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- Weight: 29Kg
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- 5 axis model in kit form £445
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- Arm lengths between axes: 14.0"
- Weight 34Kg
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- 6 axis model in kit form £595
- 6 axis model READY BUILT £950

**COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE**

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- 5 axis system in kit form £855.00
- 5 axis system READY BUILT £1355.00

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As featured in this journal November '81–April'82 issues.

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Cabinet construction

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SEMICONDUCTOR UPDATE by R. W. Coles
AD549, IAPX 186, TSC9403

ELECTROLUBE REVIEW
New p.c.b. process reviewed

INGENUITY UNLIMITED
‘Challenge’—CMOS touch switch—Percussion synth—Stereo width control—Instant diode tester

MICROPROMPT
Hardware and software ideas for PE computer projects

NEWS AND COMMENT

EDITORIAL

NEWS AND MARKET PLACE
With Countdown and Points Arising

INDUSTRY NOTEBOOK by Nexus
News and views from the electronics industry

USING THE I.C. INSERTION TOOL
Information

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<thead>
<tr>
<th>Value (pF)</th>
<th>Brand</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5pF - 220pF</td>
<td>Mylar</td>
<td>Film</td>
<td>Polyester, 100V, 1% Tolerance</td>
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#### SILVER MICA

<table>
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<th>Brand</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>0.01nF - 10nF</td>
<td>Silver Mica</td>
<td>Slip</td>
<td>1000V, 1% Tolerance</td>
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#### CERAMIC Capacitors

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<th>Description</th>
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<tbody>
<tr>
<td>10pF - 330pF</td>
<td>CERAmic</td>
<td>Capacitor</td>
<td>50V, 5% Tolerance</td>
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#### LINEAR ICs

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<th>Description</th>
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<tr>
<td>1000pF - 10µF</td>
<td>CERAmic</td>
<td>Capacitor</td>
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#### TRANSISTORS

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<tr>
<td>1µF - 10µF</td>
<td>TO220</td>
<td>Transistor</td>
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#### RESISTORS

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<th>Value (Ω)</th>
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<th>Description</th>
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<tr>
<td>1kΩ - 10MΩ</td>
<td>RESistor</td>
<td>Variable, 1% Tolerance</td>
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#### POLYVINGE Components

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<th>Value (Ω)</th>
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<td>10kΩ - 100MΩ</td>
<td>RESistor</td>
<td>Variable, 5% Tolerance</td>
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#### SLIDER POTENTIOMETERS

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<th>Description</th>
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<td>10kΩ - 1MΩ</td>
<td>SLIDER</td>
<td>Potentiometer</td>
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#### RESISTORS S.L. Package 2%

<table>
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<th>Value (Ω)</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1kΩ - 100kΩ</td>
<td>RESistor</td>
<td>Resistor, 2% Tolerance</td>
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</table>

#### COMPUTER ICs

<table>
<thead>
<tr>
<th>Value (µA)</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>2µA - 10µA</td>
<td>RESistor</td>
<td>Resistor, 10% Tolerance</td>
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#### 74C Devices

<table>
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<th>Value (µA)</th>
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<th>Description</th>
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<td>2µA - 10µA</td>
<td>RESistor</td>
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#### 74S Devices

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<td>RESistor</td>
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#### 74L Devices

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<td>RESistor</td>
<td>Resistor, 5% Tolerance</td>
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#### CMOS Devices

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<th>Description</th>
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<tbody>
<tr>
<td>2µA - 10µA</td>
<td>RESistor</td>
<td>Resistor, 10% Tolerance</td>
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- **Z8OADMA:** 210
- **ZN427E-8:** 850, 850, 850, 350
- **BC167A, BC159, BC108:** Transistors
- **MC1469, MC145835:** 225nF
- **LM348:** 300nF
- **36:** 32
- **7041004:** 747205
- **74S571, 74S472:** 1150
- **7492, 7470, 7447:** 15Ω
- **5K, 0-500K, 0 Single gang:** SLIDER POTENTIOMETERS
- **225:** 32
- **290:** 745287
- **12:** 30
- **79:** 9
- **40:** 28
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SYNTHESIZER KIT, FOR GROUP OR HOME USE. WITH A FOUR OCTAVE COMPASS AND SPLIT KEYBOARD FACILITY.
COMPONENT KIT £129.00

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Sinclair ZX Spectrum

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!

First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power - personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer - available now - is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232/network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour - 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound - BEEP command with variable pitch and duration.
- Massive RAM - 16K or 48K.
- Full-size moving-key keyboard - all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution - 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCIl character set - with upper- and lower-case characters.
- Teletext compatible - user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE - 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC - incorporating unique 'one-touch' keyword entry, syntax check, and report codes.
RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers. The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

ZX Spectrum

Available only by mail order and only from

sinclair

Sinclair Research Ltd,
Stanhope Road, Camberley, Surrey, GU15 3PS
Tel. Camberley (0276) 685311.

The ZX Printer—available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set—including lower-case characters and high-resolution graphics. A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch. The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive—coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing. Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy. The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum. All the BASIC commands required for the Microdrives are included on the Spectrum. A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard. EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. Order

Qty Item Code Item Price £ Total £
1 Sinclair ZX Spectrum—16K RAM version 100 125.00
1 Sinclair ZX Spectrum—48K RAM version 101 175.00
1 Sinclair ZX Printer 27 59.95
1 Printer paper (pack of 5 rolls) 16 11.95
Postage and packing: orders under £100 28 2.95
orders over £100 29 4.95
Total £

Please tick if you require a VAT receipt

* Please charge to my Access/Barclaycard/Trustcard account no.
* Please delete/complete as applicable

Signature

PLEASE PRINT
Name: Mr/Mrs/Miss

Address

FREEPOST – no stamp needed. Prices apply to UK only. Export prices on application.

FREEPOST- no stamp needed. Prices apply to UK only. Export prices on application.
Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder and hook-up wire. Self assembly simulated wood cabinet — only £4.50 + £1.50 p+p.

Featured in April issue of P.E. Reprint 50p. Free klkirt, You only supply solder and hook-up wire. i.e. semiconductors, resistors, capacitors, hardware, top back printed quality circuit board and all electronic parts.

125W HIGH POWER AMP MODULE

SPECIFICATIONS: Max output power: 125W rms. Output voltage (DC): 55-60Vrms. Input: 4-16 ohms. Frequency response measured ± 1dB from 100 Hz to 15 kHz. Sensitivity for 100 watts: 400mV @ 8 ohms. Frequency response measured ± 3% from 50 Hz to 20 kHz. Operating voltage (DC), 45-80Vmax. Loads: 4-16 ohms. Switches, fascia, knobs and contrasting case. Also features slider controls, push button amp assembly kit and mains power supply.

SPECIFICATIONS: Suitable for 4 to 8 ohm speakers. Frequency response: 40Hz - 20kHz. Input sensitivity: R. U. 150mv. Aux. 200mV, MC. 1.5mV. Tone controls: Bass ± 12dB @ 60Hz. Treble ± 12dB @ 1kHz. Distortion: 0.1% typ. @ 8W. Mains supply: 220 - 750V @ 50Hz. B" SPEAKER KIT: Two 8" twin cones domes tic spacers. £3.75 a stereo pair £1.70 per pair.

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STEREO TUNER KIT

£17.95 + £2.50 p&p.

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£32.95

P.E. STEREO CASSETTE RECORDER KIT

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- Switchable C.C.
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- Wow & Flutter 0.1% at 1kHz
- Record playback IC with electronic switching
- Fully variable recording bias for accurate matching of all tapes

£32.95 + £2.75 p&p.

STEREO AMPLIFIER KIT

- Featuring latest SGS/ATES TDA 2006 10 watt output IC's with in-built thermal and short circuit protection.
- Mullard stereo preamplifier module.
- Attraction block vinyl finish cabinet, 8" x 8" x 3" (approx.)
- 10-10 stereo converts to a 20 watt disc amplifier.
- To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or turner. Outputs — tape, speakers and head-phones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1113 pre-amp module, plug-in amp assembly kit and mains power supply. Also features slider controls, push button switches, fascia, knobs and contrasting case. Instructions, free — supplied free with kit.

£47K. Typical T.H.D. @ 50 watts: 4 ohms: 1%
25Hz - 20KHz. Sensitivity for 100 watts: 400mV @ 8 ohms. Frequency response measured @ 100 watts:
Operating voltage (DC), 50-80Vmax. Loads: 4 - 16 ohms.

£16-50 + £2.90 p&p.

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Special Offers Tuner Kit Plus:
- Matching I.C. 10 watt per channel Power amp kit.
- Mullard LP1113 built in pre-amp. Suitable for ceramic pickup and aux. inputs.
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Orders to: 323 Evers Rd. London W2. Tel: 61-723 0432 9.30 - 5.30, Monday to Friday. All prices include VAT at 15%.

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

PE CAR COMPUTER

"One of the neatest, most comprehensive and most useful of these car computers that we have yet come across . . ." PRACTICAL MOTORIST

The PE Car Computer was designed to exceed the specification of all others, both for number of functions and accuracy. It provides three classes of information:

Driving information — 7 functions including miles per gallon (or litres per 100 kilometres), speed, fuel used. Journey information — 11 functions such as how far to go, ETA, how far you can go on fuel left, how fast you need to drive to meet an arrival time.

Car performance information - measure acceleration (eg 0 to 60), standing quarter miles, braking tests and much more using the unique 'programmed' mode. Check which types of driving are particularly un-economic, tune your car for optimum performance and economy. The unit also incorporates an ignition cut-out as an optional extra.

The unit is housed in a custom designed box with high quality printed panel. The lock and the engine will not restart until a three digit combination is entered. The unit allows you to programme for fuel consumption for each type of driving, and in this way you can go on fuel left, how fast you need to drive to meet an arrival time.

The unit also incorporates the ability to set each of the three different combinations, the lock and the engine will not restart until a three digit combination is entered.

The unit is housed in a custom designed box with high quality printed panel and can be fitted above or below the dashboard. The display is liquid crystal for clarity in all lighting conditions.

The kit includes all sensors, wiring, etc and is suitable for all cars except those fitted with diesel or fuel injection engines.

Kit price: £78.50 Assembled Price: £88.50
Ignition cut-out £7.75 + £1.90 p&p includes VAT.

Goods by return of post. Send S.A.E. for list of separately available parts.
BI-PAK BARGAINS

**Screwdriver Set**
- 6 precision screwdrivers in hinged plastic case
- Sizes: 0, 1, 2, 3, 4, 5
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- 5 precision nut drivers in hinged plastic case with turning ring
- Sizes: 3, 3.5, 4, 4.5, and 5mm
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**Tool Set**
- 5 precision instruments in hinged plastic case
- Crosspoint (Phillips) screwdrivers
- Hex and Hex key wrenches
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- Only £1.75

**Wrench Set**
- 5 precision wrenches in hinged plastic case
- Sizes: 4, 5, 5.5, 5.6, and 6mm
- Only £1.75

**Handy Tools**
- Heat Shunt tool tweezer Type 2
- 2 yds (1.83m) Resin Cored Solder on Card
- Only £1.75

**Capacitor Packs**
- 300 Ceramic Capacitors
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- 50 Assorted Size Grommets
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**PREMIUM BARGAIN**
- 21-PAK Bargains
- Approx size 80 x 120 x 66mm
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**Mini Vice**
- This small cast iron quality make vice will be a welcome addition to any bench or table having a maximum thickness of 1/2". The 2" jaws open to max of 1 1/2". Approx size 80 x 120 x 66mm
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- 1 x 1mm x 210mm Sheet PCB Cleaners
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- T03
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**5 watt (RMA) Audio Amplifier**
- High Quality audio amplifier Maxamp: Ideal for use in recoreds, tape recorders, stereo amplifiers, and computer systems
- Full data and back up for each model
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**Programmable Multifunction Transistor**
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- Only £1.75

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- The Electronic Components and Semiconductor Bargain of the Year. A host of Electronic components, including transistors, diodes, resistors, ceramics, etc.
- You save at least 100% off the normal price.
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- **S550** 0.001 micro PIG covered 50uH 0603
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- **S570** 0.001 micro PIG covered 50uH 0603
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- London WC2B 5AA

**October 1982**

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**Practical Electronics**

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WATCH TV

Readers may have seen the various announcements recently concerning the development of a wrist watch style TV by Seiko. In case you missed them; basically Seiko intend to market this device for around £200 next spring. It consists of an I.C.D. display about 28mm across fitted in the face of a watch, with back up electronics in a walkman style case.

Various claims have been made for resolution and a new technique has been devised to mount the I.C.D. and CMOS I.C.s in the compact space, the details. However, in this issue of PE the screen consists of 32,000 dots, but Seiko are being very cagey about details. However, in this issue of PE you will find a description of the technique used to make the display. No, it's not an exclusive from Seiko nor do we have an industrial spy. In fact our source is wide open to everyone who cares to look and, at the present time, a publicity campaign is being mounted to get people to do just that.

So what is this wondrous source of information on new techniques that companies otherwise protect? When we tell you the data on Seiko's technique can be found in Patents Review it becomes clear!

PIN

We recently received a sample copy of PIN Bulletin (Patents Information Network), a quarterly publication issued free by the Science Reference Library. The publication is "intended to help bring, to wider attention, the wealth of technical and commercial information contained in patent specifications". It is available through SRL and the 26 other libraries of the UK Patents Information Network.

The bulletin is in itself quite interesting, giving a taste of the information available from various patents. Such items as Prestel, fibre optics, Enigma (the wartime code machine) and a time domain multiple access satellite communications system are outlined and their relevant patent numbers quoted. As you can see this source of free information is well worth exploiting.

The other patent we describe this month was taken out by an engineer who has been a PE contributor. We were not aware of his work in this area until Barry Fox, our Patents Review author, sent in the piece for publication. We can all learn from patents!

PAT OR PAY?

By the way Barry (an acknowledged expert in this field) informs us that the correct pronunciation of patent is "pay-ent", not "pat-ent". However, many people pronounce it the latter way and this point has caused much friendly argument in the PE office! Try talking it over at work, school or college, but don't rely on dictionaries for an answer — some give both pronunciations, others give one or other version!

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Electronic Hobbies Fair

The Electronic Hobbies Fair has been launched in response to demand from both trade and hobbyists (following dissatisfaction with last year's Breadboard Exhibition) for a major national show of the highest quality. A visit to the new Alexandra Palace Pavilion from November 18-21 will illustrate how the hobby market is being expanded by the application of electronics.

In addition to the three sponsoring magazines (P.E., P.W. and E.E.) the following IPC titles will also have a presence at the fair Wireless World, Practical Computing, Your Computer, Practical Hi-Fi and Television. Virtually all the big names in the retail hobby supply business will be exhibiting and a few industrial suppliers now getting involved in the hobby scene will also be there.

Dubbed the "Palace of Light," the new Pavilion is set in 200 acres of London's most attractive parkland. To assist visitors to attend, a concessionary fare that includes admission to the show has been arranged with British Rail, from every major British Rail station in the country, direct to Alexandra Palace station with a free bus service to the Pavilion.

Admission is £2 for adults and £1 for children under 14, but money off vouchers will be published in PE, and the other sponsoring magazines, to enable our readers to come in at a special rate. Reductions will also be made for organised groups. There is ample free car parking and easy access from Alexandra Palace tube station. Opening times are 10:00-18:00hrs for the first three days and 10:00-17:00hrs on the final day. We hope to see you there!
REMOTE CONTROLLER

The XK112 remote control kit from TK Electronics has been developed to enable the user to control, via a hand held transmitter, any electrical appliance which is plugged into a domestic supply.

The 18-key transmitter which has 16 control keys and 2 command keys (on/off) modulates the domestic supply with a 470kHz signal. Each appliance is plugged into a receiver module which is coded using 4 wire links. Up to 16 receiver modules and therefore 16 appliances can be controlled via one transmitter unit.

A major advantage of this system is that the transmitter includes circuitry which allows it to be controlled by logic levels enabling automatic control of all appliances in the house from a central controller, such as a digital clock, microprocessor or other logic system without the need to run separate wires to each appliance.

The XK112 kit includes a transmitter and two receiver units. The transmitter kit includes an 18-key keyboard, i.e.d. indicator, p.c.b., components and a case. The receiver kit includes the p.c.b. and components but a housing is not included as the unit is small enough to be built into existing equipment, although a suitable case can be supplied if required.

The XK112 is priced at £42.00 plus VAT or the transmitter (XK110) kit is available separately priced at £25.00 plus VAT. Separate receivers are also available, price £10.00 plus VAT.

TK Electronics have also made Mail Order easier by installing a new telephone No. which even the most forgetful constructor will have difficulty in forgetting. The number is 567 8910.

By dialling the above number and quoting your Access or Barclaycard number TK will despatch your order on the same day.

Also available from TK is a copy of their latest catalogue which can be obtained by writing and enclosing a s.a.e. (6" x 9") to the following address:

TK Electronics, 11 Boston Road, London W7 3SJ (01-579 9794).

CHIP QUACK

From the Softy people, Dataman Designs, now comes Microdoctor, an intelligent device which helps engineers to diagnose faults in computers and microprocessor controlled equipment. Whilst malfunctioning ROM, RAM, I/O and data line shorts are burdensome on labour time, the rather more conventional tools, such as scopes and logic analysers, are less than ideal in diagnostic work of this nature.

Microdoctor, which can be used by an unskilled operator, prints out the results of pre-programmed tests on all memory mapped chips, dynamic or static RAM.

Is this machine a doctor, or psychiatrist? Well, it cannot solve software problems, but it can, for example, memory map an unknown system for you, memory contents being printed out in Hex or ASCII.

Microdoctor is a Z80 based product, supplied with a free Z80 disassembler which may be used to print a disassembled listing of the ROM in any Z80 system. The machine is equally applicable to other µP systems as it stands, and disassemblers for other popular micro's will be available soon for low cost retrofit.

The Microdoctor has 4K of firmware and 1K of CMOS RAM with battery back-up, allowing up to 15 test sequences (of up to 12 tests each) to be retained in memory for several months whilst switched off.

On examining an unknown system, for example, a memory map print-out would find ROM, RAM and I/O. A dump in Hex or ASCII would find the data tables, and once the location of peripheral drivers were known a SEARCH would find the software routines, which could then be disassembled. There are numerous other features.

Microdoctor costs £295 + VAT and carriage, from: Dataman Designs, Lombard House, Cornwall Rd., Dorchester, Dorset DT1 1RX.

Briefly...

Many readers may not be aware of a PO service called Transcash. This service has been in operation for some time but was previously called "Inpayment Service", it allows an order with cash to be placed for a minimal charge with any company (or individual) that has a Girobank account.

All you do is fill in a Transcash form, write your order or message in the space provided on the back and hand it in with the cash (no cheques) plus a 30p payment at any Post Office. The order and payment are then delivered to the Girobank account holder you nominate.

This service is now being advertised by Radio Component Specialists (see their ad in this issue) and is obviously a simple, cheap (when compared to postal orders plus stamps etc.) and safe way of placing orders.

The paperless office, according to a report in Computer Weekly, may not be imminent after all. There is growth in the paper industry research, revealing, which in the UK is stated as increasing at two per cent per year, with business gobbling it up at twice that speed. The trouble is that messages and data sent by electronic communications systems are invariably delivered ultimately on paper. Indications are that new technology will not have any effect on paper consumption at least until the 1990s, and in many cases not before the end of the next century!

In Electronics Times it was reported recently that the US Defence Department believes that the Soviets are developing a computer-based airborne combat system which allows a pilot to manoeuvre, aim and fire his weapons simply by thinking! The Russians, we are told, have taken a version of their MIG-25, now known as the MIG-29, and modified the on-board computer for control by thought.

Another report in Electronics Times tells of two British companies, which have joined forces, one being DJ'Ai of "Last One" fame (the self-programing computer program, you may remember), to produce the "Hyperspatial" RAM. No technical details, of course; but Micro Xeno, the other half of the arrangement, have worked on the problem of bulk storage from the hardware end, and DJ'Ai from the software end. The report described Micro Xeno as having been the subject of controversy in the computer industry since it claimed to be able to make a 9.9 gigabyte solid state memory using only 8K bytes of normal memory!
Merchant of Menace

Caverns Of Doom, Deadly Triangle and Warp War are but a mere glimpse of the lethal range of software available from Premier Publications. Yet for the peace-loving Earth man, particularly he who flies UK 101/OHIO systems? Yes, disk for the couple of examples: BASIC X. This adds 25 new BASIC words to your interpreter for around £20. Approximately 80p a word is not bad! What about the disk system for UK 101/OHIO systems? Yes, disk for the 101! The card plugs into J1. Single or double drive units. Single or double density mode. ROM/DOS or O/S65–D, cables etc. 80k capacity (90k under Premier Forth) at 125k bits per second.

What will really interest the computerist is the TRS/GENIE/OHIO/UK 101 REPAIR SERVICE. You have to put £35 up front for repair and postage, and if extra money is required to complete the work, you are informed first (so we are informed). However, generally there is a rebate, if anything. Turn-around can be from two to eight weeks, and you are asked to put through a prior telephone call to make arrangements. Both computers and peripherals are taken into care.

If it's a case of want information then there's the CUSTOMER SERVICE for "enquiries, moans or a chat" (ring 01-659 7131) between 7 and 9 p.m., Monday evenings, when incidentally the new shop is open in addition to normal hours. General technical enquiries are accepted between 4 and 6 p.m., except Wednesdays and weekends. Most UK 101 owners will pin their ears back to learn that just about all spares for their machine are available from Premier—except the p.c.b.

The Newsletter, which goes out to regular customers is highly informative and easy to follow.

The new, and much expanded site for Premier Publications is at 208 Croydon Rd., Anley, London SE20 7YX. The "large white" building is opposite the junction at Croydon Rd. and Thornsett Rd., not far from Norwood Junction Station. There are two Croydon Roads, apparently, so watch out!

Nieles and points arising ...

AUTOMATIC PHOTOGRAPHER
(August '82)

In Fig. 3, R3 should be 4k7. In the components list for the circuit of Fig. 4, C2 should be 1µF electrolytic.

PROGRAMMABLE TIMER CONTROLLER
(May, June '82)

In Figs 3 and 4, an extra copper track appears which should be deleted. The unwanted track joins the track of D15 to A25 to the track of D27 to D20.

In Fig. 8 the capacitor nearest C1 should be C2 not C4. Also R1 should be R39.

In Fig. 11 there are two C15 connecting points. The one nearest T1 should be C14.

COMBO AMPLIFIER-I (Aug '82)

Refer to Fig. 3, circuit diagram: IC2b & IC3a pins 4 should correct to −15V (not OV). VR3 should be VOLUME CH.2 & VR4 should be CH1. C13 is shown with reversed polarity. IC1a, IC2a, IC3a—all pins marked 7 should be 1.

Refer Fig. 4, p.c.b. & 5, overlay: R35 should be connected to OV (not floating).

Terminal pin between pins 20 & 22 should be 21 (not 12).

Terminal pin connecting to C11 should be pin 1 (not pin 7).

Terminal pin connecting to C7 should be 23 (not R3).

Junction of R5 & R6 should have track joining it to pin 1 of IC1.

Refer to components list: R8 listed twice!

First R8 should be R28.

C17 listed twice! Second C17 should be C8.

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 arranging any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here.

Labotory London
Sept. 14–16, Grosvenor Ho. Park Lane, London E
ElectroWest Sept. 14–16. Bristol Exhibition Ctrr Q
Two Countries Fair Sept. 15–18, Plymouth Exhibition Ctrr, Millbay, Devon T
IBC (Int. Broadcasting Convention) Sept. 18–21, Metropole, Brighton T

Northern Computer Fair Nov. 25–27. Belle Vue, Manchester Z1


Science On. 6x

All above: University Of Salford. 061-736 5843

ZX81 Science On. 6x Fri. eve's (6.00 till 8.00) from Nov. 12, '82

ZX81 30 Hour BASIC. Home study + visits to tutor (C&C option)

Northern Computer Fair Nov. 25–27. Belle Vue, Manchester Z1


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Fundamentals of Micro Engineering
µP Systems & Fault Finding
µP Interfacing & Applications

Above: Mid-Kent College. 0799 22612

First R8 should be R28.

C17 listed twice! Second C17 should be C8.

Northern Computer Fair Nov. 25–27. Belle Vue, Manchester Z1


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First R8 should be R28.

C17 listed twice! Second C17 should be C8.
**Defence**

The defence sector continues buoyant and, if anything, reinforced by the aftermath of the Falklands crisis. Recently announced contracts would have been in negotiation for some months and not necessarily due to operations in the South Atlantic. In fact the £30 million contract for the full development of BATES (Battlefield Artillery Target Engagement System) is a culmination of five years of feasibility and project definition studies at Marconi Space and Defence Systems think tank at Frimley. The system design is based on assessment of the European mainland scenario in which multiple engagement of highly mobile targets is envisaged. It is fully modular, entirely digital and operates at all levels of artillery command from Battery to Corps. Computer-based, it provides commanders with information on target priorities and artillery resources with which to engage them, as well as firing-data to enhance accuracy.

MSDS’s earlier system FACE (Field Artillery Computer Equipment) was sold to 16 countries. More recently MSDS was jointly engaged in conjunction with Norden Systems on BCS (Battery Computer System) developed for the U.S. Army and now in full production.

Similarly the £20 million contract for advanced electronic warfare equipment to be fitted to Royal Navy submarines was probably in negotiation with Decca Radar before that company was acquired by Racal Electronics Group as it appears to be a natural advanced follow-on from Decca EW systems currently in service on all Royal Navy fleet nuclear and Polaris submarines.

On the export front Racal-SMS, another of the re-vamped Decca companies, has a £580,000 order from the Portuguese Navy for a ship navigational simulator to be installed at a training school on the River Targus, Lisbon. One that Racal didn’t get was the contract from the Swedish government for new-generation frequency-hopping tactical radios. Racal was bidding with Jaguar-V which had already built itself a fine reputation. Plessey were also in the bidding as was the newly acquired Tadiran. Winner, however, was Marconi Space and Defence Systems with Scimitar-V. which was offered in collaboration with the Swedish company SRA. The contract could be worth more than £20 million to MSDS.

Another MSDS winner is the Clansman vehicle radio which has clocked up £15 million worth of exports this year. Latest buyer is an unspecified Asian country and part of the deal is local manufacture of Scimitar-V at a later date. The practice of overseas buyers to insist on an element of local assembly is now widespread. It automatically Invokes a transfer of technology and that is why it is so important that a country like Britain should retain a lead in technology. As other countries learn how to build equipment employing local, generally cheaper, labour it is the only way, long-term, that we can stay in business.

Marconi Avionics recently entreated the Secretary of State for Industry, Mr Patrick Jenkins, of the new technology day celebrating the hand-over of the 1,000th head-up display (HUD) for the Central Dynamics F-16 combat aircraft. At the same time a senior executive of General Dynamics from Fort Worth, Texas, handed over a further order worth 23 million dollars which will keep the F-16 HUD system production line active until 1985.

Over 5,000 HUD’s for 40 different aircraft types have been produced by Marconi Avionics since they produced their first for RAF Buccaneers 21 years ago which, incidentally, is still in service. The company claims that this total exceeds the rest of the world’s combined production and in the broad field of avionics the company generates over half of all British output. Marconi Avionics now employs 12,000 people, an increase of 4,000 since 1977.

New orders directly attributable to the Falklands will be additional to those already in the pipeline. Replacements for lost Harriers plus an increase in Harrier establishments, replacement Sea Kings and other helicopters, new frigates will all require a full complement of electronics which will load the production lines of specialist manufacturers, perhaps to bursting point.

**Vitality**

Once again while “old-fashioned” industry remains wallowing in recession the capital goods sector of electronics continues to comp away. By mid-year Ferranti, GEC, Plessey and Racal had all announced big gains in turnover and profit, well ahead of inflation and generally at the optimistic end of stockbrokers forecasts. Racal, for example, where City pundits were tipping £98 million pre-tax profits turned in a comfortably £102.6 million, an increase of 40.2 per cent on a sales increase of 20 per cent. Seventy per cent of Racal’s business was overseas. Ferranti, on a smaller scale had a 31 per cent profit growth to £23.8 million.

Talking point in the City was the prospect of a bid for Ferranti by one of the big three. What had once seemed a probability disintegrated only a possibility in the light of Ferranti results. True, Racal would be delighted to slot in Ferranti’s avionics business into complementary activities of its own but Ferranti is no longer cheaply acquired and Racal is but recently recovering from spending £101 million in acquiring Decca.

A new factor is that Ferranti’s great recovery has generated a cash balance enabling it, in turn, to become a predator, albeit on a modest scale. Compared with GEC’s cash mountain, Ferranti’s is a molehill but sufficient to acquire new interests. And with an order book said to be worth £400 million before adding in Falklands extras the company should further strengthen its relative position. GEC could comfortably afford to pay, say, £300 million in cash but could meet Monopolies opposition. Plessey might be too timid to bid. Racal would have to increase borrowing to win the prize but the City would provide the backing.

The consumer/entertainment sector is still in the hoildrums except for a few exceptions like home computers. But I notice quite a few of these are appearing in the small ads for second-hand sale (just look at Bazaar — Ed). It is not yet clear whether users are upgrading their computers or are disillusioned or just can’t get the hang of the thing. Meantime production soars and people are finding the money to buy them.

**Why Commute?**

Fifty years ago a new technology, electrification of the railways fostered the idea of living out of town. The old London Metropolitan Railway promoted Metroland as the new Mecca. The old Southern Railway advertised the joy of living in places like Herne Bay. But now fast, comfortable and reliable travel and it was true.

Alas, no longer true. Among the most pitiful spectacles today is that of London commuters transported by rail in conditions which would be condemned if commuters were animals and, in addition to the misery, the uncertainty of the service not to mention the cost of a season ticket in the £500—1,000 a year bracket.

But is their journey really necessary? With transport costs rising and telecommunications costs relatively falling a good percentage could easily and comfortably do their work at home. All those now tied to a v.d.u. and a computer in a city office block could just as easily have the same equipment at home or in a local centre and the economics should make sense with fuel and transport costs plus office rent savings outweighing increased telecommunication costs. There could be a big net saving in cash, not to mention improved mental health and other benefits. It’s worth thinking about. The technology is available today.
T. J. JOHNSON

This four function, high precision digital stopwatch has a standard seven segment, eight digit display and is capable of timing events from 1/100th of a second up to 24 hours. The oscillator used in the design has a typical stability of 1 ppm.

The circuit is very simple, consisting of an i.c., crystal, trimmer capacitor, switches and of course batteries and displays. The i.c. used is an improved version of the ICM7205.

**BLOCK DIAGRAM**

A block diagram for the Digital Stopwatch is shown in Fig. 1. The circuit takes the 6.5536MHz oscillator frequency and by way of a series of dividers takes the frequency down to 100Hz. Some of the divider outputs are used to generate multiplex waveforms, typically at 800Hz.

The 100Hz signal is then processed in the counters according to the type of control signal from the controller (e.g. standard, split modes etc.).

The processed signals are then passed to the latches where they are either stored as required, or allowed to pass to the multiplexer thus providing a 'moving' display. From the multiplexer and decoder the time interval is presented to the eight seven segment displays. The pin configuration for the i.c. is shown in Fig. 2.

**CIRCUIT**

The full circuit for the Digital Stopwatch is shown in Fig. 3. The power requirement for the circuit is nominally between 2.5V and 4.5V, and can conveniently be supplied by three 1.2V ni-cads giving 3.6V when fully charged. A jack socket is provided in series with the batteries, so that an external charger may be connected without removing the batteries from the case. The current requirement is dependent on whether the displays are on or off. In their off state, the current is typically 1 mA or less. With all the displays on, the current rises to a maximum of 150mA.

Selection of each of the four modes, Standard, Sequential, Split and Rally, is accomplished by means of the four slide switches S4 to S7. They are connected so that only one input is connected to +ve at any one time. It is important to note this, as problems could occur if more than one input was connected to the supply.

The on/off switch and the reset switch are both s.p.s.t. miniature toggle switches. The display and start/stop switches are s.p.d.t. toggle switches, and are used to ensure the operation is free from any contact bounce which may occur if push switches are used. The switches used in the prototype were not biased in their normally closed position although these types could of course be tried.

Although the circuit is shown with a trimmer capacitor, it will probably be found that a frequency meter can be used to trim the crystal to precisely 6.5536MHz. Sufficient accuracy was obtained with the prototype when the trimmer capacitor was approximately half enmeshed.

**CONSTRUCTION**

Construction is quite straightforward, although some care is required when fitting the p.c.b. and switches into the case and when drilling the front panel.

The p.c.b. design is shown in Fig. 4 with the component layout shown in Fig. 5. Note the various wire links on the underside of the p.c.b., and also the flying leads. These connect direct to the i.c. pads and should be soldered with care to prevent short circuits etc.

The crystal is mounted on the underside and is fixed in place with a piece of double sided foam pad.

The four miniature toggle switches should be mounted as shown in the photographs, with any unused tags cut off, and the used tags bent upwards at approximately 45°. Bend the tags as carefully as possible and check after bending that the switches operate correctly because the tags can be pulled out of alignment within the casing of the switch.

It is important to obtain switches which will comfortably fit in the case. Switches advertised as sub-miniature toggles are generally acceptable. The same also applies to the slide switches, although the maximum size should not exceed 15x12x10mm.

Drilling details for the front panel are shown in Fig. 6. These dimensions will need to be varied according to the size of slide switches used. It is very important to ensure that the proposed drilling details will enable the front panel to fit.
correctly. A check can be made using a dummy plastic or paxolin panel with the switches then being mounted and fitted in the case. Once the correct positions have been found they can then be transferred to the aluminium panel.

The final wiring shown in Fig. 7 can then be completed. When soldering the leads to the ni-cads, ensure that the batteries do not overheat in any way.

If the recommended case is being used then the four mounting pillars near the top of the case should be cut down to a height of about 4mm. The height of the pillars may need slight variation according to the thickness of the Perspex used for the filter. The p.c.b. should be gently placed into position as near to the top of the case as possible. Ensure that the connecting wires underneath the board do not get trapped between it and the pillars. The three batteries are placed into position and are held in place with a small piece of foam affixed to the front panel. Finally the front panel may be fixed into place, ensuring that no wires become trapped, and that the front panel sits flat. The success of this operation depends on the accuracy achieved when trying out the dummy front panel as mentioned earlier.

MODES OF OPERATION

RESET
When the stopwatch is first switched on, the reset switch will normally be operated. This puts the stopwatch into a ready condition by:

1. Resetting all the circuitry.
2. Blanking the display except for the 100's and 10ths of a second.
3. Turning on the display if it was previously turned off.

Having reset the stopwatch it is ready for use. Before going on to describe the functions it is important to note the correct way to operate the reset/display on/off/start-stop switches.

When operating the start/stop, reset, and display on/off switches the toggle must first be thrown to one position to achieve the desired operation and then returned to its normal rest position. If this simple procedure is not followed then subsequent operations of the switch toggle will not achieve the desired result.

SEQUENTIAL MODE

The sequential mode is used for timing events which consist of more than one leg. For example relays, multi-lap races etc.

After the initial reset (as mentioned above), the start/stop switch is operated at the beginning of the event. A second operation of the start/stop switch stops the timing and halts the display, allowing the time to be read, and at the same time resets the timer to zero allowing a further leg to be timed. This sequence can continue indefinitely.

If it is desired to see the display moving after a time has been recorded then the display unlock switch S2 should be operated, to release the dis-
COMPONENTS . . .

Semiconductor
IC1 ICM7045

Displays
X1-X8 DL704, MAN74 etc. 0-3" 7-segment common cathode display (8 off)

Switches
S1 s.p.s.t. sub-miniature toggle
S2 s.p.d.t. sub-miniature toggle
S3 s.p.d.t. sub-miniature toggle
S4-S7 s.p.d.t. miniature slide (4 off)
S8 s.p.s.t. sub-miniature toggle

Miscellaneous
XL1 6.5536MHz crystal
VC1 2-20pF plastic foil trimmer
B1-B3 1.2V 450mA ni-cads (3 off)
JK1 2-5mm jack socket
Printed circuit board, red Perspex, Vero flip-top box
No. 21317D.

play and allow it to catch up with the event being timed.

The reset switch may be operated at any time during event timing. The display cannot be switched off in this particular mode.

STANDARD MODE

This mode is perhaps the most useful of the four, as it is very similar to a normal non-electronic stopwatch.

In this mode, after the normal reset has taken place, the start/stop switch is operated. The timer and display follow each other allowing the time to be read at any instant.

A second operation of the start/stop switch halts the timer and allows the total elapsed time to be read. For timing the next event there are two options. The first is to operate the start/stop switch; this will momentarily reset the timer and the display so that the second event timing starts from zero.

A further operation of the start/stop switch halts the timer and display, allowing the time of the second event to be read. The second option is to operate the reset switch after the first event is finished. This will then reset the timer ready for the second event to be timed.

It should be clear from the above, that operation of the reset allows a 'rest' interval between events, whereas before, when the start/stop switch was operated no such interval was accommodated — the timing of the second event began immediately.

The display may be turned off at any time in this mode which results in a considerable saving in battery power.

---

Fig. 4. P.c.b. design

Fig. 5. Component layout

Fig. 6. Front panel drilling details
**RALLY MODE**

This mode is used for timing events which are both long in duration and have long periods of interruption between successive legs. The most obvious example is in car rallies.

Before the stopwatch is switched on, the rally mode switch should be placed in the off position. It is important that the stopwatch is switched on in another mode apart from the rally mode otherwise the timer and display will not be able to be reset. It is good practice to return all mode switches to their off positions when the stopwatch is not being used.

After the initial reset, the start/stop switch is operated at the beginning of the rally. At this point the reset is disabled to prevent accidental resets during long timing periods. After the first leg of the rally, the start/stop switch is operated. This then stops both the timer and the display, allowing the time to be read.

After a suitable rest period the second leg starts with operation of the start/stop switch. The timer restarts and the display shows the moving time. The timer and display immediately follow each other and show the cumulative time so far for the total event, i.e. each successive leg is added to the previous.

In this mode the reset switch has no effect. The display may be turned off at any time to conserve battery power.

**SPLIT MODE**

This mode is also for timing multi-leg events, but in contrast to the sequential mode its effect is cumulative.

From the usual reset at switch-on, the start/stop switch is operated, the timer and display follow each other allowing the time elapsed to be read at any instant. A second operation of the start/stop switch halts the display to allow the leg time to be read while the timer continues counting. A further half-operation of the start/stop unlocks the display and allows the display to follow the timer. The reset can be operated at any time and resets the stopwatch to zero.

The display cannot be turned off in this mode.
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A limited quantity of extra tools are available for 50p each including postage and VAT etc. Order by sending cheque or P.O., crossed and made payable to IPC Magazines Ltd., to the editorial offices.

The above photograph shows the tool dismantled. This enables the elastic band, which forms the plunger return spring, to be replaced should it ever perish. The two halves of the body can be parted by carefully inserting a blade in the joint. It is then a simple operation to replace the band and reassemble the tool.

The two halves are held by four fixed pegs which are a tight press fit, no adhesive is used on the joint. It is of course possible to use the tool without the return spring, though it will lose its smooth "feel".
COLD COMFORT

One very popular type of temperature transducer, especially useful when fast response at a high temperature is required, is the very simple thermocouple. These devices consist of nothing more than a junction between two dissimilar metals, and rely for their operation on the Seebeck or thermoelectric effect which recognises that across the junction there will be a difference in electric potential called the contact potential which varies with the junction temperature.

As with most simple phenomena, there is a catch. Before the contact potential can be measured, two extra junctions have to be created between this thermocouple wire and the copper wires of the measuring circuitry, and these new junctions are also subject to the thermoelectric effect. To use the thermocouple as a practical transducer, these new junctions must be at the same, constant temperature so that their contributions are fixed and therefore act as a reference level against which the output of the transducer junction can be measured.

The actual temperature at which the reference junctions are maintained is not important provided that it does not change, but a common technique has been to use 0 degrees C as defined by an ice/water mixture. This has resulted in the term "cold junction" being applied to this sort of reference.

Our once simple thermocouple sensor, now armed with a frequently replenished ice/water reference cell is beginning to look a bit cumbersome. But, thanks to electronics, it has been possible for some time now to dispense with the reference on the rocks and use what is commonly called an “automatic cold junction” which is not actually cold at all! Using this technique the reference junction is allowed to follow the ambient temperature which is itself measured (not by a thermocouple!) and used to generate an appropriate compensating voltage which when added to the thermocouple output gives a direct indication of sensor temperature.

Well, so far so good, but the circuitry required to use our thermocouple is getting quite complex, at least a circuit-board-full of op-amps and stuff, so what we really need to make the thermocouple simple to use is a complete conditioning system in a single integrated circuit. I bet you guessed, but that’s exactly what Analog Devices have just produced in the form of their AD594 thermocouple signal conditioner device.

Now to measure temperature, you just connect your thermocouple probe to two pins of the AD594 and get 10 millivolts per degree Celsius out the other end. The chip is optimised for use with type J thermocouples which use the metals Iron and Constantan, but other types can be accommodated by the addition of external compensating components.

To correct for ambient temperature changes the AD594 adds two temperature controlled suppression voltages (+T and -T) to the input signal from the sensor. The +T level creates a positive temperature coefficient term in the output signal while -T generates a negative term and adds an offset which establishes the output voltage at 0 degrees C as 0 volts. The difference between +T and -T results in a sensitivity of 52 microvolts per degree C, which just happens to be the 25 degrees C temperature sensitivity of the type J couple, so variations in ambient temperature are cancelled by the compensating signal to give the appearance that the reference junction is maintained at 0 degrees C. One interesting side effect is that the AD594 itself can be used as a temperature sensor over a limited range. If its inputs are connected to ground, a 10 mV per degree C output is generated.

In addition to providing a direct temperature analogue output, the AD594 can be operated as a set point controller which switches on a load above or below a reference point, and to warn of open or short circuited thermocouples there is an alarm output pin which can be used to drive an I.A.D.

The AD594 comes in a 14 pin ceramic d.j.p. and in two accuracy grades.

SOUPED UP '86

Up to now you have probably been happy to jog along with your trusty 8 bit microprocessor, and you may have eyed those 16 bit monsters with some trepidation. Several megabytes of memory addressing range can seem a somewhat academic advantage, as you gaze wistfully at the price tag on the 16K ZX81 RAM pack while rattling the sadly depleted piggy bank. But don't be put off, the price of 64K dynamic RAM chips is already plummeting, and Uncle Clive is probably even now considering a 16 bit successor to the ZX81 and the Spectrum. Far be it from me to interfere, but he could find it useful to cast his eyes over the data sheet on the new 16 bit offering from Intel, the so-called i APX 186.

Intel were the first with a powerful and practical 16 bit processor (I don't count the 9900!) but since the introduction of their 8086, they have seen lots of competition from the bigger and sexier Zilog Z8000, Motorola 68000, and more recently the National 16000 and the Texas 99000. To re-establish contact with those whose eyes have been distracted by these attractive newcomers, Intel have joined in the leap-frog game with two new devices, namely the i APX 286 and the i APX 186, both of which are upwards compatible with their 8086. The 286 is certainly a mighty machine, but it is the 186 which interests me at the moment since not only does it provide a higher performance than the 8086, but, more important, it holds out the promise of more affordable systems by cramming a whole board full of 16 bit features on to just one chip.

The 186 is fabricated in Intel's new HMOS III technology and runs at about twice the speed of the 8086 with ten new instructions which add several powerful new features without making existing 8086 software obsolete. In addition to being a better, faster, processor than its predecessor, the new chip also includes many features which had to be provided externally in 8086 systems. Three on-chip 16 bit timers are provided to allow waveform generation, event timing and time delays to be programmed, and a multilevel vectored interrupt controller is available to handle internal or external service requests. Another important feature is an on-chip clock generator, and to speed up data transfer with fast peripherals such as disc controllers the 186 has two independent Direct Memory Access (D.M.A.) channels capable of moving up to 2 Megabytes per second.

POWER SHIFT

To drive high power loads such as relays, lamps, and numerical displays from a microprocessor system the usual ploy is to use a parallel port chip and a high current/high voltage driver chip. If you need 16 parallel outputs you will have to use a complex port chip such as the 8255 and a couple of octal drivers which together may have as many as eighty pins with all the attendant implications for the circuit board area and the bank balance.

A device from Teledyne could make the job a lot simpler for some applications since the new TSC 9403 power shift register lives in a compact 24 pin package and yet provides 16 parallel outputs each capable of sinking 60 milliamps at 20 volts. To save package pins the TSC 9403 is not loaded in parallel. Instead, the 16 data bits are shifted in serially at clock rates of up to 3MHz under the control of the microprocessor. Compared with a parallel load scheme this method is rather slow, but this is not always a limitation especially if the output data changes infrequently.

The outputs of the TSC 9403 are driven by common source open drain MOS transistors having a maximum saturation level of 0.5 volts at 60 milliamps and maximum OFF leakage of 100 microamps at 20 volts.
This Micro Controller board is a universal control system which is based around the 6800 microprocessor. The system will be the subject of a special offer to PE readers and includes a p.s.u., keyboard, display and main controller board which features four PIA's, a real time clock and a monitor.

EXTRA 8 PAGE PULLOUT
PE MICRO-FILE

First of a series of pull-outs giving information and data on a wide range of microprocessor chips. MICRO-FILE will lay bare the essential characteristics of the most popular processors so that readers can choose and use the correct processor for their needs. Don't miss the start of this invaluable series, it details the 8080A/8085A.

Also...

COMPUTER INTERFACE Part 1

PRACTICAL ELECTRONICS

NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 8
THE mixer described in this article is constructed from a range of input and output modules all of which plug into a common bus. Even the mixer chassis is modular. It comes in 6 module sections which can be bolted together. The mixer can be assembled with up to 18 inputs (you could even have 24 inputs if you are that keen) and 4 output channels. For example, if you wanted a 6 into 2 mixer then all you would need is 6 input modules, 2 output modules, 1 auxiliary module (optional) and three blanking panels. The power supply for the system is contained in an external box.

INPUT MODULE

The circuit diagram of the input module is shown in Fig. 1. IC1 forms an unbalanced low noise preamplifier with switched and variable gain. The system is designed to run with a signal level of 0dBm (0.775Vr.m.s. or 2.2Vpp) and it is the job of input stage to amplify/attenuate the input signal to this level. For a 0dBm signal level at IC1 pin 1, the microphone signal level can vary between -56 to -16dBm and the line level signal from -24 to +11dBm. Therefore the preamplifier can accept input levels from -56dBm to +11dBm for a 0dBm output. Also the maximum level at IC1 pin 1 before clipping is +18dBm and so there is 18dB of headroom when operating at a signal level of 0dBm.

The tone control has a conventional treble and bass circuit plus a parametric section. The parametric equaliser is constructed from a variable-frequency state-variable bandpass filter which can be used to provide feedforward (lift) or feedback (cut) around an amplifier section (IC2b). Fig. 2 shows the tone control frequency responses. The equaliser can be bypassed by using the FLAT/EQ switch.
The input module can be used to send the amplified signal to an external effects unit via the SEND jack. This signal can then be re-inserted via the RETURN jack. The RETURN jack has a break contact, but the SEND jack has not. Therefore you can use the SEND output to drive foldback monitors without interrupting the signal path. PPM signal level monitoring per input channel is very expensive and so a simple peak level detector has been used. This device lights up a I.e.d. when the signal level exceeds +4dBm. When this I.e.d. turns on it produces a very dirty current which can cause an annoying background noise. However by not dumping this current down the ground rail (the current travels from one supply rail to the other) this effect can be avoided. In fact throughout the mixer all currents that are dirty have not been dumped into the ground rail.

The output signal from the input module can be sent to up to 7 different outputs. Before the channel fader it can be switched to the PFL (pre-fade-listen) bus. This route has a fixed unity gain and it enables the mixer operator to monitor the channel signal level on the PFL PPM (this is on the AUX channel) and also to listen to the signal on its own, on either headphones or monitor speakers. Also there are two aux-
Fig. 4. Circuit diagram of the Output Channel. Note D1 to D3 should be 1N4002

Fig 3 P.s.u. circuit diagram

Fig 4 P.s.u. circuit diagram

POWER SUPPLY
The p.s.u. circuit is shown in Fig. 3. The power supply can deliver up to ±1 amp at ±12V. It is mounted externally to the mixer to avoid mains hum problems. An RC filter in the circuit (R2, R3 & C3, C4) smoothes out the unregulated rail so that the regulators are presented with a very small ripple (about 100mVpp at full load). An 18 into 4 mixer consumes about 500mA from each rail. This current increases when the PPM displays, peak i.e.d.s and headphone amplifier are on. Make certain that both regulators are insulated from the metal work and that all mains wiring is covered with rubber sleeving.

OUTPUT CHANNEL
The output channel which consists of three virtual earth amplifiers and a PPM circuit is shown in Fig. 4. Both the 'Record' and the 'Studio' output stages have +10dBs of gain. The 'Record' output uses a high performance op-amp which is capable of driving a +18dBm 20kHz sinewave into 600 ohms without anything nasty happening! This is the best output to use; the PPM circuit monitors the signal level at this output. The PPM (peak programme meter) consists of a precision full wave rectifier, a peak level detector and a National Semiconductor logarithmic bar graph driver, IC4.
The display has been designed to consume very little current. IC4 is run in its dot mode, so that only one output is on at any time. However the current being sunk into any display output also lights up all the l.e.d.s below it. In this way the dot mode is transformed into a bar graph. The display current is only 10mA and is constant even though 10 l.e.d.s may be on. Note that none of the l.e.d. current is dumped into the ground rail.

It is important that the l.e.d.s protrude through the panel to the same height, otherwise the PPM display looks rather nasty. A small metal or wooden jig should be constructed so that all the l.e.d.s can be bent to exactly the same length.

**AUX CHANNEL**

Both the auxiliary channels in Fig. 5 are simple virtual earth amplifiers. AUX2 is available as a direct signal and as a mix with the mixer talk back signal. When the talk switch is pressed the AUX2 level is attenuated and the talk back microphone signal is enabled.

The PFL amplifier has unity gain (fixed) so that the signal level in any input channel can be monitored on the PFL PPM unit. A small power amplifier (IC4) provides a headphone monitor for the PFL signal. Note that a synthetic ground rail (TR1) has been produced so that the large headphone current is not dumped down the real ground rail.

---

**Fig. 5. Circuit diagram of the Auxiliary Channel**

---

The display has been designed to consume very little current. IC4 is run in its dot mode, so that only one output is on at any time. However the current being sunk into any display output also lights up all the l.e.d.s below it. In this way the dot mode is transformed into a bar graph. The display current is only 10mA and is constant even though 10 l.e.d.s may be on. Note that none of the l.e.d. current is dumped into the ground rail.

It is important that the l.e.d.s protrude through the panel to the same height, otherwise the PPM display looks rather nasty. A small metal or wooden jig should be constructed so that all the l.e.d.s can be bent to exactly the same length.

**AUX CHANNEL**

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The PFL amplifier has unity gain (fixed) so that the signal level in any input channel can be monitored on the PFL PPM unit. A small power amplifier (IC4) provides a headphone monitor for the PFL signal. Note that a synthetic ground rail (TR1) has been produced so that the large headphone current is not dumped down the real ground rail.
### COMPONENTS...

#### INPUT CHANNEL

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>R1</td>
<td>8k2</td>
</tr>
<tr>
<td>R2, R6, R7</td>
<td>2k2 (3 off)</td>
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<tr>
<td>R3</td>
<td>5k1</td>
</tr>
<tr>
<td>R4</td>
<td>2k4</td>
</tr>
<tr>
<td>R5</td>
<td>390</td>
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<tr>
<td>R8</td>
<td>22k</td>
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<tr>
<td>R9, R17, R25, R34</td>
<td>100k (4 off)</td>
</tr>
<tr>
<td>R10, R11</td>
<td>16k (2 off)</td>
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<td>R12</td>
<td>12k</td>
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<tr>
<td>R13, R14</td>
<td>5k6 (2 off)</td>
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<tr>
<td>R15, R23</td>
<td>39k (2 off)</td>
</tr>
<tr>
<td>R16</td>
<td>27k</td>
</tr>
<tr>
<td>R18, R20, R24, R30, R31, R32, R33, R40, R41, R42</td>
<td>47k (10 off)</td>
</tr>
<tr>
<td>R19, R21, R37</td>
<td>10k (3 off)</td>
</tr>
<tr>
<td>R22, R36</td>
<td>15k (2 off)</td>
</tr>
<tr>
<td>R26, R27</td>
<td>10 (2 off)</td>
</tr>
<tr>
<td>R28, R29</td>
<td>4k7 (2 off)</td>
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<td>R35</td>
<td>24k</td>
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<tr>
<td>R36</td>
<td>470k</td>
</tr>
<tr>
<td>R39</td>
<td>1k5</td>
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All resistors \(\frac{1}{2}\) W metal film

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<tr>
<th>Potentiometers</th>
<th>Value</th>
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<tbody>
<tr>
<td>VR1</td>
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</tr>
<tr>
<td>VR2, VR5</td>
<td>100k lin (2 off)</td>
</tr>
<tr>
<td>VR3, VR6</td>
<td>10k lin (2 off)</td>
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<tr>
<td>VR4</td>
<td>10k reverse log dual pot</td>
</tr>
<tr>
<td>VR7, VR8</td>
<td>47k log pot with p.c. bracket (2 off)</td>
</tr>
<tr>
<td>VR9</td>
<td>10k log slider ALPS 191 M10kA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
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<tbody>
<tr>
<td>C1</td>
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</tr>
<tr>
<td>C2, C16</td>
<td>100p ceramic (2 off)</td>
</tr>
<tr>
<td>C3, C4</td>
<td>22µ 10V tans (2 off)</td>
</tr>
<tr>
<td>C5, C6, C14</td>
<td>1µ 35V elect (3 off)</td>
</tr>
<tr>
<td>C7</td>
<td>220p ceramic</td>
</tr>
<tr>
<td>C8</td>
<td>1µ BS32560</td>
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<tr>
<td>C9</td>
<td>22n BS32560</td>
</tr>
<tr>
<td>C10</td>
<td>1n5 BS32560</td>
</tr>
<tr>
<td>C11, C12</td>
<td>3n3 BS32560 (2 off)</td>
</tr>
<tr>
<td>C13</td>
<td>470n BS32560</td>
</tr>
<tr>
<td>C15</td>
<td>470n 35V elect</td>
</tr>
<tr>
<td>C17, C18</td>
<td>470µ 16V elect (2 off)</td>
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<table>
<thead>
<tr>
<th>Semiconductors</th>
<th>Value</th>
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<tbody>
<tr>
<td>D1</td>
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</tr>
<tr>
<td>D2</td>
<td>0·2in red l.e.d.</td>
</tr>
<tr>
<td>TR1</td>
<td>BC182L</td>
</tr>
<tr>
<td>TR2</td>
<td>BC212L</td>
</tr>
<tr>
<td>IC1–IC4</td>
<td>RC4558 (4 off)</td>
</tr>
</tbody>
</table>

**Miscellaneous**

- SK1–SK4: \(\frac{1}{4}\) in mono jack socket with shorting tip pin (4 off)
- SK1–S7: Push switches p.c.b. mounting d.p.d.t. (7 off)
- SK8: Knobs \(\frac{1}{4}\) in (8 off)
- SK9: Caps with line, black (4 off)
- SK10: Caps with line, black (4 off)
- SK11: p.c.b.
- SK12: 10 way Molex 0·156in p.c. socket
- SK13: 8 pin d.i.l. socket (4 off)

### OUTPUT CHANNEL

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R2</td>
<td>10 (2 off)</td>
</tr>
<tr>
<td>R3, R16</td>
<td>4k7 (2 off)</td>
</tr>
<tr>
<td>R4, R8</td>
<td>47k (2 off)</td>
</tr>
<tr>
<td>R5</td>
<td>33k</td>
</tr>
<tr>
<td>R6, R11, R13, R14</td>
<td>100k (4 off)</td>
</tr>
<tr>
<td>R7, R10</td>
<td>100 (2 off)</td>
</tr>
<tr>
<td>R9</td>
<td>150k</td>
</tr>
<tr>
<td>R12</td>
<td>200k</td>
</tr>
<tr>
<td>R15</td>
<td>110k</td>
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<tr>
<td>R17</td>
<td>1k5</td>
</tr>
<tr>
<td>R18</td>
<td>2k2</td>
</tr>
</tbody>
</table>

All resistors \(\frac{1}{2}\) W metal film

<table>
<thead>
<tr>
<th>Potentiometers</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1, VR3, VR4</td>
<td>47k log pot with p.c. bracket (3 off)</td>
</tr>
<tr>
<td>VR2</td>
<td>10k log slider 191 M10kA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>C1</td>
<td>1µ BS32560</td>
</tr>
<tr>
<td>C2, C3</td>
<td>470µ 16V elect (2 off)</td>
</tr>
<tr>
<td>C4</td>
<td>1µp ceramic</td>
</tr>
<tr>
<td>C5, C6</td>
<td>47n 35V ceramic (2 off)</td>
</tr>
<tr>
<td>C7</td>
<td>100n BS32560</td>
</tr>
<tr>
<td>C8</td>
<td>1µ 16V elect</td>
</tr>
<tr>
<td>C9</td>
<td>100µ 40V elect</td>
</tr>
<tr>
<td>C10, C11</td>
<td>33p ceramic (2 off)</td>
</tr>
<tr>
<td>C12</td>
<td>22p ceramic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>D1, D2, D3</td>
<td>1N4002 (3 off)</td>
</tr>
<tr>
<td>D4, D5, D6, D7</td>
<td>1N4148 (4 off)</td>
</tr>
<tr>
<td>D8–D17</td>
<td>0·2in l.e.d. (10 off)</td>
</tr>
<tr>
<td>IC1, IC3</td>
<td>RC4558 (2 off)</td>
</tr>
<tr>
<td>IC2</td>
<td>NE5534</td>
</tr>
<tr>
<td>IC4</td>
<td>LM3915</td>
</tr>
</tbody>
</table>

**Miscellaneous**

- SK1–SK4: \(\frac{1}{4}\) in mono jack socket with shorting tip pin (4 off)
- SK1–S7: \(\frac{1}{4}\) in knobs (3 off)
- SK8: Caps with line, black (3 off)
- SK9: Slider knob (CS9)
- SK10: p.c.b.
- SK11: 10 way Molex p.c. socket
- SK12: 8 pin d.i.l. socket (3 off)
- SK13: 18 pin d.i.l. socket

### GENERAL PARTS

- Chassis units
- Wooden end cheeks
- Wooden front pieces
- Bus p.c.b. (with 6 x 10 way Molex pins)
- Rubber feet
- Grommet
- Ty-rap base
- Ty-rap
- 3 core lead
- 3 pin 180° inline plug
AUX CHANNEL

Resistors
R1, R2 10 (2 off)
R3 2k2 1W
R4, R6, R16, R18 100 (4 off)
R5, R7, R12, R17, R24 47k (5 off)
R8, R19 330k (2 off)
R9 820
R10, R13, R14 12k (3 off)
R11 1k2
R15 56k
R20, R30 4k7 (2 off)
R21 120
R22 47
R23 2k17
R25 200k
R26, R27, R28 100k (3 off)
R29 110k
R31 1k5
R32 2k2
All resistors 1/2W metal film unless otherwise stated

Potentiometers
VR1-VR4 47k log pot with p.c. bracket

Capacitors
C1, C2, C8 470µ 16V elect (3 off)
C3 470n B32560
C4, C14, C15, C16 100p ceramic (4 off)
C5, C6, C10, C11 100n B32560 (4 off)
C7 10µ 16V elect
C9 47µ 16V elect
C12 1µ 16V elect
C13 100µ 40V elect

Semiconductors
D1, D5, D6, D7, D8 1N4148 (5 off)
D2, D3, D4 1N4002 (3 off)
D9-D18 0.2in square red l.e.d. (10 off)
D19 0.2in red l.e.d.
TR1 Tip30A
IC1, IC2, IC3, IC6 RC4558 (4 off)
IC4 LM380
IC5 LM3915

Miscellaneous
SK1-SK4 1/4 in mono jack socket plus shorting tip pin (4 off)
SK5 1/4 in stereo jack socket
VR1-VR4 47k log pot plus p.c. bracket (4 off)
S1, S2 Push switch p.c. mounting d.p.d.t. 1/4 in knob (4 off)
S3 Push switch 8125-811 3/3
Cap with fine, black (4 off)

POWER SUPPLY UNIT

Resistors
R1 4k7 1/2W
R2, R3 2k2 2-5W

Capacitors
C1-C4 4700µ 25V elect (4 off)
C5, C6 47n 35V ceramic disc (2 off)
C7, C8 1µ 16V tent (2 off)

Semiconductors
D1-D4 1N4002 (4 off)
IC1 7812 with insulating kit
IC2 7912 with insulating kit

Miscellaneous
S1 Mains switch d.p.s.t.
T1 15-0-15V torroid at 30VA
FS1 20mm 1A fuseholder
Rubber feet
Heat sink bracket
P.c.b.
Mains grommet
P.s.u. case
4 way screw block
3 pin 180° din socket

Constructor's Note

Complete kits of parts for this project can be obtained from Powertran Electronics, Portway Industrial Estate, Andover, Hants SP10 3WN (0264 64455)

Input channel (including p.c.b., panel and controls) £19.90
Output channel (including p.c.b., panel and controls) £18.50
Auxiliary channel (including p.c.b., panel and controls) £22.50
Blank panel £3.00
Base unit for up to 6 channels (including wooden front) £27.50
Pair of dark mahogany end cheeks £12.50
Power supply (including transformer and cabinet) £19.50

All prices subject to 15% VAT. No charge is made for carriage
THE dB, THE dBm AND NOISE

The dB (deci-Bell) is always used to describe gains and losses in audio networks. If a signal passes through an audio network with a multiplicative gain of X, then that gain in dBs is $20\log_{10}(X)$. At first sight it may seem that the dB is just a complicated way of describing gain and loss. It is not. If a signal passes through several stages of gain then the total gain is the product of all the multiplicative gains in the system. However if you use dBs to describe the gain then the overall gain is merely the sum of the gains. It is generally easier to add than to multiply. Table 1 illustrates the advantages of using the dB.

The dBm is a logarithmic method of measuring voltage. If a voltage of $-10\text{dBm}$ is passed through an amplifier with a...
Power= commonly used signal levels in audio work. Note that 0dBm

\[ V_{r.m.s.} = 0.775V \]

Table 2 shows a chart of 1mW of power into a 600 ohm load.

\[ 1mW = 0.001\text{watt} \]

Voltage gain = 1.41 x 10 x 0.5 x 4 x 0.032

or in dBs

\[ \text{Voltage gain} = 3 \times 20 - 6 + 12 = 30 \text{dBs} \]

Typical system

<table>
<thead>
<tr>
<th>dB</th>
<th>Multiplier</th>
<th>Rule of thumb approximation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+80</td>
<td>x10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>+70</td>
<td>x3,162</td>
<td>3,000</td>
</tr>
<tr>
<td>+60</td>
<td>x1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>+50</td>
<td>x316.2</td>
<td>300</td>
</tr>
<tr>
<td>+40</td>
<td>x100</td>
<td>100</td>
</tr>
<tr>
<td>+30</td>
<td>x31.6</td>
<td>30</td>
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<tr>
<td>+20</td>
<td>x10</td>
<td>10</td>
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<td>0.7</td>
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<td>-6</td>
<td>x0.501</td>
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<td>-80</td>
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</table>

Table 1

Voltage gain = 1.41 x 10 x 0.5 x 4 x 0.032

TABLE 2

<table>
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<tr>
<th>dBm</th>
<th>Vr.m.s.</th>
<th>Vpp</th>
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<td>6.18V</td>
<td>17.47V</td>
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<tr>
<td>+12</td>
<td>3.08V</td>
<td>8.76V</td>
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<td>+10</td>
<td>2.45V</td>
<td>6.95V</td>
</tr>
<tr>
<td>+6</td>
<td>1.55V</td>
<td>4.39V</td>
</tr>
<tr>
<td>0</td>
<td>0.775V</td>
<td>2.2V</td>
</tr>
<tr>
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<td>388mV</td>
<td>1.1V</td>
</tr>
<tr>
<td>-12</td>
<td>197mV</td>
<td>553mV</td>
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<tr>
<td>-60</td>
<td>775µV</td>
<td>2.2mV</td>
</tr>
<tr>
<td>-70</td>
<td>245µV</td>
<td>695µV</td>
</tr>
<tr>
<td>-80</td>
<td>77.5µV</td>
<td>220µV</td>
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<tr>
<td>-120</td>
<td>775nV</td>
<td>2.2µV</td>
</tr>
<tr>
<td>-130</td>
<td>245nV</td>
<td>695nV</td>
</tr>
</tbody>
</table>

Signal levels and the dBm.

Next month: Construction
CM100 CIRCUIT MAKER

 glance through a selection of hobby electronics magazines, it soon becomes apparent that the vast majority of projects published use printed circuit boards. Yet, until now, most constructors have not had the means of producing professional quality p.c.b.s, and have had to rely on kit or specialist manufacturers to supply their needs, or resort to such laborious tasks as re-drawing designs on copper-clad boards with etch-resistant pens. Which brings us to Electrolube.

Electrolube is a company that specialises in products such as electrical contact treatments and maintenance chemicals. Recently they entered the field of hobby electronics, introducing the CM100 Circuit Maker, a unique new kit, which, say Electrolube, contains everything the home constructor needs to produce professional quality p.c.b.s from artwork printed in magazines. As the kit is boasted to be almost foolproof, we decided to put Electrolube’s claim to the test.

FILM POSITIVE

The problem for constructors has until now been in transferring a p.c.b. design in “etch resist form” onto a copper-clad board. While boards pre-coated with a photo-sensitive etch-resist coating have been available, one still needs a film-positive of the p.c.b. to lay over the pre-sensitized board before exposing. Producing this film-positive has until now been impossible without expensive specialist photographic equipment.

This is where the CM100 really scores. Supplied in the kit is Autopositive film (FPF). To produce a film-positive, simply lay a piece of FPF over the printed p.c.b. design; expose; and develop in the chemicals provided. It really is as simple as that. Incidentally, producing the film-positive turned out to be the simplest stage in the p.c.b. making process.

The next stage in the process is to coat the board in photo-resist. I mentioned earlier that pre-coated boards are available, but Electrolube have chosen to supply bare copper-clad boards and a jar of photo-resist. The board must be thoroughly cleaned before the photo-resist is applied, and once applied the ‘resist must be left to dry properly. Electrolube say an hour is enough, but we found that it was necessary to allow a coated board several hours to dry—preferably overnight—otherwise all the photo-resist would come off in the developer [Electrolube have now changed their instructions to recommend over night drying—Ed]. This brings us to exposure and developing of the coated board; again a simple process. Place the film positive over the board, expose (for about 25 minutes in normal daylight), and develop. The board is then ready for etching.

ETCHING

Anybody who has ever etched a p.c.b. will know how messy a process it can be. Ferric chloride has an annoying habit of finding its way into the wrong places, and once there, is difficult to clean off. The etching kit supplied with the CM100 is a different story altogether. Everything takes place in a long, narrow and very thick plastic bag. With the aid of a couple of clips, the bag can be sectioned off into compartments so that the whole etching process can be carried out without any mess or fuss. When the etchant is finally finished with (it should last for several boards), a bag of neutralizing powder supplied with the kit turns the etching solution into a solid, harmless lump which can then be disposed of. All that remains is for the photo-resist to be cleaned of the p.c.b. tracks, holes drilled and flux lacquer applied.

The CM100 does provide a simple and almost foolproof means of producing professional quality p.c.b.s from magazine designs. The kit is comprehensive, down to a length of sponge for applying the photo-resist, a scouring pad for cleaning the boards, and a very useful frame to hold the film during exposure (which can also be used as an assembly frame to hold the p.c.b. when inserting and soldering components). The instructions supplied with the kit are clear and comprehensive, and replacement supplies of film, chemicals and boards are available.

COATING

The main drawback lies in the process of coating the boards. This is by far the most messy, time consuming and unreliable stage in the whole process. As I have already mentioned, the photo-resist takes some time to set and it is difficult to keep the boards dust free, which they should be, both before and after application of the photo-resist. It would not add much to the cost of the kit to supply pre-coated boards, and would, as we found out, enable the whole process to be completed in an afternoon rather than spread over two days. However as Electrolube point out the system employed does have the advantage that any boards messed up at the exposure stage can be re-coated and used, whereas pre-coated boards would be useless. Also, most of the p.c.b.s that we wanted to produce were single sided, but as all the boards supplied in the kit are double sided, the etching solution became exhausted much quicker than it need to have been.

To conclude, I would strongly recommend the CM100 to the serious constructor or school/college lab, despite the drawbacks mentioned (and of course there is nothing to stop you buying your own pre-coated boards), and the relatively high initial retail price of £65. Perhaps Electrolube might consider supplying just the film producing parts of the kit separately, as many constructors must already have p.c.b. etching equipment.

The CM100 Circuit Maker is available from a number of retail outlets, for details contact Electrolube Ltd., Blake Road, Wargrave, Berkshire RG1 8AW (073 522 3014).

Jasper Scott.

Note: The p.c.b. used in our Seat Belt Reminder (last month) was made by this process, from a photostat of the original artwork, with excellent results.
FREE ENTRY COMPETITION

OVER £500 WORTH OF MICRO-PROFESSORS TO BE WON

In the August issue of PE our contributor, Michael Tooley, reviewed the Micro-Professor MPF-1 low cost learning, teaching and prototyping tool. We are now pleased to be able to arrange this competition with Flight Electronics Ltd., the sole U.K. agents for the system.

The prizes presented by Flight will be:

1st Prize: A full system comprising MPF-1B Micro-Professor (which includes MPF 2K BASIC Interpreter), an MPF-EPB EPROM programming board, an MPF-SSB Speech Synthesiser board.

2nd, 3rd, 4th & 5th Prizes: Micro-Professor MPF-1B microcomputers.

HOW TO ENTER

For the purposes of this competition we'd like to assume that you are a student who has a basic understanding of electronics but wants to learn about microprocessors and machine code programming. Listed here are eight features of a microcomputer teaching aid, such as the MPF-1. In what order do you consider they warrant the greatest consideration when purchasing such a unit?

If, for example, you consider that "cassette interface" is the most important feature of them all, put "K" in the first space on your entry coupon. The letter of your next choice goes under 2 and so on for all eight. Complete the coupon with your full name and address and post in a sealed envelope to PE Micro-Professor Competition, 55 Ewer Street, London SE99 6YP, to arrive no later than Friday, 29th October, 1982, the closing date.

IMPORTANT

Before sealing, copy out on the outside back of the envelope the eight key letters in exactly the same order as they appear on your entry coupon. FAILURE TO DO SO MAY RESULT IN YOUR ENTRY BEING DISQUALIFIED. Do not enclose any correspondence or matter other than the entry coupon.

RULES

There is no entry fee but each attempt must be on a proper entry coupon cut from Practical Electronics and must bear the entrant's own name and address.

All accepted entries will be examined and the first prize awarded to the entrant who, in the judges' opinion, has shown the greatest skill and judgement in placing the eight features of a microcomputer teaching aid in order of importance to the described student. Remaining prizes will be awarded for the next best attempts in order of merit. No entrant may win more than one award.

In the event of a tie for any prize(s) those tying will take part in a postal eliminating contest to determine such winner(s) or winning order. Entries arriving after the closing date will be disqualified as will any received incomplete, illegible, mutilated or altered, or not complying with the rules and instructions exactly. No responsibility can be accepted for entries lost or delayed in the post. Decisions of the Judges and those of the Editor in all matters affecting this competition will be final and legally binding.

The competition is open to all readers in Great Britain, Northern Ireland, Eire, the Channel Islands and the Isle of Man, other than employees and their families of IPC Magazines Ltd., the printers of Practical Electronics or Flight Electronics Ltd.

Winners will be notified and the result published later in Practical Electronics.
EQUIPMENT for displaying the frequency responses of filter systems range from a simple sinewave generator and meter (also requiring graph paper and a great deal of patience!), to real-time spectrum analysers costing thousands of pounds. Sweep Oscillators fall somewhere between these extremes, using an oscilloscope to display the response in near-real time. They are immensely useful in the audio design or repair workshop, though ready-built models are unaffordable luxuries to most amateurs. This project uses a special i.c. to overcome the major design problems at low cost, and is also simple to build and set up.

The P.E. Audio Sweep Oscillator provides a low-distortion sinewave whose frequency can be swept over the audio range by an internal rampwave generator. The sinewave is fed to the system under test while the output is viewed on an oscilloscope with the sweep voltage from the oscillator controlling the horizontal deflection. The response of the system is displayed as a graph of amplitude against frequency, with the frequency axis logarithmic since the signal frequency is an exponential function of the sweep voltage. For oscilloscopes without a horizontal input, a pulse that marks the start of each sweep is provided to trigger the internal timebase.

A squarewave output is also provided, allowing the unit to double as a general purpose test oscillator, along with option of using an external ± 15V regulated supply.

SINEWAVE GENERATION

This design employs an unusual approach to sinewave generation, in that the triangle output of a voltage-controlled oscillator is fed to a tracking low-pass filter which removes the harmonics from the signal (see the block diagram in Fig. 1). The result is a sinewave which covers the whole audio range without switching and has less than 1% distortion. This would not be a practical alternative to designs based upon quadrature oscillators or diode shaping networks but for the availability of the SSM2040, manufactured by Solid State Micro Technology specifically for low-cost audio applications. This i.c., with one external op-amp, provides the VCO and matched 3-pole filter, plus the exponential control voltage converter required for a logarithmic frequency axis.

CIRCUIT DESCRIPTION

The circuit diagram appears in Fig. 2. The oscillator is based around one of the four gain cell-buffer pairs of the SSM2040 (IC3 pins 15, 14, 13) and IC4, which form the integrator and schmitt trigger respectively of the familiar triangle/squarewave generator arrangement. The gain cell outputs a current proportional to the input voltage and the exponential converter current. This is used to charge and discharge C7 between fixed thresholds of + and - 0.6V, producing triangle and square waves with voltage-controlled frequency. R1 injects a small current into R2 to allow the effect of gain cell input offset and unequal maximum and minimum output voltages of IC4 to be trimmed out for best waveform symmetry.

The Voltage Controlled Filter consists of three identical low-pass stage in series. Looking at the first stage (using IC:3 pins 12, 11, 10), the arrangement is seen to be similar to the integrator, but with feedback provided by R8. At input frequencies below the filter breakpoint C8 has little effect and the negative feedback produces a virtual earth at the gain cell input. Hence the stage acts as an inverting amplifier with gain equal to R8/R6, in this case unity. At higher frequencies the voltage on C8 lags behind the input signal, the difference between the two appearing at the input of the gain cell. This causes the voltage on C8 to approach the new value of the inverted input signal exponentially, and the result is a low-pass filtered signal at the buffer output. The exponential generator current controls the current delivered to C8 and therefore the break frequency of the filter.

The filter breakpoint is set to track slightly below the VCO frequency, so that even though the total passband gain of the filter is one, the fundamental sinewave is actually slightly attenuated. This ensures that maximum slope exists between the fundamental and the third harmonic (there being no second harmonic in a triangle wave) so that within component tolerances a higher or lower cut-off frequency will only affect the sinewave amplitude, with the purity remaining at maximum.
Fig. 1. Block diagram of Audio Sweep Oscillator

Fig. 2. Full circuit diagram. G=variable transconductance amplifier. B=high input impedance buffer.
Fig. 3. Printed circuit layout (actual size)
Fig. 4. Component layout
Device IC5 boosts the sinewave amplitude and VR7 allows it to be set to exactly 10V p.p. IC5 and R43 provide h.f. roll-off to compensate for the increase in amplitude of the triangle wave at high frequencies, due to the SSM2040's limited bandwidth when used in oscillator mode. The variation in the level of the resultant sinewave is within ±1dB over the full range. S2 selects the output waveform, VR2 controls the level, and R20 & R21 attenuate the 10V p.p. signal for the 1V p.p. output.

The sweep generator is based around a unijunction transistor, TR2. TR1 forms a constant-current source that charges C12. When the voltage reaches +2.5V, TR2 turns on and C12 is rapidly discharged to -11V through R26. Charging then continues and the cycle is repeated, generating a rising ramp wave whose frequency is dependent on the values of the fixed thresholds and the charge current set by VR3. This gives a sweep time range of 12sec.-30ms. A log. pot. is used with maximum sweep time at the clockwise end, giving the best distribution of times over the range of the control.

Device IC6a buffers the voltage on C12 and shifts the rampwave to be symmetrical about 0V. To avoid a visible flyback on the screen, the falling edge of the ramp must be speeded up—this is the function of the track-and-hold circuit around TR14, C13 and IC6b. During the rising section of the waveform TR4 is on, and both the voltage on C13 (and the output of IC6b, the buffer) track the output of IC6a. While the ramp is resetting, TR3 holds TR4 off and the buffered voltage remains at the peak value. At the end of the reset pulse, TR4 turns on again and the output of IC6b falls very rapidly to the new ramp voltage. The reset pulse is also coupled to the trigger socket.

Device IC7a inverts the sweep voltage and S3 selects the non-inverted or inverted version for upwards or downwards sweep respectively. R35 and R36 attenuate it to suit the horizontal inputs of most oscilloscopes; if the trace is too wide or too narrow, the value of R36 should be adjusted accordingly. IC7b sums the voltages from the frequency pot VR6, the sweep width pot VR4, and the range preset VR5, using D3 and D4 to limit the output voltage swing to the required range. The exponential converter input (pin 7 of IC3) has a sensitivity of 18mV/octave, and R41 & R42 divide the output of IC7b to suit this.

The power supply is conventional, using two 100mA monolithic regulators for the ±15V rails. Current consumption is about 20mA from each during normal operation.

CONSTRUCTION
Assemble the p.c.b. in the usual order, i.e. resistors first, then capacitors, followed by semiconductors, using the com-
ponent overlay in Fig. 4 as a guide. Solder in the i.c. sockets (strongly recommended) and Veropins. The p.c.b. has provision for accepting an external ±15V supply, and if this option is used, all the power supply components can be omitted. Check the underside of the board for solder bridges etc., paying particular attention to the area around the SSM2040. The inputs and outputs of this device are not protected, and a short to either supply is likely to destroy it. Fit the pots, switches and sockets to the front panel, and fix the board to the bottom of the case with the screws supplied. Connect up the front panel components and the board, making separate connections rather than grouping them together. To avoid the sinewave output picking up the squarewave edges at low output levels, use miniature screened cable between the level pot, the board and both output sockets. Earth the screens at the pot end, and also earth the front panel by connecting the earthed tag of the pot to its body, filing the metal first to ensure a good joint.

**MAINS ALTERNATIVE**

If the internal PSU option is being used, the mains should be brought to the unit via an IEC plug mounted on the back panel of the case. Also on this panel are the fuse and transformer, and these components should now be fitted and wired up, with the transformer located in the top right-hand corner as viewed from the front of the case. All bare mains connections must be sleeved or protected with insulating tape before proceeding to the setting-up stage. Finally, check all the connections to the board from the front and back panel components.

**ASSEMBLY DETAILS**

Fig. 5. Wiring diagram. Dotted lines represent the braid of screened wire.
SETTING-UP

Power-up the unit and with the frequency and level controls at their mid-points, examine the 10V and 1V outputs with an oscilloscope. The wave switch should give the expected sine and square waves at both. Check that the sweep controls are functioning correctly, remembering that the sweep time control should produce the longest time at the clockwise end. Without the sweep in use and with the level initially at minimum, connect the 1V output to an audio amplifier and speaker. Monitor the squarewave at a frequency of around 100Hz and carefully adjust VR1 until the point is found where only odd harmonics are heard, with even harmonics being introduced to each side. Those constructors who do not feel confident about trimming a pulse wave to 50% mark/space ratio by ear can attempt this visually on the scope screen, but after a little experimentation with the preset, most should be able to obtain much better results by the aural method.

After VR1 has been properly set, the sinewave will have minimum distortion. The other two adjustments are straightforward. With the frequency control at maximum, set VR5 for a frequency of 20kHz. Then turn the frequency control to its mid-point and adjust VR7 for a sinewave amplitude of precisely 10V p.p at the 10V output.

Before screwing the case together check the sweep and trigger outputs with the scope, and if any modification of the sweep width is needed, make it as previously described.

IN USE

Connect the input of the system under test to the appropriate output of the sweep oscillator, and its output to the Y-input of the oscilloscope. Select external input for the X-amplifier and connect the sweep output of the oscillator. With the level control set to suit the input of the audio device and all other rotary controls at their central positions, adjust the scope controls for the best trace. The wave switch should be on sine, and the sweep switch on up or down sweep.

Best results will be obtained with a slow sweep, but since this makes the trace difficult to read, a compromise must be arrived at. A sweep time of around 0.5s gives good results with most filters and medium persistence CRT's, but with high Q-factors or low frequencies, longer times are needed. Short sweep times should be reserved for examining responses at high frequencies, or over a narrow band.

The range of the oscillator is limited to the values corresponding to the ends of the frequency control, so for use at maximum sweep width this must be at its mid-point if the actual sweep is to cover the full range. Reducing the sweep width 'zooms in' on the centre of the displayed section of the response, and altering the frequency moves the 'window' up and down.

Fig. 6a and b are examples of displayed frequency responses, in this case of a 5-band graphic equaliser with the boost/cut controls at different positions. Fig. 7 is an example of use as a general test oscillator. The display shows severe ringing at the output of a system driven by the squarewave from the Sweep Oscillator.

To use the trigger facility, the trigger output should be routed to the external trigger socket of the oscilloscope and the trigger level adjusted for a stable trace. Experiment with the sweep rate to give a single full sweep of the oscillator frequency in each timebase period.

THE KIND OF OUTPUT DISPLAYS YOU CAN EXPECT

Fig. 6 (a) & (b). Graphic equaliser output examples

Fig. 7 (below). Squarewave test signal upon which the system under test has superimposed severe ringing
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JUSTIN CASEY HOWELLS

British patent application 2 082 363 from Graham Jackson of Surrey describes in detail the electronic system for generating a noise similar to that heard by a baby in its mother's womb. According to the inventor this has a comforting effect on babies, particularly when they are new born. The sound is described as a whooshing noise which occurs cyclically with the sound of the heartbeat, over a general background noise. The whooshing increases in frequency and then decreases again before the end of the cycle. The aim is to provide a unit which will produce this noise, but is cheap to make so that families can buy them for home use.

Figure 1 shows the general layout. Ramp generator 1 produces a waveform at heartbeat frequency (nominal 72 beats per minute), generator 2 modulates this waveform with white noise and voltage controlled, oscillator 3 uses the modulated waveform to produce an audio frequency of nominal 1.5kHz. The audio signal from oscillator 3 is filtered at 4 and reproduced by loudspeaker LS1.

Figure 2 shows a pair of operational amplifiers IC1a and IC1b functioning as the ramp generator and another pair of operational amplifiers IC2a and IC2b functioning as the white noise generator. VC03 also relies on a pair of operational amplifiers IC1c and IC1d and the filter uses a single op amp IC1d to modulate its audio output of nominal 1.5kHz value. So within each heartbeat period there is an increase in frequency followed by a decrease in frequency. This swooping signal is shaped and filtered free of high harmonics by network R14, R15 and R16, C5 and C6. The shaped signal is then amplified at IC2e to drive speaker LS1.

The patent gives full circuit diagrams with component values. The inventor suggests that the output signal can be recorded on a record or tape to make it even cheaper for parents to produce the soothing noise in their own homes.

SEIKO FLAT TV

Flat screens for small portable monochrome television sets are likely to be the next big news in consumer electronics. Sinclair and Sony have gone for a flattened cathode ray tube. Other Japanese manufacturers, such as Hitachi and Toshiba, have gone for liquid crystal displays which modify ambient light. It's impractical to use a display which produces its own light, for instance a matrix of I.e.d.s, as power consumption is too high.

The Japanese firm Kabushiki Kaisha Suwa Seikosha, in British patent application 2 081 018, claims broad protection on what could be an important step forward towards making liquid crystal display TV screens more practical, and gives some insight into the technology employed in the Seiko "watch TV".

Figure 1 shows the circuit for a conventional display. Address line X is connected to gate of transistor 2. When it conducts a signal from data line Y is stored on capacitor 3 to drive I.c.d. segment 4. A rectangular matrix of a large number of these segments produces a small TV picture. A disadvantage of the system is that the driving electrode is made of aluminium, and does not transmit light. So the screen only...
blocks with light reflected from the electrode. Figure 2 shows the new type of display which is being patented. A layer of polycrystalline silicon is grown on a substrate, which is of high melting point glass, such as quartz. $p$ ions are then implanted to form an $n$-type polycrystalline silicon layer. A gate 26 and capacitor electrode 27 are formed by photo-etching a film 30 of silicon di-oxide. A second layer of silicon is then formed and $p$ ions implanted, except over channel 28, to form source and drain electrodes, data line 25 and driving electrodes. The whole assembly is then illuminated with laser light to anneal it. The electrodes and substrate are transparent so that a TV screen made from a matrix of these elements has an increased viewing angle and gives better contrast, even when watched outdoors in sunlight.

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WITH the current increase in the number of reported break-ins, together with the considerable publicity given to annual crime figures, the public awareness of the need to have some form of intruder deterrent in the house is growing to the point where a burglar alarm is no longer considered a requirement of only large houses or very wealthy occupants. To meet such a need, a large number of companies are currently engaged in producing a wide range of intruder alarms. The units offered vary from simple magnetic switches and bells to highly sophisticated microprocessor controlled systems.

It is an area, however, where the enthusiast can save a considerable amount of money by fitting their own system. One requirement which the majority have in common is the need for flexible control, and it is as a result of this need that this project was originated.

CIRCUIT

In Fig. 1 the power supply for the unstabilised requirement uses the conventional full wave circuit resulting in some 18V off load falling to 14–15V in the event of an alarm. It can be seen that it is this output which is switched by S2 to the relay and CSR which is triggered by breaking the anti-tamper loops (AT1 and AT2) or pressing the panic switch which is a push to break type. With the CSR switched the relay closes and the siren is operated continuously until reset. The siren circuitry is comprised of IC2 and 3 and the output pair TR5 and TR6. Here IC3 acts as a 1 kHz oscillator which is modulated by IC2 at approximately 1.5Hz. The output of IC3 is then amplified by the complementary pair. The siren frequency slides between 1 and 2kHz with a high level output for driving a minimum load of 4 ohms. In practice this usually consists of two 8 ohm speakers in parallel with one speaker mounted in the house and the other external to draw the attention of neighbours etc.

When used with horn speakers sound pressure levels of 110dB at 2 metres can be obtained which are extremely effective.

With S2 switched to ‘Alarm’ the diode D3 ensures that the supply reaches the relay, CSR and the stabiliser circuitry. A discrete voltage stabiliser was adopted rather than the more usual integrated type since a low voltage drop was the prime requirement. In the circuit used only 300–400mV is dropped compared to 1.5V–2V for the integrated type. Here, TR4 limits the stabilised output current.

The stabilised supply of 11V is fed to the timing circuitry around IC1. Here IC1a and b constitute a modified monostable arrangement in that the circuit has one stable state in the true sense, but two alternative states. The duration of these are used to provide the alarm time and entrance delay with the actual value being set by R7 and C3 and R9 and C4 respectively. IC1d detects when the output from b and c is low (this occurs during the alarm time) thus switching TR1 and energising the relay. R11 and C6 comprise a filter to reduce unwanted transients.

IC1a provides the exit delay since pin 1 is held high until C2 becomes fully charged. This occurs after the time constant of C2 and R5 which is approximately 30 seconds.

R25 and D10, if fitted, provide for a delay following an alarm period. Such a null might be required in order to allow an alarm siren etc., to die down before resetting the system.

The 11V supply will also supply external units such as ultrasonic or infra-red transducers. The maximum current which can be drawn from this line is 100ma and it is short circuit protected. The choice of 11V as against a more normal 12V allows the stabilised output to be maintained even when used with batteries which are not fully charged, since the stabilisers used drops only some 300–400mV. The battery back-up facility provides a trickle charge of some 2ma, chosen to be the maximum safe continuous current permitted for small nicad cells. For other types of battery it may be possible to increase the charge rate.

The unstabilised output supplies the relay and siren requirements.

MAIN SWITCH POSITIONS

In position 3 of S2, the alarm becomes active after a delay of approximately 30 seconds. This delay allows the individual to leave the premises, close the door etc. without setting off the alarm. A further delay of some 20 seconds following an entrance to the premises allows authorised individuals time to switch off the alarm before the siren sounds, preferably by some means of security switch. If this is not switched off it will sound for a period of approximately
1-5 minutes before resetting itself, providing the original cause of the triggering has been removed.

The two operating modes are indicated by i.e.d.s.

In position 2, the 'Off' position, neither the alarm or panic facility are operating, however, the test loop facility may be used in order to determine that it is safe to switch on the alarm without it being immediately activated (i.e. a door or window has not been left open). In position 1 the alarm is not activated by detection systems, in other words, doors may be opened or movements, made within the covered space. The unit will however, respond to wires being cut (AT1/AT2—the anti-tamper loops) and also to S1, this being a switch normally fitted close to the front door or the bedside used for summoning assistance. In this mode the alarm when sounded is continuous until the unit is reset by the switch set to position 2 for 5 seconds or more.

RELAY SWITCHING

As mentioned, the relay is switched by either CSR1 or TR1 enabling the siren circuit via RLA1.

The second set of contacts RLA2 are available for the switching of external loads up to 5A such as room or spot lights etc.

CONSTRUCTION

With a unit of this nature reliability is of paramount importance so the p.c.b. assembly should be carefully constructed.

The assembly procedure should start by inserting the resistors, followed by diodes, taking care to observe correct polarity. The three i.c.s should next be fitted, then small signal transistors, capacitors, power transistors and CSR, the overall aim being to build up the unit commencing with the lowest profits components, ending with the largest and most bulky. This means that the relay and C8 should be among the last to be attached to the board.

Although it is possible to install the finished board by soldering flying leads it is recommended that the screw type printed circuit terminals are used as seen in the photograph.

Before the final part of the assembly, i.e. fitting of the transformer, the location of the components should be thoroughly checked, together with the quality of the soldered joints. The transformer should now be firmly pushed into the p.c.b. and held in place whilst the tags are soldered.

TESTING

Wire links should be fitted between terminals 10-11,
19–20 and 1–2. A suitable 8 ohm speaker with a 100 ohm series resistor (in order to attenuate the output) should then be connected to O/P1 and a mains lead attached to the appropriate 240V terminals.

Finally, an I.e.d. should be fitted to the p.c.b. at locations 29–30 with the anode connected to 30.

It must be emphasised that before applying mains voltage to the unit, it should be either placed on a non-conducting surface or mounted on pillars at the four mounting points.

With the supply connected the relay should not energise, nor the I.e.d. be illuminated. The link 19–20 across the panic switch terminals should be temporarily broken. When this happens the CSR should trigger energising the relay which in turn should switch on the siren. A sliding tone between 1–2kHz should be heard from the speaker.

If this is not the case it should first be ascertained that the relay has energised switching the supply to the siren circuitry. Assuming all is well, the link on the panic switch should be restored and the supply switched off in order to reset the unit. Before reconnecting the supply the link 1–2 should be removed and the supply restored. After approximately 30 seconds (the exit delay) the I.e.d. should glow indicating that the alarm has been triggered. When a further 30 seconds have elapsed, the relay should energise and the alarm sound. This will continue for about 90 seconds if the link 1–2 has been restored. If not the siren will sound continuously.

If the results achieved deviate to any extent the component locations should be re-checked and the board examined for previously undiscovered solder splices.

When all is working well the unit may be installed in a suitable enclosure and wired to the appropriate mode switch which should take the form of a three position security or key switch.

The outputs from the siren may also be taken direct to a single or pair of speakers dependent upon the installation.

Finally, do not forget to remove the small links on the copper side of the board when fitting the anti-tamper loops. The other facilities may be used or not dependant upon the requirements of the particular installation.
### Components

<table>
<thead>
<tr>
<th>Resistors</th>
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### Capacitors

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<td>10µ</td>
</tr>
<tr>
<td>C12</td>
<td>220µ</td>
</tr>
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### Transistors

| TR1 | 1N4148      |
| TR2 | 1N4001      |
| TR3 | 1N4148      |
| TR4 | 1N4001      |
| TR5 | 1N4148      |
| TR6 | 1N4148      |

### Diodes

| D1  | 1N4148      |
| D2  | 1N4001      |
| D4  | 1N4148      |
| D5  | 1N4148      |
| D8  | 1N4148      |
| D9  | B2ZSB 11V Zener |

### Integrated Circuits

| IC1 | 4001        |
| IC2-IC3 | 555      |

### Transformer

<table>
<thead>
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<th>Transformer</th>
<th>12-0-12V</th>
<th>12VA</th>
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**BAZAAR**

**TANGERINE** Micron plus lots of extras worth £500. £250 or consider PX, swap for good synthesiser. Mr. J. Spink — 0642 565962.


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Ingenuity Unlimited

A selection of readers' original circuit ideas. Why not submit your idea? Any idea published will be awarded payment according to its merits.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

'THIS game is similar to an old game using matchsticks. Here nine matches are placed in a line. Two opponents can take either one, two, or three starting from the left. The player who takes the last stick is the winner. 'Challenge' takes this one a stage further and allows a single player to pit his wits against the circuit.

You choose who is going first using S3. This is shown in the 'Your Turn' position. If you go first, your chosen number is fed to the circuit using the 'Number Chosen' push button. IC1 and IC3a make sure that you do not take more than three. Your chosen number is fed to IC2 where it is counted and displayed on a row of nine l.e.d.s, which are analogous to the matches. After your turn, or if the circuit went first S3 is moved to its other position.

This disconnects the 'Number Chosen' push button and resets IC1 ready for your next turn. So that the circuit's chosen number is not displayed immediately a small delay of a couple of seconds is introduced by the charging of a 100µ capacitor feeding IC5a and b. After this delay, the number is displayed. The optimum number is programmed by a diode matrix on the outputs of IC2 and depends on your last turn. Imagine that you had had first turn and chose three. It is now the circuit's turn. IC7 is in its reset state and as the AND gates, IC4b, c, and d are connected to its '1', '2', and '3' outputs, their outputs will all be low and IC5d will have a high output. This enables IC6, a 1Hz clock via IC3c after the delay caused by the 100µ capacitor. Thus a 1Hz clock signal is fed to both IC2 and IC7. Now if you had chosen three last time, the optimum number for the circuit to choose is two and this is implemented by the diode on pin 7 of IC2 (i.e. the pin which is high at the time) which will make one of the inputs of IC4c high. When two clock signals have occurred and IC7 has counted two, the output of IC4c goes high, and disables the clock via IC5d and IC3c. Thus the display has moved on two places and it is now your turn again.

As stated before, the winner is the one who lights the last l.e.d. and this is determined by IC3d, IC4a and IC5c. The appropriate win l.e.d. is then illuminated.

G. Durant, Braton, Selby.

Practical Electronics  October 1982

G. Durant, Braton, Selby.
This is yet another resistive touch switch but with some new features. The usual type is momentary action and requires a Schmitt trigger at the input for reliable operation. To get a latching on/off action a flip-flop is used, sometimes using one set of contacts for 'on' and another set for 'off'. This simple little circuit provides a latching on/off action using only one pair of contacts. It also gives complementary (Q and \( \overline{Q} \)) outputs (Fig. 1).

The two inverters are linked into a positive feedback loop via R2. On their own they form a bistable latch; once set in either logic state the positive feedback keeps the circuit in this state. The usual purpose of R2 is to allow a new logic level to be fed into IC1a, without short circuiting the output of IC1b. In this case it also prevents the rapid discharge of C1.

Before the contacts are touched, X is at Q and Y is at Q. When the contacts are bridged by a low resistance, X is forced to the new state Q (Fig. 2). This propagates very rapidly around the loop to reinforce itself. Working at a very much slower rate, the potential at X heads for its new steady state value. It should not be allowed to get too close to this value, however, because X will then enter the indeterminate region of the inverter input. (Fig. 3).

In the prototype unit the output changed from 0 to 1 then reverted to 0 if the contact was made for more than 1 second. To make sure that this does not happen the level on X must be kept within the guaranteed input levels shown in Fig. 3. This can be achieved by touching the contacts for less than 1 second, which is not at all difficult.

When the power is switched on the bistable can adopt either state. The state which is actually adopted depends on the circuitry connected to the Q and \( \overline{Q} \) outputs. As a test, an I.e.d. in series with a resistor was connected from one of the outputs to ground. It was found that the bistable always came on in such a state that the I.e.d. was not lit.

The touch contacts used on the prototype were made from 14 s.w.g. silver plated copper wire. The exposed lengths were 1" in length and these were placed A" in apart in a piece of wood. None of this is critical though. The most important point to consider, as with any resistive touch switch, is the danger of getting an electric shock due to faulty components or wiring.

L. O. Green,
New Costessey,
Norwich.

Percussion synthesiser

Many rhythm generator i.c.s are limited in the amount of control over the actual instrument voices that they offer the operator. Shown is a percussion synthesiser designed to add special effects to such an i.c. The circuit is based around the popular SN76477N sound generator chip. All that this chip requires to function correctly are a few discrete components. The chip can be triggered directly from the rhythm generator chip itself via a suitable capacitor to provide a falling edge. The output from the i.c. is available at pin 13, via a 2\( \mu \)F/6V capacitor.

S1 selects the mode of the internal mixer, and hence the audio source (i.e. VCO and/or Noise). VR1 sets the frequency of the internal noise clock and hence the overall tone colour of the signal.

VR2 sets the upper cut off frequency of the noise filter. VR3 and VR4 set the attack and decay times of the envelope shaper, 0-100ms and 0-1000ms respectively, and VR5 sets the pitch of the VCO. With experience a wide range of complicated and interesting effects can be created (several units all working in VCO mode, set to different pitches and controlled by different outputs of a RG chip could produce some unusual sequences).

The unit can be powered from a single 9V battery.

R.A. Jagger,
Hambleton,
Yorkshire.
**STEREO WIDTH CONTROL**

This simple circuit was designed to allow the width of a stereo image to be adjusted, and as such is useful for headphones and systems with unduly large or small spacing between speakers.

A stereo channel signal is far more complex than is commonly appreciated and is not pure "left" and "right". The actual left channel signal has a percentage of the right channel added and vice versa at the recording stage. If we devote pure left and right by L and R, and the left channel by A, the right channel by B we can (with some simplification) write:

\[ A = L + nR \]
\[ B = R + nL \]

where \( n \) is the mixing proportion, determining the image width. If we produce the signals \( (A + KB) \) and \( (B + KA) \) where \( K \) is a variable gain whose sign (as well as gain) can be changed, the proportion of \( L \) and \( R \) in each channel can be increased or decreased. In this way the stereo width can also be increased or decreased.

This is achieved by the circuit shown where the necessary arithmetic is performed by three dual op. amps. A and B denote the two channels, which are buffered by IC1a and IC2a. IC1b and IC2b invert the signals to give \(-A\) and \(-B\).

The ganged potentiometer VR1 is connected between \(+A\) and \(-A\), \(+B\) and \(-B\). In the centre position there will be no signal, but as the slider is moved towards either end, a signal of either polarity can be obtained. The sliders thus give KA and KB where the sign and value of \( K \) is determined by the potentiometer position.

The signals KB and KA are added to A and B respectively by the simple summing amplifiers IC3a and b to give the required adjusted output.

The circuit works on a dual supply in the range \( \pm 5 \) volts to \( \pm 15 \) volts, best provided by an i.c. regulator. It could be made to work with a single split rail supply, but care would have to be taken to prevent crosstalk.

With VR1 in the centre position the stereo signal is unaffected by the circuit. Moving VR1 to one side or the other will reduce or increase the stereo image. At the limits a monophonic signal results, or the stereo signal will fall apart into two separate sounds. The optimum setting will depend on the listener's preference.

E. A. Parr,
Carlisle, Lanarkshire.

**INSTANT DIODE TESTER**

This is an add-on feature, for mains powered test equipment, which gives an instant indication of the condition of the diode under test and identifies its anode. It is so simple to make that it could easily be added to a workshop power supply, for instance.

The operation of the circuit is very simple. If the diode under test is working correctly then an i.e.d. will indicate the anode. Otherwise, neither or both i.e.d.s will light, showing which type of fault is present.

The i.e.d.s protect each other by limiting the reverse voltages to 2V. Consequently, if one is wired in reverse or fails then the other could be destroyed. Although a diode could be put in series with each i.e.d. for protection, this was not considered to be worthwhile.

It is quite safe to connect this unit directly across a transformer that is being used for other purposes, e.g. a stabilised power supply.

---

**A.C. Supply Voltage (RMS)**

<table>
<thead>
<tr>
<th>Voltage (RMS)</th>
<th>10mA</th>
<th>15mA</th>
<th>20mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>120</td>
<td>82</td>
<td>56</td>
</tr>
<tr>
<td>9</td>
<td>240</td>
<td>160</td>
<td>120</td>
</tr>
<tr>
<td>12</td>
<td>390</td>
<td>240</td>
<td>180</td>
</tr>
<tr>
<td>15</td>
<td>510</td>
<td>330</td>
<td>270</td>
</tr>
<tr>
<td>20</td>
<td>750</td>
<td>470</td>
<td>360</td>
</tr>
<tr>
<td>25</td>
<td>910</td>
<td>620</td>
<td>470</td>
</tr>
<tr>
<td>30</td>
<td>1100</td>
<td>750</td>
<td>560</td>
</tr>
</tbody>
</table>

---

L. Green,
New Costessey,
Norwich.
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The letter you read here is a genuine unsolicited letter from a happy WERSI maker to AURA SOUNDS. It has been abbreviated by necessity but the original letter is on our files and photocopies can be provided on request. If D.B. of Manchester can do it — so can you!

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To:
Mr. Arthur Griffen
AURA SOUNDS LTD
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Brighton Road, Purley,
Surrey.

D.B. Manchester.

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IF THEY SAY IT'S DIFFICULT — THEY'VE NEVER BUILT A WERSI.
THE mini chorus effect is one that receives a great deal of use these days, and it is probably used most by vocalists although it is also perfectly suitable for use with electronic instruments. The effect is basically very simple, and is produced by mixing a delayed signal with an undelayed signal, and the length of the delay is usually varied at a low frequency. Apart from varying the degree to which the two signals are out of synchronisation, this varying of the delay also gives a degree of vibrato to the delayed signal. The resultant audio output gives the impression that there are two instruments or vocalists singing or playing in unison, and this normally gives a much richer and more interesting sound. This effect should not be confused with the more complex chorus effect which uses more than one delay circuit and gives the impression of many vocalists or instruments using a single source.

BLOCK DIAGRAM
The block diagram Fig. 1 shows the various stages of which the Mini Chorus unit is comprised. The delay line is of the usual charge coupled (bucket brigade) type, and this provides a delay that is governed by the frequency of a two phase clock oscillator. A delay of 10ms or more is needed in order to give the desired double output effect, and in practice a delay which is varied from about 10ms to 20ms or so is perfectly satisfactory. A low frequency sweep oscillator is used to frequency modulate the clock oscillator and give the required variation in the delay time.

The delay required in this application can be obtained using a 512 stage delay line, but as the delay time is equal to the number of delaying stages divided by twice the clock frequency (in Hertz), this would give a clock frequency range of approximately 12 to 25kHz. This would give a rather restricted bandwidth since the maximum input frequency should be no more than half the clock frequency and should preferably be no more than a third of the clock frequency. In order to obtain reasonable output quality this would give a maximum bandwidth of only about 4kHz. Filters are used at the input and output of the delay line to remove input signals at frequencies above the acceptable maximum input frequency, and to remove the clock signal (which effectively modulates the output signal) at the output. With a minimum clock frequency of about 12kHz both filters would need to have a very high level of performance in order to give satisfactory results.

It was therefore decided to use a 1024 stage delay line which is admittedly a little more expensive than a 512 stage type, but gives a more respectable bandwidth of about 8kHz, and with a clock frequency range of about 24 to 50kHz puts less stringent requirements on the input and output filters.

CIRCUIT
Fig. 2 shows the circuit diagram of the filter, delay line, and mixer stages of the unit.

The input filter is an active type which is based on TR1 and has a nominal roll-off rate of 12dB per octave and a cut-off frequency of approximately 9kHz. The output filter is essentially the same, but the emitter follower transistor is a pnp type instead of an npn device, and it is biased from the output of the delay line rather than from a potential divider.

The delay line integrated circuit is an SAD1024A which actually contains two 512 stage delay lines which are independent apart from common supply pins. R8 and R9 are used to bias the input of the first section of IC1 and C4 couples the output from TR1 to the input of this section. One output of the first delay line section (pin 11) is connected to the positive supply rail in accordance with the i.c. manufacturer’s recommendations, and the other output (pin 12) is coupled to the input of the second section of IC1 by R10 and C5. C5 is needed as there is a small but significant d.c. shift through each delay line, and the second section of IC1 is biased by R6 and R7. R10 provides a small amount of attenuation that counteracts the small voltage gain through the delay line.

VR1 forms a simple mixer circuit which combines the outputs of the last two stages of IC1, and this component is adjusted to produce maximum cancelling of the clock signal. C6 provides a certain amount of filtering at the output in addition to that produced by the main filter circuit.

The mixer stage is a conventional operational amplifier summing mode circuit which utilises IC2. C12 rolls off the high frequency response of the mixer stage slightly and gives a small amount of additional output filtering. The effect can be switched out by opening S2 to cut the delayed signal to the mixer.

OSCILLATORS
Fig. 3 shows the circuit diagram of the sweep and clock oscillators, together with the supply and regulator circuitry.

The clock oscillator uses the four two input NOR gates of a 4001 CMOS device, and all four gates have their two inputs connected together so that they act as four inverters.

R.A. Penfold
IC4a and IC4b are used in a conventional CMOS astable circuit, and IC4c is used as a buffer stage at the output of the oscillator. IC4d is used as an inverter which gives an output signal which is complementary to that at the output of IC4c, and thus gives the required two phase clock signal.

The frequency of this type of astable can be varied by applying a control voltage to the input of the first inverter via a series resistor (R24). TR3 is used as a buffer stage between the sweep and clock oscillators and is needed in order to present a suitably high load impedance to the sweep oscillator.

The sweep oscillator uses operational amplifier IC3 in a well known configuration, and this oscillator operates by charging and discharging C14 through VR2, R22, and the output stage of IC3. C14 charges and discharges exponentially and a non-linear triangular waveform is therefore produced across C14, and this signal is used to sweep the clock oscillator up and down in frequency. VR2 gives an adjustable frequency range of approximately 0.1 Hz to nearly 10 Hz.

The circuit requires a reasonably stable 15 volt supply, and this is derived from two 9 volt batteries in series using a simple series regulator circuit which consists of TR4, R26, D1, D2, and C17. This uses a well known configuration with the Zener stabiliser formed by R26, D1, and D2 being used to drive emitter follower transistor TR4. D2 is used to boost the input voltage to TR4 by about 0.65 volts to compensate for the voltage drop of approximately the same amount between the base and emitter of TR4.

The current consumption of the circuit is about 11mA and this gives a reasonable battery life using PP3s or equivalents, but if the unit is likely to receive a great deal of use it would probably be more economic to use larger batteries or rechargeable nickel-cadmium types.

CONSTRUCTION

The printed circuit board design is shown in Fig. 4 and the wiring of the unit is illustrated in Fig. 5.

IC1 and IC4 are both MOS devices, and while the 4001 integrated circuit costs only a few pence, the SAD1024A is quite expensive and should be treated with respect. Use a socket for this component and do not fit it into place until the printed circuit board is in other respects complete. Leave it in its protective packaging until it is to be plugged into circuit, and try to avoid touching the pins.

All the components, including PP3 size batteries, can be fitted into a diecast aluminium box having approximate outside dimensions of 150 by 80 by 50mm. A diecast aluminium box is ideal for this application as it is both very strong and has excellent screening properties. S2 is mounted centrally on the top panel of the case so that it can be
operated by foot. SK1, SK2, and VR2 are mounted along one of the 150 by 50mm sides and must be offset slightly towards the top so that sufficient room is left for the printed circuit board. The latter is mounted on the removable base panel of the case. S2 is a pair of make contacts on the input socket SK1, so that the unit is automatically switched on and off when the input is connected to and disconnected from SK1 (which is standard practice with effects units). A separate on/off switch can obviously be employed if preferred.
## COMPONENTS

### Resistors

<table>
<thead>
<tr>
<th>Resistor(s)</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R19, R20</td>
<td>100k</td>
<td>(3 off)</td>
</tr>
<tr>
<td>R2, R3, R4, R11, R12</td>
<td>47k</td>
<td>(2 off)</td>
</tr>
<tr>
<td>R5, R10, R13, R23, R25</td>
<td>100k</td>
<td>(5 off)</td>
</tr>
<tr>
<td>R6, R8</td>
<td>180k</td>
<td>(2 off)</td>
</tr>
<tr>
<td>R7, R9</td>
<td>82k</td>
<td>(2 off)</td>
</tr>
<tr>
<td>R21, R22, R26</td>
<td>1k2</td>
<td>(2 off)</td>
</tr>
<tr>
<td>R24</td>
<td>15k</td>
<td>(2 off)</td>
</tr>
<tr>
<td>R27</td>
<td>2k2</td>
<td>(2 off)</td>
</tr>
</tbody>
</table>

All resistors +W 5%

### Capacitors

<table>
<thead>
<tr>
<th>Capacitor(s)</th>
<th>Type</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4, C5</td>
<td>1µ 63V elect</td>
<td>(3 off)</td>
</tr>
<tr>
<td>C2, C7</td>
<td>1n5 ceramic 10%</td>
<td>(2 off)</td>
</tr>
<tr>
<td>C3, C8</td>
<td>220p ceramic 10%</td>
<td>(2 off)</td>
</tr>
<tr>
<td>C6</td>
<td>10n polyester</td>
<td></td>
</tr>
<tr>
<td>C9, C10, C13</td>
<td>100n polyester</td>
<td></td>
</tr>
<tr>
<td>C11, C17</td>
<td>10µ 25V elect</td>
<td>(2 off)</td>
</tr>
<tr>
<td>C12</td>
<td>47p ceramic 10%</td>
<td></td>
</tr>
<tr>
<td>C14</td>
<td>33µ tantalum</td>
<td></td>
</tr>
<tr>
<td>C15</td>
<td>3n3 ceramic 10%</td>
<td></td>
</tr>
<tr>
<td>C16</td>
<td>100µ 25V elect</td>
<td></td>
</tr>
</tbody>
</table>

### Semiconductors

<table>
<thead>
<tr>
<th>Component</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>BZY88C15V (15V 400mW Zener)</td>
</tr>
<tr>
<td>D2</td>
<td>1N4148</td>
</tr>
<tr>
<td>IC1</td>
<td>SAD1024A</td>
</tr>
<tr>
<td>IC2, IC3</td>
<td>741C</td>
</tr>
<tr>
<td>IC4</td>
<td>4001</td>
</tr>
<tr>
<td>TR1, TR3</td>
<td>BC109</td>
</tr>
<tr>
<td>TR2</td>
<td>2N3906</td>
</tr>
<tr>
<td>TR4</td>
<td>BC337</td>
</tr>
</tbody>
</table>

### Potentiometers

<table>
<thead>
<tr>
<th>Potentiometer</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1</td>
<td>2k2 0.1W horizontal preset</td>
</tr>
<tr>
<td>VR2</td>
<td>100k linear carbon</td>
</tr>
</tbody>
</table>

### Miscellaneous

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SK1/S1</td>
<td>Standard jack with DPDT contacts (Maplin)</td>
</tr>
<tr>
<td>SK2</td>
<td>Standard jack</td>
</tr>
<tr>
<td>S2</td>
<td>Heavy duty push-to-make, push-to-break type</td>
</tr>
<tr>
<td>B1, B2</td>
<td>PP3 size 9 volt (2 off)</td>
</tr>
<tr>
<td>Battery connectors</td>
<td></td>
</tr>
<tr>
<td>Control knob</td>
<td></td>
</tr>
<tr>
<td>Printed circuit board</td>
<td></td>
</tr>
<tr>
<td>One 16 pin DIL, one 14 pin DIL, and two 8 pin DIL i.c. sockets</td>
<td></td>
</tr>
<tr>
<td>Veropins</td>
<td></td>
</tr>
<tr>
<td>6BA fixings</td>
<td></td>
</tr>
<tr>
<td>Diecast aluminium box about 150 x 80 x 50mm</td>
<td></td>
</tr>
<tr>
<td>Wire, solder, etc.</td>
<td></td>
</tr>
</tbody>
</table>

---

It is advisable to fix four cabinet feet to the base of the unit so that it does not tend to slip away when S2 is operated.

**ADJUSTMENT**

Only one preset needs to be adjusted before the unit is ready for use, and this is VR1. If an oscilloscope or a.c. millivoltmeter is available, this can be used to monitor the signal at the wiper terminal of VR1 while this component is adjusted for minimum signal level. There should be no input signal present when making this adjustment. A simple alternative which does not require any test equipment is to add a capacitor of around 47nF in parallel with C15 so that the clock oscillator operates at an audible frequency. VR1 is then adjusted for minimum output of the clock tone.

**INPUT LEVEL**

The output noise level of the unit is well below 1mV r.m.s., and provided an input signal level of at least a few hundred millivolts r.m.s. is used a signal to noise ratio of about 60dB or more will be obtained. An input level of up to about 1 volt r.m.s. can be handled by the circuit without serious distortion occurring.
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In circuit

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**SPECIFICATION**

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Wow & Flutter: Typically 0.1%.
Drive Motor: 12V d.c. with electrical governor.
Play Torque: 40–75g/cm (DYNAMIC).
Rewind & Fast Forward Torque: 60–140g/cm (STATIC).
Rewind & Forward Time: Less than 100 sec. for C60 tapes.
Bias/Erase Oscillator: Externally variable, frequency 90–100kHz.
Output: (Adjustable) Up to 1 volt r.m.s.
Mic. Sensitivity: 1mV @ 47k.
DIN Sensitivity: 30mV @ 47k.
Frequency Response; 30Hz–12.5kHz (–3dB).
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Noise reduction H.F. –56dB
Noise reduction FLAT –70dB
Cross Talk: Typically –50dB.

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The remaining item to complete the Combo-Amplifier is, of course, a suitable cabinet which can either be purchased ready made, providing dimensions are suitable, or constructed on the lines described. Whichever is adopted the speaker enclosure capacity must be not less than, or not very much more than 2 cubic feet, otherwise the overall frequency response will be impaired. It is also essential, for the same reason, to use the speakers and crossover network specified.

**THE CABINET**

The diagrams of Fig. 1 are given as a guide to the construction of a suitable cabinet made from half-inch thick ordinary chipboard. All panels must be reinforced with battens of three quarter inch square or similar, preferably both glued and screwed. The rear speaker panel must be very close fitting to ensure no passage of air outward from the speaker enclosure. A soft non-setting sealing compound is recommended as well as screws every few inches all round. Use a speaker front panel covering of approved material such as Tygan or Type D5 material from Falcon Acoustics. The crossover unit may be fixed (securely) inside the speaker enclosure.

The power amplifier is housed in the lower compartment beneath the speaker enclosure and, apart from secure fixing, calls for no other special requirements, except possibly, that a punched hardboard panel (pegboard) could be used to enclose this section for protection. Some air circulation is necessary.

Finishing and covering the completed cabinet should be done before the units are fitted, and choice of covering is left to the constructor. There are plenty of strong glue-on or self-adhesive vynal and/or imitation leatherette coverings and trim material available from DIY retailers. Handles for carrying, one each side, are recommended if the Combo-amp is to be transported around. By the way, many DIY suppliers will cut chipboard panels to size, including cutting out the circular areas for the speakers. The chipboard, including cutting etc. should not cost more than £12 to £15.

**SPEAKER CONNECTIONS**

Speaker connections, and the connections to the Falcon Acoustic type crossover network, are shown in Fig. 3. As already mentioned it is essential to use the specified...
speakers and crossover network to obtain the overall frequency and impedance response as per the B & K readout given in Fig. 2. This is the response taken from the prototype Combo-amplifier speaker system described in this article and as shown in the photographs. Use thick multi-strand cables for connections between the amplifier output and the crossover networks and speakers, otherwise power will be lost.

When the speakers and crossover network have been fitted and wired, the enclosure is filled with loosely packed acoustic wadding, the amount required being as per the components list.

Note: The power amplifier is capable of driving two of these speaker systems in parallel to a maximum audio power of 100 watts. Connection between the output of the preamplifier to the input of the power amplifier must of course be screened, i.e., a single screened cable must be used.

APPLICATIONS OF THE COMBO-AMPLIFIER

The input/output facilities on the preamplifier can be used in a number of ways, and some are shown in Fig. 4. Here, a microphone is used on one channel, together with an external reverb. unit coupled back into the amplifier via the accessory socket of that channel. The remaining channel takes in an electric guitar and an external wah or fuzz unit. Signals picked up from these channels can, as shown, be fed to a tape recorder. Tape replay can be made via the auxiliary amplifier socket (J9). Sockets J8 or J6 can also be used as individual inputs. For disc record replay a suitable RIAA response corrected preamplifier is necessary (assuming the usual magnetic pickup), the output from this being connected to the amplifier via J6, J8 or J9 depending on the output signal level from the pickup preamp.

COMPONENTS . . .

- Bass loudspeaker 12" (Falcon type TL80P)
- Tweeter unit (Falcon type KSN6001A)
- Crossover network (Falcon type R40)
- Acoustic wadding (13yd. x 24in. wide, 1in. thick)
- Speaker front material, woodscrews and glue etc.

Constructor’s Note

Falcon Acoustics, Tabor House, Norwich Road, Mulbarton, Nr. Norwich.

There is no reason why the circuitry should not be adapted for disco work for example, by duplication for stereo and using two speaker systems on each amplifier thus giving a combined “stereo” output in the region of 200 watts.
The “Getaway Special” however was not so successful. The first attempts to activate the package failed. At first it was decided that there would not be any point in continuing efforts to start since it was possible that the algae, Duckweed and fruit flies were not likely to survive the space conditions. However the fault was found to be a broken connection from the switch panel of the spacecraft. This was by glassed and the package activated. The experiments in the Getaway Special were set up by the students from UTAH University. There were nine experiments and among them were the Algae and Duckweed growth project. This was designed to check the effect of weightlessness on the growth of the plants and also the effects due to changing conditions right down to the touchdown period. The effects of space were also to be examined as to the genetic growth of the fruit fly. The same study was set up for the brine shrimp.

Other activities of the crew involved the use of the television camera to observe storms in action over South America and obtain data regarding lightning effects and other cloud data. The lightning survey is important for there is much need to know more of its effects. For one thing it will help to throw some light on the birth of storms and the evolution of the energy which makes them fresh air.

The television camera was also used to transmit to Earth pictures of the Gulf Coast and Florida. Pictures were also transmitted of the flight deck and mid-decks of the Shuttle itself. The crew were excited about their own view of the Earth. Thomas Mattingly said "You can look out on the horizon and see the Earth’s rim and at the same time a lot of the light cloud patterns.” As the Orbiter flew over Florida, most of the peninsular was clearly visible including Cape Canaveral. It was possible to see the Orbiter’s 4,500 metre runway. "That is a familiar sight," said Mattingly. The camera was also turned to take pictures of the 2 metre high Electrophoresis Unit.

Some critical tests were made on the performance of the hull of Columbia. The underside was exposed to a temperature of 93 degrees C. The doors remained in the shade and their temperature fell to minus 93 degrees C. One of the doors could not be latched due to these extremes of temperature and consequent distortion. The effects of these wide ranging differences of temperature, from the Sun side to the dark side, are reduced by “rolling”. That is the spacecraft presents all its surface to the Sun in a planned sequence. In the case of this particular vehicle there was an important reason for the long period of exposure to the extreme heat.

While Columbia was on the launch pad a severe thunderstorm with torrential rain caused the protective heat shield tiles to absorb a great deal of water. If the water remained in the tiles it would freeze in the deep cold of space but on the re-entry mode would turn to steam causing tiles to crack and even fall off. While this is not necessarily a fatal hazard it could cause a measure of overheating of the spacecraft in exposed places. It is not a risk that should be taken. The “rolling” manoeuvre will be continued in order to keep a stable temperature over all surfaces. This mission, the fourth of the series, brings the Shuttle plan to the point of going commercial. The first of the new generation of shuttle orbiters begins with the Challenger which will be launched in full mode in January 1983.

**GETAWAY SPECIALS**

Before leaving the first chapter of “Shuttles Progress” there are some points worth mentioning relating to the spirit of progress. Gilbert Moore is an executive of Utah Aerospace with the old pioneer spirit and the will to take a chance. He spent 10,000 dollars six years ago for a “Getaway Special” package. He donated it to Utah State University to be used in a programme of student developed experiments. So confident was he in the worth of this package that he has already pledged another 40,000 dollars for more such packages. Already he has enthusiastically declared his faith in the value of the experiments but also the importance of developing equipment for future space experiments.

More than 350 similar payloads have been booked for the future and the applicants range from school children to the major corporations. One example is that of a city high school that is hoping to fly an ant colony in space. A Japanese newspaper is hoping to make a snow-making experiment under near-zero gravity conditions of space to investigate the formation of ice crystals.

The green algae experiment calls to mind the work done by the Russian experimental space program years ago and detailed in an earlier Spacewatch. The experiment was directed to the production of oxygen by subjecting the algae to ultra-violet light. The result on earth was a great success so much so that there was a bonus of oxygen. This was part of a study for the long time manned space exploration where special growth of certain plants and primitive cell growth was used in a two month stay in a capsule for a cosmonaut. It was later extended to much longer periods successfully enough to prove the possibility of new life support.

It is surely inevitable man will not be confined to instrumental exploration, sophisticated though it is. Simulation of reality is of great value in search of a preliminary understanding, but knowing in real time is real knowing. It is perhaps fitting that this report should end with Gilbert Moore’s own words, “Another group of students have put up experiments to determine whether better metals, alloys and composite graphite materials can be made in space. One student is melting and solidifying smooth metallic surfaces for the possible future manufacture of telescopes in space. Another of the alloy experiments is to make alloy of two metals which cannot be combined on Earth. These are a powdered mixture of bismuth and tin... but the real significance of the “Getaway Special” is that it represents unfettered science, the opportunity for young individuals to try out new ideas.”

Frank W. Hyde
### NEW CASIO WATCHES

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<td>W-500C</td>
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- **100 METRE WATER RESISTANT**
- **50M W/R**
  - W-35: £19.95
  - W-450C: £19.95
  - DW-1000: £39.95

### LOWER PRICES

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### NEW CT-1000P DIGITALIZED SYNTHESIZER

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**TEMPUS**

Practical Electronics  October 1982
TEXT STRING SEARCH

Sir—This editing program fits neatly into the 'Text RAM' between 0222 and 02FA and E0 to E6, and operates as follows: The text string to be located in the program list is entered in the normal way as a BASIC statement with the line number 0. To avoid the interpreter being confused by a meaningless BASIC line, it is necessary to enter the line thus:

0 LIST string

Where string is a text string of any length.

If a Warm Start is now executed, all the program lines containing the desired text will be listed on the VDU. Should there be too many to fit on the screen at one time, holding down space bar will temporarily stop the listing.

At the end of the listing, the machine is again ready for normal BASIC operations or another 0 LIST command. If a line number 0 does not exist then the Warm Start operates in the normal way.

When entering BASIC words (eg. IF, GOSUB, THEN etc.) into the zero line, they must be entered in full. For example 0 LISTGOTOS3 will work but 0 LISTGO will not. This is because BASIC words are stored in a single codeword. The program then compares these codewords looking for a match. For the same reason any BASIC words or symbols used in the program between quotes must be specified within quotes in the 0 LIST line too. Non BASIC words and characters do not need to be specified in full however.

The machine code program is loaded into RAM by executing the BASIC program below. The USR function is used to jump to the initialisation point 0222.

P. Beckett, Blackpool.

5 REM ZEROLIST ** P.BECKETT ** JUL 80
10 DATA 169,34,133,1,169,2,132,2,2,132,3,228,5
20 DATA 173,4,2,240,6,3,218,169,76,115,162,32
30 DATA 188,188,169,169,169,169,133
40 DATA 255,177,224,248,8,3,182,2,76,71,1,177
50 DATA 224,248,56,169,6,133,226,169,3,133,227
60 DATA 165,224,133,228,169,255,133,229,17,226
70 DATA 288,3,1,133,238,268,177,228,197,228
80 DATA 288,49,24,165,226,105,1,133,226,144,2
90 DATA 168,227,24,165,226,105,1,133,228,144
100 DATA 2,238,299,76,181,2,32,182,2,177,224
110 DATA 248,84,32,182,2,32,182,2,177,224,133
120 DATA 17,32,182,2,177,224,133,18,32,182,2
130 DATA 138,81,169,8,133,18,133,15,9,176
140 DATA 155,182,2,155,224,135,1,133,224,144
150 DATA 2,238,299,169,255,133,4,169,2,133
160 DATA 3,76,192,164,168,255,133,4,169,2
170 DATA 168,133,5,184,104,169,253,141,0,223
180 DATA 173,287,281,256,288,244,76,71,2,32
190 DATA 182,1,177,224,288,3,76,171,2,151,2
200 FOR I = 545 TO 756
210 READ X : POKE 1, X
220 NEXT
230 POKE 11,34 : POKE 12,2 : XUSR(X)

Comments for Disassembled Listing

0222-0228 Change warm start vector to 0222
022A-0232 If line 0 exists go to 023A
0234-0237 No line zero—normal warm start
023F-0245 Set E0, E1 to 0306 ie start of BASIC text
0247-0253 Set E0, E1 to point to line after line 0
0255-025B Set E2, E3 to point to line 0
025D-0263 Set E4, E5 to point to current line
0265 Get character from line 0
0266 End of line 0?
0269 Yes, then a match has been found
026D No, store in E6
026E Get character from current line
0270 Compare
0272 Match, no
0274-027D Yes, then increment E2, E3 to point to next character in line 0
027F-0285 Increment E4, E5 to point to next character in current line
028D-029A Mismatch found so increment E0, E1 to point to next line and try again
02AB-02B9 Delete line 0 and return to BASIC
02B6-02C1 Increment address at E0, E1
02C2-02C9 Match found; set 04, 05 to come back to this program after listing the current line. List the line who's number is in 11, 12
02CD-02DB Re-entry point after listing line on VDU
02D9-02DE Loop if spacer-bar pressed.

GARBAGE COLLECTION

Sir—one of the more picturesque phrases in computer jargon is ‘Garbage Collection’, a term which crops up occasionally in reference to a routine which had caused problems in several machines including the UK 101. In the earlier machines, this was responsible for causing hang ups when running programs involving extensive string handling. It was also responsible for the fact that the FRE(X) function didn’t work properly.

Current machines have a Garbage Collector (written by myself), which works correctly but the process seems to remain a mystery to many people. Whilst it is true that the detailed operation of BASIC is extremely complex, many of the routines are quite simple in principle and these notes are intended as a non-technical guide to ‘Garbage Collection’, all that will be assumed is an elementary knowledge of BASIC programming.

The value of numeric variables, no matter how large or small, is contained in just four bytes. The name of the variable uses two bytes so that each numeric variable may be stored in just six memory cells. This does
not represent much of the available memory so it is perfectly efficient to set aside this space for each numeric variable mentioned in the program and this is what is done.

String variables, however, can be anything between 1 and 255 characters long and it would be extremely inefficient to set aside 255 memory locations for each String variable just in case it happened to be needed. Instead, BASIC keeps an 'index' of all the strings referred to in the program. This index records the name of the String followed by its length and the address of the memory cell containing the first character. The string itself can be practically anywhere in memory, it doesn’t matter as long as BASIC knows where it is. If, for example, a program line contains the statement: AS = "TITLE", then BASIC simply notes in its index the address of the initial ‘T’ of that word where it stands in the program line. Note how efficient this is, no extra memory is used until it becomes necessary.

Many strings, however, don’t appear in the program line at all, those called for by 'INPUT' statements are an obvious example but complex strings created during the program run also fall into this category. Such strings are stored at the very top of the available memory using space downwards as they are created. By 'top of memory' we mean high numbered addresses. The program itself is stored near the bottom of memory (low numbered addresses) working upwards. A block of data following the last program line contains the values of numeric variables and our 'index' of String variables. If a new line is entered in the program this block of variables data is pushed further up the memory.

As each string is recorded in memory the gap between the end of the program/variables block and the start of the strings gets smaller and smaller. Eventually a collision is imminent and this is when the problems begin. If every string is still current at this point then nothing can be done and an Out of Memory error will result.

More often than not, however, some of the strings still in memory will have been updated during the program run and the previous versions are no longer required. It is easy for BASIC to decide which strings are still current, it merely has to check down its 'index' — any string not listed there may as well not exist because BASIC no longer knows where it is. In other words it represents Garbage.

What is required is a routine to sort out which strings are still needed and pack those to the top of memory, overwriting any obsolescent strings in the process — a routine known as a 'Garbage Collection'. The task sounds incredibly difficult, the current strings may be of any length and stored in any order. Actually, it's quite straightforward as we shall see.

The whole index is scanned to find the string whose start is at the highest numbered address, this string is then moved to the top of memory. Any strings which get overwritten in the process must be redundant otherwise they would have been in the index and their address would have been found instead. As each string is moved it is 'ticked off' and the record kept of the 'top of available memory' is amended to take account of the space which has been used up. The index is also updated to keep track of the new position of the string.

This process is repeated until all the strings have been moved. Thus all current strings are neatly packed to the top of memory regardless of length, and no gaps are left. The space created in memory is then available for further use.

Many people seem curious to know what was wrong with the original routine. The answer, strangely enough, is nothing! It was, however, set up to handle a string index of a different structure to the one which actually exists.

The guess is that this BASIC was modified at some stage to automate the allocation of string space. Many BASICS require the user to set memory aside for strings using the CLEAR instruction and it is feasible to assume that under these conditions the structure of the string index would be simpler.

Having created a more complex arrangement, the problem arose of how to expand the Garbage Collector using no extra space. Anyone who has dug into this BASIC will be aware of the brilliant efficiency of the coding. The chances of being able to expand a routine are virtually nil.

By extraordinary good fortune, however, the Garbage Collector happened to be the exception. A calculation was performed twice within the routine using very different methods and it was possible to exploit this redundancy to gain just enough space to incorporate the necessary expansion.

The revised routine resides in the BASIC 3 ROM labelled BASUK03-2. This is now supplied as standard, re-affirming the lead of the UK 101 in terms of quality, speed and value for money. Owners of the earlier machines still fitted with the original ROM may, of course, obtain a direct plug-in replacement from any UK 101 dealer.

Dick Stibbons,
Hayes, Middx.

WEMONISING YOUR EXTENDED MONITOR

Sir—Owners of the UK101 interested in machine-code programming who have fitted the WEMON monitor may be a little disappointed to find that the excellent Extended Monitor supplied with the UK101 will not run.

Although the WEMON has many machine-code handling features which did not exist in the original monitor, serious programmers will find the disassembler and relocater in the Extended Monitor virtually essential.

Here are the modifications which must be made to the Extended Monitor to enable it to run under WEMON:

The original program is saved in checksum format with a 256-byte checksum loader added ahead of it. The latter is saved as a hex dump and is not compatible with the WEMON named hex file format. However, WEMON does embrace the old UK101 memory-select, modify and execute feature and uses the same key functions. Thus, it is possible to load the checksum loader—then the Extended Monitor—by adopting the following procedure:

1) Execute a Cold Start then reset and return to machine-code monitor.
2) Press 'M' (Return) to enter the register-select mode.
3) Key in address 00E0, press 'I' and change the contents of this location by pressing 'F' (this sets the monitor to receive input from cassette).
4) Start tape recorder.

The checksum loader will be seen loading from the top of the screen and, when this has finished, the main program loads from the bottom as it did with the old monitor. When the load is complete, reset and return to machine-code monitor, then save the Extended Monitor in WEMON format, without the checksum loader, from 0800 to 0FF. This is a worthwhile precaution because if the program is accidentally lost during modification, reloading in WEMON format is easier and very much faster than the original checksum load.

Program modifications are:

1) The sub-routine call at 0855 must be changed to call a WEMON keyboard routine (KBRD) at F369.
Change content of 0856 to 69
Change content of 0857 to F3

2) The original Extended Monitor used 48 Page Zero locations from 0000 to 0FF.
The program must be modified to use a different area of Page Zero (00A0 to 00CF) in order to avoid locations, used by WEMON. Fig. 1 lists a total of 222 addresses. The contents of each location must be changed to the new value shown in the table.

3) On the original Extended Monitor, the key 'o' was used to access the 'Open
Location NNNN' feature. The 'b' character is not available from the keyboard under WEMON, therefore another key must be used. There are two choices, one is to utilise one of the spare letters—J, U, or Z. However, the author preferred to retain these as user-defined keys and chose a second option. This involves adding a short machine-code routine ahead of the Extended Monitor which interrupts the keyboard routine. The new routine looks for CTRL-A and if found prints 'b' and returns with 40 (ASCII value of 'b') in the accumulator. This causes the Extended Monitor to select the 'Open Location NNNN' mode and starts the first line of eight bytes. The code for this is from OFB7 to 07FF. The sub-routine call at 082F must be changed to call the new routine.

Change content of 0830 to F2
Change content of 0831 to 07
Change content of 0832 to CF
Change content of 0833 to 08
Change content of 0834 to 03
Change content of 0835 to 20
Change content of 0836 to 00
Change content of 0837 to AA

Fig. 1. Table of Extended Monitor addresses showing new contents necessary to avoid Page Zero locations which are used by WEMON

It should be emphasised that material presented in Prompt has not necessarily been proven 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.

Regrettably, the Extended Monitor now occupies more than 2K but this is of little consequence if the program is loaded from cassette.

However, for those who want to store the modified program in EPROM, there is a way to fit it into 2K. Key 'b' on the Extended Monitor, followed by a 2-byte address, causes a line of eight bytes to be printed.

This feature is not mentioned in the sheet which accompanies the Extended Monitor and is of doubtful value anyway as WEMON 'Verify' also prints lines of eight bytes. The code for this is from 0FB7 to 0FF and this area could be used to contain the two new sub-routines. The sub-routines are fully relocatable but the call addresses at 082F and OEC3 would have to be changed to call the routines at their new locations.
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**FLIPP DISC CONTROLLERS**

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