RS232 I/O CARD FOR THE PSION 3
Makes your Organiser into a controller.

MEDIUM WAVE LOOP AERIAL
An adjustable stand antenna for better medium-wave reception.

AVR: THE NEW CHIP ON THE BLOCK
Flash memory microcontrollers move in.

PLUS
- MIDI Drum Pads
- GCSE Bargraph Module
- Fast Fivers - A Digital Die
If you are looking for an easy and enjoyable way of studying or improving your knowledge of electronics then this is the software for you.

Now includes the PIC16C84 & PIC16C71 hardware and instruction set.

Electronics Principles 5.0 is a significant upgrade of our popular educational software. Now contain even more analogue, digital and microcomputer theory. PLUS over hundred new mathematics topics further your understanding of formula and calculations. Telephone for comprehensive list or upgrade details.

This software has been developed to teach electronics and is suited to both complete novice and the advanced student or hobbyist wanting quick revision and access to hundred electronics formulae. It is extremely easy to use. Just select a topic, which is all presented as a default diagram (no blank screens!) and input your own values. Alternatively, use those from any stand electronics text book to see the results frequency response curves, calculate logic states, voltages and currents etc.

Graphics presentation has been enhanced and speeded up with new menus and indexing which enables a quicker access and more informative description of the extended range of five hundred and sixty electronics and mathematics topics.

The PIC16C84 microcontroller hardware and instruction set has been introduced and brought to life through colourful interactive graphics where you can study the architecture of this device by changing the data values to simulate all of the registers, direct/indirect addressing, program/data memory and input/output port configuration. Along with those analogue to digital functions of the PIC16C71. If you would like to learn more about the principles of these popular microcontrollers then it could not be made easier.

Electronics Principles software is currently used in hundreds of UK and overseas schools and colleges to support City & Guilds, GCSE, A-Level, BTEC and university foundation courses. Also NVQ’s and GNVQ’s where students are required to have an understanding of electronics principles.

Still only £99.95*

EPT Educational Software. Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ.
Tel/Fax: 01376 514008. sales@eptsoft.demon.co.uk http://www.eptsoft.demon.co.uk

*UK and EC countries add £2 per order for post & packing. VAT should be added to the total.

Outside Europe £3.50 for air mail postage by return.

Switch, Delta, Visa and Mastercard orders accepted - please give card number and expiry date. Cheques & Postal Orders should be made payable to EPT Educational software.
AVR: The New Chip on the Block
Kevin Kirk describes a recent arrival on the microcontroller market, the Atmel AVR 1200, with Flash memory and a nanosecond instruction cycle time.

AA Cell Eliminator
Reduce your AA battery throughput by powering your gadget collection from the mains around the house and workshop with Terry Balbirnie's dedicated battery eliminator.

Five Range Capacitance Meter
Many capacitance meters have difficulty returning accurate measurements for low-value capacitors such as those widely used in radio and other high-frequency circuits. Robert Penfold's design uses close-tolerance components to give good accuracy down to very low values.

An RS232 I/O Card for Psion 3s and PCs
The Psion Organiser 3, 3A, 3C and Sienna conceal a general-purpose computer behind the popular electronic diaries. This interface card by Pei An enables you to program the palmtops for control or data logging.

Medium Wave Loop Aerial
Raymond Haigh's inexpensive aerial for the serious listener unit is designed to greatly improve reception on the medium wave band, especially under difficult conditions. The design includes a guide to building a compact wooden stand and casing.

GCSE Grounding: Bargraph Module
Terry Balbirnie continues a series of adaptable circuits for GCSE projects with a voltage-sensitive 10-LED Bargraph module with adjustable sensitivity, based on the LM3914 display driver.

Fast Fivers 8 - A Digital Die
Owen Bishop's electronic die shows all the faces from 1 to 6, but won't roll under the sofa just as the game is getting exciting. The display uses red LEDs and is driven by a counter with a built-in oscillator.

Pic-Based Double Bass Tuner
Samuel Dick designed this portable tuning aid, based on the PIC 16C64, with the lower frequencies of the double bass in mind. It uses good quality earphones rather than a loudspeaker for better bass reproduction and portability.

Midi Drum Pads
Probably the easiest way to transfer rhythm to your computer or hardware sequencer is to use MIDI drum pads that can be hit with drumsticks. Tom Scarff designed this low cost unit around the PIC 16C84 microcontroller.

Regulars
News 4,5,7
ETI PCB Service 46
PCB foils 68, 69
Practically Speaking 73
Terry Balbirnie tailors an analogue panel meter to read volts using just a resistor.
Round the Corner 74
Electronics Lessons on Video from the Maplin Catalogue

Maplin has launched a series of electronics training videos in its Spring catalogue. The Ucando range of educational videos is described as providing comprehensive instruction on electronics theory, covering a wide range of topics including DC/AC circuits, semiconductors, amplifiers, power supplies and oscillators, digital electronics, radio theory, fibre optics and laser technology.

The hour-long videos use animation, text and commentary to make the learning material more eye-catching. Maplin sees them as particularly relevant to schools, colleges and industrial departments, as well as students following distance-learning courses.

The tapes are available from the current Maplin catalogue and from Mondo Maplin superstores. For further information on ordering codes and store locations, call 01792 554002.

DSP Chip Brings Parametric EQ to Auto and Home Electronics

Medianix Semiconductor has introduced the MED25022 Digital Cross-over; parametric Equaliser, a single-chip, multi-channel digital filter that uses digital signal processing (DSP) to provide parametric equalisation and crossover filtering in a range of audio applications that includes car audio, home entertainment centres, multimedia computers, and audio engineering and mixing consoles.

This is the first time these functions have been made available in a single application-specific standard product (ASSP).

The CMOS chip provides five bands of parametric equalisation with up to 24 dB per octave crossover filtering for each of two audio channels. Devices can be used in parallel for more channels, or can be cascaded to achieve higher order filters. All the desired EQ band amplitudes and filter cutoff frequencies are programmable. On-chip memory provides up to 35 microseconds of programmable digital delay that allows time alignment of audio signals from speakers that are different distances from the listener.

Filtering characteristics can be changed by changing the contents of a finite number of registers. The centre frequency, the -3 dB bandwidth and level of each of the five EQ bands can be independently adjusted over a +/- 16 dB range by sending a 24-bit word in three 8-bit blocks, or by calculation using formulae stored in the on-chip ROM. The cutoff frequencies of the crossover filters on each channel are digitally programmable at either 12 dB/octave or 24 dB/octave, and can create lowpass, highpass or bandpass filters as needed, providing very precise control. The chip allows dynamic system reconfiguration so that, for example, the performance of a car stereo in a convertible can remain optimised whether the top is up or down.

For more information, contact Medianix Semiconductor Inc., 100 View St., Suite 101, Mountain View, CA 94041, USA. Tel +1 650 960 7081 ex. 225 Fax +1 650 960 0478. Web: www.medianix.com
The Institution of Electrical Engineers (IEE) has produced a leaflet to warn embedded systems users and manufacturers about the "Year2000 problem", or the "Millenium problem" as it is sometimes known in a more apocalyptic vein. When the world's timing devices click over to the year 2000, a proportion of them will not be able to interpret dates starting with 01/01/00, and may not be able to deal with operational cycles such as "do X every 100 days" under the new dates. The IEE leaflet flags with problem with a concise checklist of action for organisations that depend on computer systems to take, starting with "Get more information"; "Appoint a team" and "Investigate" to "Organise formal reporting and review." The IEE will be providing general guidance based on information supplied by industry and Government. The first line of access to this guidance is the IEE website at http://www.iee.org.uk/2000risk. Later in the year a guidance document for small and medium sized businesses will follow. The IEE can be contacted via Alasdair Kemp, the Public Affairs Department, IEE, Savoy Place, London WC2R 0BL. Fax only 0171 497 2143.

**Orchid Vehicle Tracking uses GSM and DGPS**

European Telecom and Racal Survey, world leaders respectively in the distribution of wireless communications products and the development of satellite positioning technology, have combined to launch a mobile telephony-based vehicle tracking, navigation and on-line driver information service, Orchid, under the joint venture name Global Telematics. Orchid will integrate GSM and digital technology, cellular telephone and satellite DGPS (Differential Global Positioning System) to provide telematics services using a voice-based system safety-compliant for motorists and fleet-operators, and expects to turn cellular telephony into a fast, accurate 24-hour comms system.

Orchid has been launched in the UK and will begin its international launches with South Africa in early 1998. Starting, as have most vehicular cellular telephony systems, with the commercial fleet market, Orchid will allow entire fleet positions can be viewed at a glance, drivers contacted with updated information, and data sent to and from vehicles. Routes can be planned and re-planned and emergencies dealt with quickly.

Orchid is available now for all types of vehicle users, however, as the system expands more into private cars, vehicles are more likely to have the system as a factory fitted option, rather than retro fit.

Among other organisations already involved are the Automobile Association (AA) which will provide a 24-hour monitoring and information bureau service, and Vodafone as the mobile network carrier.

Current services include a 24-hour year-round monitoring and information service; precise vehicle tracking; navigational assistance, route planning and real time traffic updates; roadside assistance and emergency service callout; local service information such as hotels, restaurants, service stations and so on; fleet management packages with mapping and reporting facilities. Future services will include security vehicle tracking and authorised assisted recovery; remote vehicle diagnostics; remote lock and unlock capabilities and floating car data.

For more information or a tariff list, call 0800 731 6677 or 0181 974 1100, fax 0181 974 1133.

**Logging Goes Walkabout**

Lascar Electronics have responded to customer demand and produced EI-Link-IR as an easy cable-free short distance data transfer solution. The EI-Link-IR module allow easy construction of an infra red link for EasyLog or other instrumentation systems where a remote control is required. EI-Link-IR converts RS232 serial data into infra red, and vice versa. The EI-Link-IR offers original equipment manufacturers (OEMs) "plug-and-play" accessibility to IR serial communications, and has the added benefit of being totally self-contained in a 9-to-25-way adapter shell.

Needing no additional software, EI-Link-IR plugs straight into a PC serial COM port or a Psion Workabout. It uses the industry standard IrDA comm standards to achieve half-duplex comm over a distance of up to one metre. The EI-Link-IR needs no external power supply, drawing the little current it consumes (approximately 2.5mA) from its host equipment through the 9-way D-type connector. The baud rate is preset to 9600 baud. EI-Link-IR can be used with the EI-2-IR module to form part of a wireless data logging system. It can be used with Panel-IR to provide infra red control capability.

For more information, contact Lascar Electronics, Module House, Whiteparish, Salisbury, Wilts SP5 2SJ, UK. Tel. 01794 884567.
LOW COST PC'S

SUPER SALE

AT 286

40Mb HD + 3Mb RAM

Industrial grade 12Mhz HI GRADE 286 systems Made in USA in an industry leading case. Full memory expansion and a choice of high density hard disk to the front. Real time clock with battery backup and config iron. Fully tested, aligned and shipped to you with a full 90 day guarantee. Using 25mb drive with 128k ram. Refurb.

ORDER AS HAGRADE 286 ONLY £99.00

(F) Including free 10Mb disk drive

(2) Including free 20Mb disk drive

(3) Including free 30Mb disk drive

(4) including free 40Mb disk drive

(5) Including free 50Mb disk drive

13.5" THERMO ELECTRON 286 150Mb IDE with 128k cache and modem £199.00

(2) including free 200Mb disk drive

(3) including free 450Mb disk drive

(4) including free 600Mb disk drive

(5) including free 750Mb disk drive

19" TOSHIBA 286/35 SERIES with 128k cache + modem £299.00

(2) including free 600Mb disk drive

(3) including free 1200Mb disk drive

(4) including free 1800Mb disk drive

19" COMPAQ 286 series with 128k cache + modem £399.00

(2) including free 600Mb disk drive

(3) including free 1200Mb disk drive

(4) including free 1800Mb disk drive

Many other drives in stock - Shipping on all drives Is code (0)

LOW COST RAM & CPU'S

IC's - TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

6,000,000 items EX STOCK

For MAJOR SAVINGS - CALL FOR SEMICONDUCTOR HOGIST

VIDEO MONITOR SPECIALS

One of the highest specification monitors you will ever see - At this price - Don't miss it!!

Mitsubishi FSH506TXL 14" 3VGA Multi-sync monitor with full 90 day guarantee. Ex stock. £195.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

Matsushita V23STX 14" 3VGA Multi-sync monitor with full 90 day guarantee. Ex stock. £195.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

Matsushita FSH506TDL 14" 3VGA Multi-sync monitor with full 90 day guarantee. Ex stock. £195.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

SPECIAL ORDER MONITORS

17" 0.28 SWGA Mitsubishi Diamond Pro monitors Full multycmc Fe 90 day guarantee. £235.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

Just In - Microvitec 20" VGA (600 x res.) monitors. Good used condition. £235.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

PHILIPS HCS53 (same style as BM8333) attractively styled 14" colour monitor with both RGB and standard composite 15.75Hz video inputs. £135.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

PHILIPS HCS51 ultra compact 9" colour monitor with standard RGB and composite 15.75Hz video inputs. £99.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

KME 19" 15M0029 high definition monitors with 1280 x768 dot pitch. Superb clarity and modern styling. Comes from a well know mfr. £415.00

(2) including free 10 Mb disk drive

(3) including free 20 Mb disk drive

(4) including free 30 Mb drive

(5) including free 40 Mb drive

OPF Rack CABINETS

Superb quality 6 foot 40U Virtually New, Ultra Smart Less than Half Price!

19" RACK CABINETS

Made by Eurocraft Ltd. To the highest possible standard this rack features all steel construction with removable side panels. It is hinged for easy access and all are lockable with a secure 5 lever barrel lock. The front door is constructed of double walled steel with a ‘frameless’ design. All recessed edges and corners give a fully enclosed integral design. It is fully featured with standard simm connectors 30 & 72 pin. Supplied complete with 2 rack mount brackets and key. Free delivery. Made in UK 1U or more are £25.00 Vat

24U £1750

36U £2995

48U £4195

60U £4795

72U £5395

84U £5995

96U £6595

108U £7195

120U £7795

REELS & SPOOLS SPECIALS

5000 Reel Spools of 20" 354" self winder £49.99 each

50000 Reel Spools of 20" 354" self winder £499.99 each

500000 Reel Spools of 20" 354" self winder £4999.99 each

LOW COST DC POWER SUPPLIES

AT 286 DC POWER SUPPLIES

LOW COST PC's

THE ORIGINAL SURPLUS WONDERLAND!

This MONTH'S SELECTION FROM OUR VAST EVER EXPANDING range of Test Equipment and other bargains. IEEE 1490, VME Boards etc.

ALL MAIL & OFFICES

Open Mon - Fri 9.00 to 5.30

109 Whiteknights

5 LONDON ROAD

Upper Norwood

Bigin Biggin

LONDON SE19 3XJ

DISTEL®

ALL ENQUIRIES

0181 679 4414

FAX 0181 679 1927

www.distel.co.uk

enquiries@distel.co.uk

Visit our London shop for a full range of Test Equipment and other bargains.

Discounts are available for cash.
**Dedicated Wireless Internet for Homes Before 2000?**

DECT (digitally enhanced cordless telecommunications) technology will be at the heart of a wireless Internet revolution in homes before the year 2000, according to Cambridge-based designers Symbionics.

The high-speed Internet system will use technology similar to that in digital cordless telephones (like the former Rabbit cellular handsets, now in use as domestic cordless phones) to link PCs to a network of outdoor base stations with access to the Internet. The base stations will link into the Internet through fibre-optic cabling, copper wiring or microwave links. All three methods are capable of high-speed data transfer, and would operate separately from the telephone network.

At 550 kbps, DECT technology can already transfer data ten times faster than telephone wires that use analogue modems. Symbionics aims to increase this to 2 Mbps over the next two years, using higher rate modulation schemes and equalisation technology. They say that the outdoor base stations will be accessible to PCs within a range of a few kilometres. The system will allow new operators without access to existing fixed-wire telephone lines to offer Internet facilities. Connecting customers to the Internet using DECT technology should prove cheaper than using telephone lines.

Italy will be the first country to adopt the system. Networks of DECT base stations are already being installed throughout the country's major towns and cities by telephone suppliers, who are expected to offer a service later in 1998. The new systems will handle voice mail, but significant demand for Internet access and email is expected. Because Internet and email will no longer tie up the telephone lines, it would be possible to use the PC and call out on the phone line simultaneously without installing a second line.

For more information contact Symbionics Ltd., St. John's Innovation Park, Cowley Road, Cambridge CB4 4WS. Tel. 01223 421025 Fax 01223 421031.

---

**Improved Resistor Paste Formula Doubles Pot Life**

Manufacturer Omeg has doubled the life of its 20mm potentiometers from 10,000 to more than 20,000 cycles. The life enhancement was achieved by improving and refining the conductive polymer resistor paste formulation used to make the resistive track.

The pastes contain hardwearing resins and polymers, solvents, lubricant, and carbon to provide the conductive/resistive properties. The track is made by screen printing the paste onto a paper based phenolic substrate, and then curing it in an oven. The curing process removes all solvents, and allows the conductive polymer to polymerise and cross-link. This produces a hard wearing track with good stability in terms of temperature and electrical resistance during its working life.

The life of Omeg's 16mm potentiometers has also been increased to more than 20,000 cycles, a boost of 33 percent. The new life expectancy figures apply to all potentiometers in the catalogue, and any non-catalogue specials with resistances higher than 1 megohm (linear) or 470 kilohm (non-linear).

For more information contact M. Grantham, Omeg Ltd., Imberthorne Industrial Estate, East Grinstead, W. Sussex RH19 1RJ, UK. Tel 01342 410420 Fax 01342 316253. email: Omeg.Sales@Omeg.co.uk Web: www.omeg.co.uk/omeg/

---

Eurosoft (UK) have provided a solution to the "year 2000" computer date change known popularly as the "millennium problem". Their find-and-fix utility assists with the automatic date rollover of AT-style PCs and applications that were not originally programmed for the imminent 1999-to-2000 century year change. Using a small software utility, users can now automatically find out whether their PCs have the year 2000 date change problem, and fix the date change without adjusting the hardware setup. "Fix 2000" identifies the PC's BIOS to reveal whether the date rollover is supported or not, and then performs the correction to update the stored "century" value. For more information, contact Sharon Richards, Eurosoft (UK) Ltd., Hanover House, 136 Old Christchurch Rd., Bournemouth, Dorset BH1 1NL. Tel. 01202 297315.
**£1 BARGAIN PACKS**

If you would like to receive the other four £1, lots of other lists, request these when you order or send £4.

**TEST PRODS FOR MULTIMETERS with 4mm sockets. Good length very flexible lead, Ref 586.**

800V PM SPEAKERS, size 8" x 4", pack of two. These may be slightly noisy and that is why they are so cheap but are electrically OK. Ref 1050.

PAKULON PANELS, size 8" x 6", approximately 1.18" thick, pack of two, Ref D101.

12A POLARISED RELAY, virtually unbreakable, for tolling traffic. Ref D95.

PIEZO BUZZER with electronic sounder circuit. 3V or 9V D.C. operated, Ref D76.

DITTO without internal electronics, pack of two, Ref D77.

LUMINOUS ROCKER SWITCH approximately 30mm sq, pack of two, Ref D94.

FERRITE ROSS, 7" with coils for Long and Medium waves, pack of two. Ref D93.

ROTARY SWITCH, 9-pole, 5-way, size small 77mm sq, pack of two, Ref D95.

MINI SP SPOTLIGHT socket, pack of three, Ref: 852.

HI-LEVEL rotary switch with 1/4" control spindle, pack of five, Ref: D102.

ELECTROCAP, 800µF at 6.3V, pack of 20, Ref:D48.

ELECTROCAP, 10µF at 160V 122, pack of 50, Ref: D47.

MINI ROLLER, with V0, size only 25mm x 15mm x 3mm, has two sets of changeover contacts, Ref: D42.

MUTTER FOR SIGNAL CAPS 1µF at 250V A.C. per 10. Ref: D103.

TELESCOPIC AERIALS, chrome plated, extendable and foldable for improved F. M. reception. Ref 1051.

MIXING COUNTERS, 6 digit, full set, pack of 10, Ref 1054.

PAKULON in TUBE/15" inside diameter, pack of 2, length 12". Ref 1063.

ULTRA TWIST DRILLS, 0.4mm, pack of 10, Ref 1042.

20A TOGGLE SWITCHES, centre off, part spring controlled, will stay on pushed up but will spring back when pushed down, pack of two, Ref 1064.

HALL EFFECT DEVICES, mounted on small heat sink, pack of two, Ref: D102.

12V POLARISED RELAY, two changeover contacts, Ref 1033.

PAKULON PANEL, 12" x 12" x 1.18" thick, Ref 1043.

MINI POTTED TRANSFORMER, only 15VA 15V-OV. Ref 1047.

9V or 120 operated Mullard 1153. Ref: 823.

18V -QV -12V lOW MAINS TRANSFORMER, Ref: 813.

887.

BATTERY CONNECTOR FOR PP3, superior quality, pack of four. Ref 888.

18V -QV -12V lOW MAINS TRANSFORMER, Ref: 813.

18V -QV -12V lOW MAINS TRANSFORMER, Ref: 813.

2M MAINS LEAD. 3-core with instrument plug moulded on. Ref: 879

SOLENOIDS. 12V to 24V, will push or pull. pack of two, Ref: 877.

4MOLN PANEL. 8½" x 3½ width electrolytics 250pF and 100pF, Ref: 901.

LOUDSPEAKER, 5" 4 Ohm 5W rating, Ref: 939.

ANOTHER PSU. mains operated, output 15V A.C. at 320mA, Ref: 967.

other 15V at 150mA, Ref: 968.

LOUDSPEAKER. 8 Ohm 5W, 3.7" round, Ref: 962.

5V SOLENOID, good strong pull but quite small, pack of two. Ref: 787.

MINI POTTED TRANSFORMER, only 1.5VA 15V-OV. Ref: 849.

PAXOLIN PANEL, 12" x12" 1/18" thick. Ref: 1033.

12V POLARISED RELAY, two changeover contacts. Ref: D103.

DITTO but without internal electronics, pack of two, Ref:D75.

OPERATOR, in tip top condition and in good working order. Ref 942.

DIGITAL THERMOMETER. Suitable for outdoors or indoors, has an extra wide temperature range -50° to +70°C, complete with heavy duty battery which should last several years. Its sensor can be opened. Light makes the bell ring. Neatly cased, requires only a simple mounting frame. £5. Order Ref: 5P23.

No. 120 2.3AH, regular price £14, yours for only £3.50, Order Ref: 8PG3. 0.35V + 0.35V at 20A TOGGLE SWITCHES, centre off, part spring controlled, will stay on pushed up but will spring back when pushed down, pack of two, Ref 1042.

HALL EFFECT DEVICES, mounted on small heat sink, pack of two, Ref: D102.

**SMART HIGH QUALITY ELECTRONIC KITS**

All kits are complete with PCB and other components in a blister pack. If you want more information about them, we have copies of the illustrated Smart catalogue available at £1.

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1092</td>
<td>5 watt electronic siren</td>
<td>£2.55</td>
</tr>
<tr>
<td>1093</td>
<td>Touch switch</td>
<td>£2.80</td>
</tr>
<tr>
<td>1094</td>
<td>9F generator function</td>
<td>£6.90</td>
</tr>
<tr>
<td>1095</td>
<td>Input mixer/switch, with monitor output</td>
<td>£15.15</td>
</tr>
<tr>
<td>1096</td>
<td>Loudspeaker protection unit</td>
<td>£3.22</td>
</tr>
<tr>
<td>1097</td>
<td>Linear CB 50W</td>
<td>£4.70</td>
</tr>
<tr>
<td>1098</td>
<td>Electronic thermometer</td>
<td>£4.60</td>
</tr>
<tr>
<td>1099</td>
<td>Dynamic headphone preamp</td>
<td>£2.50</td>
</tr>
<tr>
<td>1100</td>
<td>7 watt Hi power amplifier</td>
<td>£2.53</td>
</tr>
<tr>
<td>1101</td>
<td>Radio lights</td>
<td>£4.60</td>
</tr>
<tr>
<td>1102</td>
<td>Nicad battery charger</td>
<td>£3.91</td>
</tr>
<tr>
<td>1103</td>
<td>Light dimmer</td>
<td>£2.55</td>
</tr>
<tr>
<td>1104</td>
<td>Stereo control</td>
<td>£3.95</td>
</tr>
<tr>
<td>1105</td>
<td>Space sound effects</td>
<td>£2.30</td>
</tr>
<tr>
<td>1106</td>
<td>Stereo VU meter</td>
<td>£4.40</td>
</tr>
<tr>
<td>1107</td>
<td>Equaliser 250K-15KHz</td>
<td>£1.70</td>
</tr>
<tr>
<td>1108</td>
<td>Loudness stereo unit</td>
<td>£3.22</td>
</tr>
<tr>
<td>1109</td>
<td>Sound switch</td>
<td>£5.29</td>
</tr>
<tr>
<td>1110</td>
<td>Electronic thermometer</td>
<td>£2.68</td>
</tr>
<tr>
<td>1111</td>
<td>4-input Hi stereo preamplifier</td>
<td>£12.42</td>
</tr>
<tr>
<td>1112</td>
<td>3-input mono mixer</td>
<td>£6.21</td>
</tr>
<tr>
<td>1113</td>
<td>Electronic mixer</td>
<td>£3.22</td>
</tr>
<tr>
<td>1114</td>
<td>4-input Instrument mixer</td>
<td>£2.76</td>
</tr>
<tr>
<td>1115</td>
<td>TV sound masking circuit</td>
<td>£12.42</td>
</tr>
<tr>
<td>1116</td>
<td>Cassette head preamp</td>
<td>£3.22</td>
</tr>
<tr>
<td>1117</td>
<td>Telephone amplifier</td>
<td>£4.60</td>
</tr>
<tr>
<td>1118</td>
<td>8V capacitor/6V booster</td>
<td>£8.28</td>
</tr>
<tr>
<td>1119</td>
<td>120V/12A 24V power supply</td>
<td>£3.36</td>
</tr>
<tr>
<td>1120</td>
<td>6V or 0.4A stabilised power supply</td>
<td>£3.20</td>
</tr>
<tr>
<td>1121</td>
<td>12V stabilised power supply</td>
<td>£3.22</td>
</tr>
<tr>
<td>1122</td>
<td>Stereo VU meter with leads</td>
<td>£9.20</td>
</tr>
<tr>
<td>1123</td>
<td>12V 2A power supply</td>
<td>£2.50</td>
</tr>
<tr>
<td>1124</td>
<td>Hi power amplifier</td>
<td>£4.74</td>
</tr>
<tr>
<td>1125</td>
<td>D.C. converter 12V to 6V or 7.5V or 9V</td>
<td>£2.53</td>
</tr>
<tr>
<td>1126</td>
<td>MOSFET for your car</td>
<td>£4.60</td>
</tr>
</tbody>
</table>
Development kit designer Kevin Kirk tells what he likes about the Atmel AVR 1200, the microcontroller with the nanosecond instruction cycle time.

One of the fastest growing sectors of the electronics market is microcontrollers. In 1994 the market was quantified as 7 billion US dollars. It is now 14 billion US dollars, and is expected to be 20 billion US dollars in 1999 - and this is just the 8-bit market. If you add the 4-, 16- and 32-bit markets you could double those figures at least. In the hobbyist sector, the best known microcontroller is the PIC, which finds its way into a good proportion of all projects published. The appeal of the PIC is obvious: it is cheap, small and has a low-cost starter kit that everyone can afford.

But the electronics industry moves on all the time, and now there is a plethora of microcontrollers available, some general-purpose and others targeted at specific markets, such as the new Cypress CY7C63xxx microcontroller, designed specifically for USB bus applications.

We, the developers and end-users, are becoming more discerning. If we were to create a wish list for the ideal microcontroller, we would probably list the following much-desired features:

- Low cost
- Low power consumption
- High speed
- A low-cost starter kit
- Re-programmable hundreds of times
- Interrupt capabilities
- Re-programmable without removing it from the circuit into which it is soldered
- Programming will not need any special programming voltages
- At least some analogue capabilities
- Easy to use
- A rich instruction set
- The option of an on-board clock for minimal component designs
- A watchdog timer (primarily for EMC purposes)
- High level (C) language support
- Substantial source and sink capabilities on each I/O pin (enough at least to drive an LED)
- Some security features (such as lock bits) to ensure the onboard code cannot be read
- Quite a tall order!

But we are the customers, and we are getting choosy. After a considerable amount of research we came up with only one device that would fit the bill. You've guessed it - it was the Atmel AVR. Atmel, the manufacturers, are a bit coy about how their new offspring got its name. Suffice it to say that it is a RISC processor, and the design team leaders are called Alf and Vergard, so if you are any good at crossword puzzles you could probably make an estimate.

The internal architecture

Most microcontrollers perform their operations using some kind of central register, through which all the mathematics and Boolean operations are carried out. In the venerable old 51 series you had the 'A' register. The PIC has its 'W' register. While this is fine for chip designers, it does create some problems for the circuit designer trying to shoehorn a multiple interrupt operating system into the parsimonious amount of memory generously allocated by the manufacturers. Students of the history of computing will recognise the origins of this type of structure, for instance, the DEC PDP8. The designers of the AVR have decided to write their own story here, and have created a multiple register based system, of 32 registers (see the block diagram in figure 1), each of which is effectively capable of this task. So dealing with interrupts becomes easy; just use another register as your main working register. Then you can get out and away before comparable processors have finished shuffling data to let you get at the main register. So ISRs can be fast and neat.

While we're talking about speed, it is a good idea to look at exactly what a processor does with its clock pulses. The clock is the heart of the processor. Without the clock, you've just got a black slab of plastic with some shiny legs. The 51, bless it, divides the clock pulses by 12 (called 'p' states by Intel and 't' states by the rest of the universe). It uses these time slots to perform various tasks like setting high byte memory addressing, low byte memory addressing, instruction fetches, instruction decoding and so on. So if you start with a clock of, say, 12MHz, after the division the internal clock lumbers along at a sedate rate of 1MHz. So an instruction cycle takes at least 1 microsecond. The PIC did better than this: there, the clock was divided by 4 and, if you count the fact that the processor actually performs a pre-fetch while executing the last instruction, then we could say that they have a divide-by-2 on the clock. But the AVR doesn't bother with dusty old divides - it just performs everything in one clock cycle. If your clock is 16MHz, then your instruction cycle time is 62.5 nanoseconds. No other small, low
TEACHERS... STUDENTS... HOME USERS... etc.

Your opportunity to save EEEEE's

Now a proven piece of software, with over 10,000 single seat users throughout the world, Edwin NC has come of age. This non-commercial version of our popular Edwin package has proven really popular with Academic institutions, students and Enthusiasts alike.

The package is currently on Version 1.52 and is updated on a regular basis, updates cost only £35.00 + p/p, and this price is expected to hold for at least another 12 months. Why not join the growing band of Edwin users, and be the owner of a CAD software package that we believe has no equal in its price range. Software support is offered free by phone, fax and e-mail, and if we cannot help personally, we will try to get an answer direct from the software writers.

Edwin is the first true seamlessly integrated Windows Electronics CAD package on the market, you choose whether you wish to work in layout or Schematic, whatever action is taken in either platform is automatically relayed to the other. FORGET front and back annotation, this is a thing of the past. Edwin also has extensive Gerber file manipulation, and the ability to automatically create split voltage planes and edit airgaps in copper, full library edit features give you the opportunity to create your own working libraries.

Computer Compatibility

To run the program you will need:
- Windows 3.x, Win95 or Win NT
- a min. 386 processor (486+ rec.)
- 8mb of RAM
- CD-ROM Drive

All Major Credit Cards Accepted

**YES! Please Rush Me My Edwin NC Program.**

Swift Designs Ltd., Dept.EFF, Business & Technology Centre, Bessemer Drive, Stevenage, Herts, SG1 2DX.

Name: ___________________________________________
Address: __________________________________________
_________________________________________________
_________________________________________________
_________________________________________________
_________________________________________________
_________________________________________________
Postcode: _________________________________________

Tel: (Day) ___________________________________________
(Evening) ___________________________________________

Version Required: Basic De Luxe 1 2 3 4 (please circle)

I enclose £____________+ p/p. £5.00 UK (p/p. £10.00 outside UK)

Cheque/PP/Credit Card: Visa/Access/Mastercard:
N: _________________________________
Expiry Date: ________________

Signature: _________________________________

Please ALLOW 10-15 DAYS FOR DELIVERY.

---

System Features
- Complete End-to-End CAD/CAD system.
- Simultaneous Schematic and Layout generation.
- Automatic Front and back annotation.
- Intuitive hierarchical menu structure.
- Mouse or keyboard command activation.
- Macro operations.
- Real-time display of: ratsnest, active nodes, single line or true trace width.
- On-line help.
- Auto reconnect.
- Full Integration of Schematic and Layout.
- Automatic file backup.
- User definable text sizes.
- DXF in and output.
- Screen hardcopy.
- Library viewer with editing possibility.
- Switching on/off possibility for tool and scroll bars.
- Visible schematic and PCB symbols by editing.
- Monochrome mode for better print resolution.
- Bitmap support for loading logos, documentation, etc. Can be used in hierarchical as well as in simple schematic or PCB design.

Maximum number of nets: 16,000
Maximum number of nodes: 32,000
Maximum number of bend points: 64,000.
Maximum number of connections: 64,000.
Maximum number of symbols: 32,000

Maximum number of components: 32,000
Maximum number of multi-segment traces: 32,000, with a total of 64,000 trace segments.
ANSI/EC libraries.
Full Gerber, NCd, pick and place output.

Software Features

**Schematic Capture**
Up to 100 schematic sheets.
Up to 64 x 64 sheet size.
Industry standard sheet sizes.
Rotate, scale and mirror symbols.
Real-time dragging of components and wires.
Automatic package and pin assignment.
Orthogonal and free mode manual routing.
Automatic bus annotation.
Block scale, add, move and delete.
Direct access to mixed mode simulation.
Auto-routing of connections.
Merging and splitting of nets possibility.
Definable line width, also for bus-lines.
Swapping of component positions.
Automatic component renumbering by swapping.

**PCB Layout**
32 layers (28 route layers, 2 silk-screen layers (front and back), 2 soldermask layers (front and back)).
User definable trace sizes.
User definable pads.
Curved traces.
1 mil grid resolution - Fine grid 10 micron.
STF, Test line, analog support.
Component repeat, rotate and mirror.
Components "Move by name".
Component, gate and pin swap.
Automatic component renaming.
Trace repeat.
On-line, multi-layer routing with automatic via insertion.
Pin-to-pin, free or 45 degree routing.
Change segment side and width, trace side by width.
Fast interactive generation of ground planes with user definable cross-hatch or solid fill.
Automatic ground plane with thermal relief insertion.
Automatic DRC with user specified parameters.
Electrical connectivity checking.
Linear rotation of symbols.
Gerber output and use possibility.
And Arizona Autorouter.
Bitmap functions (logos, drawings, ...).
Switching on/off possibility for tool and scroll bars.
Library viewer with editing possibility.
Screen hardcopy.
DXF in and output.
User definable text sizes.
Automatic file backup.
Full Integration of Schematic and Layout.
On-line help.
Dynamic parameter definition of active and passive components.
Output graphs displayed on screen, hardcopy placed on schematic.
Oscilloscope function.
DLL based analog/digital simulation primitives, modeling language and library creation tools.
Built-in model generator for discrete devices.

Please Note: Some of the above are ONLY provided on the De Luxe 3 & 4 Versions. EdSpi and Thermal analysis & EDCOM'X are available as bolt-on extras.

---

**Deluxe 4 - THE LOT!** - £199.99 inc. VAT

Special Offer to the End of May 1998
WORTH £217.00

YES! Please Rush Me My Edwin NC Program.
cost chip comes close to this performance.

Another way of speeding the beast up is to have a reduced instruction set, aka RISC. Essentially, microprocessors are fairly stupid animals: every time they get an instruction, they have to go and look up how to deal with that instruction. So, in theory, if you reduce the number of instructions then the processor will spend less time hunting through its internal library, and so it moves faster. The PIC is an excellent example of this. Its makers Microchip couldn't have reduced the instruction set more if they'd tried. And they probably did. That's a clever bit of work! If you study the instruction set of the AVR (see figure 2), you will immediately be struck by the fact that, with over 180 instructions it is hardly a reduced instruction set. However, if you root around in the binary structures of the instruction coding, you will find see that many of the instructions are actually duplicates under a different name. So, in reality, you are getting a RISC core with a CISC (complex) instruction set.

**Reprogramming**

OK, so now we've dealt with the speed issue. To many hobbyists this isn't an issue at all - getting the thing to work in the first place is what matters. If you are one of those fortunate (or weird) people that can write code and get it to work first time, reprogramming the device is not something you need concern yourself about. To the rest of us it is of vital importance. If you belong to the 'masochist' school of designers, you will probably be happy with the EPROM version of a device that you can program, test and then spend 20 minutes waiting for it to erase. Microchip, with the 16C84, added some EEPROM on so that you could electrically erase the program memory and reprogram it up to 100 times.

Atmel have taken a different route and have stuffed Flash ram (see figure 3) in as their main program memory, which gives you at least 1,000 reprogramming lives. So even if you have the confidence of a Conservative candidate in the middle of the last Election Count, you are unlikely to use up that many programming lives. It also has ISP (In-System Programming) capability, which is a fancy way of saying that you can program the device even if its soldered into a circuit. Arguably, the PIC 16C84 has had this facility all along, and there have been some pretty neat circuits bandied around that let you do it. The problem is Vpp, which is the voltage you must apply to the
POWER AMPLIFIER MODULES- TURNABLES-DIMMERS-Loudspeakers- 19 inch Stereo Rack Amplifiers

THOUSANDS PURCHASED BY PROFESSIONAL USERS

THE RENOWNED MXF SERIES OF POWER AMPLIFIERS
FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

FEATURES:-
- Independent power supplies with two toroidal transformers + Twin L.E.D. Vu meters
- Level controls + illuminated on/off switch + XLR connectors + Standard 75mm inputs + Open and short circuit proof + Latest Mos-Fets for stress free power delivery into virtually any load + High slew rate + Very low distortion + Aluminium cases + MXF900 fan cooled, D.C. loudspeaker protection and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCO'S ETC.

SIZE= MXF200 W19" x H5" D7" (14+4)x13" (3U)x6" SPECIALIST CARREL DEL £15.50 EACH

PRICE= £117.44 + £5.00 P&P

STEREO DISCO MIXER SDJ400S

- ECHO & SOUND EFFECTS

STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. MANY OUTSTANDING FEATURES including Crossfader, Direct To Tape, Echo with repeat & Talk over. Selectable 2 x 500mV inputs with plus cross fade, Dac, Headphone Monitor, 8 Sound Effects. Useful combination of the following effects: 3 drum loops, 3 basslines, 9 lines for C.C., Tape, Video etc.

PRICE £144.00 + £8.00 P&P

DIEZO ELECTRIC VIOLINISTS, MOTOPIA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an Improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required Piezo tweeters can be used to advantage in 2 way or 3 way systems. As a synthesizer loudspeaker they are ideal for musical applications. They produce low distortion, high power efficient and simple to drive with conventional mixers. A wide range of cabinets are available including pre built monitor and flight cases.

PRICE £110.99 - £1.50 P&P

UNFLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and cabinet design techniques. The cabinets utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion cone drivers for superb stereo imaging and corner protection and steel ball corners, complimented with heavy duty black carry straps. The enclosures are fixed as standard with top flaps for optional loudspeaker stands.

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

PRICE £150.00 - £20.00 EACH

THREE SUPERS HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 300 WATTS (150 + 150) Stereo, 400 WATTS (200 + 200) Stereo, 400W Bridge Mono

ALL POWER ENTRIES INTO 4 OHMS

Features:
- 8选购滨, bridgable mono + Choice of high & low level inputs + L & R level controls + Remote on/off + Speaker & thermal protection.

PRICE = 150W £44.00 250W £59.00 400W £109.00 P&P £2.00 EACH

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four modules can be linked in series for a maximum of 4000 watts R.M.S. into 2 ohms or 7250 watts R.M.S. into 4 ohms. T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. >300, Slew Rate 45V/µS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. >110dB, Size 300 x 155 x 100mm. PRICE £40.85 + £3.50 P&P

STEREO DISCO MIXER SDJ400S

IN-AR STEREO BOOSTER AMPS

FEATURES:- including Echo with repeat & Talk over. Selectable 2 x 500mV inputs with plus cross fade, Dac, Headphone Monitor, 8 Sound Effects. Useful combination of the following effects: 3 drum loops, 3 basslines, 9 lines for C.C., Tape, Video etc.

PRICE = £144.00 + £8.00 P&P

STEREO DISCO MIXER SDJ400S

Loudspeakers

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLS, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLET'S AND HORNS, LARGE (A4) S.A.E. (50 stamp) FOR COMPLETE LIST.

McKenzie and Fans Loudspeakers are also available.

SUBMINIATURE INSTRUMENTS, PA, DISCO ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE

RE: FRID. 75W, DISC. FRID. 85W, SENS. 103dB, FREQ. RESP. 40Hz - 10KHz, R.M.S. 1000W, FREQ. RESP. 1Hz - 100KHz -3dB, Damping Factor 300, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.

PRICE £132.95 + £5.00 P&P

OEM/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/µS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. >110dB, Size 300 x 155 x 100mm. PRICE £40.85 + £3.50 P&P

OEM/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/µS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. >110dB, Size 300 x 155 x 100mm. PRICE £132.95 + £5.00 P&P

OEM/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/µS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. >110dB, Size 300 x 155 x 100mm. PRICE £259.00 + £12.00 P&P

PRICE NOTES: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 3000V, BAND WIDTH 10KHz. PROFESSIONAL EQUIPMENT - INPUT SENS 77Vrms, BAND WIDTH 50KHz, ORDER STANDARD OR SPEC.

THREE SUPERS HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 300 WATTS (150 + 150) Stereo, 400 WATTS (200 + 200) Stereo, 400W Bridge Mono

ALL POWER ENTRIES INTO 4 OHMS

Features:
- 8选购滨, bridgable mono + Choice of high & low level inputs + L & R level controls + Remote on/off + Speaker & thermal protection.

PRICE = 150W £44.00 250W £59.00 400W £109.00 P&P £2.00 EACH

THREE SUPERS HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 300 WATTS (150 + 150) Stereo, 400 WATTS (200 + 200) Stereo, 400W Bridge Mono

ALL POWER ENTRIES INTO 4 OHMS

Features:
- 8选购滨, bridgable mono + Choice of high & low level inputs + L & R level controls + Remote on/off + Speaker & thermal protection.

PRICE = 150W £44.00 250W £59.00 400W £109.00 P&P £2.00 EACH
The particular device has 1K bytes of program code space, which is a little disingenuous, as it uses two bytes per instruction, and 64 bytes of EEPROM data space. The EEPROM operation is self-timed, which is nice, and is good for over 100,000 erase/write cycles and the data will last for 100 years (That kind of specification always makes me want to ask: how do they know?). This particular version has no static RAM as such, as it uses the registers, but later versions of the family are surprisingly rich in program storage, RAM and EEPROM.

The main weakness on the AVR is the way you get to the I/O ports. The PIC treats the I/O ports like registers, which makes them very easy to use. The AVR uses a different approach, which is to treat them as ports (it does sound logical when you put it like that, doesn’t it?) using IN and OUT instructions, just like in a PC. Inevitably, this reduces the flexibility, as you should really have a shadow register set up to move byte-wide data in and out of the port. Bit instructions like Test, Set and Clear are directly available on the port pins, however. The consolation is that it does have a slightly more flexible port-reading mechanism.

You have two methods of reading the port: one is to go ahead and read the port pin, the other is to read the output registers associated with that port pin. What’s the difference? Look at it like this: imagine you are using the port to directly drive the base of a bipolar transistor. Basic transistor theory tells you that the base is not going to go higher than 0.7 volts (or so), and that you should really have a shadow register set up to move byte-wide data in and out of the port. Bit instructions like Test, Set and Clear are directly available on the port pins, however. The consolation is that it does have a slightly more flexible port-reading mechanism.

The watchdog

Microcontrollers need to be able to perform control tasks on their own, which means that if they crash then they must be able to recover without recourse to human intervention. If your PC crashes when running Windows 95 then you can press reset and off you go, no harm done, except to your blood pressure and anything you forgot to save up to that point. If your microcontroller is controlling the nuclear fusion project you have...
in your basement, then it is annoying if it crashes and the reactor goes critical. The worst thing with a microcontroller crash is that you usually don’t know that it has happened. When Windows 95 crashes then it glares balefully at you and refuses to do anything. You may now know why, but at least you know. With a microcontroller, you may not have any user feedback at all, so it has to be self-sufficient. Atmel recognised this and included a watchdog circuit. The operation of a watchdog is surprisingly simple. Imagine you are sitting in your mother in law’s house with her pet Pit Bull terrier. You need to tell it ‘good boy’ every couple of minutes, or it will sink its fangs into anything it can reach. You keep up the ‘good boys’ and everything is fine, but forget for a moment, or go to sleep and ... The watchdog on the microcontroller is very similar. It is a timer which must be reset by the processor at regular intervals. If the processor doesn’t reset it (because it has crashed), then the timer times out and resets the processor.

A processor crash takes one of two forms. The first is that it leaps into a software loop from which there is no escape, which is usually because of poor software design, and the other is where it slips a cog and gets its operators and operands mixed up. In order for a processor to process an instruction, it needs details of both the instruction (the operator) and the register(s) on which it is to perform the operation and store the result (the operand). If it gets these two mixed up, usually because a glitch in the power has created a knot in its lingerie, then it tries to decode operands as operators. The only way out of this is to reset the processor. Under the rules for EMC compliance, the system must be immune to electrical interference; put more bluntly, this means that if you zap the system with more volts than it wants for operation, then it should be capable of recovering itself and carrying on sweetly as before. Put very simply indeed, if you want to design microcontroller-based equipment with the (required) CE mark, then it must have a watchdog.

**Pulse width modulation**

This may be a good time to look at pulse width modulation and what it can do for you. If you’ve ever looked at hi-fi, you will be aware of the various classes of amplifier. First there is class A, in which the output stage is biased to the mid point in the device’s swing. This means that the output device will conduct the whole of the waveform, so that distortion is lower. The problem here is inefficiency, as much of the power is wasted as it consumes power even in its quiescent state. Next is class B, with two transistors (or valves) arranged such that one conducts on positive half cycles and the other on negative. During its quiescent stage both transistors are off, so that it is very much more efficient. The fact that you need to put about 0.7V on the base of the transistor before it conducts means that there will be a point where both transistors are off during the crossover stage. This introduces crossover distortion. Class C is for RF applications, so I’ll skip that.

Class D (or class E If you happen to be Japanese) uses a
PLANS
PORTABLE X-RAY MACHINE PLANS Easy to construct plans on a simple and cheap way to build a home X-ray machine. Effective, X-ray sealed assemblies, can be used for experimental purposes. Not a toy for minors. £15 ref F/E/BD2.

TELEKINETIC ENHANCER PLANS Mysterize and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £15 ref F/T/BD1.

ELECTRONIC HYPOSYNAP DATES 
This data shows several ways to put subjects under your control. Included is a full volume reference test and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use in experiments at parties etc only, those experienced in its use. £15 ref F/P/D1.

GOLD PANNING PLANS w/ BRACELET 
This unique plan demonstrates a valuable technique for gem mining that produces a wave of golden energy. You can actually build a small mock-up that is self-sustaining and can be used in such activities as gold mining, etc. £20 ref F/E/BD1.

INTERNATIONAL TRANSMITTER PLANS Telephone line grabs secret tones on your phone line, allows you access to phone bank accounts, secret government messages, and tocedes to out ultra sensitive electronics. Plans also show an international wireless transmission system. £15 ref F/P/D1.

COLOURED CCTV VIDEO CAMERAS
BRAND NEW AND CARED FROM £99.
Works with most modern video's, TV's, Composite monitors, video grabber cards etc.
Fal, 1v P, composite, 75ohm, 1/3" CCD, 4mm F2.8, 500x582, 12vdc, mounting bracket, auto shutter, 100x50x180mm, 3 months warranty, 1 off price £119 ref XEP150, 10 or more £99 ea 100+ £89

SUPERBRIGHT LASER GAS PLANS Projects a powerful energy stream of neutrons or other particles. A strong laser beam or a powerful light stream that can penetrate metal and fabric to cause damage. £50 ref F/T/BD1.

ANCILLARY BLASTER PLANS Laboratory sources of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquids. Many cleaning uses for PC boards, jewelry, coins, small parts etc. £15 ref F/T/BD1.

ANTIBUDDY LISTENER SYSTEM PLANS Allows you to hear sounds from a premises without going across. £12 ref RBD1.

PORTABLE BLAST WAVE PISTOL SERIES PLANS Handheld, has large transducer and battery capacity with external charge socket. £25 ref F/T/BD1.

INFINITY TRANSMITTER PLANS Telephone line grabs secret tones on your phone line, allows you access to phone bank accounts, secret government messages, and tocedes to out ultra sensitive electronics. Plans also show an international wireless transmission system. £15 ref F/P/D1.

BUG DETECTOR PLANS In an emergency although we haven't tried it yell £6.99 ref SCL2.

HELIOs PNB-2 RUSSIAN BORDER GUARD OBSERVATION BINOCULARS £1799
Intended for the trained to long range observation of air and ground targets and the determination of their angular co-ordinates. These giant binoculars are a tribute Russian optical ingenuity, with a perform that simply has to be seen to be believed. Allowed field of view at a diameter of 7.3mm provides absolute sharp focusing power, which when combined with its high magnification of x5 the user to view over vast distances with delightfully bright, crisp, high resolution images. Robust and in construction incorporating an uncomplotted yet thoughtfully designed mechanical layout ensuring ease of operation and quick precise targeting. These binoculars have a wide variety of applications and are suitable for use by coastguard, law enforcement organizations, customs, farmers etc.

Specifications
x5 magnification, 110mm objective, 6 deg angle of view. First at 100m 100m, focusing 10m-ref, fully coated precision ground optic, orange and neutral filters, rubber lens caps, rapidfiring handling grip, padded headrest, screw in lens gel capsules, wooden tripod,. Operating temperatures -40 to +50c, 25kg (10kg without tripod),. Stopped in wooden carrying case. Border guard binoculars £1799 ref PR2.

DYNAMO FLASHLIGHT Interesting concept, no batteries needed, just squeeze the trigger for instant light apparently even works under water in an emergency although we haven't tried it yet £5.99 ref SC152.

FLOWER BOUNCER PLANS Allows you to place an invisible electric field on a person or object. £5 ref F/BD1.

UTROBONIC BLADES PROJECTS A potent electronic beam designed to prevent or stop, any person from doing something. £25 ref F/BD1.

ULTRASONIC BLASTER PLANS Laboratory sources of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquids. Many cleaning uses for PC boards, jewelry, coins, small parts etc. £15 ref F/T/BD1.

DYNADOG BLADES PROJECTS A potent electronic beam designed to prevent or stop, any person from doing something. £25 ref F/BD1.

FOOTPRINT DETECTOR PLANS Detects both radar and laser. X, K, superwide KA bands. LED signal strength ripples in the ambient area. £15 ref F/BD1.

INFLATABLE TRANSMITTER PLANS Telephone line grabs secret tones on your phone line, allows you access to phone bank accounts, secret government messages, and tocedes to out ultra sensitive electronics. Plans also show an international wireless transmission system. £15 ref F/P/D1.

ITELECTRONIC GUN PLANS Projects a metal object a considerable distance—require adult supervision. £5 ref F/T/BD1.

E-NITRONIC GUN PLANS Projects a metal object a considerable distance—require adult supervision. £5 ref F/T/BD1.

ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND! £15 ref F/BD1.

PARABOLIC DISH MICROPHONE PLANS Listen to distant sounds and voices, open windows, sound sources in hard to get or hostile premises. Uses satellite technology to gather distant sounds and focuses them to our ultra sensitive electronics. Plans also show an optional wireless transmission system. £15 ref F/P/D1.

2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS Operates on 0-12vdc, many possible experiments. £10 ref F/P/D1.

SUPERBRIGHT LASER GAS PLANS Projects a powerful energy stream of neutrons or other particles. A strong laser beam or a powerful light stream that can penetrate metal and fabric to cause damage. £50 ref F/T/BD1.

Laser Bounce Listener System PLANS Allows you to bounce a laser beam back and forth from facing optical waveguides, Triplexed,track verification, city mode, tutorial mode, dark mode, locak, source, control. These may be illegal to use in certain countries. £1 ref F/T/BD1.

OVERSEAS ORDERS WITH ORDER PLUS 13.50 P&P PLUS VAT.

PLACE YOUR ORDER VIA OUR WEBSITE AT BULL-ELECTRICAL.COM
different approach, which curiously enough was pioneered by Sir Clive Sinclair many years ago in his X10 amplifiers. This is a completely digital amplifier. We know that inefficiencies occur when you need to bias a bipolar transistor to On. It sits eating up current even at low revs. However, if we use it at either end of its conduction curve, in other words when it is turned hard on (saturated) or hard off, then it is very efficient. This can be proved using the power theorem. If the current through the device is 0 (we'll assume a perfect transistor with no leakage current), then the power dissipated across the device is 0 (I x R) similarly if the voltage across the device is 0 then again the power dissipated is 0 (V^2/R). So if we could devise a system whereby the transistors can always be used only as switching devices, then we could achieve maximum efficiencies. To do this we use Pulse Width Modulation. In a nutshell, this means varying the mark (high) to space (low) ratio of a pulsed waveform, so that the mean power delivered to the load is based on the ratio between the 1s and the 0s. The more 1s, the higher the output. To achieve this we need to provide some form of storage device to integrate the mean power. In a fi-fi this is easy; the speaker is just a type of inductor and naturally acts as an integrator. In a digital system, we can use a filter with a long time constant, in other words a capacitor charged via a resistor.

So what use is it in a digital system? The answer is that we can use it for digital to analogue conversion. If we need a voltage output, or we need to control the speed of a motor, then we can use the PWM output.

The relatives
At the time of writing there are three versions of the AVR in the family. The first off the line was the 1200, which is the one I have been discussing up to now. That was followed by the 8515, which has the same pin-out as the ubiquitous 51 series (see figure 5). Apart from all the features listed above, the 8515 has an asynchronous serial port (sometimes, wrongly, referred to as an RS232 port), a synchronous serial port, pulse width modulation, and the ability to use external data memory. This device was followed by another 20-pin device, the 2313, which is just a type of inductor and naturally acts as an integrator. In a digital system, we can use a filter with a long time constant, in other words a capacitor charged via a resistor.

So what use is it in a digital system? The answer is that we can use it for digital to analogue conversion. If we need a voltage output, or we need to control the speed of a motor, then we can use the PWM output.

The outstanding feature of this device family is that it was designed around a high level C compiler. The C compiler manufacturer actually worked with the chip designers to create the chip, so that you can use C to write the code, instead of assembler, and the resulting code is fully optimised. So, unlike many processors, the compiled object code is very nearly as efficient as the code created by the native assembler. You also have access to the range of professional standard debugging tools that are, optionally, supplied by the makers of the C compiler, IAR Systems. Atmel have commissioned a special version of the compiler for less than half the normal price. Contact numbers follow.

AVR Starter kit available from Maplin and Rapid Electronics
AVR Training System (AVR Explorer) and a "Get Going with AVR" book are available from Maplin
AVR Devices available from Maplin, Rapid Electronics and Farnell
C Compilers available from Kanda Systems (demos available on request).
Programming software is available from Kanda's website www.kanda-systems.com
Free development tools are available from Atmel's website www.Atmel.com

Maplin: PO Box 3, Rayleigh, Essex SS6 8LS. Tel 01702 554161.
Farnell Electronic Components: Canal Road, Leeds, LS12 2TU. Tel 0113 263 6311.
Rapid Electronics: 40 Heckworth Close, Severalls Industrial Park, Colchester, Essex CO4 4TB. Tel 01206 751166.
Kanda Systems: PO Box 2, Ystrad Meurig, Ceregigion, UK SY25 6DX. Tel 01974 282670.

Cover picture: Atmel's AT90S1200 is based on the AVR architecture, the world's first 8-bit RISC. The AT90S1200 combines an AVR core, 1KB of Flash memory and 64 bytes of EEPROM on a monolithic 20-pin chip.
**PROTEUS**

**Schematic Capture**

- Produces attractive schematics like you see in the magazines.
- Netlist, Parts List & ERC reports. Hierarchical Design. Full support for buses including bus pins.
- Extensive component/model libraries. Advanced Property Management.
- Seamless integration with simulation and PCB design.

**Simulation**

- Non-Linear & Linear Analogue Simulation. Event driven Digital Simulation with modelling language.
- Partitioned simulation of large designs with multiple analogue & digital sections. Graphs displayed directly on the schematic.

**New Features**

- Component Auto-Placer
- Pinswap/Gateswap Optimizer
- Background Regeneration of Power Planes
- Enhanced Autorouting with Tidy Pass
- Full Control of Schematic Appearance
- Extensive New Component Libraries

**PCB Design**

- Pinswap/Gateswap Optimizer & Backannotation. 32 bit high resolution database.
- Full DRC and Connectivity Checking.
- Shape based gridless power planes.
- Gerber and DXF Import capability.

---

**PROTEUS is particularly good with its rip-up-and-retry autorouter**

EWW January 1997

Write, phone or fax for your free demo disk, or ask about our full evaluation kit.

Tel: 01756 753440. Fax: 01756 752857. EMAIL: info@labcenter.co.uk

53-55 Main St, Grassington, BD23 5AA. WWW: http://www.labcenter.co.uk

Fully interactive demo versions available for download from our WWW site.

Call for educational, multi-user and dealer pricing—new dealers always wanted.

Prices exclude VAT and delivery. All manufacturer’s trademarks acknowledged.
Look around the house and you are bound to find several devices powered from two, three or four AA cells. All those radios, games, personal stereos, photographic equipment and computer add-ons that you haven’t already thought of an energy-saving strategy for. They build up all the time, especially after Christmas. Many of these things need less than 300mA, which puts them well within the scope of a mains-powered eliminator like this one. Mains electricity is about three thousand times cheaper than the equivalent power from alkaline “AA” cells. Where there is a mains supply, it makes sense to use it, especially if you have anything that you use for long stretches of time.

Certain pieces of equipment, such as photoflash guns, require a large current for a relatively short time. My photoflash unit, for example, needs about 3A at the beginning of its operating cycle. This kind of item is not suitable to use with this battery eliminator.

Good substitute

Although this circuit was originally designed as a substitute for AA cells, there is no reason why it could not replace other batteries. In any event, you will need to look at the way in which the output will be connected to the terminals inside the battery compartment. You must also check that the equipment needs a maximum of 300 milliamps. For AA cells, the connections will possibly be made using a pair of dummy cells. More will be said about this later. Make sure that there is enough space inside the battery compartment for the wires. Also, check that it will be possible to file a small section out of the cover to allow the wires to pass through. A number of appliances have a separate cell holder inside the battery compartment to which connections are made via a PP3-type battery snap. If this is the case, the cell holder may be discarded. The eliminator output can then be linked to the existing connector using a similar battery snap.

This eliminator provides the correct output voltage via the value of a single “program resistor” on the circuit panel. However, to make sure that the voltage is correct, you will need to use a voltmeter at the end of construction. The output voltage must not be taken on trust. The current limit (that is, the maximum current which the unit can deliver) is set by another resistor. This provides protection in the event of a short circuit or overload, and takes the place of a fuse in the output. In fact, such a fuse would be undesirable because of the rather large voltage drop across it.

This eliminator must not be used by children. Because it receives power from the mains, it must be regarded as potentially dangerous. This is an “adults only” circuit. For the same reason, it must only be used in a dry indoor location.

How it works

The circuit is shown in figure 1. The mains is applied to transformer T1 primary via the fuse, FS1. The secondary provides an ac output of about 12V (with both 6V windings...
connected in series, that is, by connecting C to B as shown) or 6V (with the link connecting C to A instead - this uses only one secondary section). For equipment designed for two cells, the latter is used. For three or four cells, both secondaries will be needed. The mains earth wire is connected to the case and also runs through to the negative (OV) output terminal.

The transformer output is connected to bridge rectifier REC1 and smoothed by C1. The result is an on-load dc supply of some 7V (if one secondary has been selected) or 15V (for two). LED1 glows to show that the circuit is on. The value of series resistor R1 will be chosen according to whether the higher or lower secondary voltage has been selected. This will enable it to draw the correct operating current.

The positive rail is connected to the input (pin 1) of voltage and current regulator IC1. The output is provided at pin 5. Current then flows through R2 to the positive output. The output voltage depends on the values of R3 and R4. These should be of the 1 percent tolerance type so that the voltage may be accurately predicted. Since R3 is fixed in value, the output is determined by R4 (the program resistor) alone. The value of this is chosen from Table 1 according to which voltage output is required. For two cells this will be 3V, for three, 4.5V and for four, 6V. In fact, the voltages as calculated are slightly on the low side for safety. Capacitors C2 and C3 are necessary for stable operation of the regulator.

### Table 1

<table>
<thead>
<tr>
<th>For nominal output</th>
<th>Use R4 value (0.1 percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3V</td>
<td>33R</td>
</tr>
<tr>
<td>4.5V</td>
<td>560R</td>
</tr>
<tr>
<td>6V</td>
<td>1k1</td>
</tr>
</tbody>
</table>

**Voltage sensing**

The maximum output current is controlled by the value of R2. With the current flowing through this, a certain voltage is developed across it according to Ohm's Law. As the current increases so does the voltage. This is sensed by pin 2 and if it reaches 0.4V, the output is turned down so that it never exceeds this figure. Table 2 shows the value of R2 required to produce various current limits up to the maximum of 300mA. Note that these are not accurately determined and may only be regarded as nominal values.

### Table 2

<table>
<thead>
<tr>
<th>For current limit (mA)</th>
<th>Use R2 value (ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>8.2</td>
</tr>
<tr>
<td>100</td>
<td>3.9</td>
</tr>
<tr>
<td>150</td>
<td>2.7</td>
</tr>
<tr>
<td>200</td>
<td>1.8</td>
</tr>
<tr>
<td>250</td>
<td>1.5</td>
</tr>
<tr>
<td>300</td>
<td>1.2</td>
</tr>
</tbody>
</table>

See also text.

The difference between the input and output voltage appears between IC1 pins 1 and 5 (less the small voltage developed across R2). This, multiplied by the current flowing in the circuit gives the power which must be dissipated by the device. This is converted into heat, and measures must be taken to release this into the air without causing overheating. The maximum normal (non-fault) power dissipation will occur when the highest allowed current (300mA) is drawn and the circuit is configured for a 6V output. If 15V appears at pin 1, there will be a voltage difference of some 9V which, when multiplied by 300mA, will result in a power a little under 3W. This will produce a small amount of heat which is easily dissipated by the aluminium box in which the circuit is housed (and to which IC1 is bolted). Many pieces of equipment require less than 300mA and the heat developed will be correspondingly less. Under
short-circuit conditions, the power will be greater because the full 15V will now appear across the IC. With a set limit of 300mA, this will be in the region of 5W. It will be safe, but the box may become quite warm especially if the short circuit is applied for a long period of time.

**Construction**

All soldered connections must be made with-care. In some circumstances where there is a faulty connection, the output voltage could rise to that at IC1 pin 1 causing damage to the equipment connected to the unit.

The PCB design, as given, connects both 120V transformer primary windings in series for use with European (nominally 230V) supplies. Readers in the USA should make the following modifications: Cut away a section of track linking the Neutral (N) terminal on TB1 to the lower 0V transformer pin. Hard wire the lower transformer 120V pin to TB1 Neutral instead.

This project must be built in an earthed metal case. This provides sufficient mechanical strength and also acts as a heat sink for the IC. Drill holes for entry of the mains lead and for the output wires. Make these large enough for the strain relief bushes which are needed to hold them securely and prevent them from pulling free. Drill a small hole in the base close to TB1 position for a solder tag.

Drill the four mounting holes in the PCB. Four are necessary because the transformer is a heavy component and needs plenty of support. Mount the transformer, terminal blocks TB1 and TB2 also the fuseholder as shown in the photographs. Solder the link wire in position. This connects the common position (C) with either A (for 3V or 4.5V output) or B (for 6V output). Solder R1 in place - if one transformer secondary is used, the correct value is 330Ω; if both are used, it should be 1200Ω. Refer to Table 1, choose the correct program resistor (R4) and solder it in position. Refer to Table 2 and select the output voltage drop. This is especially important if a high current is being drawn. If a long lead is essential, use thicker wire. Secure this with the second strain relief bush and connect the wires to TB2. Note which colour is the positive. Just leave the other ends bare for the moment. Replace the lid of the case. Connect a voltmeter to the output and plug in the unit. The power will be greater because the full 15V will now appear across the IC. With a set limit of 300mA, this will be in the region of 5W. It will be safe, but the box may become quite warm especially if the short circuit is applied for a long period of time.

**Testing**

Note: For safety reasons, the lid of the case must be in position whenever the unit is plugged into the mains.

Make up an input lead using light-duty three-core mains-type wire. Fit a plug to one end and, if it is of the UK type, insert a 2A or 3A fuse. Pass the wire through the hole drilled for it and secure it using one of the strain relief bushes leaving a little slack. Make certain that the wire is tightly held. Connect the Live and Neutral wires to TB1 as shown in **Figure 3**. Twist the end of the earth wire to a further short piece of mains earth wire. Hook the wires through the hole in the solder tag and solder them securely. Attach the short piece of earth wire to the ground terminal of the device. Make certain that the mains earth wires are securely attached to the solder tag. Make up an output wire. This should be kept as short as practicable to minimise voltage drop. This is especially important if a high current is being drawn. If a long lead is essential, use thicker wire. Secure this with the second strain relief bush and connect the wires to TB2. Note which colour is the positive. Just leave the other ends bare for the moment. Replace the lid of the case. Connect a voltmeter to the output and plug in the unit. The

![Figure 3: connecting the Live and Neutral wires to TB1](image)
LED should glow and the voltmeter reading should be slightly below the nominal voltage (say, 95 percent of it). As a guide, these are the actual off-load voltages given by the prototype: 2.81V (for 3V), 4.25V (for 4.5V), 5.71V (for 6V). The voltage will fall a little according to the current drawn but it will still operate the equipment correctly. If it is found that 300mA is needed and this cannot be obtained, reduce the value of R2 slightly. In the unlikely event of the voltage being higher than the correct value, reduce the value of R4.

**Finishing off**

If all is well, arrangements can be made to connect the output lead to the battery connector in the appliance. However this is done, make absolutely certain that the wires are applied with the correct polarity. Some pieces of equipment do not have an internal diode which protects them against incorrect connection. Check and double check this point before connecting the wires and switching on.

The dummy AA cells referred to earlier consist of a plastic body with the ends linked by a thin metal strip. Depending on the particular arrangements, it may not always be necessary to cut through the strips. However, it will be safer if you do. Remove a small section of strip from each “cell” so that the ends cannot re-touch. The positive wire is soldered to the positive piece of link wire on one “cell” and the negative wire to the negative on the other. If the equipment uses three or four cells, it will be necessary to find which one makes the positive connection and which the negative. Only two dummy cells will normally be needed. However, some equipment relies on the mechanical support of all the cells to make a reliable connection, so more dummy units may be needed depending on the use. Careful inspection will reveal to which terminals the wires from the circuit panel inside are connected.

Due to safety regulations, this circuit must not be used to operate a battery-type electric razor in the bathroom.

After a long period of use, the case will become warm, especially if the maximum current is drawn.
SALE PRICE £9.95

VIDEO PROCESSOR UNITS 76v 10AH BATTs/24V BA
TX To suit are the function of these units is but they certainly make good strip outs. Measures 300 x 20 x 100mm on the front are adjustable for scan speed, scan delay, scan mode, loads of connections on the rear. Inside x 2 x 10AH sealed lead acid battery, a 6v and a 24v transformer (mains in). See as seen, may have one or two broken knobs etc due to poor storage. £9.95 ref VP0X

SALE PRICE £2.50

Customer returns, domestic telephone coin boxes, used to convert ordinary phones in to pay phones. ref CB71X

Dell switched mode psu
12v 15amp £9.95
140 x 150 x 90mm, fully cased with banana joiner 12 @ 13A, +5 @ 15A IEC power inst, flylead output. £9.95 ref DEL2

UK made energy saving device that can give you a 15% saving on the running costs of fridges etc. Suitable for mains appliances fitted with a motor of up to 3A rating. We have tried the device on other things like soldering irons, blow dryers, fans and still achieved a saving. Suitable for mains appliances fitted with a motor of up to 2A running costs of fridges etc. £99.50 ref DEL2

SALE PRICE £10

These units are must be cleared at the absurd price of just £9.11
You get loads of chips, resistors, capacitors etc etc. For what the function of these units is but we imagine you could use one to convert a monitor to a TV or maybe use the video input side of things for something else. £9.11 ref MO2

ORDER VIA OUR WEB SITE AT www.bull-electrical.com

SOLAR PANELS
3 ' x 1 Amorphous silicon, 7 watt 12-14v output. Unframed. Ref SOLX
SALE PRICE 4 FOR £59

PC KEYBOARDS
sale price just £2.99
Standard ps2 type connector, 104 keys. ref PCX

Compaq
244 watt pc power supplies
buy 2 for £16
Ex equipment but in full working order direct from one of the top manufacturers. 145 x 175 x 25mm, fitted fan and IEC inlet, switch on flylead. Outputs 3.3vdc, 5vdc, 5vdc, 12vdc, +12vdc. You may need to change the motherboard connector so we have included another one with the power supply to help. £16 for 2 ref COM2

SALE PRICE £2.99

Switched mode psu special offer
£2.99
Brand new psu's giving 5v at 4.4amps. Originally made for the Archimedes but obviously have many other uses. Fitted on/off switch and fly lead. 150 x 190 x 42mm. £2.99 ref ARCH1X

SALE PRICE £2.99

VIDEOPROCESSOR

18111111

Dell switched mode psu
12v 15amp £9.95
140 x 150 x 90mm, fully cased with banana joiner 12 @ 13A, +5 @ 15A IEC power inst, flylead output. £9.95 ref DEL2

RCB UNITS £2.99

This is line fence earth leakage unit instantly shuts off the mains supply in the event of any current flowing between line and earth thus preventing a potentially lethal shock. IEC plug one end, socket the other. Fitted in seconds, reset button. The ultimate safety aid when working on electronic equipment, computers etc.

Complete accounts system for your PC for just £9.95
Unlimited companies, general ledger, multiple cash books, debtors and creditors, stock, invoicing, purchasing, budgets, report writer, calculator, wordprocessor, automated backups, on line help, windowing, networkable up to 10 workstations. Free telephone support for 30 days from MAP computer products 0161 578 9513 all for the bargain price of just £9.95 worth it for the 200 page Pastel manual alone ref SA12 3.5" disk version only. £9.95 ref PAS2

MAINS SMOKE ALARMS (GENT)
NEW AND BOXED £4.99 ref SMXX

BBC selector video copy 's'
tvtuner with smart card
sale price £9.95
Interesting new item in this week is the Selecto. Originally made for the BBC to send encoded video fits to your VCR at night time. project seems to have lapsed. Very complex units consisting of a smart card slot in the front plus several switches and an IR receiver. Fully cased and measuring 140 x 300 x 90mm, new and boxed. £99.95 ref SXL1

BULL ELECTRICAL
250 PORTLAND ROAD, HOVE, SUSSEX, BN3 5QT. (ESTABLISHED 59 YEARS).
MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3.50 P&P PLUS VAT.
24 HOUR SERVICE. £5.00 PLUS VAT.
OVERSEAS ORDERS AT COST PLUS £3.50 (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)
phone orders: 01273 203500
FAX 01273 323977
E-mail bull@pavilion.co.uk

Introducing our mega magnet
that lifts 33 kilo's!
Just in this week are these incredible Neodymium magnets that will lift an incredible 33 kilos! Each magnet has a threaded bolt protruding from the rear for easy fixing. 52mm diameter. £150 ref MAG33
The complete, powerful schematic and PCB layout tools for Windows.

1. Design your schematic with WinDraft...
   - Choose from over 10,000 parts in WinDraft’s complete library of components.
   - All the utilities you need are included in the package from an Electrical Rules Checker to netlist output to printing and plotting outputs.
   - Cut and Paste into other Windows applications such as Microsoft Word. Makes it easy to document your projects.

2. Create the artwork for the PCB with WinBoard...
   - Quickly route boards on up to 16 layers.
   - Use SMD or through-hole components — or mix them for maximum flexibility.
   - Unique pad-stack editor can create pads of virtually any size or shape.
   - Rotate components in 0.01° increments.

3. Create a Gerber photoplot, NC Drill, pick and place, and other manufacturing outputs!

Tel 0181 926 1161

The PC Solution, 2a High Road Leyton, London, E15 2BP. Fax 0181 926 1160 http://www.thepcsoi.demon.co.uk

HOW DOES YOUR EQUIPMENT MEASURE UP?
AT STEWART OF READING THERE’S ALWAYS ‘SCOPE’ FOR IMPROVEMENT!

THE COMPLETE/TENSILE 40 SERIES

434 Digital Storage Dual Trace 100MHZ Delay Sweep
475 Dual Trace 50MHZ Delay Sweep
502 Dual Trace 100MHZ Delay Sweep
5210 Dual Trace 50MHZ Delay Sweep
5310 Dual Trace 100MHZ Delay Sweep
5110 Dual Trace 100MHZ Delay Sweep
5120 Dual Trace 100MHZ Delay Sweep
5220 Dual Trace 100MHZ Delay Sweep
5320 Dual Trace 100MHZ Delay Sweep

THE CLASSIC TEXTRONIX 40 SERIES

414 Digital Storage Dual Trace 100MHZ Delay Sweep
444 Digital Storage 4 Channel 100MHZ Delay Sweep
474 Digital Storage Dual Trace 100MHZ Delay Sweep
478 Digital Storage Dual Trace 100MHZ Delay Sweep
504 Digital Storage Dual Trace 50MHZ Delay Sweep
524 Digital Storage Dual Trace 50MHZ Delay Sweep
534 Digital Storage Dual Trace 50MHZ Delay Sweep
515 Digital Storage 4 Channel 100MHZ Delay Sweep
525 Digital Storage 4 Channel 50MHZ Delay Sweep
526 Digital Storage 4 Channel 50MHZ Delay Sweep
536 Digital Storage 4 Channel 50MHZ Delay Sweep
519 Digital Storage 4 Channel 100MHZ Delay Sweep
529 Digital Storage 4 Channel 100MHZ Delay Sweep
539 Digital Storage 4 Channel 100MHZ Delay Sweep

AND REMEMBER ALL OUR EQUIPMENT IS TESTED PROPERLY
Five Range Capacitance Meter

The careful use of close-tolerance components on this meter gives good results for low capacitance values where many meters fail. By Robert Penfold.

An analogue capacitance meter can be very simple indeed, often consisting of little more than an oscillator and a monostable. Many designs of this type have been published in the past, and no doubt they all perform quite well. The problem with the ultra-simple approach is that it usually provides a relatively confined measuring range. In particular, the accuracy at low values can be very poor, and it is often impossible to check components having values of less than about 50 to 100pF. This is a serious drawback for anyone interested in radio circuits, or high frequency circuits in general, where a large number of low-value capacitors are used. Even in low frequency circuits, there is usually a sprinkling of small capacitors to provide frequency compensation and so on.

This analogue capacitance meter has five ranges with full-scale values of 100pF, 1nF, 10nF, 100nF, and 1uF. Its coverage is less extensive at the high value end than some other designs, but high value capacitors are easily checked using a multimeter. Good results are provided at low values where the unit will happily measure values down to a few picofarads. Excellent accuracy is obtained on all five ranges provided close-tolerance resistors are used in the range-switching circuit. The circuit is powered from a PP3 size battery, or a simple unregulated 9V battery eliminator can be used if preferred.

Operation
The block diagram (figure 1) shows the general arrangement used in this capacitance meter. The first three stages generate a sinewave signal of pre-set amplitude. A simple C-R oscillator generates a low frequency triangular waveform, and lowpass filtering is then used to reduce the harmonic content of this signal. This rounds the waveform to give a reasonable sinewave signal of adequate purity for the present application. A variable gain amplifier enables the amplitude of the output signal to be controlled, and this stage provides a small amount of additional lowpass filtering.

The sinewave output signal is fed to an operational amplifier which is used in an inverting mode circuit of sorts.

Figure 1: the block diagram of the Five-range Capacitance Meter

---

ELECTRONICS TODAY INTERNATIONAL
What would normally be the input resistor is actually the capacitor under test, and the feedback resistor is one of five switched resistors (one for each range). The closed loop voltage gain of this modified arrangement is governed by the normal rules, and is simply equal to the feedback resistance divided by the reactance of the test capacitor. The reactance of the test capacitor is dependent on the applied frequency and the value of the capacitor. In this case the input frequency is fixed, and the reactance value is therefore dependent only on the value of the test component.

This method of capacitance measurement relies on the fact that the reactance of a capacitor is inversely proportional to its value. For example, at a given frequency a 10nF capacitor will have a reactance that is ten times higher than that of a 100nF component. Suppose that a 100nF test capacitor has a reactance that is equal to the selected feedback resistor. This gives unity voltage gain through the inverting amplifier, and an output level that is equal to the input level. The reactance of a 50nF test capacitance would be double the value of the feedback resistor, giving a voltage gain of 0.5. The output level from the inverting amplifier would therefore be half the input level. A 10nF test capacitor would have a reactance value some ten times higher than the value of the feedback resistor, giving a voltage gain of just 0.1. The amplitude of the output signal from the inverting amplifier would obviously be one tenth of the input level.

It should be apparent from this that there is a linear

Figure 2: the Five-range Capacitance Meter circuit diagram
Electronic **DESIGNERs**

know how to get their

**PROTOTYPE PCBs**

from their **usual manufacturer** for a

**FRACTION of the COST!**

DO YOU?

STOP WASTING YOUR MONEY!

CALL NOW: 00353 65 66500
relationship between the value of the test capacitor and the amplitude of the output signal from the inverting amplifier.

Feeding the output of the inverting amplifier to a precision rectifier and smoothing circuit produces a dc output voltage that is proportional to the ac output voltage from the inverting amplifier. This drives a moving coil meter which indicates the value of the test components, and has linear scaling. The gain control in the sinewave generator circuit enables the unit to be calibrated against a precision capacitor which should preferably have a tolerance of one percent or better.

The circuit

The full circuit diagram for the five range capacitance meter appears in figure 2. IC1 is used in a standard triangular/squarewave oscillator of the type that uses an integrator (IC1a) and a trigger circuit (IC1b). In this case it is only the triangular output signal from IC1a that is required. The oscillator circuit has an operating frequency of about 115Hz. The triangular output signal is fed to a conventional third order (18dB per octave) lowpass filter based on IC2. This filter has its cut-off frequency at approximately 100Hz. It therefore allows the fundamental input frequency to pass with little attenuation, but severely attenuates even the lower order harmonics. IC3 is used in the variable gain amplifier, which is a simple inverting mode circuit. Its gain can be varied from approximately 12 with VR1 at minimum resistance, to just under two with VR1 set for maximum resistance. C6 applies increased feedback at high frequencies, which gives some additional lowpass filtering, and a slightly improved sinewave output signal.

The test capacitors are connected across SK1 and SK2. IC4 is the operational amplifier in the inverting mode amplifier, and R13 to R17 are the range resistors. These must have a tolerance of one percent or better if good accuracy is to be achieved on all five ranges. R13 is the feedback resistor on the 1uF range, running through to R17, which is the feedback resistor for the 100pF range.

The precision rectifier uses IC5 as (in effect) a non-inverting amplifier with a voltage gain of about 5.5. However, IC5 is used without a negative supply, which means that it cannot provide negative output signals. The CA3140E specified for IC5 is a type which can operate with its inputs and output at very low potentials, and the circuit therefore functions normally on positive input half cycles. This circuit therefore provides a half-wave rectified and slightly boosted output signal which is fed to the meter via the simple lowpass filter circuit comprising R22 and C9. Note that most operational amplifiers cannot operate with their inputs and output at less than about one or two volts above the negative supply terminal, so devices such as the TL071CP, LF351N, uA741C, and so on, will not work in the IC5 position of this circuit. It is also worth noting that the circuit operates from a five-volt supply, and that this is too low for many operational amplifiers. The use of alternatives for IC1 to IC4 is not recommended, either.

Figure 3: the pcb component layout for the Five-range Capacitance Meter
It is essential that the circuit is powered from a stable supply, since the output level from the sinewave generator circuit varies with changes in the supply voltage. A stabilised five volt supply is derived from the nine volt battery supply by monolithic voltage regulator IC6. S2 connects the positive terminal of meter ME1 to R22 and C9 in normal operation, but it can be set to the other position to check that the battery voltage is acceptable. The meter is then connected across the stabilised five volt supply via R21, which effectively converts the meter to a simple voltmeter having a full scale value of 10 volts. If any “sagging” of the stabilised supply is evident, the battery is exhausted and must be replaced immediately.

The total current consumption of the circuit is about eight to 10 milliamps, and a PP3 size battery is just about adequate to supply this. Alternatively, any nine-volt battery eliminator should be able to supply such a modest current. Due to the inclusion of IC6 it is not necessary to use a battery eliminator that has a built-in regulator circuit, but a supply of this type is, of course, perfectly suitable for use with this unit.

Construction
Most of the components are assembled on a printed circuit board, as detailed in figure 3, the component layout. Construction of the circuit board is largely straightforward, but there are a few points that merit amplification. Bear in mind that the CA3140E used for IC5 is a MOS input device which requires standard anti-static handling precautions. The most important of these is to fit the device in an ic holder, and not to plug the ic into place until the circuit board and all the wiring are otherwise complete. Before that it should be left in its anti-static packing. Try to handle IC5 as little as possible when fitting it into the holder, and keep it away from any obvious sources of static charges. Although IC1 to IC4 all have fet input stages, they do not require any special handling precautions as they have jfet rather than mosfet input stages. However, it is still advisable to use ic holders for all four of these devices.

In order to fit neatly into this board layout the non-electrolytic capacitors should be small printed circuit mounting types having 7.5 millimetre lead spacing. The only exceptions are C10 and C11 which are miniature ceramic capacitors having five millimetre lead spacing. VR1 must be a miniature (0.1 or 0.15 watt) horizontal mounting preset. Fit single-sided one-millimetre diameter pins to the board at the positions where connections will eventually be made to the off-board components such as the switches and ME1. Tin the tops of the pins with a liberal amount of solder.

A metal instrument case measuring about 150 by 100 by 75 millimetres is adequate to accommodate this project. The exact layout is not critical, but try to use one that avoids having long connecting wires to SK1, SK2, and S1. Excessively long connecting wires can give problems with stray capacitance, causing reduced accuracy when...
measuring very low value capacitors. On the prototype, SK1 and SK2 are one-millimetre sockets mounted about 15 millimetres apart. Many capacitors will plug straight into these, but a set of small test leads fitted with miniature crocodile clips must be made up so that small printed circuit mounting capacitors can be tested.

Fitting the meter on the case is slightly awkward because the meter requires a sizeable cut-out. A 38-millimetre diameter hole is required for a standard 60 by 45 millimetre panel meter. This can be cut using an Abrafila or any other miniature round file. It is advisable to cut just within the perimeter of the required cut-out, and then carefully enlarge the hole using a large half-round file. A special tool for making large diameter holes is available from some do-it-yourself stores, and this represents the quickest and easiest way of making the mounting hole. These hole-cutters are also known as "tank cutters", and they are intended for use in hand drills or (preferably) a brace, as they must be used at very slow speeds. They can be adjusted to produce any size of hole from about 20 millimetres in diameter to 60 millimetres or more. The meter also requires four 2.5 millimetre diameter mounting holes for its built-in threaded mounting rods. The positions of these can be located using the meter itself as a sort of template.

Details of the hard wiring are provided in figure 4. In order to keep stray capacitance to a minimum the range resistors (R13 to R17) are mounted on SW1. I used a six-way two-pole switch for SW1, with its adjustable end-stop set for five-way operation, but a standard 12-way single pole switch is also suitable. There should be no difficulty in fitting the resistors in place provided the ends of the leadout wires and the tags of SW1 are tinned with solder first. Try to make the connections reasonably swiftly so that there is no danger of the resistors becoming overheated, and their accuracy being impaired. In other respects the hard wiring offers nothing out of the ordinary.

**Calibration and use**

A close tolerance (one percent or better) capacitor is needed in order to calibrate the unit, and this capacitor should ideally have a value that is equal to the full scale value of one of the capacitance meter's ranges. If a suitable component has to be bought specially it is advisable to calibrate the unit on the 100pF or 1nF range, because close tolerance capacitors with higher values tend to be quite expensive. To calibrate the unit, simply switch it to the appropriate range, connect the calibration capacitor across SK1 and SK2, and then adjust VR1 for the correct reading on ME1. The meter should then function with good accuracy on all five ranges.

In theory it is not possible to test small electrolytic capacitors using this meter because the test capacitor is fed with a pure ac signal that does not include a dc component. In practice though, accurate measurements seem to be obtained with electrolytic capacitors connected either way round. When using the unit, try not to touch either leadout wire of the test components, as this could result in noise picked up in your body being fed into the rectifier circuit. This could significantly inflate readings. This is especially important when testing low value components, as the tester is more sensitive to stray pickup on the 100pF and 1nF ranges.

It is perhaps worth bearing in mind that the circuit responds to the impedance across SK1 and SK2 at the test frequency. A capacitor that is faulty with a high leakage level might give a reading on one range of the unit, but the indicated value would be much higher than the marked value of the test component. If a high leakage level is expected, a quick test with a multimeter set to a resistance range will soon show whether or not the test component exhibits this fault.

One final important point is that with any practically any capacitance meter, it is courting disaster to test a capacitor that is charged to anything more than a few volts. If there is any risk of a test component having a significant charge voltage, discharge it prior to connection to the capacitance meter.

---

**Resistors**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1,2,11,12,19</td>
<td>10k</td>
</tr>
<tr>
<td>R3</td>
<td>150k</td>
</tr>
<tr>
<td>R4</td>
<td>18k</td>
</tr>
<tr>
<td>R5</td>
<td>39k</td>
</tr>
<tr>
<td>R6,7,8,21</td>
<td>100k</td>
</tr>
<tr>
<td>R9</td>
<td>3k9</td>
</tr>
<tr>
<td>R10</td>
<td>47k</td>
</tr>
<tr>
<td>R13</td>
<td>1k (metal film 1 percent)</td>
</tr>
<tr>
<td>R14</td>
<td>10k (metal film 1 percent)</td>
</tr>
<tr>
<td>R15</td>
<td>100k (metal film 1 percent)</td>
</tr>
<tr>
<td>R16</td>
<td>1M (metal film 1 percent)</td>
</tr>
<tr>
<td>R17</td>
<td>10M (metal film 1 percent)</td>
</tr>
<tr>
<td>R18</td>
<td>33k</td>
</tr>
<tr>
<td>R20</td>
<td>2k2</td>
</tr>
<tr>
<td>R22</td>
<td>5k6</td>
</tr>
<tr>
<td>VR1</td>
<td>22k min hor preset</td>
</tr>
</tbody>
</table>

**Capacitors**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1,3</td>
<td>33n polyester, 7.5mm lead spacing</td>
</tr>
<tr>
<td>C2,9</td>
<td>10u 25V radial elect spacing</td>
</tr>
<tr>
<td>C4,6</td>
<td>47n polyester, 7.5mm lead spacing</td>
</tr>
<tr>
<td>C5</td>
<td>3n3 polyester, 7.5mm lead spacing</td>
</tr>
<tr>
<td>C7,8</td>
<td>1u 50V radial elect</td>
</tr>
<tr>
<td>C10,11</td>
<td>100n disc ceramic</td>
</tr>
</tbody>
</table>

**Semiconductors**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1</td>
<td>TL072CP dual bifet op amp</td>
</tr>
<tr>
<td>IC2,3,4</td>
<td>TL071CP bifet op amp</td>
</tr>
<tr>
<td>IC5</td>
<td>CA3140E PMOS op amp</td>
</tr>
<tr>
<td>IC6</td>
<td>uA78L05 5V 100mA positive regulator</td>
</tr>
</tbody>
</table>

**Miscellaneous**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME1</td>
<td>100uA moving coil panel meter</td>
</tr>
<tr>
<td>SW1</td>
<td>6-way 2-pole rotary switch with adjustable end-stop (set for 5-way operation, only one pole used)</td>
</tr>
<tr>
<td>SW2</td>
<td>SPDT min toggle switch</td>
</tr>
<tr>
<td>SW3</td>
<td>SPST min toggle switch</td>
</tr>
<tr>
<td>B1</td>
<td>9 volt (PP3 size)</td>
</tr>
<tr>
<td>SK1,2</td>
<td>1mm socket</td>
</tr>
</tbody>
</table>

Metal instrument case about 150 x 100 x 75mm, printed circuit board, 5 x 8-pin DIL holder; battery clip, control knob, wire, solder, etc.
SUBSCRIBE AND SAVE UP TO £9

... and LET THE POSTMAN DO THE WORK!

ACORN ARCHIMEDES WORLD
13 issues
UK: WAS £48.75, NOW £39.75, YOU SAVE £9,
Europe: £60.50, Overseas: £62.50, USA: £100.00

Now this just has to be a good deal! Not only will you save a considerable amount of money, but your postman will also deliver the next 13 issues of your favourite electronics magazine directly to your door - with no fuss, no hassle, and no future price increases.

So go on, subscribe now, save your shoe leather, and up to 70p per issue.

Here's why YOU should subscribe to either ETI, Ham Radio Today or Acorn Archimedes World:
♦ FREE home delivery in the UK.
♦ A saving of up to £9 a year.
♦ Price protection - you won't pay any more if the cover price goes up.
♦ Guarantee receiving every issue.

This is one deal where you really can't lose.

REMEMBER, it's always cheaper to subscribe!

All savings are based upon buying the same number of issues from your newsagent, UK only.

HAM RADIO TODAY
13 issues
UK: WAS £32.50, NOW £29.00, YOU SAVE £3.50,
Europe: £39.50, Overseas: £41.50, USA: £66.00

E.T.I. PRICE FREEZE OFFER!
13 issues
UK: WAS £32.50, NOW £27.00, YOU SAVE £5.50,
Europe: £40.00, Overseas: £41.80, USA: £64.00

The cover price of ETI has now risen to £2.50 BUT you can still subscribe at the old price - if you order today! After this issue we will have to charge a new, higher rate - so take advantage of this offer now.

To order by phone, please call our credit card hotline on 01858-435344 (Mon to Fri, 9am - 5.30pm)

To order by post, please return the form below with your payment to:
Nexus Subscriptions, Tower House, Sovereign Park, Lathkill Street, Market Harborough, Leics LE16 9EF

Offer closes: 31/8/97 Code: 0210
An RS232 I/O Card for Psion 3s and PCs

The Psion Organiser can be more than an electronic diary. Using this interface by Pei An, you can program it to control things for you, or work as a simple data logger.

The Psion series 3, 3A, 3C and Sienna are palmtop computers. Although they are packaged as personal organisers, they are really general-purpose computers. They are equipped not only with powerful built-in organiser applications like word processing, spreadsheet, agenda and database management (such as telephone and address books), but also contain a powerful built-in Basic-like programming language, the Organiser Programming Language (OPL). The latter allows the user to write sophisticated software for applications other than the ones that are built in. Psion organisers have a comprehensive power saving scheme, which makes them excellent computers with the major benefits of compactness and long battery life. Psions also have an I/O port which allows them to be connected up to desktop computers, modems and printers. The I/O ports on the Psion 3 and 3A can be converted into a standard RS232 or a Centronics port by means of external plug-in devices. The Psion 3C/Sienna, however, already has an industrial-standard RS232 interface and an IrDA data communications port incorporated.

Like other PCs, the Psions can be used for computer interfacing applications. Using the RS232 port, external circuits can be connected up to form PC-based systems for applications such as data acquisition and control, which can be made truly portable and mobile owing to the compactness and low power consumption of the Psions.

This article describes a general purpose RS232 I/O card for the Psion 3C organiser as well as for PCs. It is connected to the port by three wires, and offers eight digital inputs and eight digital outputs. Figure 1 shows the I/O system connected to a Psion 3C. The card itself is shown in one of the photos accompanying this article. It allows the user to explore the RS232 port and make use of the port for other PC interfacing applications using the Psion and PCs.

**Fundamentals**

The RS-232C port is an industrial-standard asynchronous serial data communications interface for passing serial data between two devices. It is included in almost all types of desktop and notebook PCs and is used mainly for connecting printers, modems, mice and other peripherals.

**Serial data**

Unlike a parallel port, which normally has eight data lines and transmits one 8-bit byte in each go, a serial port only has one data line to transmit 8 bits. The byte is transmitted serially.
There are two serial data transfer schemes, synchronous and asynchronous. With synchronous data transfer, additional lines are needed to transmit handshake signals along with the data line to indicate when the next bit is to be transmitted. The advantage of this is that the receiver is able to respond to the clock rate of the transmitter automatically.

With asynchronous data transfer, the transmitted data itself contains the synchronisation information, and no handshake signal is needed. The transmitted serial data comprises a start bit, which indicates the beginning of a data transmission, followed by serial data bits and then stop bits indicating the end of the transmission. An optional parity bit can be added between the serial data bits and the stop bit for parity checking.

The receiver device detects the start bit and receives the subsequent data bits. This scheme requires that the transmitter and the receiver must have the same clock frequency. Asynchronous data transmission is used in most personal computers. The asynchronous standard is facilitated by a family of industrial peripheral UCSs known as the UARTs (Universal Asynchronous Receivers and Transmitters). The card in this project employs a 6402 UART.

**The format**

The format of the serial data transmission generated by UARTS is in four parts: a start bit, data bits, one parity bit, and at least one stop bit (see figure 2). When no data is sent, the transmitting data line is in the high state (2V-5V TTL level). The beginning of a data transmission is indicated by the line going low (0-0.8V TTL level) for the duration of 1 bit. This the start bit. The data bits are then sent out one after another with the least significant bit sent first. The length of the data bit can be 6, 7 or 8. Following the data bits is the parity bit, which is used to check for errors occurring in the data transmission. The last bits are the stop bits. The data line goes high for at least 1 bit, to identify the end of the data transmission. The stop bit can be 1, 1.5 and 2 bits in length.

The serial data transmission format is generated by the electronics inside the transmitting UARTS. The electronics in the receiver detect the leading edge of the start bit. The chip then waits for one and a half bits before reading the data bit. The reading should therefore come exactly in the middle of the first data bit. Then it waits for one bit, and reads the second bit. This time the reading comes exactly in the middle of the second data bit. After completing the reading of the data bits, the electronics detects the parity of the received data for error checking, and resets itself during the stop bit to wait for the next data transmission.

The rate at which data bits are sent is measured by the Baud rate. It is defined as 1/(the time between the shortest signal transition period) - see figure 2. The standard Baud rates for RS232 serial port are 110, 150, 300, 600, 1200, 2400, 4800, 9600 and 19200. Knowing the Baud rate, the number of characters (or bytes) to be transmitted per second can be calculated. For example, if the serial data transmission has 8 data bits, no parity bit and 1 stop bit, the total length of serial data bits is 10. The transfer rate for characters is the Baud rate divided by 10; for example, a Baud rate of 9600 transfers 960 characters per second.

The parity check can be Odd, Even or None. The odd and even parity checks indicate that the total number of ones in the transmitted serial data is an odd number or an even one. This method is the simplest way of checking for errors during data transmission. However, it is only reliable for detecting single-bit errors. Errors with several bits may not be detected. The parity bit is generated by the electronics of the transmitting UART in such a way that the number of ones in the data bits plus the parity bit is odd or even as declared. Suppose we send a binary byte 01000011 (there are three 1s in the byte) from the computer to an external device and the parity has been declared as odd (the total number of ones is odd). The parity bit will be set 0, since the number of ones in these nine data bits is already odd. At the receiver end, the receiver must also be configured to have an odd parity check. The electronics in the receiver UART will count the number of ones in the received data. If the data does not have an odd parity, an error signal is generated indicating that a transmission error has been occurred. If parity check is declared as None, the parity bit will not be generated and checked.

**Line drivers and receivers for the RS232 link**

The signal from the UARTs has a TTL level. A logic high corresponds to a voltage ranging from 2V to 5V and a logic low corresponds to a voltage between 0V and 0.8V. Signals of this voltage level cannot be transmitted reliably over a long distance. To solve the problem, RS232 transceivers are used to boost up the voltage of the transmit signal from the TTL level to the RS232 level, which is substantially higher than the former. Receivers are used in the receiving device to convert the RS232 voltage level to the TTL level. This arrangement enables the RS232 interface to communicate over a maximum distance of about 30 meters. The voltage conversion between TTL and RS232 is facilitated by a family of industrial RS232 transceiver ICs. The current project uses a MAX232CPD. All the RS232 transceivers have an inverting action. A TTL logic high is translated to -3V to -12V at the RS232 side, and a TTL logic low is translated to +3 to 12V. It
PSION 3C
Connected to
the RS232 port
of the PSION 3C

Figure 1: versatile RS232 I/O card connected to a Psion 3C palmtop

<table>
<thead>
<tr>
<th>CONNECTOR ON PSION 3C</th>
<th>9 PINS ON PSION CABLE</th>
<th>DIRECTION</th>
<th>SIGNAL</th>
<th>PIN FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>OUTPUT</td>
<td>TX</td>
<td>PROTECTIVE GROUND</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>INPUT</td>
<td>RD</td>
<td>COMPUTER RECEIVES DATA</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>INPUT</td>
<td>RTS</td>
<td>REQUEST TO SEND</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>INPUT</td>
<td>CTS</td>
<td>CLEAR TO SEND</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>INPUT</td>
<td>DSR</td>
<td>DATA SET READY</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>INPUT</td>
<td>DCD</td>
<td>SIGNAL GROUND (COMMON)</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>INPUT</td>
<td>DTR</td>
<td>DATA TERMINAL READY</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>INPUT</td>
<td>RI</td>
<td>RING INDICATOR</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>INPUT</td>
<td>DSR/C</td>
<td>DATA SIGNAL RATE DETECTOR</td>
</tr>
</tbody>
</table>

Table 1: the pin functions of the RS232 ports on PCs and Psions

should be noted that, for IBM PCs, the voltage swing is from -12V to +12V, while for the Psion the output voltage swing is from -5V to +5V (not -12V to +12V). It can, however, receive an RS232 signal with a swing from -12V to +12V.

RS232 interfaces on Psion 3Cs and PCs

The RS232 port is a 15-pin male PCMCIA-type connector on the left-hand side of the Psion 3C/Sienna computers. Although it is not a standard version, the pins are the same as those in a standard RS232 port. As mentioned earlier, the voltage swing of the signal line is from -5V to +5V instead of -12V to +12V, but it does accept standard RS232 voltage levels.

A cable is used to connect a Psion 3C/Sienna to an external device. The cable is screened 15-core with a 15-pin PCMCIA female connector at one end and a 9-pin D-type female connector at the other. It can be purchased with the PsiWin software package, or you can make one up yourself (see the construction section). Figure 3 shows the pin-outs of the RS232 port on the Psion, and of the D-type connector. The RS-232 interface on computers is a 25-pin interface housed in a 25-pin male D-type connector. An abbreviated version is also commonly used on PCs: this is a 9-pin male D-type connector. The pin functions of the connectors are shown in Figure 4. The pin functions of the RS232 ports on PCs and Psions are summarised in Table 1. The signal transmission direction is related to Psion or PC computers.

Operation of the RS232 port

Data is transmitted from the computer via the TX line, and the computer receives data from external devices via the RX line. Handshake lines are used to manage data flow between the computer and the external device. RTS (active high) is issued by the computer to instruct the external device to prepare for a data transfer from the computer. CTS (active high) is issued by the external device to tell the computer that the external device is ready to accept data. RTS and CTS are used as a handshake for data transfer. DCD (active high) is issued by the external device to tell the computer that it has detected the carrier signal. DSR is generated by the external device to inform the computer that it is switched on. DTR is a signal generated by the computer to tell the external device that the computer is switched on and is ready to communicate with the external devices. DSR and DTR are used to indicate an established connection between a computer and an external device.

A simple communication can be achieved between a computer and an external device using just three lines: TD, RD and GND. This simple communication scheme is the one adopted for the present project - all the handshake lines are not used; in fact, in order to use this scheme, the Psion and PC computers have to disable all handshake functions.

Hands-on experiments with the Psion 3C

Using a Psion 3C, users can conduct a simple experiment to find out how to use the RS232 port on the Psion 3C and to understand RS232 data transmission. The experimental set-up is shown in Figure 5. The Psion 3C continuously transmits the same byte from the TX line of the RS232 port. The waveform of the TX signal can be viewed using an oscilloscope. Figures 5a to f show the waveforms for output bytes of 0, 1, 2, 64, 128 and 255.

To output data from the RS232 port of a Psion 3C, use the following set-up: at the system screen (press the SYSTEM keypad), press MENU, then select SPECIAL and
COMMUNICATIONS. Next, make sure USE is set to either INFRARED or NONE (not LINK CABLE). This ensures that the series link is used solely by the user’s program and is not used by other programs. If the serial port is used by the communication link, an error will appear when you run your program.

After this, you are in full control of the RS232 port from your own OPL program. An OPL program which repeatedly outputs the same byte from the RS232 port is given below. This program first configures the RS232 port to the following specification:

Baud rate: 9600; data bit: 8; stop bit 1; parity: none; handshake: none

Then the program continuously outputs a byte to the RS232 port. The program code must be typed in exactly as it appears here. A detailed explanation of the commands will be given later in the OPL programming section. When the program is running, the waveform of the TX signal can be viewed with an oscilloscope.

PSION 3C OPL program listing, RS232TX:

```
PROC RS232TX:
REM RS232 output test program
REM communication setting: None or Infrared
REM define local variables to be used in the program
LOCAL term&, baud%, parity%, data%, stop%, hand%, frame%, srchar%(6)
LOCAL err%, dummy%
LOCAL outbyte%
REM open RS232 port
LOPEN "TTY:A"
REM define RS232 configuration parameters
REM RS232 setting: 9600, 8 bit, no parity, 1 stop, no handshake
baud% = 15 : parity[percent] = 0 : data[percent] = 8
stop% = 1 : hand[percent] = 4 : term% = 60
frame% = data% - 5
IF stop% = 2 : frame% = frame% OR 16 : ENDIF
IF parity% = 1 : frame% = frame% OR 32 : ENDIF
Srchar%(1) = (baud% * 65536) OR (baud% * 256)
Srchar%(2) = frame% OR (parity% * 256)
Srchar%(3) = (hand% AND 255) OR $1100
Srchar%(4) = $13
REM configure the RS232 port using the above parameters
err% = IOW(-1, 7, srchar[percent](1), dummy%)
DO
CLS
clear screen
REM
FONT 8, 8
set fonts
PRINT "INPUT DATA = ",
INPUT outbyte%
```

PROC RS232TX:
REM RS232 output test program
REM communication setting: None or Infrared
REM define local variables to be used in the program
LOCAL term&, baud%, parity%, data%, stop%, hand%, frame%, srchar%(6)
LOCAL err%, dummy%
LOCAL outbyte%
REM open RS232 port
LOPEN "TTY:A"
REM define RS232 configuration parameters
REM RS232 setting: 9600, 8 bit, no parity, 1 stop, no handshake
baud% = 15 : parity[percent] = 0 : data[percent] = 8
stop% = 1 : hand[percent] = 4 : term% = 60
frame% = data% - 5
IF stop% = 2 : frame% = frame% OR 16 : ENDIF
IF parity% = 1 : frame% = frame% OR 32 : ENDIF
Srchar%(1) = (baud% * 65536) OR (baud% * 256)
Srchar%(2) = frame% OR (parity% * 256)
Srchar%(3) = (hand% AND 255) OR $1100
Srchar%(4) = $13
REM configure the RS232 port using the above parameters
err% = IOW(-1, 7, srchar[percent](1), dummy%)
DO
CLS
clear screen
REM
FONT 8, 8
set fonts
PRINT "INPUT DATA = ",
INPUT outbyte%
The Low Cost Controller
That’s Easy To Use

**Features**

**Analogue**
- 4 Channels in 1 Channel out
- 36 Digital in or out & Timers

**Serial**
- RS-232 or RS-485 plus I2C

**Display**
- LCD both text and graphics

**Keyboard**
- Upto 8 x 8 matrix keyboard
- > 2Mbytes available on board

**Memory**
- Many modes to choose from

**Development**

The PC Starter Pack provides the quickest method to get your application up & running

- **Operating System**
  - Real Time Multi Tasking
- **Languages**
  - ‘C’, Modula-2 and Assembler
- **Expansion**
  - Easy to expand to a wide range of peripheral cards

**Other Features**

- Real Time Calendar Clock, Battery Back Up, Watch Dog, Power Fail Detect, STE I/O Bus, 8051 interface, 68000 and PC Interface

Cambridge Microprocessor Systems Limited

CMS
Units 17 - 18 Zone ‘D’
Chelmsford Road Ind Est
Great Dunmow Essex CM6 1XG
E-mail cms@dial.pipex.com

Phone 01 371 875 644
SMART CARD EVALUATION SYSTEM

- Smart Card Reader/Writer (Programming Interface)
- Smart Card Interrogation System, to identify cards and commands accepted by any valid SmartCard and log them to disk for evaluation.
- Will allow the user to "re send" known commands and monitor the result.
- Passive interface to allow the user to monitor the data flow between cards and host systems.
- 244 page Hardback reference book, covering all aspects of Smart Card design and programming.
- Sample program to read memory type Phone cards
- Data on NEW Visa Smart Cards.
- Sample Smart Cards, Electronic Purse, Credit / Debit card, ID Card
- £169.95 + VAT
- Other systems available for specific projects, credit / debit, access control, GSM etc etc
- AS SUPPLIED TO POLICE, GOVT & Government Operators.

CALL FOR FULL SPEC & CATALOGUE

CHORPONIAL PROFESSIONAL
SMART CARD PROGRAMMING SYSTEM
http://www.towitoko.co.uk

£79.95 + VAT
PRINT "TRANSMITTING..."
PRINT "PRESS ANY KEY TO CHANGE NEW DATA"
REM the following commands are repeated
until a key is pressed
DO
REM to output data from RS232 port
LPRINT chr$(outbyte$); REM output
a byte to RS232 port
UNTIL KEY$=CHR$(13)
REM if key is pressed, then stop
UNTIL outbyte$[right arrow]=256

**The RS232 I/O card**

The circuit diagram of the RS232 card is shown in figure 6. In the diagram, IC1 (MAX232CPE) is the RS232/TTL transceiver; IC2 (CD4060) is the Baud rate generator and IC4 (CPD6402) is the UART. The card is connected to the RS232 interface via three lines: TX (transmit data), RX (receive data) and GND.

**CPD6402 UART**

The CPD6402 (Harris semiconductors) is a CMOS Universal Asynchronous Receiver/Transmitter for interfacing to asynchronous serial data channels. It has a programmable serial data format. It can have a length of 5, 6, 7, or 8 bits. The parity check can be odd, even or none. Stop bits can be 1, 1.5, or 2. The IC requires a power supply voltage of 4 to 10 volts. The quiescent supply current is 1.5 mA for a supply voltage of 5V.

The pin-out and the internal block diagram are shown in figure 7. Pin 21 is the Master Reset (MR), which should be at the logic low state in normal operations. Pins 35 through 39 control the serial data format. To enable the control pins, pin 34 (Control Register Load, CRL) must be at logic high. A high level on pin 35 (Parity Inhibit, PI) inhibits parity generation and check. It also forces the Parity Error (PE, pin 13) to stay low. When PI is low, a high level on Even Parity Enable (EPE, pin 39) selects even parity. A low level on EPE pin selects odd parity. Pin 36 (Stop Bit Select) high selects 1.5 stop bits for 5-character format and two stop bits for other data lengths. If it is low, one stop bit is selected. Pins 37 (Character Length Selected, CLS2) and 38 (CLS1) select the data length: CLS1=0, CLS2=0 for five bits; CLS1=1, CLS2=0 for 6; CLS1=0, CLS2=1 for seven bits and CLS1=1 and CLS2=1 for eight bits.

Pins 17 (Receiver Register Clock) and 40 (Transmitter Register Clock) are the clock inputs for the receiver and transmitter. The two inputs are driven by a clock which runs at 16 times the required Baud rate. They are normally connected together.

Pin 20 (Receiver Register Input, RRI) is the serial data input. The received data is stored in the receiver buffer registers which are accessed via pins 5 to 12 (Receiver Buffer Registers). Pin 4 (Receiver Register Disable, RRDI) should be low. When a datum is successfully received and loaded into the receiver buffer registers, pin 19 (Data Received) goes to high level. It can be set to low by making pin 18 (-Data Received Reset) low. This enables the UART to receive the new data. Pins 13 (Parity Error), 14 (Framing Error) and 15 (Overrun Error) give the status of errors occurring during a data transmission and they are all high active. To enable these status outputs, pin 16 (Status Flag Disable, SFD) should be low.

Pin 25 (Transmitter Register Output, TRO) is the serial data output. Data to be sent is written into the transmit buffer registers via pins 26 to 33 (Transmitter Buffer Registers). When pin 23 (-Transmitter Buffer Register Load, TBRL) goes low, the data is loaded into the transmitter buffer registers and when it goes from low to high, it loads the data into the transmitter register and initiates the serial data transmission. Pin 22 is Transmitter Buffer Register Empty. A high level on this indicates that transmitter buffer register has transferred data into the transmitter register and is ready for new data. Pin 24 is Transmitter Register Empty. A high level on this pin indicates the completion of a serial data.
transmission.

A receive timing sequence is shown in figure 8a. Data is received at the RRI input. When no data is being received, the RRI input must be high. At stage A, a low level on -DDR clears the DR line. At stage B, during the first stop bit of the transmission, the data is transferred from the receiver register to the transmitter buffer registers. An overrun error occurs when DR has not been cleared before the present character is transferred to the registers. At stage C, half a clock cycle after B, DR goes high, indicating that a new data is received. A logic high on FE indicates that an invalid stop bit has been received and a logic high on PE indicates a parity error. If the UART operates in a continuous mode, DDR can be pulled down to ground.

A transmit timing procedure is shown in figure 8b. At stage A, Data is loaded into the transmitter buffer register from the inputs TBR1 through TBR8 at the high-to-low transition on the -TBRL input. Valid data must appear on TBR1-TBRL before and after the rising edge of -TBRL. If the data bit length is less than 8, only the least significant bits are used. At stage B, the rising edge of -TBRL clears TBRE. After a short delay, data is transferred to the transmitter register and TRE is low. TBRE goes to a logic high showing that the transmit buffer registers are empty. Output data is clocked out by TRC. The clock rate is 16 times the data Baud. At stage C, -TBRL goes from high-to-low-then-high again. This loads the second data to the transmit buffer register. Data transfer to the transmitter register is delayed until the transmission of the current character is complete. At stage D, Data is automatically transferred to the transmitter registers and the transmission of the second data begins. In the present circuit, after the 6402 receives a valid data, DR goes high. The C9 is charged up and the output of the inverter, IC3, goes low. This resets the data receive register and enables the 6402 to receive new data. A low at -DRR also makes DR to become low. For transmitting data, -TBRL should be brought from low to high. -TBRL is programmable on the card using jumper wires. It can be connected to -DRR, OUT-0, OUT-1... OUT7 or other signal sources. If -TBRL is connected to -DRR, every time the 6402 receives a valid datum, it automatically transmits a byte. If it is connected to OUT-0, the 6402 will only transmit data if OUT-0 goes from high to low and to high again.

**Baud rate generator**

The clock signal to the UART is generated by a circuit around a CD4060 (IC2) and a 2.4575-MHz crystal. From pins 7, 5, 4 and 6 of IC2, clock signals at 153.6kHz, 76.8kHz, 38.4kHz and 19.2kHz are generated which set a Baud rate of 9600, 4800, 2400 and 1200 for the UART. The Baud rate is selected by a jumper selector J2.

**RS232 driver**

The conversion of the voltage levels between the RS232 and TTL is achieved by the MAX232CPD (IC1). This chip requires a single +5V power supply and can produce the right voltage level specified by the RS232 standard.

**Power supply**

The power supply incorporates a 7805 (1A, 5V) voltage supply.
the components on the PCB boards, a careful inspection of the component layout is given in figure 9. Before soldering of the power supply unit.

Connecting the power supply to the board, check again that some joins due to excessive use of solder and bad soldering are avoided. Soldering may then begin.

Components may be soldered onto the board in the following order: links, resistors, diodes, ic-sockets, capacitors, connectors, and so on. After soldering, another careful inspection must be carried out to check if there are some joints due to excessive use of solder and bad soldering points. Then ics can be inserted into the sockets. Before connecting the power supply to the board, check again that all the components are in the right place and the right orientation. This card does not require any adjustment, and should work straight away.

When making the connection from the Psion 3C serial cable to the I/O board, care must be taken to ensure the TX, RX and GND lines are connected correctly. Pin 2 and pin 3 of the D-type connector on the Psion 3C serial cable are TX and RX, respectively. Pin 5 is the ground. If the card is to be connected to the serial cable of an IBM PC, pin 2 and pin 3 are the RX and TX. Pin 5 is the ground.

The Psion 3C serial cable used for the I/O card can be constructed by you. You need a 15-pin PCMCIA cable assembly, which is available from CPC. The assembly has a PCMCIA connector which is inserted into Psion's RS232 port. A 9-pin female D-type plug is connected to the assembly at the other end. Although the cable has 15 cores, only three lines (RX, TX and GND) are connected to the D-type connector. The connection details of these three wires are given in figure 10. All handshake lines are left unconnected.

I/O programming using the Psion OPL

The Organiser Programming Language is a powerful Basic-like programming language: the program is fairly demanding to learn. There are about 260 keywords; on the other hand, the extensive instructions enable users to write sophisticated and professional window-driven programs quite easily. Details of the language are beyond the scope of this article, but they can be found in the programming manual of the Psion 3a.

The demo program listed below is a very simple program which allows user to type in a byte. Then the Psion 3C outputs the byte from the TX line of the RS232 port continuously. After each transmission, the Psion 3C reads data from the RS232 port and displays the data on the screen. Once the basic input and output through the RS232 port is realised, it is up to the reader's imagination to write programs for other applications.

regulator, which requires an 8-12V DC external power supply. The card consumes about 120mA. An 800mA fuse is used to limit the current usage by the external circuitry connected to the card. Figure 6 shows the circuit diagram of the power supply unit.

**Construction**

The I/O card is constructed on a single-sided PCB board. The component layout is given in figure 9. Before soldering the components on the PCB boards, a careful inspection of the PCB board must be excised to check if there are unwanted joints or cuts. Soldering may then begin. Components may be soldered onto the board in the following order: links, resistors, diodes, ic-sockets, capacitors, connectors, and so on. After soldering, another careful inspection must be carried out to check if there are some joins due to excessive use of solder and bad soldering points. Then ics can be inserted into the sockets. Before connecting the power supply to the board, check again that all the components are in the right place and the right orientation. This card does not require any adjustment, and should work straight away.

When making the connection from the Psion 3C serial cable to the I/O board, care must be taken to ensure the TX, RX and GND lines are connected correctly. Pin 2 and pin 3 of the D-type connector on the Psion 3C serial cable are TX and RX, respectively. Pin 5 is the ground. If the card is to be connected to the serial cable of an IBM PC, pin 2 and pin 3 are the RX and TX. Pin 5 is the ground.

The Psion 3C serial cable used for the I/O card can be constructed by you. You need a 15-pin PCMCIA cable assembly, which is available from CPC. The assembly has a PCMCIA connector which is inserted into Psion's RS232 port. A 9-pin female D-type plug is connected to the assembly at the other end. Although the cable has 15 cores, only three lines (RX, TX and GND) are connected to the D-type connector. The connection details of these three wires are given in figure 10. All handshake lines are left unconnected.

I/O programming using the Psion OPL

The Organiser Programming Language is a powerful Basic-like programming language: the program is fairly demanding to learn. There are about 260 keywords; on the other hand, the extensive instructions enable users to write sophisticated and professional window-driven programs quite easily. Details of the language are beyond the scope of this article, but they can be found in the programming manual of the Psion 3a.

The demo program listed below is a very simple program which allows user to type in a byte. Then the Psion 3C outputs the byte from the TX line of the RS232 port continuously. After each transmission, the Psion 3C reads data from the RS232 port and displays the data on the screen. Once the basic input and output through the RS232 port is realised, it is up to the reader's imagination to write programs for other applications.
Psion 3C OPL program list, RS232IOTEST:

PROC RS232IOTEST:
  REM PSION 3A OPL test program for RS232
  port and i/o port
  REM COPYRIGHT to Pei AN
  REM communication setting: None or
  Infrared
  REM define local variables to be used in
  the program
  LOCAL term&, baud%, parity%, data%
  LOCAL stop%, hand%, frame%, srchar%(6)
  LOCAL dl%, dummy%, err%, ret%, len%
  LOCAL outbyte%
  REM open the RS232 channel
  LOPEN "TTY:A"
  REM dedline RS232 configuration parameters
  REM RS232 setting: 9600, 8 bit, no parity, 1
  stop, no handshake
  baud%=15 : parity%=0 : data%=8
  stop%=1 : hand%=0 : term=&04002400
  frame%=data%-5
  IF stop%=2 : frame%=frame% OR 16 : ENDIF
  IF parity% : frame%=frame% OR 32 : ENDIF
  Srchar%(1)=baud% OR (baud% * 256)
  Srchar%(2)=frame% OR (parity% * 256)
  Srchar%(3)=(hand% AND 255) OR $1100
  Srchar%(4)=$13
  REM configure the RS232 port using the
  above parameters
  err%=IOW(-1,7,srchar%(1), dummy%)
  REM PSION output the outbyte% from the
  port
  REM PSION input data
  DO
    FONT 8,8
    PRINT "INPUT NEW DATA ", inputbyte%
    CLS
    PRINT "OUTPUT BYTE ", outbyte%
    DO
      LPRINT CHR$(outbyte%): REM
      output data from PSION
      len%=1
      REM number
      of data read =1
      ret%=IOW(-1,1,dl[percent],len%)
      REM input data. It
      only read 1 data
      REM and assign the data to dl%
      AT 1,3
      PRINT "INPUT BYTE ", d1%
      REM display d1% which is the data input to 3C
      via serial port
      UNTIL KEYS=CHR$(13)
      UNTIL outbyte%>=256
    END
**Video Surveillance**

Pinhole Board Camera (B&W) 12v DC, 0.1 LUX, 380 TV Resolution
Size: 35mm x 35mm £35.00

Pinhole Board Camera (Color) 12v DC, 0.5 LUX, 420 TV Resolution
2 board foldable
Size: 40mm x 40mm £190.00

Audio/Video Transmitter module
12v DC, 4 Channel Selection
500MHz-1200MHz, FM Modulation £120.00

4 Channel Receiver + Switcher
12v DC, Composite Audio/Video
TFT 4 Colour Monitor 12v DC £150.00

We also stock:
Time & Date Generator, Miniature PIR etc.

---

**Confidential Communications Limited**
344 Kilburn Lane, Maida Vale
London W9 3EF
Tel (44)(0) 181 968 0277 Fax: (44)(0) 181 968 0194
Email: 106075.276 @Compuserve.com

---

**osziFOX**
A universal 20 MHz storage oscilloscope
£75 inc

---

**CONTROL & ROBOTICS**
from Milford Instruments

---

**NEW**

---

**3-Axis Machine**

---

**JPG ELECTRONICS**

---

**ELECTRONICS TODAY INTERNATIONAL**
43
When reading data from the serial port, handl6 is -1 and function6 is 1. A terminator mask (term&8) may be supplied. This parameter allows users to specify one or more characters to be treated as terminating characters. The number of bytes to be received should be also specified. A reading terminates if a terminating character is received or if the number of bytes read is exactly the number of bytes requested. If term& is not supplied (that is, term&=0), the 3C terminates only if the number of bytes read into the 3C is exactly the number of bytes requested. In the present application, the input data is a binary data which could be any value from 0 to 255. The terminating character cannot therefore be used. The number of bytes to be received has to be set to 1. Consequently, the Psion 3C only reads one byte a time. Variable1 is the variable which stores the value of the byte read from the serial port. Variable2 is the number of data to be read. Every time, the command is issued, a byte is read from the serial port and is assigned to variable1. You could then process the data. In the above example, this data is displayed on the screen.

Testing
After soldering, check all the joints and connections to make sure there are no shorts due to excess solder. Do not connect the power supply to the card until you have checked thoroughly that the board is properly constructed. Since the card is simple to construct and involves no adjustment at all, it will work straight away if all the ICs are functional and properly located. To test the output of the ports, connect the card to the RS232 port of the Psion or PC via the RS232 cable and run the sample program. A logic probe can be used for testing the logic level of the outputs. If a logic generator is at hand, run the sample program. A logic probe can be used for testing the RS232 port of the Psion or PC via the RS232 cable and will work straight away if all the ICs are functional and properly located. Since the card is properly constructed, you can use the card for various PC interfacing applications using the powerful Psion 3C palmtop computers.

Applications
Constructing the card and writing a software driver will enable you to understand the RS232 port in depth. After construction, you can use the card for various PC interfacing applications using the powerful Psion 3C palmtop computers.

Eight digital outputs, eight digital input lines and a regulated +5V power supply (800mA) are all available from the I/O expansion socket, J6. A ribbon cable is used to connect the card to your application circuit. Some applications ideas are given below:

- For controlling laboratory experiments; a mobile heart beat monitor and analyser, for example.

Technical support
All components are available from RS Electromail or Maplin Electronics except the PCMCIA assembly which is available from CPC, Component House, Faraday Drive, Fullwood, Preston PR2 9PP, UK. Tel:44 1772 654455, stock no. CN00842. The Psion 3C serial cable and PsiiWin software package are available from Psion dealers. The PCB board is available from the author at a price of £9 and the ready-made Psion 3C serial cable for the I/O card is also available at a price of £16. A kit including all the parts is available from me. Please address enquiries to Dr. Pei An. 11 Sandpiper Drive, Stockport, Cheshire, SK3 8UL, U.K. Tel/Fax/Ans: +44 (0)1614779583, e-mail: pan@fs1.eng.man.ac.uk.

### PARTS LIST
For The RS232 I/O Card

#### Resistors
- (Metal film, 0.25W 1[percent])
  - R1: 4M7
  - R2: 1k
  - R3: 390R

#### Capacitors
- C1-C5: 22uF electro
- C6,10,11,12: 100µF ceramic disc
- C7,8: 22µF ceramic disc
- C9: 2n2 ceramic disc

#### Semiconductors
- IC1: MAX232CPE single voltage RS232 transceiver ic
- IC2: CD4060 binary counter
- IC3: 74LS14 Hex NOR gate ic
- IC4: CDP6402 UART
- IC5: 7805 +5V voltage regulator

#### Others
- Links 0.6 diameter copper wire or similar
- J1: 3-way PCB connector
- J2: 4-way dIL PCB pins
- J3,4,5: 2-way PCB connector
- J6: 20-way PCB dIL male connector
- J7: 11-way PCB sil socket
- J8: Fuse holder
- F1: 800mA fuse
- HS: Heat sinks for 7805 power regulator
  - XTR: 2.4575MHz crystal oscillator
  - Three-pin PCB connector to male D-type connector assembly
  - Psion 3C/Sienna serial cable

#### Optional
- LED Standard LEDs
- SW: Toggle switch
- SK: 2.5mm power socket

Maplin: PO Box 3, Rayleigh, Essex SS6 8L.
Tel 01702 554161.
(RS) Electromail: PO Box 33, Corby, Northants NN17 9EL.
Tel:01536 405555.
CPC, Component House, Faraday Drive, Fullwood, Preston PR2 9PP.
Tel 01772 654455.
An opportunity not to miss

Did you know that there is an organisation which has 30,000 research assistants at your disposal?

Members with creative ideas - they've done it - not just talked about it!

Valuable resource information including:
- EMC advice
- Propagation forecasting
- Technical data
- Recruitment adverts

Plus, a comprehensive list of specialist publications and much, much more!

As a member you would receive RadCom, the 100 page colour magazine delivered to your door every month.

Who are we?

Radio Society of Great Britain (Dept ET19) Lambda House Cranborne Road Potters Bar Herts EN6 3JE
Tel: 01707 659015 Fax: 01707 645105;
e-mail: sales@rsgb.org.uk

NATIONAL COLLEGE OF TECHNOLOGY
DISTANCE LEARNING COURSES in:
Analogue and Digital Electronic Circuits, Fibres & Opto-Electronics Programmable Logic Controllers Mechanics and Mechanisms Mathematics

- Courses to suit beginners and those wishing to update their knowledge and practical skills
- Courses are delivered as self-contained kits
- No travelling or college attendance
- Learning is at your own pace
- Courses may have BTEC Certification and Tutoring

For information contact:
NCT Enterprises
Barnfield Technology Centre
Enterprise Way, Luton LU3 4BU
Telephone 01582 569757 • Fax 01582 492928

CHELMER VALVE COMPANY
If you need Valves/Tubes or RF Power Transistors etc. ...then try us!
We have vast stocks, widespread sources and 35 years specialist experience in meeting our customers requirements.

Chelmer Valve Company, 130 New London Road, Chelmsford, Essex CM2 0RG, England.
Tel: 44-01245-355296/265865
Fax: 44-01245-490064

Tuned to the needs of the Radio Amateur
<table>
<thead>
<tr>
<th>Name and Issue of project</th>
<th>Unit Code</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETI Issue 3 1998</td>
<td>E/397/1</td>
<td>£5.09</td>
</tr>
<tr>
<td>Medium Wave Loop</td>
<td>E/398/1</td>
<td>£7.32</td>
</tr>
<tr>
<td>AA Cell Eliminator</td>
<td>E/398/2</td>
<td>£7.32</td>
</tr>
<tr>
<td>PIC Based Double Bass Tuner</td>
<td>E/398/3</td>
<td>£5.64</td>
</tr>
<tr>
<td>5 Range Capacitor Meter</td>
<td>E/398/4</td>
<td>£5.64</td>
</tr>
<tr>
<td>MIDI Drum Pads</td>
<td>E/398/5</td>
<td>£5.64</td>
</tr>
<tr>
<td>ETI Issue 2 1998</td>
<td>E/298/1</td>
<td>£5.09</td>
</tr>
<tr>
<td>Smartcam main board</td>
<td>E/298/2</td>
<td>£5.09</td>
</tr>
<tr>
<td>Smartcam opto-sensor board</td>
<td>E/298/3</td>
<td>£5.09</td>
</tr>
<tr>
<td>Both smartcam boards</td>
<td>E/298/1&amp;2</td>
<td>£7.00</td>
</tr>
<tr>
<td>Switched Mode Internal Power Supply</td>
<td>E/298/5</td>
<td>£7.97</td>
</tr>
<tr>
<td>Auto Cupboard Light</td>
<td>E/298/6</td>
<td>£5.04</td>
</tr>
<tr>
<td>ETI Issue 1 1998</td>
<td>E/0197/1</td>
<td>£8.99</td>
</tr>
<tr>
<td>Control Centre Desk-Top Unit</td>
<td>E/0197/2</td>
<td>£7.87</td>
</tr>
<tr>
<td>ETI Issue 13 1997</td>
<td>E/1397/1</td>
<td>£5.64</td>
</tr>
<tr>
<td>4-Go Rocket Launcher - main board</td>
<td>E/1397/2</td>
<td>£5.64</td>
</tr>
<tr>
<td>4-Go Rocket Launcher - relay board</td>
<td>E/1397/3</td>
<td>£5.64</td>
</tr>
<tr>
<td>Mighty Midget</td>
<td>E/1397/5</td>
<td>£5.64</td>
</tr>
<tr>
<td>PTI Issue 12 1997</td>
<td>E/2197/1</td>
<td>£5.22</td>
</tr>
<tr>
<td>PC Phonecard Reader: ITT Cannon only</td>
<td>E/2197/2</td>
<td>£5.22</td>
</tr>
<tr>
<td>Minute Minder</td>
<td>E/2197/3</td>
<td>£3.98</td>
</tr>
<tr>
<td>Medium Wave Receiver - RF board</td>
<td>E/2197/4</td>
<td>£11.76</td>
</tr>
<tr>
<td>Medium Wave Receiver - Tuning board</td>
<td>E/2197/5</td>
<td>£2.00</td>
</tr>
<tr>
<td>Medium Wave Receiver - Audio board</td>
<td>E/2197/6</td>
<td>£5.00</td>
</tr>
<tr>
<td>Medium Wave Receiver - PSU board</td>
<td>E/2197/7</td>
<td>£6.77</td>
</tr>
<tr>
<td>ETI Issue 11 1997</td>
<td>E/1197/1</td>
<td>£5.00</td>
</tr>
<tr>
<td>Total Harmonic Distortion Meter</td>
<td>E/1197/2</td>
<td>£5.00</td>
</tr>
<tr>
<td>Alphanumeric Morse Touchkey</td>
<td>E/1197/3</td>
<td>£5.00</td>
</tr>
<tr>
<td>ETI Issue 10 1997</td>
<td>E/1097/1</td>
<td>£5.64</td>
</tr>
<tr>
<td>The IQ Tester</td>
<td>E/1097/2</td>
<td>£5.00</td>
</tr>
<tr>
<td>DC Motors (Part 2)</td>
<td>E/1097/3</td>
<td>£5.77</td>
</tr>
<tr>
<td>Valve Tester - Main Board</td>
<td>E/1097/4</td>
<td>£5.64</td>
</tr>
<tr>
<td>Valve Tester - Socket Board</td>
<td>E/1097/5</td>
<td>£5.00</td>
</tr>
<tr>
<td>Valve Tester - Heater Regulator</td>
<td>E/1097/6</td>
<td>£5.00</td>
</tr>
<tr>
<td>All three Valve Tester boards</td>
<td>E/1097/4&amp;5&amp;6</td>
<td>£30.30</td>
</tr>
<tr>
<td>The IQ Tester (previously E/897/2)</td>
<td>E/1097/7</td>
<td>£5.64</td>
</tr>
<tr>
<td>ETI Issue 9 1997</td>
<td>E/997/1</td>
<td>£16.49</td>
</tr>
<tr>
<td>Eprom Emulator</td>
<td>E/997/2</td>
<td>£5.09</td>
</tr>
<tr>
<td>The Power Supply</td>
<td>E/997/3</td>
<td>£5.09</td>
</tr>
<tr>
<td>Electronic Door Chimes</td>
<td>E/997/4</td>
<td>£10.11</td>
</tr>
<tr>
<td>Digital Power Supply</td>
<td>E/997/5</td>
<td>£5.09</td>
</tr>
</tbody>
</table>

**Please supply:**

**Quantity** | **Project** | **Unit Order Code** | **Price** | **Total price**

Prices are inclusive of post and packing in the UK. Overseas Post and Packing (if applicable): Add £1 per unit.

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

I enclose payment of £ _____________ (cheque/PO/money order in £) sterling only) to:

PCB Service, READERS SERVICES DEPARTMENT, Nexus Special Interests Ltd., Nexus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST UK.

Signature: _______________________

Card expiry date: _______________
Medium Wave
LOOP AERIAL

Intended for the serious listener, Raymond Haigh's inexpensive unit will greatly improve reception on the medium wave band, especially under difficult conditions.

A loop aerial is a standard item for the serious medium wave listener. Although the design described here has been prepared with the "High Performance Medium Wave Receiver" (published in ETI 12 and 13 of 1997) very much in mind, it should work well with most receivers that have provision for the connection of an external aerial and earth. It will also greatly enhance the performance of portables with internal ferrite rod aerials.

Loop aerials have been used for medium wave reception since the early days of radio. They fell out of favour for domestic table sets during the 30s and 40s, but the introduction of ferrite materials at the close of the next decade enabled good signal pick-up to be achieved with a very small coil, and loop aerials wound on ferrite rods became standard fitments.

Basic design
The most important attribute of the loop aerial is its directional properties; in particular, its ability to null out an unwanted station or interference. This is not very pronounced in loops wound on ferrite rods because of the form and very small dimensions of the coil, and a larger, air-cored loop is required for serious medium wave listening.

Maximum signal pick-up is obtained when the plane of the loop is at right angles to the advancing wave. When the loop is parallel to the wave front, equal and opposing voltages are induced in the loop windings and the output is, in theory, zero.

It is this feature that enables it to null out a signal.

Figure 1 shows the response pattern of a loop aerial. The loop is viewed from the top or side, and it will be appreciated that the setting for a strong response to a signal is quite broad, but the null position is extremely sharp (in practice well within a degree of angular rotation).

Signal pick-up is directly proportional to loop area and the number of turns of wire wound on the loop. Number of turns is, of course, determined by the required frequency coverage, and care must be taken to keep the self-capacitance of the winding as low as possible or the tuning range will be excessively curtailed at the HF end of the band. A widely published loop design consists of six or seven turns of wire, wound to a 10mm pitch on a 1-metre square frame, and tuned by a 500pF variable capacitor.

An aspect of loop design seldom touched upon is the need for it to tilt as well as rotate in order to obtain the deepest...
The loop aerial from the front showing the loop and PCB assembled

The PCB and switch assembly in the aerial

Detail of the tuning pots mounted on the case

Figure 2: a theoretical circuit of the ‘Q’ multiplier

The sheer size of the standard 1-metre square loop militates against dual pivoting. Loops as large as this are certainly inconvenient to handle and rather out of place in a domestic setting.

Windings can be arranged solenoid fashion or spirally, and it is claimed that the optimum width-to-diameter ratio of the latter improves directivity. In practice, however, little or no difference can be discerned between the two types. What is crucial is the symmetry of the windings (there must be a whole number of turns) if the nulling properties of the device are to be realised.

Traditionally, loops are connected to the aerial and earth terminals of the receiver via a single turn coupling winding and a short length of twisted flex or coaxial cable. This results in an imperfect match to the 50 ohm input impedance of modern communications receivers, particularly when a large loop with a main winding of only six turns is involved. Field effect transistors, configured in a differential amplifier circuit, are sometimes used to make the energy transfer more efficient. While some designers claim that this
arrangement enhances the directional properties of the loop, others advise against the inclusion of active devices in the signal path between loop and receiver, suggesting that cross modulation and other spurious response problems can arise.

There is usually no wired connection between a loop and a transistor portable, the transfer of energy relying upon inductive coupling with the receiver's internal ferrite rod aerial.

**Design details**

Consideration of the above factors, and experiments with loops and associated circuits of various kinds, culminated in the design described here. At 380mm diameter, this loop is easy to handle and reasonably compact, and provision is made for tilting. Although signal amplifiers have been avoided, the inclusion of a 'Q' multiplier circuit makes it possible to increase the signal output from the unit to a level where it is comparable to that of a much larger loop. Increasing 'Q' enhances selectivity as well as sensitivity, and the reduction in bandwidth cuts the amount of atmospheric and man-made noise reaching the receiver (the wider the window is opened the more the dirt flies in). This feature is extremely useful in resolving weak signals under difficult conditions.

**The circuit.**

The circuit of the unit is given in Figure 2. The eighteen-turn

---

**Figure 3: the dimensions of the loop aerial**

Detail of the stand showing the circular protractor and a hardboard pointer disc at the base
The stand before the rotating column, aerial case and counterweight are mounted main winding, L1, is tuned by variable capacitor C2. An integral trimmer, C1, sets the upper limit on the HF coverage. Field effect transistor Q1 buffers the signal voltage across the resonant circuit and feeds a portion back, in phase, via the single-turn feedback winding L3. This positive feedback, or regeneration, enhances the 'Q' of the tuned circuit and signal magnification and selectivity are very considerably increased. Full control over the amount of feedback, from zero to the point of oscillation, is provided by potentiometer R3, which varies the voltage on the drain of Q1. Smoothing capacitor C5 eliminates potentiometer noise.

A low value coupling capacitor C3, together with C4 and R2, ensure that the action of the 'Q' control is smooth and completely free from backlash. The value of C4 has been determined experimentally to ensure that its setting is as constant as possible over the full swing of the tuning capacitor. R2 is pre-set to suit the characteristics of the particular FET used, and its adjustment is not critical.

Equipment of this kind can be inadvertently left switched on, and low-current LED, D1, makes use of the current flowing through the 'Q' control potentiometer chain to provide a visual indication. Series resistor R4 sets the voltage across the potentiometer. On/off switch S1 controls the 9V supply.

The loop and associated circuitry are completely 'floating'. Connection to the receiver is via the single turn coupling loop L2.

Components
The only item requiring comment is the tuning capacitor. A component with a low minimum capacitance (not more than 10pF) and a maximum capacitance of at least 365pF is needed to secure full coverage of the medium wave band. An inexpensive Toko polyvaricon solid dielectric variable is fitted in the prototype unit. With one of its FM and one of its AM gangs connected in parallel, a 10 to 365pF swing is achieved. Trimmer capacitor C1 is integral with this unit, which is retailed by Cirkit, who supply a suitable extender for the short spindle.

Front-end 'Q' multiplying circuits can be microphonic when critically adjusted, and the solid dielectric in the Toko capacitor inhibits this tendency. (The prototype unit did not display any problems of this kind.)

The remaining components and construction materials are widely available.

Construction
Details of the loop are given in Figure 3 and the photographs. A 380-mm diameter hardboard or MDF disc supports the windings. Cut 33 radial slots, each 25mm deep, around the circumference to accommodate L1. (The slots are spaced a trifle less than 11 degrees, and 'tight' setting out to this angle should result in even spacing).

Drill 1-mm diameter anchor holes at the top and bottom of one of the slots, and wind on 18 turns of 22 SWG enamelled copper wire, weaving it 'in and out' of the slots, basket fashion. Keep the turns tight and space them as evenly as possible. This form of winding is necessary in order to separate the turns and reduce the self-capacity of the coil, and an odd number of slots must be cut to produce the basket-weave effect.

Draw an inner concentric circle, 70mm in diameter, and drill twelve, 1-mm diameter holes around its circumference. Thread 22 SWG enamelled wire 'in and out' of these holes to produce the coupling winding L2.

Draw a 130-mm diameter circle, drill eighteen 1-mm diameter holes and repeat the process to produce feedback winding L3.

Drill a 6-mm diameter hole for the output leads, close to the ends of L2, and mount a three-way tag strip over it. Solder the ends of L2 to the outer tags.

Spacing the turns of L1
The upper frequency limit of the medium wave band is usually taken as 1600kHz. However, in Europe, Africa and the near and Middle East, transmissions extend up to 1620kHz. Australia boasts low powered transmitters working at 1720kHz, and stations in the USA have, fairly recently, begun to operate at frequencies up to 1700kHz. In the UK, cordless 'phones use channels between 1600 and 1700kHz.

Notwithstanding the possibility of interference from this allocation, it is clearly desirable to extend loop coverage up to 1700kHz.

This can only be achieved by carefully spacing the turns of L1 in order to reduce the self capacity of the winding. Using the tip of a small screwdriver, ease the winding segments on both sides of the disc apart, and take care to ensure that adjacent turns don't touch where they cross in the slots. Half an hour spent on this task increased the HF coverage of the prototype coil from 1600 to 1750kHz.

Apply ribbons of Durofix or some similar general-purpose tube glue across the turns to keep them in place.

The 'Q' multiplier.
The only item requiring comment is the tuning capacitor. A component with a low minimum capacitance (not more than 10pF) and a maximum capacitance of at least 365pF is needed to secure full coverage of the medium wave band. An inexpensive Toko polyvaricon solid dielectric variable is fitted in the prototype unit. With one of its FM and one of its AM gangs connected in parallel, a 10 to 365pF swing is achieved. Trimmer capacitor C1 is integral with this unit, which is retailed by Cirkit, who supply a suitable extender for the short spindle.

Front-end 'Q' multiplying circuits can be microphonic when critically adjusted, and the solid dielectric in the Toko capacitor inhibits this tendency. (The prototype unit did not display any problems of this kind.)

The remaining components and construction materials are widely available.
**Resistors**

All 0.25 watt, 5 percent or better

R1 2M2
R2 1k linear preset
R3 2k linear potentiometer
R4 1k2

**Capacitors**

C1, C2 Toko polythene dielectric variable with integral trimmer (see text).
C3 2p2 ceramic
C4 150p ceramic
C5 1u radial electrolytic

**Semiconductors**

Q1 2N3819 field effect transistor
D1 Low current (2mA) LED

**Miscellaneous**

100g reel of 22 SWG enamelled copper wire for the loop windings, PCB materials, Vero pins, hook-up wire, and screened twin cable. LED holder and battery connector. PP3 battery. Toggle switch. Spindle extender for tuning capacitor, spindle coupler, 50mm of 6.3mm plastic spindle and reduction drive. Two control knobs. Three-way tag strip. Hardboard or medium density fibreboard, plywood and blockboard for loop former, case and stand. Length of 25-mm dowel or broom handle. One large circular and one small semicircular protractor. Glue, screws, pins, bolts, nuts, wing nuts, washers and finishing materials.

**Initial testing**

Loop and 'Q' multiplier can be tested before being mounted on a stand. Check the PCB for bridged tracks and poor soldered joints, and check the orientation of D1, TR1, C1 and C2, and C5. If all is in order, set R2 to half-travel and connect up a fresh 9V battery. Current consumption should be around 3mA.

Connect the loop to the PCB and prop it in a vertical position. Connect L2 to the receiver with a short length of twisted flex (not much more than 1 metre), and tune the receiver to a station around the centre of the dial. Set C2 to resonate the loop at the same frequency.

Switch on the 'Q' multiplier and advance R3. The increasing selectivity will expose any inaccuracies in the setting of the tuning capacitor, and it may have to be adjusted slightly to peak the output from the loop. Gently advance R3. If the transmission is reasonably strong, the 'S' meter pointer should be moving across the scale now. Band noise should reduce, then the upper audio frequencies will disappear and, finally, the audio will become muffled just before the onset of oscillation.

Set R2 to the highest possible resistance consistent with 'Q' control R3 being able to just bring the system into oscillation at any setting of the tuning capacitor. Six different specimens of 2N3819 were tried in the prototype. All enhanced the 'Q', but one failed to oscillate with the component values shown. If advancing R3 produces no increase in loop output, check that L3 has been connected, as shown, to inject positive feedback.

**Tuning and hand-capacitance**

The initial test will reveal that loop tuning is critical when the 'Q' multiplier control is well advanced, and the tuning capacitor must be fitted with a reduction drive. Most loop aerials are prone to hand-capacity effects, but this unit is comparatively free from problems of this kind. An insulated extension (40mm waste cut from a plastic potentiometer shaft), fitted to the tuning capacitor, almost eliminates the effect, even when 'Q' is

---

Figure 4: the component layout of the PCB, and the offboard wiring

---

**Electronics Today International**
The aerial mounting used on the prototype, showing the angle adjustment and the counterweight

The aerial mounting used on the prototype, showing the angle adjustment and the counterweight

Figure 5: a side view of the aerial assembly, with dimensions

set high. Any residual traces when the loop is tuned to the HF end of the band can be eliminated by earthing the metal reduction drive and the case of the 'Q' control potentiometer.

NB: no other parts of the loop or its circuitry should be earthed, or its performance will be impaired. The centre contact on the lead-out tag strip can be used to anchor the earth wire, and the earth connection made via the screening braid of the cable between loop and receiver.

Simple loop mountings

The loop cannot be used without an adjustable mounting. The method adopted will depend on the time and resources of individual constructors. It need not be complicated. A 50 x 50-mm softwood post, screwed to a 250 x 250-mm blockboard or chipboard base, and free to rotate, will act as a vertical pivot. The loop disc can be attached to the top of this post by a stiff hinge to provide a means of tilting it.

The 'Q' multiplier PCB, the various controls, and the battery must be mounted as close as possible to the loop and be rigidly fixed to it. A metal or plastic box could be used to house these parts, and it could be slung just beneath the loop on plastic or wooden battens. If a metal case is used, it should be earthed.

This basic arrangement was adopted for the initial testing, and it worked tolerably well. It soon became clear, however, that in order to make the most of the loop's potential, and maximise the pleasure of using it, a more elegant mounting is required.

Case construction

Figures 3, 5 and 6, and the photographs, show how the prototype loop is housed and mounted. A little more time and effort (but very little cash) will be required to duplicate these arrangements, and no doubt individual constructors will have some excellent ideas for improving on them. Bearing in mind that the only comparable commercial loop (which is somewhat smaller than this unit) retails in the UK for around £350, the extra time and effort spent on these refinements is worthwhile.

The loop case

The loop case consists of a hardboard tray with 35-mm deep plywood sides. Back and sides are glued and pinned together: the front is held in place by screws to facilitate access. Softwood blocks permit the rounding of the corners, and the lower end is extended and tapered to accommodate the PCB and controls.

The loop is spaced off the back of the case by four softwood blocks, 15-mm thick, and a compartment for the battery is accessed from the rear.

Because the loop sometimes has to be rotated away from the operator, the controls are best brought out through the lower end of the case rather than the front. Arranged in this way they can be operated fairly easily with the loop in any position. Dials are useful rather than essential. On the prototype, these were made from thick discs of ply cut out with an electric drill-powered hole-saw. Lids from small tins or jars would probably serve just as well.

The stand

The vertical pivot needs to be elevated if the loop is to rotate smoothly and without judder. It is formed at the top of a length of 25-mm dowel or broom handle, which is glued into a substantial base. A plywood box column is pivoted on, and rotates around, the dowel. Use a bolt for the top pivot, and form the hole for the bottom bearing around the dowel with the hole saw. (This tool can also be used to form the dowel hole in the base.)

Some form of counterbalancing is required for the loop case, and a horizontal arm, comprising another box member, carries the
loop at one end and a counterweight at the other. Two bolts pivot the arm at the top of the column, and wing nuts control the friction of these bearings. Tapered battens strengthen the fixing between the arm and the back of the loop case. A burnt out mains transformer or a tin filled with scrap lead will act as a counterweight. (An old iron ball was used in the prototype. Located at a distance of 300mm, the mass of metal did not affect the performance of the loop.)

Some means of measuring the horizontal and vertical position of the loop is helpful. Fix a circular protractor to the base and a hardboard pointer disc to the underside of the rotating column. There must, of course, be a millimetre or so clearance between protractor and pointer disc. Fine adjustment of the clearance can be made by placing washers on the top pivot bolt. If the centre of the protractor is drilled or cut so that it can rotate around the dowel or another hardboard disc, it can be set with 0 degrees pointing north to make bearing calculations easier.

Cut a semicircular protractor into two quadrants and sandwich a slip of paper between the pieces to produce a readable means of measuring the tilt angle. This is fixed at the rounded top of the rotating column, and a pointer is secured to the horizontal arm.

Plywood for the column, arm, and battens should be at least 9mm thick, and parts should be glued and screwed, or glued and pinned, together.

**Finishing the case**

The loop case, plywood dials and hardboard pointer disc were sprayed satin black with car paint. The stand parts were stained and French polished, but a few coats of clear satin varnish would have served just as well. The tuning dial is best calibrated, after the final setting up process, by matching it to the receiver dial. Rubdown transfers were used to annotate the dial and form the pointers.

**Connecting the loop**

For best results, link the loop to the receiver by means of twin screened cable. The cable’s inner cores connect the ends of the coupling coil L2 to the floating input on the ‘High Performance Medium Wave Receiver’, or to the aerial and earth terminals on other receivers. The outer screen is connected to earth at the receiver.

The loop has been checked out on a high performance communications receiver with an unbalanced 500hm input, and it worked well. Damping caused by the low input impedance did not inhibit the operation of the ‘Q’ multiplier. Experiments with impedance matching transformers wound on dust iron toroids did not reveal any discernible improvement over the direct connection of the coupling loop.

Portable receivers should be placed in close proximity to the loop with the coils on their internal ferrite rods parallel to it. Small portableies can be rested inside the counterbalance arm.

**Using the aerial**

Loop tuning must, of course, be kept in step with main receiver tuning, and the ‘Q’ multiplier control is best switched off while band browsing in order leave selectivity as wide as possible. When using the loop, always switch any aerial attenuators out of circuit.

It will be found that perfect nulls cannot be obtained on all signals (the BBC and commercial operators transmit the same programme material, on the same frequency, from a number of locations). Careful adjustment of the horizontal and vertical bearings of the loop will, however, usually result in a deep null when the signal is being received from a single source, and the drop of the ‘S’ meter pointer will be sudden and pronounced.

Local electrical interference and interference from different stations on the same or adjacent channels can usually be nulled out, and this is the loop’s main virtue. Sometimes, nulling out a strong signal will reveal a more distant station operating on the same frequency.

Selectivity is greatly increased by advancing the ‘Q’ multiplier control, and bandwidth can be reduced to the point where the signal loses intelligibility. A slight shifting of loop tuning then enables clear reception to be obtained from one or other of the transmitted side bands. This sometimes improves reception under difficult conditions. Reducing bandwidth also improves the signal-to-noise ratio.

Signal magnification, that is, loop output, is greatly increased when the ‘Q’ control is advanced, and weak signals can be lifted right out of the noise. When a station has been accurately tuned in, operation of the ‘Q’ multiplier control is extremely smooth, completely free from back lash, and has no perceptible effect on the setting of the tuning control.

Both ‘Q’ is turned up, the loop will pull the tuning of portable and simple receivers (that is, the loop, not the receiver, will determine), within narrow limits, what station is received). Don’t operate the loop in close proximity to computers, television receivers, fluorescent lights and other sources of radio interference. In this connection, it should be noted that the digital circuits driving the frequency displays of some communications receivers can radiate quite strong interference. (The internal circuits of the receiver are appropriately screened.) Bringing the front panel of the receiver close to the loop will expose any problems of this kind. Sometimes the arrangement of house wiring and metal conduits in the vicinity of the loop will impair its nulling properties. If this is suspected, try the loop in another room or, better, in the garden.

A compass to set the bearing protractor and conventional and great circle maps will assist in seeking out and identifying stations.
Bargraph Module

Terry Balbirnie continues a series of adaptable circuits for GCSE projects with a voltage-sensitive Bargraph module based on the LM3914 display driver

In this series we are describing some electronic modules that will be useful to students of GCSE Technology and those following similar courses at school or college. The circuits may be used as a basis for practical projects.

All the designs are given as a circuit diagram and a stripboard (Veroboard) layout. Details such as what the circuit is to be used for and how it will be built into a box are left for you to apply to your needs.

**Drawing a graph**

This month we shall describe a Bargraph module. This responds to a voltage applied to its input, and lights up one of a row of LEDs according to the value of this voltage. The sensitivity is adjustable using a preset potentiometer on the circuit panel. The most sensitive setting is 0.125V per LED - that is, it requires 0.125V to light the first one, 0.25V for the second and so on up to 1.25V for the last. With the component values stated, the least sensitive setting corresponds to about 3V per LED - that is, the first one operating at 3V and the last one at 30V.

The display used in the prototype was a commercial package consisting of ten LEDs arranged in the form of horizontal bars, so that a small voltage will light up the first bar and increasing voltages will light up successive ones. It would also be possible to use separate LEDs. This would involve a lot more building work, but it would have the advantage that different colours could be used, so that the first LEDs to light could be green, followed by yellow, orange and red (for example).

The finished circuit could be used to indicate the output voltage of a power supply unit. It could also be used to check the voltage of a car-type battery to give an indication of its state of charge. It could also determine the state of standard throwaway batteries and nickel-cadmium cells. A further use would be to display sound levels by connecting the input to the headphone socket of a personal stereo. The circuit will respond to absolute voltage levels.

A novel use for the circuit would be to sense position or movement by using the object to rotate the sliding contact of a potentiometer which would vary the voltage applied to the input. In that case, you would need to obtain the supply for the potentiometer from a voltage regulator, because the circuit responds to absolute voltage levels.

**The circuit**

The circuit for the Bargraph module is shown in figure 1. The device requires a supply of its own, and any battery having an output of between about 6V and 9V will be found to work well. Diode D1 provides protection to the circuit if the battery were to be connected with the wrong polarity, as it would then not conduct and no current would flow.

The circuit centres on IC1, an LM3914 bargraph driver IC. This is a complex device which contains a set of ten op-amps connected as voltage comparators. The inputting inputs are all connected together and receive a voltage from the external source applied to pin 5. The non-inverting inputs are connected to a resistor chain. The top end of this is connected to a precision on-chip 1.25V reference. The chain of resistors provide a set of potential dividers which apply fractions of the reference voltage to each of the ten op-amp non-inverting inputs. These fractions increase in 0.125V steps. With no voltage applied to pin 5, all non-inverting inputs are at zero voltage, so all the op-amps will be on. As the voltage applied to pin 5 increases form zero to, say, 1.3V, the non-inverting input voltage of each op-amp will exceed the voltage applied to its non-inverting input and the output will switch off. This will allow current to sink through the LED connected to it. This will happen at 0.125V, 0.25V, 0.375V etc. up to the reference value of 1.25V.

Pin 9 is the "mode pin". If it is left unconnected as shown, the display will be in "dot" mode. This means that as each successive LED bar lights up, the one before it will go out. In fact, there is a small crossover where two bars may be on at the same time.

By connecting pin 9 to supply positive, the display will enter "bar" mode. Here, the display will look rather like a thermometer. As each successive bar lights up, those before it will remain on. Although other approaches are interesting and possibly a subject for experiment, using a practical circuit in dot mode is strongly advised because it has certain advantages. The most important is that only the current for one LED is drawn from the supply at any time. If bar mode were used, with all ten bars lit, the current requirement would be considerable.
and this would quickly drain the battery. A further point is that the power required for this could exceed the limit of IC1 (about 600mW) and it could be destroyed.

The circuit would not be very versatile if the input voltage had to lie within the "basic" range set by IC1, that is, 0.125V to 1.25V. Preset potentiometer RV1 is therefore used to scale down the input voltage so that, with any voltage within range, it will apply the basic voltage to pin 5.

Construction
The topside stripboard layout (component side view) is shown in figure 2. As shown, the LEDs will light from the top. It will need to be turned upside down if the bars are to progress from the bottom.

There are a large number of inter-strip links and a few track breaks needed in this circuit. Begin with the track breaks then solder the link wires in place. If the circuit does not work, it is almost certainly due to a strip not being properly broken, a break or link wire being left out or a blob of solder or particle of copper bridging adjacent copper tracks. Note how all strips to the right-hand side of IC2 (pins 11 to 20) are connected together and taken to the positive supply rail. This is done by soldering a piece of connecting wire on the copper strip side of the circuit panel as shown in the diagram.

Solder the ic sockets and all other components in position. Take care to mount diode D1 with the correct orientation. Solder battery connectors to the "+9V" and one of the "0V" points. Solder short pieces of wire to the "+Vin" and the other "0V" point. Adjust RV1 to approximately mid-track position, which will give medium sensitivity to start with.

Insert IC1, taking care over its orientation. This is a CMOS device and could be damaged by static charge on the body. To make sure this does not happen, touch something which is earthed - such as a water tap - before handling the pins. Insert the LED display (this is labelled IC2, although it only contains an array of LEDs). It seems that the only simple way of identifying which way round this should be placed is to look at the lettering on the side. This should be placed to the right. If the circuit does not work at the end, it may be that it is the wrong way round.
Capacitors C1 and C2 promote stability. They bypass the small amount of alternating current which could be induced in the wiring and this could cause several LED bars to flicker on at the same time.

**Testing**

Connect a 6V or 9V battery. Apply a 9V battery to the "Vin" wire (positive) and the inner 0V wire (negative). If the wires are connected the wrong way round, nothing will happen. You should see one of the bars light up. By adjusting RV1, it should be possible to make others do so. If more than two bars are lit at the same time, try increasing the value of C1, C2 or both.

The input is protected and no harm will result if the voltage being measured is either connected in the wrong sense or is too high. An applied voltage above the range will simply keep the tenth bar operating.

Resistor R3 determines the brightness of the LEDs, and this will hardly vary with changes in supply voltage. The value stated should work well.

**Sensitivity adjustment**

With RV1 sliding contact turned fully anti-clockwise (as viewed from the left-hand edge of the circuit panel), the circuit will be as sensitive as IC1 will allow - that is, 0.125V per bar. Here, the input voltage is effectively connected direct to pin 5 via resistor R2. This resistor normally has virtually no effect. However, if an excessive voltage were to be applied to pin 5, it would limit the current entering pin 5 and no harm would result up to a few tens of volts. With RV1 sliding contact rotated, a potential divider is formed which effectively scales down the voltage applied to pin 5. RV1 does not behave in a linear way but, with the values shown and with maximum rotation the sensitivity of the prototype was 3V per LED.

---

**ETI Electronics Today International**

**DSP Comms Chip Requires Fewer Support ICs**

The DSP16000 from Lucent Technologies Microelectronics Group is a new-generation digital signal processing core for applications such as cellular telephones, multi-channel modems and, in the case of the first device, the DSP16210, wireless base stations. The 16210, which has a large on-chip RAM and so requires no external memory, is expected to lower the cost of wireless base stations by reducing the number of chips required in future base stations.

Features of the DSP16000 core include dual 32-bit access in one cycle, dual MAC in one cycle and mixed signal 16/32-bit ISA (instruction set architecture) for high performance with reduced code size. The core also has a system cache for ultra low power, extensive support for high-level languages, and is source code backwards-compatible with the Lucent DSP1600 range of comms DSPs. The core includes a dual MAC architecture, 62k x 16 SRAM, DMA on the host port (PHIP) and serial port (SIO). The peripheral mix includes DMA I/O and direct connection to E1, T1 and TDMA interfaces common in infrastructure architectures. The DSP16000 gives sufficient performance at 2.7V, say Lucent, to implement at least four complex speech coders, such as GSM, HR or EFR, and many channels of error correction, equalisation or modems such as V.34.

Lucent Technologies designs, builds and delivers public and private networks, comms systems and software, consumer and business telephone systems and microelectronic components. The R&D arm of the company is Bell Laboratories.

For more information contact the Lucent Technologies Dateline at Tel 0118 932 4299 Fax 0118 932 8148 or Simon Cosgrove, Lucent Technologies Microelectronics Group, Microelectronics House, Broad Lane, Bracknell, Berks RG12 9Gx. Tel 01344 865910 Fax 01344 865923. Web www.lucent.com/micro.
Here is a die that shows all the expected faces, from 1 to 6, but does not have the irritating habit of rolling off the table and under the sofa just as the game is getting exciting. The die consists of a square black box bearing seven red ‘dots’ (actually LEDs). When battery power is supplied, the display of dots repeatedly cycles through all the conventional dot patterns, but runs so quickly that you have no time to recognise them. When the button is pressed the display halts at one of the numbers. Release the button and off it goes again.

How it works

The display is driven by a counter (IC1 in figure 2), which has a built-in oscillator. The counter has 14 stages but we use the outputs from only three of these, stages 5, 6 and 7. With the given resistor and capacitor values, the outputs of these stages cycle through the binary states 0 (000) to 5 (101) at just about the right rate to make the display impossible to follow. The next part of the circuit consists of logic gates connected so as to light up the appropriate LEDs at each state. What we need to do is set out in the following table; figure 2 (the stripboard layout) shows the numbering of the LEDs:

<table>
<thead>
<tr>
<th>Decimal State</th>
<th>Binary State (CBA)</th>
<th>Display value</th>
<th>LEDs to be lit up</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>000</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>001</td>
<td>2</td>
<td>1, 7</td>
</tr>
<tr>
<td>2</td>
<td>010</td>
<td>3</td>
<td>1, 4, 7</td>
</tr>
<tr>
<td>3</td>
<td>011</td>
<td>4</td>
<td>1, 2, 6, 7</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>5</td>
<td>1, 2, 4, 6, 7</td>
</tr>
<tr>
<td>5</td>
<td>101</td>
<td>6</td>
<td>1, 2, 3, 5, 6, 7</td>
</tr>
</tbody>
</table>

Reset to 1

All the logic is done with two types of gate. The NAND gates (IC2) give a low output (1) when and only when both of their inputs are high. The NOR gates (IC3) give a high output when and only when both of their inputs are low. The function of the buffer gates (IC4) is to provide enough current to drive the LEDs. Because these are inverting buffers, they need a low input to turn the LEDs on.

The table shows that LEDs 1
and 7 always come on together, so we can control these from a single buffer. The same applies to LEDs 2 and 6, and LEDs 3 and 5. LED 4 operates on its own. The table shows that LED 4 is to be on when digit A is low. This makes the logic very simple; the buffer for LED4 (4b) is connected directly to the A logic line.

LEDs 3 and 5 are slightly more complicated. They are to be on only at state 5. This state is distinguished by the fact that A and C are both high during this state, but not in any other state. 'Both high' implies using a NAND gate (2c). When A and C are both high, the output of 2c goes low; this logic low is fed to the buffer (4c), turning on LEDs 3 and 5.

LEDs 2 and 6 need even more elaborate logic. They are to be on for states 3 to 5, that is when A AND B are high OR when C is high. Gate 2d takes care of the A AND B logic, except that its output is low when this state occurs. We use gate 2g with its inputs wired together to act as an INVERT (or NOT) gate and turn this low into a high. Then we use gate 3c to OR this with the state of C, to give a low when (A AND B) OR C occurs. The low supplied to buffer 4a turns on LEDs 2 and 6.

LEDs 1 and 7 must be on when all outputs are low. To make use of the gates available, we take the opposite viewpoint and say that they must be on when A OR B OR C are high. Gate B looks for high B OR C and goes low when this happens. Gate 3d changes this to a high. Gate 3a goes low when it receives a high from gate 3d OR a high directly from A. The resulting low, arriving at buffer 4d, turns on the LEDs.

If we let the counter continue beyond stage 5 it goes through stages 6 and 7 giving us an extra 5 or 6 in each cycle. The die is loaded! To prevent this, we reset the counter immediately it goes into stage 6, as soon as both digits B and C are high. We detect this with the fourth NAND gate (2a), and use a buffer (4f) to invert its low output to give a high pulse to reset the counter.

Construction
The circuit is most conveniently assembled on a single piece of stripboard with the display at one end (figure 3). But you can adapt the design to put the display on a separate board. You can use larger, jumbo-sized LEDs, but we preferred 'dot' LEDs, which are cylindrical and 3mm in diameter. The circuit is powered from a 9V battery, such as 6 AA cells in a battery box or a 9V PP3 battery. It also runs at 6V, in which case you need to reduce the value of R3 - R6 to 270 ohms.

Begin with IC1, its associated resistors and capacitor and the push-button S1. Leave a few millimetres of the leads of C1 showing above the board, to make it easier to connect another capacitor in parallel with C1 when testing (see below). Note that some of the copper strips are NOT cut beneath the ics (though they are all cut beneath IC1) or between one IC and its neighbours. This helps reduce the number of wired connections required. Also note that we have used solder blobs in some places, to make connections between adjacent copper strips. The best technique is to build up a large blob on each side of the intended join, then let the blobs cool. Finally
touch the soldering iron to both blobs simultaneously and apply a little solder across the gap.

When IC1 is assembled, temporarily connect pin 12 (reset) to ground and use a testmeter or digital probe (from an upcoming Fast Fiver, for instance) to check that the oscillator is working at a suitable rate. You should see the meter needle (yes, an old-fashioned analogue meter or a digital meter with analogue display is best for this kind of testing) flickering rapidly on all pins 4 to 6.

Next assemble IC1 and IC2, including the inter-pin blobs at F34/G34 on IC2 and at E29/F29 on IC3. Remember that the pinout of the four gates in the 74HC02 is entirely different from that in the 74HC00, so check back to the pin numbering in figure 1. IC4 comes next; gate 4e is a spare and, in order not to leave it with its input floating, it is connected to the output of gate 4c by means of the copper strip left uncut at H19.

At this stage you could use a testmeter or digital probe to confirm that everything is working properly. It helps to connect a larger-value capacitor (for example, a 10 microfarad electrolytic) in parallel with C1 to slow down the rate of cycling. Or you may prefer to carry on and complete the wiring of the resistors and LEDs before testing. A heat shunt is strongly recommended when soldering the LEDs. Unfortunately, not all manufacturers keep to a standard way of indicating which wire is the anode and which is the cathode. Before you begin to solder in the LEDs, test one with a 1.5V cell or with a higher voltage and a series resistor (9V and 470 ohms) to see which way round they should go.

The appearance of the display is improved by fitting a small square box around the LEDs, to make them look like the dots of a typical die. When all is ready, connect the battery and watch the LEDs flicker. To 'shake' the die, press and hold S1. There is no way of telling what stage the counter is at when the button is pressed so the 'throw' is in effect random.
Keeping musical instruments in tune is an everyday task for musicians, so a simple tuning device is a welcome addition to their music bag. Commercial tuners usually have a visual indication of correct tuning - either a row of LEDs or an analogue meter is used to indicate pitch offset. These are electronically very convenient, but most musicians are more accustomed to tuning to a reference sound. For example, orchestras often tune to the first oboe, chamber groups to the keyboard instrument (a harpsichord, for example), if present, and string groups agree among themselves to tune up to one of their string instruments. So tuning by ear is a skill needed by both professional and novice musicians.

The simple tuner described in this article helps the aural tuning process by generating the correct tones for - in this particular model - a double bass. To make the tuner as simple and as accurate as possible, a PIC microcontroller is used to do all the waveform timing. Using a microcontroller reduces the complexity of the project compared with a hard-wired logic design, and the microcontroller has features useful in battery-powered equipment, such as hibernation, that dedicated keyboard synthesiser chips lack.

One of the troublesome aspects of a double bass tuner is the need to reproduce very low notes. The lowest frequency needed is that of the E strong, at 82.4 Hz. Such a low frequency is not efficiently handled by the size of loudspeaker, up to around 50 mm in diameter, normally acceptable in a portable tuner, so this tuner uses good quality earphones instead.

![Figure 1: the circuit of the Double-Bass Tuner](image-url)
Timing
The heart of the tuner is a PIC 16C64 microcontroller which contains a 16-bit timer. In total, the microcontroller has three timer units. Timer-0 and Timer-2 are 8-bit counters; Timer-1 is a 16-bit counter, which is configured by the software to count pulses from the system's crystal oscillator and, when a particular value (stored in that counter's compare register) is reached, issue an interrupt request. When the microcontroller receives the interrupt request, it executes an interrupt service routine which toggles the state of two of the output pins on Port-B, one of the digital input/output ports.

The use of a 16-bit counter combined with a fairly high system oscillator frequency (8 MHz, resulting in 2 MIPS performance) allows the tuner to be very accurate. The frequencies that can be generated by this technique are given by the simple equation 2\times10^6/n, where n is the number in the counter's compare register. A little experimentation with n will show that an 8-bit counter (0\leq n < 256) cannot generate frequencies sufficiently accurate for use as a musical tuner.

When it is active, the PIC spends its time looking at the keypad (SW1a, b, c, or d), either waiting for a user to press one of the switches, or servicing an interrupt. When one of the note-selection keypad buttons is pressed, it clears its corresponding bit in Port-B (Port-B pins have an internal weak pull-up that is enabled in the software). When a keypress is detected, bit-test functions are used to determine which key was pressed. Timer-1's compare register is then loaded with the particular value needed to ensure that an interrupt is generated each half-cycle of the note requested. Timer-1 is cleared and enabled, and interrupts from Timer-1 are enabled. Timer-1's compare register is a 16-bit register each half of which (the high and low bytes, CCPR1H and CCPR1L) is accessed independently.

For example, to generate an E with a frequency of 82.4 Hz and a cycle time of 12136 microseconds, the PIC needs to change the state of the output pin every 6068 us. A sinewave spends half its cycle positive and half negative, so the output pin spends half a cycle on, half a cycle off. Timer-1 is incremented every four system-oscillator periods, that is, steps of 0.5 us with an 8-MHz system oscillator. So the Timer-1 compare register is loaded with 2F68h: every 12,136 steps (6068 us) an interrupt is generated that, in turn, calls the interrupt service routine to change the state of the output pin. Thus the output pin is high for 6068 us and low for the next 6068 us.

This scheme generates a squarewave at the correct frequency but, because of the many powerful harmonics in a squarewave, the note actually sounds to the ear as though it is perhaps one or two octaves higher. To filter out the harmonics, a simple high-cut filter (R2, C5, R3, C6) is placed between the microcontroller (IC1) and the earpiece (EP1).

Other features of the microcontroller are disabled by the software during the start-up process when power is applied or when the device wakes from sleep. Except when actually generating a note or hibernating, interrupts from all other sources within the microcontroller are disabled; when hibernating, only interrupts signalling that the keypad has been pressed are allowed; when generating a note, only interrupts from Timer-1 are allowed.

Sleep
The PIC 16C64 has a sleep facility which cuts power consumption down to a level typically less than the self-discharge rate of a battery. The chip is powered-down by

---

**Resistors**
- All 0.24 watt carbon
  - R1 22 kohm
  - R2, R3 120 ohm

**Capacitors**
- C1 100 uF 16V electro
- C2 100 nF 25V ceramic
- C3 22 pF 25V ceramic
- C4 47 pF 25V ceramic
- C5, C6 22 uF 25V electro

**Other major parts**
- IC1 PIC16C64-JW or -10P
  - X1 8 MHz crystal
  - SW1 Four-way membrane keypad

**Miscellaneous**
- BH1 to 33 N-size battery holders
- B1 to 3 N-size 1.5 V batteries
- 40-way DIL socket; small plastic box (140mm x 75 mm x 35 mm with battery compartment and access hatch; one pair of earphones

Software: The code can also be obtained from the author by email at SamDick@aol.com
issuing the SLEEP instruction which halts the crystal oscillator; the prototype’s supply current drops to less than 1 uA during sleep. By using the hibernation facility, no on/off switch is needed and the tuner cannot be left on accidentally.

The hibernation works as follows: as described above, the PIC’s main task when producing a musical note is to switch two of the digital port pins on and off at a certain rate, according to which note has been requested. In the software, two of the RAM locations within the microcontroller are allocated to a counter which is set to zero when the note starts and which is incremented each time an interrupt from the PIC’s Timer-1 is serviced. Thus, whenever the PIC changes the state of the output pins, the counter has one added to its value.

After the counter has been incremented, its value is checked to see if it exceeds 4000h and if so, the PIC executes the SLEEP command. The counter has to be a 16-bit counter. For the highest note (196 Hz), an 8-bit counter would roll-over in 1.3 seconds - too short a time for tuning! So two 8-bit counters are used in series to make a 16-bit counter. When the first counter reaches 128 (bit 7 switching on), the second counter is incremented and the first counter cleared to zero. When the second counter reaches 128, it is cleared, the output pins are set to logic zero to minimise current drain through them during sleep, interrupts are disabled, and the processor is put to sleep. This scheme gives a time-to-sleep of about 40s for the highest note, which is adequate for tuning purposes but ensures that the tuner’s battery life is long - a set of batteries should last for around a thousand tuning sessions with the 12mA active current drain. The choice of a 128 count for both 8-bit counters is somewhat arbitrary, but gives a sensibly long active period prior to hibernation; the natural roll-over 256 count of an 8-bit counter would have given a 160s active period which was judged to be needlessly long.

The PIC software clears the general interrupt-enable bit before hibernating so that, upon wake-up, it continues executing the software after the SLEEP instruction; it continues to watch the keypad for key presses.

How does the PIC wake-up? Although hibernating, the microcontroller can be stirred into activity by any one of a small number of events. For example, a master reset signal or some interrupts will trigger wake-up. Before the PIC is sent to sleep, the wake-up logic is configured so that a change in level of the voltage applied to bits 4 and 7 of Port-B will initiate wake-up. One of the keypad switches is connected to bit 4 of Port-B, so when that key is pressed, the microcontroller wakes up.

So the PIC normally sleeps. It wakes up when one of the keypad buttons (the G) is depressed, plays notes as requested by pressing momentarily any of the keypad buttons, and goes back to sleep some tens of seconds later. No on/off switch is required, and there is no need to remember to switch it off after use.

Miscellaneous
The PIC is powered by three N-size alkaline-manganese batteries. The 4.5 V supplied from the cells is within the PIC’s 3.0 to 6.0 V operating range and means that no voltage regulator device is needed. Because of the sleep feature, no on/off switch is necessary.

C1 smooths any supply ripple due to the activity of the microcontroller. R1 and C2 reset the microcontroller on power-up and X1, C3, and C4 function as the system oscillator.

The tuner is built into a small plastic box which has a hatch for access to the battery compartment. Normally, a PP3 9-volt battery would fit into the battery compartment but the three N-size cells that power the tuner can be held in three individual battery holders which, if placed at an angle of 45 degrees, will fit into the same space and will be accessible via the hatch. The earphones (wired in parallel to provide some redundancy should one of them go open-circuit) and the membrane keypad are connected directly to the circuit board, with their connecting wires requiring only small slits in the plastic case.

PIC-based Double-Bass Tuner - Code

; tuner program
list p=16c64,f=inhx8m
include "a:\pic\pl6cxx.inc" ;definitions file
variables
  opVal equ 0x20 ;output value
  cntrA equ 0x22 ;counter A
  cntrB equ 0x23 ;counter B

; start administration
org 0x00 ;reset/power-up
vector
  goto Start
org 0x04 ;irq vector
goto irqserv
org 0x05 ;program start

Start
  bsf STATUS,RP0 ;switch pages to 1
  movlw 0x3F ;port-B b0..b5 as input
  movwf TRISB
  bcf OPTION_REG,7 ;port-B pullups on
  bcf STATUS,RP0 ;switch pages to 0
  bcf opVal.7 ;off - output bits
  bcf opVal.6
  movwf opVal
gmovwf PORTB
  clr T1CON ;stop timer-1 & initialise
Again
  movfw PORTB ;read port B
  btfss PORTB.1 ;output value
  goto makeE
  btfss PORTB.2
  goto makeA
  btfss PORTB.3
  goto makeD
  btfss PORTB.4
  goto makeG
  goto Again

ELECTRONICS TODAY INTERNATIONAL
bcf INTCON,GIE ;disable irqs  
clrf T1CON ;stop count, ;internal osc/4, ;prescale=1  
movlw 0x0B ;set tmrl control ;soft irq, cmp ;mode  
movwf CCP1CON  
movlw 0x2F ;load ccp regs  
movwf CCPRLH  
movlw 0x68  
movwf CCPRL  
bcf PIR1,CCP1IF ;clear irq flag  
clrf cntrA ;clear timeout  
clrf cntrB  
bsf STATUS,RP0 ;switch page  
bsf PIE1,CCP1IE ;allow irqs  
bsf STATUS,RP0 ;switch page  
bsf INTCON,GIE ;enable irqs  
bsf INTCON,PEIE ;enable pe irqs  
bsf T1CON,TMR1ON ;start counting  
goto Again

bcf INTCON,GIE ;disable irqs  
clrf T1CON ;stop count, ;internal osc/4, ;prescale=1  
movlw 0x0B ;set tmrl control ;soft irq, cmp ;mode  
movwf CCP1CON  
movlw 0x13 ;load ccp regs  
movwf CCPRLH  
movlw 0x8E  
movwf CCPRL  
bcf PIR1,CCP1IF ;clear irq flag  
clrf cntrA ;clear timeout  
clrf cntrB  
bsf STATUS,RP0 ;switch page  
bsf PIE1,CCP1IE ;allow irqs  
bsf STATUS,RP0 ;switch page  
bsf INTCON,GIE ;enable irqs  
bsf INTCON,PEIE ;enable pe irqs  
bsf T1CON,TMR1ON ;start counting  
goto Again

irqserv ;interrupt service routine  
bcf PIR1,CCP1IF ;clear irq flag  
movlw 0x00 ;toggle op bits  
xorwf opVal,l  
movfw opVal  
movwf PORTB  

incf cntrA,l ;a=a+1  
bcfss cntrA,7 ;a=128?  
goto endISR ;no, return  
incf cntrB,l ;yes, b=b+1  
clrf cntrA ;a=0  
btfs cntrB,7 ;b=128?  
goto endISR ;no, return  
clrf cntrB ;yes...b=0  
bcf INTCON,GIE ;stop irqs  
clrf PORTB ;zero output  
movfw PORTB ;read B  
bcf INTCON,RBIF ;clear portB wakeup flag  
bsf INTCON,RBIE ;enable wake irq  
sleep  
nop  
nop  
bcf INTCON,RBIE  
bcf INTCON,RBIF  
goto Start  
endISR ;end of service routine  
retfie  
end
Have you got rhythm? Do you want to transfer that rhythm to your computer or hardware sequencer? Probably the easiest way of achieving this is to use MIDI drum pads that can be hit with drumsticks, and the data can be stored in real time with any errors corrected afterwards. While there are commercial units available, they can cost hundreds of pounds, so I designed and built this unit based around the PIC 16C84 microcontroller.

While this unit is cheaper, it does have some limitations. It provides MIDI data which has to be sent to a drum/synthesiser or sound module. The velocity byte is fixed at maximum volume and the drum selection and MIDI transmit channel are fixed at the time of programming. The software as it is written is set up for the drum sounds in the Creative Labs AWE64 or equivalent sound card on channel 10, but the drums can be mapped to suit any sound card or module. Even though the velocity bytes are fixed on record they can be edited afterwards in the sequencer software.

The MIDI data stream is a unidirectional asynchronous bit stream at 31.25 Kbits/sec with 10 bits transmitted per byte (a start bit, 8 data bits, and one stop bit). The MIDI interface on a MIDI instrument will generally include three different MIDI connectors, labelled IN, OUT, and THRU. The MIDI data stream is usually originated by a MIDI controller, such as a musical instrument keyboard, or by a MIDI sequencer. A MIDI controller is a device that is played as an instrument, and it translates the performance into a MIDI data stream in real time (as it is played). A MIDI sequencer is a device that allows MIDI data sequences to be captured, stored, edited, combined, and replayed. The MIDI data output from a MIDI controller or sequencer is transmitted via the devices MIDI OUT connector.

Each MIDI bit is transmitted for 32 microseconds, and so the timing is fairly critical. In the software this is achieved by timing loops which are accurate to the fundamental frequency of the 10MHz crystal divided by four which is 0.25us. The real time clock counter (RTCC) would not be as accurate for the MIDI transmission of 31.25 Kbits/sec because of the overheads associated with the operation of the timing overflow and interrupt routines, but obviously works fine for lower baud rates.

The circuit

The circuit in figure 1 is based around the PIC 16C84

![Diagram](Figure 1: the circuit of the MIDI Drum Pads)
The component layout for the Drum Pads PCB

Microcontroller which scans the inputs on RB0 to RB7. When a high is detected the software transmits the equivalent note-on and then the MIDI note-off after a short delay) for the required drum sound on the MIDI output on RA0.

The inputs are provided by the piezo-electric transducers which can provide up to 40Vp-p depending on how hard they are hit. This voltage is reduced by the potential dividers R1 to R8 and R9 to R16 respectively. The values chosen reduce the input level by approximately a quarter, and it is further reduced by internal clamping inside the microcontroller. If different transducers are used on the input then the potential dividers may need to be adjusted. Note that the inputs float high so the resistor values R9 to R16 need to be reasonably low so that when the microcontroller software scans the inputs it reads them all as low, with no transducer triggered. Also the maximum input continuous injection current into an I/O is specified as +/-500µA, although it will sustain larger currents (more than 100mA) for short periods of time.

The timing is generated from the 10MHz crystal and associated capacitors C1 and C2.

The MIDI output is fed to the 180 5-pin DIN socket via two 220Ω resistors which provide the required 10mA current loop. The power supply is a standard arrangement using a 9V-0-9V centre tapped transformer, which is rectified by diodes D1 and D2 smoothed by C3 and regulated to 5V by IC2.

**Software Operation**

The software consists of initialisation of the variable addresses, the constants, the ports and the drum assignments. The drum assignments can be mapped for any drum module, in the original the bass drum is decimal 36, the snare decimal 38, and so on.

For the 16C84 the origin (org) is set to 00h and the programme resets via the goto INIT where PortB is initialised as all inputs and PortA as all outputs. The main program section then polls the inputs and waits for a high input representing a drum being triggered. The particular triggered input is then detected using the "drum?" section, and is converted by the drum sound convert table. The value is placed in the drum variable and the note-on subroutine called then the note-off subroutine is called which is required for some drum modules.

**Construction**

The layout of components on the board is shown in figure 2. The unit can be mounted in any suitable enclosure and only requires connections for a mains cable, via a rubber gland if a metal enclosure is used, the on/off switch, the 5-pin DIN connector and the 8-input transducers. Originally I had the transducers mounted on the same metal panel, which worked if the transducers where hit accurately but if they were missed slightly and the panel hit instead then the incorrect drum could be triggered. To avoid this problem the transducers could be mounted in separate diecast boxes. Also each separate transducer could be mounted onto real drums and triggered when each drum is played separately.

MIDI DRUM PADS DRUMLIST1.ASM
LIST p=16C84
;Program to tx MIDI data with 10Mhz clock
;MIDI Drum-Pads

;PROGRAM: T. Scarff
;DATE: 03/12/97
;FILENAME: drm_lee1.asm
;ITERATION: 1.1
;NOTE: Channel 10 for drums is 09h

;Constant Assignments
CARRY equ 00
MSB equ 07
BORROW equ 00
LED equ 07
W equ 00
F equ 01
Z equ 02
C equ 00
Dx equ 00

;Port Assignments
PCL equ 02
STATUS equ 03
PORTA equ 05
PORTB equ 06
Drum Assignments

- drum0: 00h (dummy, never used)
- drum1: .36 (bass)
- drum2: .38 (snare)
- drum3: .43 (low tom)
- drum4: .42 (closed hh)
- drum5: .45 (high tom)
- drum6: .46 (open hh)
- drum7: .49 (crash)
- drum8: .51 (ride)

---

Programme Reset Point

```
org 0
goto INIT
```

---

Subroutines

```
delay2
movwf dyreg ;delay=1+(n-1)*3+3 cycles
dly2
decfsz dyreg ;where n is in W reg.
goto dly2 ;n=18 for delay=55 cycles
nop
return
```

---

Initialise Software

```
INIT
crfl PORTB
movlw #$FF
TRIS PORTB ;make portB all inputs

movlw #$00
TRIS PORTA ;make portA all outputs
```

---

Main Program Start

```
main
movf PORTB,W
movwf valuel
xorlw #$00
btfsc STATUS,Z
goto main
movlw #$00
movwf count
drum?
incf count,F
rrf valuel
btfss STATUS,C
goto drum?
movf count,W
```

---

Note-on subroutine

```
oteon
movlw #$99 ;note-on channel 10
movwf xmtreg
call txmidi
movf drum,W ; drum note
movwf xmtreg
call txmidi
movlw #$7f ;max velocity
movwf xmtreg
return
```

---

Electronics Today International
\texttt{note-off subroutine}

\texttt{noteoff movlw \#89 ;note-off channel 10}
\texttt{movwf xmtreg call txmidi}
\texttt{movf drum,W ; drum note}
\texttt{movwf xmtreg call txmidi}
\texttt{movlw \#7f ;max velocity}
\texttt{movwf xmtreg call txmidi return}

\texttt{Table to convert drum sound}

\texttt{convert addwf PCL}
\texttt{retlw drum0}
\texttt{retlw drum1}
\texttt{retlw drum2}
\texttt{retlw drum3}
\texttt{retlw drum4}
\texttt{retlw drum5}
\texttt{retlw drum6}
\texttt{retlw drum7}
\texttt{retlw drum8}

\texttt{PARTS LIST for the MIDI Drum Pads}

**Resistors**
- R1 to R8 4k7
- R9 to R16 1k5
- R17, R18 220

**Capacitors**
- C1, C2 22pF
- C3 470uF
- C4 100nF

**Semiconductors**
- IC1 PIC16C84 (10 MHz version)
- IC2 78L05
- D1, D2 IN4001

**Miscellaneous**
- 10 MHz crystal, 5-pin 180 DIN connector, transformer 9V-0-9V, SPST switch and a suitable enclosure. The transducers used in the prototype are Maplin order code YU87U and a rubber disc (27mm) to cover the transducer is order code QY16S. A pre-programmed PIC 16C84 is available for £15.00 and the program software is available on disk for £4.00 from the author at 1 Martello Court, Portmarnock, Dublin, Ireland.

---

**NEW FROM NEXUS!**

\textit{An Introduction to Robotics}

A fascinating and unique book that breaks new ground by exploring the exciting world of robotics in a clear and concise way. Both the theoretical and practical aspects are presented in an uncomplicated fashion using everyday English, which makes this an ideal book for the amateur. Divided into two sections, the first part explains how and why robots work and are controlled, while the second shows you how to make a simple two legged humanoid robot that can be programmed to walk. There are no complicated formulas or equations to grapple with or incomprehensible circuit diagrams to decipher - this robot can be built on your kitchen table and can be run from any personal computer! All you need are model aeroplane servos, a controller, a power supply and some plywood - and all parts are easily available in the UK and the USA. This is a book that will be of interest to modellers and everyone with a fascination for things mechanical and electronic. This is the way of the future, stay one step ahead and order your copy today! Only £11.50 UK & £12.50 Overseas (Includes Postage & Packing).

Telephone orders: 01442 266551 and ask for Nexus Direct

Please send me........ copies of NB299 @...........

I enclose my cheque/PO for £.............. made payable to Nexus Special Interests OR please debit my Access/Via.

\begin{tabular}{c}
\hline
\textbf{Expiry date} & \textbf{Signature} & \textbf{Name} \\
\hline
\end{tabular}

\begin{tabular}{c}
\hline
\textbf{Address} & \\
\hline
\end{tabular}

\begin{tabular}{c}
\hline
\textbf{Post code} & \textbf{Telephone No} \\
\hline
\end{tabular}

Complete details and return coupon to: Nexus Direct, Nexus House, Boundary Way, Hemel Hemstead, Herts, HP2 7ST. If you do not wish to receive mailing from other companies, please tick box.

---

**AN INTRODUCTION TO ROBOTICS**

ELECTRONICS TODAY INTERNATIONAL 67
RS 232 I/O Card for Psion 3s

5 Range Capacitor Meter

Midi Drum Pads
FOILS FOR THIS ISSUE

Medium Wave Loop Aerial

PIC Based Double Bass Tuner

AA Cell Eliminator
**PROGRAMMES**

**MICRO - ISP**

*In-system 8051 Programming in a FLASH!*

Now supports the AVR Microcontroller Family.

Code development for the 8051 family could not be easier. Simply plug the "Socket Stealer Module" into your existing 8051 socket and then use the Micro-ISP Programmer to download code (and data) to your target microcontroller without even removing it from the target socket.

**PRINTED CIRCUIT BOARDS**

*PRINTED CIRCUIT BOARDS*  

- DESIGNED & MANUFACTURED  
- EXACT REPLACEMENTS  
- INVESTIGATING PROTOTYPE OR PRODUCTION QUANTITIES  
- INVESTIGATING RANGE  
- WEB DESIGN  
- NESTING  
- MILLING  
- LASER ETCHING

**BASIC COMPILER**

The answer to your prayers!  

Forget assembly language - use simple but potent BASIC commands and then compile to hex code to program a standard 18, 28 or 40 pin PIC chip.

The MEL PicBasic Compiler from Pineapple Presentations  

Tel (0115) 903 1651 for details  

(10.00 + 8.00 - 7 days)  

http://www.melab.co.uk/mel/pic.htm

---

**Andy Forder**  
**01442 266551**

Send your requirements to:  
ETI Classified Department, Nexus, Nexus House,  
- Boundary Way, Hemel Hempstead, HP2 7ST  
- Lineup: 45ep per word (+ VAT) (minimum 20 words)  
- Semi display: (minimum 3cms)  
- £12.50 + VAT per single column centimetre

Ring for information on series bookings/discounts.  

All advertisements in this format will be pre-paid.  

Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).
ATTENTION ALL NORTH AMERICAN READERS!

Did you know that you can order an annual subscription to this magazine direct from our official U.S. subscription representative?

For more information and rates contact:
Wise Owl Worldwide Publications 4314 West 238th Street, Torrance, CA 90505 4509 Tel: (310) 375 6258
LABCENTER ELECTRONICS
KANDA SYSTEMS

43

J & N FACTORS
GAREX ELECTRONICS
ESR ELECTRONIC COMPONENTS

72

TECHNO INFO SERVICES
PINEAPPLE PRESENTATION

37

VISA

Bull Electrical

45

CMS

No Nuts

Cooke International

Pineapple Presentation

Confidential Communications

Plancentre Publications

Crown Hill Associates

RSGB

Dataman Programmer Ltd

Scientific Wire Co.

Display Electronics

Service Trading Co.

EPT Educational Software

Stewarts of Reading

EQT

Swift Designs

Equinox

IBC, 72

Techno Info Services

ESR Electronic Components

Telnet

GaTech Electronics

The PC Solution

J & N Factors

Variable Voltage Technology Ltd

JPG

Veronica FM

Kanda Systems

Wilson Valves

Labcenter Electronics

23

WIDEBAND SCANNER AERIALS

"REVCON" premium quality British-Made Discone. Its element for drilled orifice, 50239 connector £38.95 or N-type connector for improved UR performance £39.95. "REVCON PLUS" with improved far field frequency coverage £48.95.

"REVCON EXTRA" ready to go package: choice of 26 different models, 50239 or N-type, kit contents £49.95.

THE "REVCON" IS THE UK'S ORIGINAL QUALITY DISCONE

VHF/UHF MOBILE AERIALS

REVCON antenna is moulded from specially selected UV resistant nylon and is ideal for home, ham radio, CB, mobile or marine use. Includes 14 ft of cable, BNC plug £29.95.

ACTIVE "NOMAD"

With built-in wideband preamp complete with supply/distributor box (internal battery at centre of £15 - 15v supply) £29.95.

WIDEBAND SCANNER AERIALS

AERIAL FILTER

by your scanner useless due to breakthrough? Then this product could solve your problem: a specially designed tunable filter to be fitted in line with the aerial feeder, reduces breakthrough from strong VHF signals, etc. £23.95.

With built-in preamp (external battery) £29.95.

With built-in wideband preamp complete with supply/distributor box £49.95.

Lightweight design using ribbed cable elements. rolls into a small bundle for ease of transport, hang from any convenient point, ideal for travelling, with 4m coax £17.95.

NOMAD PORTABLE SCANNER AERIAL

"REVCONE EXTRA" ready to go package: discone, 10m coax fitted P1259, most clamps, BNC plug £49.95.

"REVCONE PLUS" with improved low frequency coverage £48.95.

"REVCONE" premium quality British-Made VHF/UHF Discone, 50239 or N-type connector £38.95.

ATTENTION ALL NORTH AMERICAN READERS!

Did you know that you can order an annual subscription to this magazine direct from our official U.S. subscription representative?

For more information and rates contact:

Wise Owl Worldwide Publications
4314 West 238th Street,
Torrance, CA 90505 4509
Tel: (310) 375 6258
Practically Speaking

TERRY BALBIRNIE

This month we continue with some of the calculations used in developing and testing circuits.

A single resistor, used to make the meter read in volts

In this month and the next, we shall look at how the scale of a pointer-on-scale (analogue) panel meter may be “tailored” to suit the application you have in mind. This month we shall concentrate on making voltmeters, and next time we shall look at milliammeters and ammeters.

On the panel

These days, it seems that panel voltmeters are less common than those scaled in milliamps or microamps. Even where a voltmeter is available, it often has a scale that is not ideal for the purpose to which the meter is going to be used. For example, you might require a meter to monitor the voltage of a nominal 12V lead-acid battery. When this is fully charged, its terminal voltage may approach 15V. You will therefore need a voltmeter scaled 0 - 15V. It may be possible to buy one scaled 0 - 30V, but then half of the scale would be unused. To make a meter read up to 15V would obviously be better.

Suppose your meter has a 0 - 500μA scale. From the manufacturer’s or supplier’s data, it is found to have a resistance of 430 ohms. You know that when 15V is applied to a pair of terminals, 500μA must flow through the meter to make it read full scale. The solution is to connect a fixed resistor in series with the meter. Suppose the value of the required series resistor is R. For the moment, forget the resistance of the meter itself - pretend it is zero.

Using Ohm’s Law, and remembering that a voltage of 15V applied to the terminals results in 500μA flowing through the meter:

\[ R = \frac{V}{I} = \frac{15}{0.0005} = 30,000 \text{ ohms (30k)} \]

(500μA is equal to 0.0005A)

However, the meter itself has a resistance of 430 ohms so, in theory, the value of the resistor will only need to have a value of 30,000 ohms minus 430 ohms, that is, 29,570 ohms. You will probably decide to forget the difference and just use a 30 kilohm resistor since the error is only 1.4 percent. You will need to check the values of the resistors available from stock in the supplier’s catalogue. These should be of the 1 percent tolerance metal film type to provide an accurate reading. In some cases, such as this one, the value is obtainable “off the shelf”. The procedure is shown in figure 1.

In many cases it will be necessary to use more than one resistor to make up the correct value. Remember, to find the result of two or more resistors connected in series, you add the values. It is interesting to note that if the tolerance of the required resistor is 1 percent, then connecting any number of 1 percent tolerance resistors in series to obtain this value will still result in an overall tolerance of 1 percent.

Some readers will prefer to use Standard Form (Scientific Notation) when performing the calculations. In this form, 500μA would be called 5.0 x 10⁻⁴ A. Use of Standard Form will be the subject of a future Practically Speaking and will not be used here.

A further example will make this all clear.

Example:

You require a voltmeter to read 0 - 25V and you have available a microammeter scaled 0 - 100μA and having a resistance of 3750 ohms.

Using Ohm’s Law and remembering that 100μA is equal to 0.0001A:

\[ R = \frac{V}{I} = \frac{25}{0.0001} = 250,000 \text{ ohms (250k)} \]

In theory, you need only the difference between this and the resistance of the meter - 246,250 ohms. However, as in the last example, the error is very small (about 1.5 percent), so it is probably not worthwhile taking it into account. Since 250,000 ohms (250 kilohms) is not a stock item, you will need to use a 240k resistor connected in series with a 10k unit.

You will need to make a new scale for the meter. The old one is easily removed and may be sprayed matt white. The new numbering may then be applied using dry print lettering.

Figure 1: Using a series resistor to make the meter read volts

You will see from the diagram that a 430 ohm resistor connected in series with the meter results in a full scale reading of 15V. If you need to游戏的大小, please click 'Developing and Testing Circuits'.
Among electronics designers there seems to be a division between those who favour digital techniques and those who are happier with analogue. Sometimes it seems as if there are two different mindsets - but are they?

It is true that individual designers will think first of what they are most familiar with, a fact immortalised in the saying that to the man who has only a hammer, every problem looks like a nail (or simply looks insoluble). We have all seen examples of this - an expensive DSP used where an op-amp, two resistors, and a capacitor would do the job very well, or a complicated circuit of op-amps, diodes, and resistors to put in simple control sequencing that could be done easily with a single CMOS logic chip.

Of course, there is a place for this philosophy: if you have a microcontroller in the system, any amount of code added without actually increasing the prom size is cheaper in production than the cost of a single extra resistor.

Equally, the addition of a couple of diodes to an analogue system to avoid the need for a logic chip, possibly with a different supply voltage, is likely to be the best course. But everything depends on who makes the decision. To do this, the main requirement is to understand a wide range of electronics and, preferably, other engineering disciplines. This understanding need not be sufficiently detailed to undertake advanced design in every field - there is always a time to call in somebody else who has the relevant expertise - but it is at least necessary to appreciate what can be done, approximately how it may be done properly and (of the greatest importance once you move above a single prototype) what the cost will be.

Returning to the area of DSP, who is more likely to design better DSP systems - a designer who understands analogue, digital, and software to a reasonable standard, or a computer programmer of the highest calibre? Perhaps both, working as a team?

In this era of narrowing specialisations, I suggest that for large projects the team leaders, and preferably a number of other designers, should have as broad a knowledge as possible. Experts in specific fields may be needed to make sure that crucial areas are designed as thoroughly as possible, but it is counterproductive for the DSP expert to write superb code to duplicate the functions of a simple analogue circuit if the DSP is not otherwise needed.

It is interesting that people specialising exclusively in digital design, perhaps because it initially appeared to be a simpler and more efficient solution, free from messy electrical behaviour, are now having to take into account electrical effects that were previously the domain of analogue circuit designers only. The combination of increased bus speeds and the stringent power supply requirements for fast processors forces designers to consider transmission line effects in digital circuit PCB tracks.

As another example, correct placement of decoupling capacitors is vital. If the ground current of a chip as it switches passes the ground connection of another on its return to the decoupling capacitor, the second chip's ground pin may receive a transient voltage of sufficient level that it interprets certain logic 1 inputs briefly as logic 0.

So the digital designer must now take steps to ensure that the 1's and 0's retain sufficient noise margin under all conditions of bus and power supply loading, before making the bold assumption that they actually will be one or zero when required. The analogue designer would do well to learn enough about digital processing to apply analogue expertise, for example, in coding DSP applications.

Next Month

Volume 27 no. 4 of Electronics Today International will be in your newsagents on 27th March 1998 ... Harprit Sandhu opens the door on DIY robotics and his walking robot design ... We have an unusual UHF model radio controller by Geoff Pike G100DP in preparation ... Robert Penfold presents the capacitance meter for his inductance - analogue circuit if the DSP is not otherwise needed.

Returning to the area of DSP, who is more likely to design better DSP systems - a designer who understands analogue, digital, and software to a reasonable standard, or a computer programmer of the highest calibre? Perhaps both, working as a team?

In this era of narrowing specialisations, I suggest that for large projects the team leaders, and preferably a number of other designers, should have as broad a knowledge as possible. Experts in specific fields may be needed to make sure that crucial areas are designed as thoroughly as possible, but it is counterproductive for the DSP expert to write superb code to duplicate the functions of a simple analogue circuit if the DSP is not otherwise needed.

It is interesting that people specialising exclusively in digital design, perhaps because it initially appeared to be a simpler and more efficient solution, free from messy electrical behaviour, are now having to take into account electrical effects that were previously the domain of analogue circuit designers only. The combination of increased bus speeds and the stringent power supply requirements for fast processors forces designers to consider transmission line effects in digital circuit PCB tracks.

As another example, correct placement of decoupling capacitors is vital. If the ground current of a chip as it switches passes the ground connection of another on its return to the decoupling capacitor, the second chip's ground pin may receive a transient voltage of sufficient level that it interprets certain logic 1 inputs briefly as logic 0.

So the digital designer must now take steps to ensure that the 1's and 0's retain sufficient noise margin under all conditions of bus and power supply loading, before making the bold assumption that they actually will be one or zero when required. The analogue designer would do well to learn enough about digital processing to apply analogue expertise, for example, in coding DSP applications.

Next Month

Volume 27 no. 4 of Electronics Today International will be in your newsagents on 27th March 1998 ... Harprit Sandhu opens the door on DIY robotics and his walking robot design ... We have an unusual UHF model radio controller by Geoff Pike G100DP in preparation ... Robert Penfold presents the capacitance meter for his inductance -
**The Ultimate 8051 Microcontroller Programmer**

- Supports Atmel FLASH 89C +89S, Generic 87C51/52/FA/FC microcontroller derivatives
- FLASH & E2 libraries also available as chargeable update

**£150.00** Order Code: MPW-SYS

**For C51 Project Development, in a FLASH**

Includes: Programmer, Evaluation module and PKST-2K

**£199.00** Order Code: AT-89C-2K-ST

---

**In-System Programming (ISP)**

"Now you can program the 8051 or the AVR™ without removing the device from the socket!"

**£39.95** Order Code: UISP-V2-SYS

---

**AVR™ Professional Starter System**

**FEATURES**

- Supports Atmel 90S (AVR)
- RISC microcontroller family
- Supports Parallel Programming mode in ZIF socket
- Supports In-System Programming via ribbon cable (provided)
- Equinox FAST ISP Programming Algorithm
- All on-chip facilities supported e.g. RC Osc.

**SYSTEM CONTENTS**

- Professional Device Programmer
- Atmel AVR™ Assembler
- AVR™ Basic Lite Compiler (NEW)
- Atmel Databook on CD ROM
- Power Supply
- ISP Ribbon Cable (to target)
- Serial Cable (to host PC)

**£199.00** Order Code: AT-89C-2K-ST

---

**AVR BASIC LITE**

- Compiled BASIC generates tight AVR™ machine code
- Not a Run-Time Interpreter, NO code overhead!
- Target speeds comparable with assembler

**£24.95**

---

**PROVIDING THE SOLUTIONS TO YOUR PROBLEMS!**

**Tel:** +44 (0) 1204 529000
**Fax:** +44 (0) 1204 535555

For product information visit our web site at: www.equinox-tech.com

E-mail: sales@equinox-tech.com

3 Atlas House, St Georges Square, Bolton, BL1 2HB UK
Surely not. Surely someone somewhere has developed a portable programmer that has even more features, even greater flexibility and is even better value for money.

Actually, no. But don’t take our word for it. Use the feature summary below to see how other manufacturers’ products compare.

**DATAMAN - 48LV**
- Plugs straight into parallel port of PC or laptop
- Programs and verifies at 2, 2.7, 3.3 & 5V
- True no-adaptor programming up to 48 pin DIL devices
- Free universal 44 pin PLCC adaptor
- Built-in world standard PSU - for go-anywhere programming
- Package adaptors available for TSOP, PSOP, QFP, SOIC and PLCC
- Optional EPROM emulator

**DATAMAN S4**
- Programs 8 and 16 bit EPROMs, EEPROMs, PEROMs, S and 12V FLASH, Boot-Block FLASH, PICs, 8751 microcontrollers and more
- EPROM emulation as standard
- Rechargeable battery power for total portability
- All-in-one price includes emulation leads, AC charger, PC software, spare library ROM, user-friendly manual
- Supplied fully charged and ready to use

**S4 GAL MODULE**
- Programs wide range of 20 and 24 pin logic devices from the major GAL vendors
- Supports JEDEC files from all popular compilers

**SUPPORT**
- 3 year parts and labour guarantee
- Windows/DOS software included
- Free technical support for life
- Next day delivery - always in stock
- Dedicated UK supplier, established 1978

Still as unbeatable as ever. Beware of cheap imitations. Beware of false promises. Beware of hidden extras. If you want the best, there’s still only one choice - Dataman.

Order via credit card hotline - phone today, use tomorrow.
Alternatively, request more detailed information on these and other market-leading programming solutions.

**MONEY-BACK 30 DAY TRIAL**
If you do not agree that these truly are the most powerful portable programmers you can buy, simply return your Dataman product within 30 days for a full refund.

**Dataman Programmers Ltd**, Station Rd, Maiden Newton, Dorchester, Dorset, DT2 0AE, UK
Telephone +44/0 1300 320719
Fax +44/0 1300 321012
BBs +44/0 1300 321095 (24hr)
Modem V.34bis
Home page: http://www.dataman.com
FTP: ftp.dataman.com
Email: sales@dataman.com