mixture of AND gates and inverters (which would require two integrated circuits in the decoding section) we could just use one quad two-input NAND i.c., as shown in Fig. 8.3.

The circuit can now be assembled on the Logic Tutor. Insert the 7473 dual J-K bistable into socket A and the 7400 quad two-input NAND into socket B. Carefully ensure that pin 1 aligns with socket 1 in each case. The following links should then be connected:

- A1 to clock (clock input)
- A2 to A3
- A3 to A16
- A4 to +5V (supply)
- A5 to A14 (Q1)
- A6 to A7
- A7 to A12
- A10 to B14 (Q2)
- A11 to B2 (Q2)
- A12 to logic 1
- A13 to 0V (supply)
- A14 to B1
- A16 to logic 1
- B1 to B15
- B3 to B4
- B4 to B5
- B5 to D4 (TL2(red))
- B6 to D3 (TL2(green))
- B7 to 0V (supply)
- B10 to D1 (TL1(green))
- B11 to D2 (TL1(red))
- B12 to B11
- B13 to B12
- B16 to +5V (supply)

Total of 24 links.

The keen student will doubtless wish to further develop the simulator. The following exercises are suggested:

1. Incorporate extra gating so that a red warning light is available to the workmen which indicates that either one of the traffic lights is showing green.
2. Improve the operation of the lights by increasing the period for which a green light shows. Make this equivalent to two clock cycles. (Hint: It will be necessary to use a further 7473 J-K bistable).
3. Devise a system for controlling three lamps in each traffic light obeying the following sequence:

<table>
<thead>
<tr>
<th>TL1</th>
<th>TL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>green</td>
</tr>
<tr>
<td>red/amber</td>
<td>amber</td>
</tr>
<tr>
<td>green</td>
<td>red</td>
</tr>
<tr>
<td>amber</td>
<td>red/amber</td>
</tr>
<tr>
<td>red</td>
<td>green</td>
</tr>
<tr>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

4. Devise an arrangement for controlling a 'Pelican' pedestrian crossing. This type of crossing uses a conventional three-lamp traffic light to control vehicles and a two-lamp light to control pedestrians, with an audible output during the period for which the pedestrian light is a continuous green.
INTRUDER ALARM FOR THE ELECTRONIC SHOP
(A practical design example)

As a 'grand finale' in the use of TTL, we have included an example of the design of a simple intruder alarm for the electronic shop which we first met in Part Two. This example has been chosen so that it illustrates many of the logic elements and techniques previously discussed.

Let us imagine that the owner of the shop requires an intruder alarm to protect the premises during the hours in which the shop is closed. The shop is to be fitted with magnetic window and door switches. For the purpose of this example we will assume that only two switches have been fitted, although in practice it would be a fairly simple matter to add as many additional switches as required. The switches are a type which open whenever the door or window is open, and close whenever the door or window is closed. These "normally closed" switches can be arranged to generate a 0->1 edge whenever the respective door or window is opened by means of the arrangement shown in Fig. 8.5.

![Fig. 8.5. Method of generating a pulse when a window or door is opened](image)

The intruder alarm is to have a control panel located just inside the door (so that it remains visible from the outside), and a keyswitch is to be placed in the wall adjacent to the door. The shopkeeper requires that a warning light be incorporated in the control panel to remind him that either the door or the window has been left open, thus enabling him to check the state of the premises at the end of the day before locking the door and setting the alarm.

Once triggered by an intruder, the alarm is to activate an audible warning device which is to be repeatedly pulsed on and off. For test purposes, when the audible warning device is temporarily disconnected, a further warning light is to be incorporated into the control panel to show that the alarm has been set off. The exterior keyswitch is used to set the alarm to the active state and to reset or disable it before entering the premises. The switch is connected to produce a logic 1 in the set/active condition and logic 0 in the reset/disabled position. The keyswitch is to activate a further warning light so that the shopkeeper is aware of the state of the alarm before unlocking the door.

The essential components of the system are shown in Fig. 8.6. Having established the operational features and nature of the external components, we shall now concentrate on the contents of the logic control box. This is where our experience in digital electronics can really be put to the test! In order to keep things simple we shall follow the design process through stage by stage and readers may wish to use the Logic Tutor to verify each section in turn. We shall start by combining the logic outputs of the window and door switches but, before we do, it is a good idea to list the functions of the various switches and indicators that we will be using on the Logic Tutor:

- S1 window switch (logic 1 when window open)
- S2 door switch (logic 1 when door open)
- S3 alarm (logic 1 to set, 0 to reset)
- D1 door/window open
- D2 alarm set (active)
- D3 alarm triggered

The logic outputs from the window and door switches, S1 and S2 respectively, need to be combined in an OR gate in order to provide a logic 1 output whenever either or both of them is open. This could be carried out quite simply using a single two-input OR gate, as shown in Fig. 8.7.

Before making a final decision as to which type of gate we should employ, it is worth considering the requirements of the next stage in the logic system. This would have to be a bistable element simply because an essential property of an intruder alarm is that it "remembers" that it has been triggered, providing a warning until someone arrives to disable it. Almost any type of bistable which has a CLEAR or SET input would be suitable. We shall settle for a simple 7474 D-type. Remember that, with a D-type bistable, data (in the form of a logic 0 or logic 1) is transferred into the bistable when there is a change of state at the clock input. Such a change can either be positive going (0->1) or negative going (1->0), depending upon the internal logic of the bistable. With the 7474 clocking occurs on a rising clock edge, and thus a 0->1 transition is required from the previous logic gate.

An OR gate produces a 0->1 output whenever either one of its inputs is taken to logic 1. A NOR gate, on the other hand, produces an opposite, 0->1 transition under similar circumstances. Thus the OR gate is to be preferred.

Now we shall turn our attention to the bistable section itself. The state of the Q output indicates whether, or not, the alarm has been triggered and thus, initially at least, the Q output should be logic 0. To ensure that it is, we can use the CLEAR input; this is simply connected directly to the keyswitch which provides logic 0 to reset the alarm.
(Note that the 7474 has a CLEAR input which is "active low"). The DATA input must be connected to logic 1 so that a logic 1 will be transferred to the Q output whenever a negative going clock input appears (i.e. when a window or door is opened).

The 'alarm set' indicator, D2, can simply be connected to the output of the keyswitch, S3, whilst the 'alarm triggered' indicator, D3, is taken directly from the Q output of the bistable. In a practical circuit, due to current sourcing limitations, such an indicator should be connected between the positive supply and Q output. The Logic Tutor's indicator diodes (D1 to D4) are, however, already buffered and may be used directly. The arrangement thus far is shown in Fig.8.8.

The final stage is to provide an audible warning indication which is capable of being pulsed on and off. On the Logic Tutor we shall use a simple piezoelectric transducer to simulate such a device. Low power transducers, particularly those which are p.c.b. mounted, consume currents as low as 10mA or less from a nominal 5V supply, and may thus be connected directly to the output of a conventional TTL gate. In this respect, they should be treated in the same manner as an i.e.d. load, i.e. connected from the +5V supply to the output of the gate. In a practical circuit, a buffer would be required in order to sink sufficient current to activate a high output alarm transducer.

At this point our design strategy can be usefully changed so that we now work backwards from the output to the bistable stage. The transducer will be connected between the output of the final gate and the positive supply, thus a logic 0 output from the gate will be necessary in order to activate the alarm. The final gate must therefore be an inverting type (unless we use the Q output from the bistable!). If the gate is a two-input NAND, one input can be taken from the Q output of the bistable and the other can be supplied from a simple Schmitt TTL oscillator of the type which we met in Part Six. The timing components (resistor and capacitor) can be chosen so as to produce an output at an appropriate frequency in the range 1Hz to 4Hz.

The final circuit of the intruder alarm is shown in Fig. 8.9 and the relevant timing diagram has been shown in Fig. 8.10. It must be stated that the alarm does not provide all of the functions which one might expect to be present on a proprietary security system.

---

To simulate the complete intruder alarm system, insert 7432, 7474, 7400 and 7414 i.c.s respectively in sockets A, B, C and E of the Logic Tutor. In each case check that the device has been inserted with the usual orientation, i.e. pin 1 to socket 1. The following links are now required:

- A1 to S1 (window switch)
- A2 to S2 (door switch)
- A3 to B3
- A7 to 0V (0V)
- A16 to +5V (positive supply)
- B1 to S3 (alarm set/reset)
- B2 to logic 1
- B3 to D1 (door/window open indicator)
- B4 to logic 1
- B5 to D3 (alarm triggered indicator)
- B7 to 0V (0V)
- B16 to +5V (positive supply)
- C1 to B5
- C2 to E2
- C3 to piezoelectric transducer (+ve)
- C7 to 0V (0V)
- C16 to +5V (positive supply)
- E1 to E2 via 470 ohm resistor
- E1 to 0V via 220µF capacitor
- E7 to 0V (0V)
- E16 to +5V (positive supply)
- S3 to D2 (alarm set indicator)

(To total of 23 links)
Readers may like to develop and extend the circuit incorporating some, or all, of the following suggested modifications:

1. Re-design the logic arrangement in order to replace the OR gate with the three unused NAND gates.
2. Add an input from a pressure sensitive mat to be placed behind the door. Assume that the mat has a 'normally open' switch. One of the unused inverters may be useful here!
3. Add an extra switch (to be located on the logic control panel) which allows the alarm to be tested without having to disconnect the audible warning device. The switch is to be a pushbutton type and should be used in conjunction with the unused bistable.
4. Add an extra output to activate an external alarm bell via a relay. The alarm bell is to be operated from a 12V battery (also external) and is to continue to operate in the event of an intruder gaining access to the premises and cutting the alarm bell connection to the control box.

Although this is the final part of our course, to complement the series, we'll be looking at CMOS devices next month and another Digital Project, the Oscilloscope Calibrator.

QUESTIONS

If you have any questions or queries you would like answered regarding our Digital Electronics series we would be pleased to receive them at our Editorial offices. All questions must be related to the course and we will publish as many questions and answers as possible. Also if you have any comments or observations about any part of the course we would be pleased to receive them.

The address to write to is: Practical Electronics, Digital Electronics Questions, Westover House, West Quay Road, Poole, Dorset BH15 1JG.

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Please return this page to Practical Electronics, May 1984.
### NEW LOGIC TESTER

Sir — I am a regular reader of Practical Electronics and followed the early series of articles on interfacing the Compukit with great interest. One of the programs (UK 101 Logic Tester) given back in the February '81 issue proved quite helpful in getting to grips with the PIA. However, after a while a number of shortcomings became apparent, namely that it only polled port A, and the rate at which it did this was fairly low. The program enclosed solves both problems in that it polls both ports, and because it is in machine code, polls the ports very rapidly and displays the inputs on the screen.

The program, which operates under a 'Cegmon' monitor, fits neatly into page two from 0236 and leaves seven free bytes below the basic workspace. The program once loaded into memory is run by typing '0236'. The sequence of events is then: the screen is cleared and the words 'PORT A' and 'PORT B' are displayed, the PIA is then configured so that all of the lines are set to input, next the input at port A is stored and each bit displayed (as with the basic program), the same is done for the input at port B, then checks for 'CTRL C' and 'CTRL A' are made before looping back to poll port A. By pressing 'CTRL A' the PIA may be reconfigured; this may be useful if the reset button on the monitor. However, should anyone require a portable version located at 0300 onwards, I would be pleased to send them a copy of the listing. (via the editor of PE).

As an extra, altering the contents of location 029F will change the rate at which the ports are polled.

---

**Joseph Arrowsmith, London**

#### CEGMOM PIA LOGIC TESTER

<table>
<thead>
<tr>
<th>Line</th>
<th>Assembly Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0235</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0236</td>
<td>20 59 FE JSR FE59</td>
<td>Store for port inputs.</td>
</tr>
<tr>
<td>0239</td>
<td>A9 50 LDA 50</td>
<td>Clear screen.</td>
</tr>
<tr>
<td>023B</td>
<td>BD 12 D2 STA D212</td>
<td>Put 'PORT A' and 'PORT B' on the screen.</td>
</tr>
<tr>
<td>023E</td>
<td>BD 92 D2 STA D292</td>
<td></td>
</tr>
<tr>
<td>0241</td>
<td>A9 4F LDA 4F</td>
<td></td>
</tr>
<tr>
<td>0243</td>
<td>BD D2 STA D213</td>
<td></td>
</tr>
<tr>
<td>0246</td>
<td>BD 93 D2 STA D293</td>
<td></td>
</tr>
<tr>
<td>0249</td>
<td>A9 52 LDA 52</td>
<td></td>
</tr>
<tr>
<td>024B</td>
<td>BD 14 D2 STA D214</td>
<td></td>
</tr>
<tr>
<td>024E</td>
<td>BD 94 D2 STA D294</td>
<td></td>
</tr>
<tr>
<td>0251</td>
<td>A9 54 LDA 54</td>
<td></td>
</tr>
<tr>
<td>0253</td>
<td>BD 15 D2 STA D215</td>
<td></td>
</tr>
<tr>
<td>0256</td>
<td>BD 95 D2 STA D295</td>
<td></td>
</tr>
<tr>
<td>0259</td>
<td>A9 41 LDA 41</td>
<td></td>
</tr>
<tr>
<td>025B</td>
<td>BD 17 D2 STA D217</td>
<td></td>
</tr>
<tr>
<td>025E</td>
<td>A9 42 LDA 42</td>
<td></td>
</tr>
<tr>
<td>0260</td>
<td>BD 97 D2 STA D297</td>
<td></td>
</tr>
<tr>
<td>0263</td>
<td>A9 00 LDA 00</td>
<td></td>
</tr>
<tr>
<td>0265</td>
<td>BD 9D EF STA EF9D</td>
<td>Access data direction register on port A.</td>
</tr>
<tr>
<td>0268</td>
<td>BD 9F EF STA EF9F</td>
<td>Access data direction register on port B.</td>
</tr>
<tr>
<td>026B</td>
<td>BD 9C EF STA EF9C</td>
<td>Set data direction for input on port A.</td>
</tr>
<tr>
<td>026E</td>
<td>BD 9E EF STA EF9E</td>
<td>Set data direction for input on port B.</td>
</tr>
<tr>
<td>0271</td>
<td>A9 FF LDA FF</td>
<td>Code for peripheral register A.</td>
</tr>
<tr>
<td>0273</td>
<td>BD 9D EF STA EF9D</td>
<td>Code for peripheral register B.</td>
</tr>
<tr>
<td>0276</td>
<td>BD 9F EF STA EF9F</td>
<td>Alter subroutine to print up contents of port A.</td>
</tr>
<tr>
<td>0279</td>
<td>A9 18 LDA 18</td>
<td>Do 'CTRL C' check.</td>
</tr>
<tr>
<td>027B</td>
<td>BD F1 02 STA 02F1</td>
<td>Collect input on port A.</td>
</tr>
<tr>
<td>027E</td>
<td>20 94 FB JSR FB94</td>
<td>Store input at 0235.</td>
</tr>
<tr>
<td>0281</td>
<td>AD 9C EF STA EF9C</td>
<td></td>
</tr>
<tr>
<td>0284</td>
<td>BD 35 02 STA 0235</td>
<td>Go to subroutine to determine which bits are on.</td>
</tr>
<tr>
<td>0287</td>
<td>A0 10 LDY 10</td>
<td>Alter subroutine to print up contents of port B.</td>
</tr>
<tr>
<td>0289</td>
<td>20 BF 02 JSR 02BF</td>
<td></td>
</tr>
<tr>
<td>028C</td>
<td>A9 98 LDA 98</td>
<td>Collect input on port B.</td>
</tr>
<tr>
<td>028E</td>
<td>BD F1 02 STA 02F1</td>
<td>Store input at 0235.</td>
</tr>
<tr>
<td>0291</td>
<td>A0 10 LDY 10</td>
<td>Go to subroutine to determine which bits are on.</td>
</tr>
<tr>
<td>0293</td>
<td>AD 9E EF LDA EF9E</td>
<td>Transfer Y register to Accumulator.</td>
</tr>
<tr>
<td>0296</td>
<td>BD 35 02 STA 0235</td>
<td>Transfer Y register to Accumulator.</td>
</tr>
<tr>
<td>0299</td>
<td>20 BF 02 JSR 02BF</td>
<td>Transfer Y register to Accumulator.</td>
</tr>
<tr>
<td>029C</td>
<td>9B TYA</td>
<td>Do 'DELAY2'.</td>
</tr>
<tr>
<td>029D</td>
<td>4B PHA</td>
<td>Pull Accumulator off stack.</td>
</tr>
<tr>
<td>029E</td>
<td>A0 08 LDY 08</td>
<td>Transfer Accumulator to Y register.</td>
</tr>
<tr>
<td>02A0</td>
<td>20 E1 FC JSR FCE1</td>
<td>Check for 'CTRL A', if not pressed JMP 0279,</td>
</tr>
<tr>
<td>02A3</td>
<td>68 PLA</td>
<td>if pressed do JMP 0263 to reconfigure ports.</td>
</tr>
<tr>
<td>02A4</td>
<td>A8 TAY</td>
<td></td>
</tr>
<tr>
<td>02A5</td>
<td>A9 FE LDA FE</td>
<td></td>
</tr>
<tr>
<td>02A7</td>
<td>BD 00 DF STA DF00</td>
<td></td>
</tr>
<tr>
<td>02AA</td>
<td>2C 00 DF BIT DF00</td>
<td></td>
</tr>
<tr>
<td>02AD</td>
<td>70 0D BVS 02BC</td>
<td></td>
</tr>
<tr>
<td>02AF</td>
<td>A9 FD LDA FD</td>
<td></td>
</tr>
<tr>
<td>02B1</td>
<td>BD 00 DF STA DF00</td>
<td></td>
</tr>
</tbody>
</table>
02B4 2C 00 DF BIT DF00
02B7 70 03 BVS 02BC
02B9 4C 63 02 JMP 0263
02BC 4C 79 02 JMP 0279
02BF 20 EB 02 JSR 02EB Display Bit 0.
02C2 6A ROR A Move Bit 1 to Bit 0.
02C3 20 EB JSR 02EB Display Bit 1.
02C6 6A ROR A Move Bit 2 to Bit 0.
02C7 6A ROR A
02C8 20 EB JSR 02EB Display Bit 2.
02CB 6A ROR A Move Bit 3 to Bit 0.
02CC 6A ROR A
02CD 6A ROR A
02CE 20 EB JSR 02EB Display Bit 3.
02D1 6A ROR A Move Bit 4 to Bit 0.
02D2 6A ROR A
02D3 6A ROR A
02D5 20 EB JSR 02EB Display Bit 4.
02D8 2A ROL A Move Bit 5 to Bit 0.
02DA 2A ROL A
02DB 2A ROL A
02DC 20 EB JSR 02EB Display Bit 5.
02DF 2A ROL A Move Bit 6 to Bit 0.
02E0 2A ROL A
02E1 2A ROL A
02E2 20 EB JSR 02EB Display Bit 6.
02E5 2A ROL A Move Bit 7 to Bit 0.
02E6 2A ROL A
02E8 20 EB JSR 02EB Display Bit 7.
02EA 60 RTS Return to main program.
02EB 29 01 AND 01 Mask off top 7 Bits.
02ED 18 CLC
02EE 69 30 ADC 30 Add ASCII character offset.
02F0 99 18 D2 STA D218, Y Print to screen.
02F3 88 DEY Point STA D218, Y to the next print location.
02F4 88 DEY
02F5 AD 35 02 LDA 0235 Collect input data from storage at 0235, and return to main subroutine.
02F8 60 RTS
02F9 00 BRK
02FA 00 BRK

CONTROLS
1) To start the program enter the monitor and type "0236 G".
2) Pressing "CTRL C" at any time will cause a warm start.
3) Pressing "CTRL A" at any time will cause the PIA to be configured for input. This may be used after the PIA has been reset.
4) The sampling rate may be changed by altering the value stored at location 029F. '00' gives a high sample rate whereas 'FF' gives a slow rate.

LOGIC SYMBOLS

It is emphasised that material presented in Micro-Bus has not necessarily been proved by us. Neither can compatibility with all generations of the computer equipment to which it relates be guaranteed. Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.
When designing this power supply, I considered adding over-voltage protection, various forms of current limiting and alarms, but experience has shown that these can be more trouble than they are worth. Thus the design offered here has no embellishments, nor is it a revolutionary design. What it does offer is a simple to build, relatively cheap, simple to use power supply with some options open for variation.

Over a period of time it was found that the voltage range most used is 5 to 12 volts, with occasional drops to 2V to test I.e.d.s. Current requirements rarely exceeded 1 amp, so with these criteria in mind, various regulators were looked at, and finally the LM317 was settled upon. I selected the 317K which is capable of delivering 1.5A, but the p.c.b. has been designed to accommodate the 317M as an alternative, which will give 500mA for readers who require a less substantial power supply. The transformer can then be down-rated. Both regulators have built-in fold-back current-limiting and thermal protection.

A 12 volt transformer was used simply because I already had one, but if constructors want to be able to draw 15V at full current rating, the transformer should be upgraded to 15V or 17.5V. By limiting the range of the power supply it was possible to use two large clear meters to give voltage and current readings without having to resort to switched ranges etc.

**HOW IT WORKS**

The secondary a.c. voltage is bridge rectified by REC1 and smoothed by C1. The resultant unregulated d.c. enters the IN pin of the 317, with C2 and C4 included to aid the stability of the regulator. The action of the i.c. is such that the output pin produces a voltage 1.25V higher than that on the ADJ pin, which is variable by means of the ratio between R1 and VR1. The circuit as described so far has a ripple-rejection factor of approx 85dB, but by adding a bypass capacitor C3 and a protection diode D1, this can be increased to approx 80dB. D1 is needed to provide a discharge path for C1 under output short-circuit conditions to prevent the capacitor discharging back into the i.c. For those readers who may be worried about the possibility of an input short circuit condition, another diode, D2, can be included to restrict the output to input reverse voltage. The d.c. regulated voltage then goes via the meter and the switch to the output terminals. A third socket for earth is also included.

**CONSTRUCTION**

It was decided for various reasons to use a Centurion case (WX3) and the finished result looks extremely professional. Once the case had been decided upon, the largest meters possible were selected to make readings easy, and the ML52 series fitted the bill perfectly.

Though few components are involved, it is recommended that for ease of construction a p.c.b. be used, and a suggested design is given in Fig. 2. A mains fuse is included and for safety reasons should not be omitted. Insert the components, including the i.c. if the 317M has been chosen (metal tab to the edge of the p.c.b.). Otherwise insert three Veropins for connection to the 317K, and Veropins for all other connections. Mount the p.c.b. in the case (in such a position that the 317M if used can be bolted via a mica washer to the rear panel). The 317K should be mounted on the rear panel, also with an insulating kit.

Theoretically a 2.2k potentiometer should produce a voltage output from 1-25V to 12-5V, but variable pots of this value are rare, 5k being much more common, so to avoid a cramped first half and a useless second half of the knob’s travel, a 5-6k resistor is connected in parallel to make the effective resistance 0-2-8k approximately. This was then mounted, along with the other components on the front panel, which had been drilled and cut to suit. Mount the transformer, incorporating a solder tag for the earth wire, and drill a hole in the rear panel for the strain-relief bush. Next make all the necessary interconnections according to
COMPONENTS...

Resistors
- R1: 220 Ω 1/2W 5%
- R2: 5k6 (see text)

Capacitors
- C1: 4700μF 25V elect.
- C2: 220nF 25V tant.
- C3, 4: 10μF 25V tant. (2 off)

Semiconductors
- D1, D2: 1N4002
- IC1: LM317K or LM317M (see text)

Miscellaneous
- Centurion case: WX3
- ML52 meter: 0–15V 0–1A
- BR1: SO4
- Terminal posts: red, black, green
- Fuseholder and fuse 250mA (20mm)
- SPST toggle switch
- Neon
- Nuts, bolts etc.

Transformer
- T1: 0–12, 0–12V 25VA

Fig. 1. Circuit diagram

Fig. 2. Printed circuit board (actual size)

Fig. 3. Component layout
Fig. 4 and use thicker than normal wire for the output connections to avoid unnecessary voltage drops caused by lead resistance. Take care with the mains connections, particularly those to the neon as these can be easily touched inadvertently. After a final check the case can be bolted together and a useful piece of equipment added to the workbench.

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- Casing-High impact textured ABS
- Colour-Brown; front and base panels 1.6mm satin anodised aluminium

Hand Held Box
This box is moulded in two sections and has a textured finish. The battery compartment accepts a PP3 or nickel cadmium stack 25 x 45mm long. A circuit board 56 x 105mm may be mounted on these pillars in the base, location being provided by a 3mm spigot. The top moulding will accept a circuit board 71 x 107mm.
- Material-Textured ABS
- Colour-Dark brown

Plastic Boxes
Type A
Plastic boxes consisting of a top and bottom moulding with front and rear aluminium panels, positively retained in the two halves.
- Top and bottom moulding-High ABS.
- Colour-Light grey top; dark grey base
- Front and rear panels-Satin anodised aluminium 1.6mm thick.

Type B
Constructed of high impact polystyrene, these handsome two-toned grey boxes are suitable for wall mounting and free standing instruments. The two halves of the box are held together by screws inserted from the base.
- Material-High impact polystyrene
- Colour-Top light grey; base dark grey
- Panels-Satin anodised aluminium

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**INTRUDER ALARM**

The circuit is described in its simplest form in order to show how very easy it is to construct a reliable alarm system for your home, or workshop, at almost negligible cost. Some commercial products are cloaked in an air of mystery (particularly with regard to the prices) and talk of infra-red, doppler and vibration detection systems, but with scant reference to false alarms, which seem to occur with increasing frequency as the circuitry grows more sophisticated.

My simple 'Intruder Alarm' (PE Mar 83 issue) was designed primarily for 'unattended' operation in boats and caravans, so a time and re-set circuit had to be provided, and although it could also be installed in the home, a 'closed-loop' system gives somewhat greater protection. The present circuit employs the absolute minimum of components and operates continuously when triggered, but a suitable timer circuit could be included to provide switch-off after a few minutes if desired.

The unit can be constructed on a small piece of stripboard and requires only two components plus the relay. (Although it is recommended that a small diode should be connected across the relay coil to protect the transistor from the back EMF's generated during operation). From Fig. 1 it will be seen that the transistor current will be seen that the transistor current will be drawn from the base, which would cause the unit to operate if it is broken at any point.

Consisting of a single wire fed around the property, possibly tucked under the edge of carpets, the loop is completed at opening windows and doors by magnetic latches, and by metal foil on the fixed glass. This self-adhesive tape can be arranged, for neatness, around the edge rather than across the panes if preferred; and some attention should be paid to the routing of this wiring in order to keep the total loop length as short as possible for efficiency as well as for economic reasons.

The reed switches are of the 'normally-open' type, whose contacts are held closed by the magnets. If a window is forced open, or the metallic tape torn by the glass, the loop will no longer be complete and the relay will operate the alarm.

Since the circuit in its dormant state draws less than 1 milliamp, battery operation is perfectly acceptable, the 12V being derived from 'AA' 1.5V pen cells in two 4-cell plastic holders, although the unit will in many cases work quite successfully from a 9V PP3.

The alarm itself is largely a matter of choice and can range from a conveniently sited doorbell, to a mains-operated gong with, possibly, some of the house lights switching on at the same time. A 'test' circuit is a useful addition and Fig. 2 shows the switching arrangement with a mains bell and neon indicator. A 3-pole 3-way rotary switch is used providing 'Off', 'Test' and 'Alarm' positions. Section S1a is the On/Off, S1b switches off mains, or connects it to either the neon or bell and S1c joins the external loop to the transistor base in the 'Alarm' position. The Test setting shows that both battery and mains supplies are good and that the circuit is operating correctly (since the loop is open-circuit).

---

The basis of operation—or rather, non-operation—relied upon the transistor base being firmly grounded, so it is important to ensure that there are no poor connections in the loop. If the foil is damaged during installation, replace it. Magnetic switches, window foil and all accessories for making the loop are readily available from advertisers and in many cases, these days, from local shops. Special connectors for joining the foil to the wiring are on the market, but quite satisfactory use has been made of standard strip-connectors, although needing a little more patience. If a 4-pole switching wafer is used, the spare tags can be connected in parallel with those of S1b so as to increase the current capacity of the switch if heavier loads are going to be used in the alarm circuit.

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<td>LW72P</td>
<td>£23.95</td>
<td>3 XAO3D</td>
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<td>7. (10)</td>
<td>8W Amp Module</td>
<td>LW36P</td>
<td>£4.45</td>
<td>Catalogue</td>
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<td>8. (14)</td>
<td>VIC20/64 RS232 Interface</td>
<td>LW86T</td>
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<td>9. (7)</td>
<td>Syntom Drum Synthesiser</td>
<td>LW91Y</td>
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<td>10. (12)</td>
<td>Harmony Generator</td>
<td>LW21X</td>
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<td>Spectrum RS232 Interface</td>
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<td>Ultrasonic Intruder Detector</td>
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<td>15. (15)</td>
<td>Logic Probe</td>
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<td>16. (26)</td>
<td>Car Battery Monitor</td>
<td>LW85G</td>
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<td>Synwave Sounds Synth</td>
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<td>20. (9)</td>
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Over 8 other kits also available. All kits supplied with instructions.

The descriptions above are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate Project Book mentioned in the list above.

MAPLIN’S FASCINATING PROJECTS BOOKS

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In Book 7 (XAO7H) Modern (RS232) Interface for ZX81/VIC20-Commodore 64 • Digital Enlarger Timer/Controler • DDXers Audio Processor • Sweep Oscillator • CMOS Crystal Calibrator.
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GREAT PROJECTS FROM E&MM

CONNECTING GATES

A standard (‘totem-pole’) TTL gate output must be connected to the input of any other TTL gate. The use of standard logic levels and common power supplies ensures that such signals will be compatible. There are many cases, however, where more than just two gates are involved in processing a signal. The rule then for connecting multiple standard gates (illustrated below) is that a single TTL output may be connected to more than one input, but not vice versa.

FAN-IN AND FAN-OUT

The output of a TTL gate may be connected to the input of one or more gates. The drive capability of a gate is known as its fan-out, and is usually expressed as the number of standard loads (usually ten) which can be driven by the gate. The fan-in of a gate indicates its loading effect on a gate output, and is usually expressed as the number of standard loads (usually one) that it represents. It is unusual for more than ten loads to be connected to a single output, but if the fan-out is exceeded, the voltage and current swings may become too small to drive all of the loads reliably.

As a general rule, the fan-out within a TTL sub-family is 10 (20 for LS), and the majority of inputs have a fan-in of one. The general rules for fan-in and fan-out for the commonly encountered TTL sub-families are summarised in Table 1.

INPUT AND OUTPUT CURRENT

The limits on fan-out are caused by the currents which must flow to hold the input of a gate at logic 0 and at logic 1. In TTL, the logic 0 currents usually predominate in determining fan-out. A standard gate input requires 1.6mA to flow between the input and 0 volts to establish a logic 0. Thus, to support a fan-out of 10, the corresponding gate output must be capable of ‘sinking’ 16mA. In the logic 1 state, the current flow is in the opposite direction, and is substantially smaller. Standard TTL inputs are typically able to ‘source’ 800μA, while typical inputs only require 40μA each in the logic 1 state. The source and sink currents for standard gates are shown in Table 2.

CIRCUIT EQUIVALENTS

There are a number of arrangements of logic gates which are very useful in building real logic circuits. These are particularly useful when trying to use the minimum number of i.c.s in the circuit. Some useful equivalents are shown below.

DRIVING LEDS

A typical red I.e.d requires a current of around 10mA to flow through it in order to provide a reasonably bright display. There are a number of ways to drive an I.e.d. from a TTL gate output. The actual method chosen depends on whether the diode is to be illuminated for a gate output of 0 or 1, and whether the gate is required to drive any other logic gates in addition to the diode. The various techniques are shown below, together with the logic input/output states required to illuminate the I.e.d., and the fan-out remaining to drive other gates. Although specific gates are shown, any logical equivalent may also be used.

---

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<tr>
<th>Driving Gate</th>
<th>Max. Number of Inputs Driven</th>
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<tr>
<td></td>
<td>74</td>
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<tr>
<td>Standard TTL (74)</td>
<td>10</td>
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<tr>
<td>Low-Power (74L)</td>
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<td>High-Power (74H)</td>
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<tr>
<td>Schottky (74S)</td>
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<td>L-P Schottky (74LS)</td>
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<table>
<thead>
<tr>
<th>Gate Type</th>
<th>High I/P (μA)</th>
<th>Low I/P (mA)</th>
<th>High O/P (μA)</th>
<th>Low O/P (mA)</th>
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<tr>
<td>74</td>
<td>40</td>
<td>-1.6</td>
<td>400</td>
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<td>74H</td>
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<td>-2</td>
<td>500</td>
<td>-20</td>
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<tr>
<td>74S</td>
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<td>74LS</td>
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