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**Hebot II Robot Turtle**

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Complete kit: £85.00 + VAT

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**MicroGrasp Electric Robot Arm**

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**Cortex II 16-bit 16-colour Computer**

The new slimline Cortex offers constructors the speed and power of 16-bit computing for the same price as an 8-bit games machine. The standard kit has TV, cassette and RS232C interfaces - others are available as optional extras. Add disc drives, printer and monitor for a fully-fledged business system.

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TRIBUTE

Regular readers will have seen our obituary to Frank Hyde in the June issue and may be surprised by the appearance of an article by Frank in this issue. Radio Astronomy was Frank's love and the article was written for us some time ago. We are pleased to publish it as a tribute to him. Frank was an excellent contributor and friend to PE and we hope he would have approved of Dr. Patrick Moore as our new Spacewatch contributor.

Patrick Moore knew Frank, as you will see from his first Spacewatch, and expressed his sadness at the reason for his being asked to take over. We are also sad about this, but pleased to welcome Patrick to our pages. Hopefully, this month will see the start of another long and rewarding relationship.

AREAS

Alert readers will also have noticed the introduction of some extra wording to our front cover title. The words Robotics, Micros, Electronics, Interfacing spell out, in no uncertain terms, what PE is all about and it is our intention—as always—to be the best "practical" magazine for the hobbyist in these areas.

Next month sees the start of our second major series on robotics with publication of three new robot designs. PE has shown the way with serious practical robots and we plan to extend our lead. No other magazine has yet come near to providing its readers with similar high quality designs: designs which are now used extensively in education, light industry, research and by hobbyists: designs which cover the whole range from a turtle through small motor driven arm up to a semi-industrial hydraulic unit—five designs in all, with three more coming now and others planned for the future.

We will not leave out the beginner and it is our intention to publish a series aimed at the novice to robotics in our sister publication Everyday Electronics—watch out for that in the near future.

LEADING

Of course we realise that robotics and computing are not close to everyone's heart so we will continue to provide plenty of useful and sensible designs of a general nature—designs that are well thought out, well expressed and illustrated and that provide readers with value for money. Just to prove that we keep ahead, from this month our regular Patents Review has been changed in approach so that it now looks at where the patents are taking us and how they may influence future products. This page, written by Barry Fox—a recognised leading journalist in the field—has been renamed The Leading Edge so that its title reflects the new approach. We hope you like it.

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Letters and Queries

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

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

Back Numbers and Binders

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

Binders for PE are available from the Subscription Department, IPC Magazines Ltd., Room 2816, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment for subscriptions can also be made using any credit card and orders placed via Teledata. Tel. 01-200 0200.
LIGHTNING PERFORMANCE

Over ten years ago, as a spin-off from a nuclear fusion modelling experiment, this ball of 'harnessed lightning' was just a brainchild of a theoretical physicist who predicted that a plasma could be limited to a tight beam even when shot across a relatively short gap so long as the control parameters were just right.

To prove the theory a model was made and ten years of refinement later the 'Starsculpture' emerged as a 'living lightning' art form. The effect you see is created by the emission of high frequency radio waves, pulsing at around 21kHz; these signals are broadcast from the small hemisphere in the centre of the 12inch diameter glass sphere. The generation circuitry is of course microprocessor controlled, the program searches for the one in a million condition where a high temperature plasma (chain of super-heated ion molecules) is triggered in the special rarified gas atmosphere. The plasma lasts for only a fraction of a second and is continuously restimulated by the microprocessor circuitry as it senses the exact triggering characteristics; in this way the continuous lightning effect is achieved.

The radio waves pulsing through these gases 'knock' electrons loose from their atoms, the result being an ionised gas which emits light when an electron is dislodged, and again when an electron is recaptured by another gas atom.

The Starsculpture is designed to be touched by one or more people, when the human body touches the sphere the free electrons floating inside are drawn to the natural 'ground'. This flow of electrons creates 'tunnels' in the rare gases through which the plasma then flows, and so it appears that the plasma is attracted to your hand when in fact the plasma flows through the tunnels created by your touch.

As if this visual extravaganza wasn't enough, the manufacturers have incorporated three slide control switches that enable the 'operator' to vary the shape, colour and pulse rate of the plasma, creating a truly infinite number of effects. The Starsculpture took more than £4m to develop and each one is hand tuned by a plasma physicist which perhaps goes some of the way to justifying the £2,500 price tag. Harrods of Knightsbridge (who else) recently featured this item in their Technology at Play exhibition.

However interested parties should contact Markplan Ltd., Old Colony House, South King St., Manchester, M2 6DQ. (061-832 2765).

SHUTTLE SPACE COMPETITION

An exciting and quite unique competition is now open to all secondary school students and apprentices in the UK. The challenge is to recognise the potential that space offers their future, and to create an experiment that takes into consideration the special environmental conditions in space, in particular vacuum and weightlessness.

The winning entry will have a reserved spot in the payload bay of the space shuttle due to be launched in early 1986. The simpler the project the better its chances as it must be small and simple enough to be housed in a self-contained cylinder no larger than 502mm diameter, 359mm long with an all up weight restriction of 27.2kg (601b). The competition is being run by ITN (Independent Television News), one of Europe's leading space consultants SSI (Space Services International) and NASA (National Aeronautics and Space Administration).

NASA's technological expertise is undoubted and it would be easy for the entrant, in this prestigious company, to get 'too technical'. Don't forget that (as far as we know) the most basic of Earthbound natural phenomena have never been asked to perform in space. For instance, what happens to tomato plants or to bees or spiders? These were some of the experiments devised by students in the USA; simplicity is the key.

Look out for this Leisuretronics logo in forthcoming issues of PE, we will bring you up to date information of this exciting new exhibition to be held at the Royal Horticultural Hall in London from November 8th-11th 1984.

The interests of all home hobbyists will be catered for from radio-controlled models to electronic music making, ham radio to Hi-Fi; robotics to photography; synthesisers to satellites; games and kits to disco and light show equipment. Hand tools and components will also be available along with many special and unusual exhibits demonstrating the most up-to-date developments in all areas of leisure electronics.

The organisers, Trident International Exhibitions, have many years experience in the exhibition industry and their efforts are expected to draw a large audience of enthusiasts with wide ranging interests. The venue is within walking distance of Victoria coach/train termini, and of course within tube and bus reach of all other London rail termini. Trident will be promoting the event through coach companies as well as British Rail, Practical Electronics along with our fellow publications—Everyday Electronics, Practical Wireless, Software Index and others will be sponsoring this new and multi-interest electronics event.
**RECON. DMM**

If you did not manage to find yourself a suitable instrument from the Multimeter Buyer's Guide in the May issue of PE, then this Beckman model just might fit the bill.

The 3020R is a hand-held DMM (a Beckman 3020 reconditioned by Beckman) with a d.c. accuracy of 0.1 per cent. D.c. voltage range 200mV to 1500V, a.c. voltage range 200mV to 1000V, current a.c./d.c. 200µA to 2A, resistance 0 to 20MO. The 3020R has a battery life of 2000 hours and would normally cost in excess of £143 (if new), the cost of the reconditioned model is £86.25 inc VAT and p&p. From, Intertec, PO Box 33, Dunstable, Beds, LU6 2QP. (0582 873377).

Money Back

From now until the end of October Superswitch is making purchasers a money-back offer on all its products as part of a summer promotion. This will be £1 if one item is bought, £3 on two.

The offer will be generally available wherever Superswitch products are sold, including electrical, DIY, hardware and lighting shops, and leading department stores. The products include dimmers, programmable lightswitches, low voltage outdoor lighting sets, immersion heater timers, smoke alarms and plug-in timeswitches.

All the purchaser has to do is send off a product carton top together with a special sticker which will be on each carton. Superswitch will refund £1 (or £3 if two purchases are submitted at once) direct to the purchaser.

Further information from Superswitch Electric Appliances Limited, 7 Station Trading Estate, Camberley, Surrey, GU17 9AH. Telephone: Camberley (0276) 34556.

**PANASONIC’S TINY RADIO**

It is anticipated that Panasonic will launch in the UK sometime in 1985 the World’s smallest a.m./f.m. stereo personal radio—the RF-07.

The super-slim receiver measures 91mm high, 55mm wide and 3.9mm deep (approximately the size of a credit card). A rechargeable NiCad battery is the inclusive power source and will give up to five hours playing time under normal use, it can be recharged in about the same time. According to Panasonic they have optimised radio circuit miniaturisation into Radio High-density Circuits (RHC’s); there are four RHC’s in the design.

Many new components have been developed for use in the RF-07 including a variable capacitor, volume control, tantalum capacitor chips and an ultra-thin a.m. antenna. All these components were designed to be less than 2.8mm thick.

Accessories include a recharger unit, stereo headphones and a carrying case. It may be a while before we actually see this slim set in the High St. but when we do it is likely to cost in the region of £110.
OPERATOR PROTECTION

Increasingly we hear of industrial working practices that damage the health of the operator, 'asbestosis' being a prime example. Goodness only knows what untold damage has been done to our bodies and those of our labouring forefathers over the past couple of hundred years?

As the acid rain continues to pour down, and the beaches around Sellafield remain contaminated, it seems that operator protection from 'hazardous environments' is still in its infancy, indeed as is so often the case, changes are only made after the damaging event.

Encouraging to see then the development of a mobile work platform for use in hostile or hazardous environments. The vehicle has been developed by researchers at the Battelle Memorial Institute's Ohio laboratories. Nicknamed 'Rocomp' (Radio or Computer Operated Mobile Platform) the tracked vehicle can, under computer control, follow a prescribed program developed for a particular application or be radio-controlled by an operator in a safe remote area. According to its inventors it is the result of combining mechanical engineering skills with 'smart' controls and sensors. A TV camera can be added for working in blind areas.

Rocomp is a tracked vehicle that can pass over obstacles, ascend and descend 45 degree slopes, and easily manoeuvre up and down stairs. It can carry weights of up to 250 pounds over almost any firm surface. In a nuclear environment the platform would be equipped to detect radiation levels, collect air and smear samples, perform simple mechanical tasks and function as a mobile tool caddy. In these inhospitable conditions fewer personnel would be required to enter the area and those that had to enter would face a lesser exposure time, similarly the unit could be used in areas from which personnel are completely restricted.

Photo-voltaic relay

A new concept in solid-state switching devices, the photo-voltaic relay (PVR), was previewed by International Rectifier at the 1984 All-Electronics/ECIF Show.

The new type of relay, which incorporates a photo-voltaic isolator array in conjunction with a new power integrated circuit known as a BOSFET (for 'bidirectional output switch field-effect transistor'), could offer an ideal solid-state replacement for electromechanical reed relays. Like reed devices, it can handle both a.c. and d.c. signals and other waveforms, but its reliability is several orders of magnitude better than electromechanical devices.

Relays using the PVR technique are expected to be commercially available in early 1985.

ATARI-400 KEYBOARD

A new silicon rubber, stick-down keyboard for the Atari 400 computer has been developed by Filesixty, the London-based computer hardware company that has successfully marketed a similar product for the Sinclair ZX-81.

The keyboard, which is virtually indestructible, can be applied to the machine in seconds. It gives the operator a calculator-type feel, thereby overcoming the Atari 400’s major drawback—its flat key pad.

The keyboard will make any operator functions more enjoyable, quicker and more satisfying.

The keyboard which has been designed to coordinate with the look of the machine, is moisture and dust proof and will not discolour. It has been tested to up to 3½ million impressions. It costs £19.95 and is available initially direct from Filesixty and later from selected retailers. The product will be marketed through the home computer and computer games specialist press.

Clairtronic has introduced a new economy range of low voltage isolating transformers with wound-in flying leads. These cable con-
nections provide additional safety by eliminating mains voltage terminals on the transformer and ensure that international
safety standards for creepage and clearance distances are easily maintained. The integral cables also provide lower circuit installation
cost.

This range of chassis mounting transfor-
mers comprise four sizes 2, 4, 10 and 18VA
each with a choice of four centre tapped
voltage outputs 6-0-6, 9-0-9, 12-0-12 and 15-
0-15V. Primary voltages are 220 and 240V.
All sizes are constructed on double section bobbins to provide 4kV insulation between
primary and secondary.

Prices range from £1.59 to £3.42 including
VAT and p&p. Further information from,
Clairtronic Ltd., Churchfield Road, Chalfont
St Peter, Bucks (0753 887227).

A new range of pliers and cutters from OK
Instruments is available with sets of finger
rings enabling the tools to be kept to hand
for operations requiring both finger and tool
work—twisting wires with the fingers and
then cutting the wire ends, for instance.
Finger rings with 19 and 23mm diameters
are supplied to clip onto the tools’ handles
so that users can tailor a suitable grip.
Another timesaver for gripping difficult-to-
hold small components in place during
assembly is the K-40 lockable tweez-
plier, it can grip objects up to 7mm thick
leaving hands free for other tasks. Made of
a tough glass-filled propylene, these
tweezers are non-magnetic and resistant
to most acids and can also be machine
washed or even boiled for perfect cleans-
ing. Details from, OK Industries UK Ltd.,
Dutton Lane, Eastleigh, Hants. S05 4AA
(0703) 619841).

The UK Patents Information Network points
out that oil rig workers in the Shetland Isles
and Strangford Lough are among those now beginning to feel the
benefits of research done nearly a decade ago.

The workers’ homes are kept warm by ‘paint-
on’ electrical heating. The houses have heated
panels which incorporate graphite and are
coated with electrically conductive paint. This
paint can act as a heating element when ap-
plied to non-conductive materials such as
brick and plasterboard etc and connected by
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Methods are described in patents such as UK
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According to the Alfred Marks research unit,
a recent study of secretarial, clerical and word
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Amstrad the consumer electronics PLC has
moved its administration offices from Gar-
man Road, Tottenham.

The move has been brought about by
continued company growth and a need for
larger premises in anticipation of the com-
pany’s CPC 464 home computer sales. The
new address will be, Brentwood House,169
Kings Road, Brentwood, Essex CM14 4EF.
(0277 228888).

Countdown . . .

Please check dates before setting out, as we cannot guarantee the ac-
curacy of the information presented below. Note: some exhibitions may
be trade only. If you are organising any electrical/electronics, radio or
scientific event, big or small, we shall be glad to include it here. Address
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Light Fantastic Open 7 days a week at the Gallery of Holography, 48
South Row, The Market, Covent Gdn., London. A8
Education, Training & Development July 10–12. NEC. B2
BAEC Amateur Electronics July 14–28 (not Mon’s, Tues’ or Thurs’).
The Shelter, The Esplanade, Penarth, S. Glam. B9
Electron & BBC User July 19–21, Alexandra Palace, London. L
Cntr. Newcastle, Y3
IBM System User Show Sept. 3–5. Olympia 2. Q2
Concerned Technology (for disabled) Sept. 3–7, Meadowbank Sports
Cntr. Edinburgh. Y3
Laboratory Sept. 4–6, Barbican, London, E

A new range of chassis mounting transformers is available with sets of finger
rings enabling the tools to be kept to hand for operations requiring both finger and tool
work—twisting wires with the fingers and then cutting the wire ends, for instance.
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The Commodore 64 home computer has a number of quite advanced features for a machine in its price bracket, and one of these is the user port. Apart from acting as an 8 bit input/output port for user add-ons, it can, with the aid of some built-in software, operate as an RS232C serial interface. This is obviously an extremely useful feature as it enables the unit to operate with equipment such as high quality printers, modems, etc., but there is a drawback in that the inputs and outputs are all normal 5 volt logic types, whereas the RS232C system uses nominal -12 volt and +12 volt signal levels. Also, an inverter is needed at some inputs and outputs to provide correct operation of the port. Presumably the necessary interfacing for RS232C operation has been omitted to enable the port to be used for other purposes as well.

Fortunately it is quite simple to add a level shifting circuit to the port so that proper RS232C operation can be obtained, and basically all that is needed is a power supply circuit to provide the level shifting. As there is a 9 volt a.c. output on the user port which can be used to generate the required plus and minus 12 volt supplies the interface simply plugs between the port and the RS232C equipment, with no other connections being needed.

The driving software of the port can provide operation at any of the popular baud rates and with any normal word format.

Line Drivers/Receivers

The level shifting in this design is provided by line driver and receiver integrated circuits which have been designed specifically for use in this application. The devices in question are the MC1488 (or SN75188) quad line driver and the MC1489 (or SN75189) quad line receiver. Pinout details of both devices are shown in Fig. 1.

---

**Fig. 1.** Pinout details for the MC1488 and MC1489 devices

---

**Fig. 2.** The arrangement used in the MC1488 line drivers

---

Fig. 2 shows the general arrangement used in each section of the MC1488 line driver. Transistor TRa is used as a sort of common base input stage, and it is normally switched on by the bias current that flows through Ra, Dc, Dd, and Rb, and the consequent voltage developed across Rb. A high input is therefore provided to the buffer stage at the output, but as the latter provides an inverting action its output goes low. If a low input signal is supplied to either input (or both inputs) of the device, the current flowing through Ra is diverted away from Dc and Dd, and instead flows to ground through Da/Db. TRa is then cut off, its collector goes low, and the output from the buffer goes high.
Some of the output signals from the user port of the Commodore 64 are of the wrong polarity, but the line drivers provide the required signal inversion in addition to the level shifting. Where no signal inversion is required an inverter added ahead of the line driver is used to counteract the inversion through the driver.

In most applications, including the present one, only one of the inputs to each driver is needed. Either the inputs can be wired in parallel or one of them can simply be ignored. Note that one of the drivers has only a single input. The 300 ohm resistor at the output is used to provide current limiting, which is a requirement of the RS232C standard.

The circuit diagram of Fig. 3 is for each of the line receivers in the MC1489 device. This is little more than three straightforward transistor inverters connected in series. This gives an overall inversion through the device, and an inverter must be used at the output of the device where a non-inverting interface is required. Ra and Da are used to clip the input signal at about -0.65 volts when it is negative in polarity, and this is done to protect TRa against an excessive reverse bias voltage and possible damage. Ra also provides current limiting when the input signal is positive in polarity and TRa is forward biased.

Resistor Rf is used to introduce a substantial amount of hysteresis which helps to avoid spurious operation due to stray pick-up of noise. A capacitor from the "Response Control" input to ground can be used to limit the high frequency response of the circuit, and again, this can help to prevent corrupted data due to noise pick-up, but in most cases this facility is not used.

THE CIRCUIT

Refer to Fig. 4 for the full circuit diagram of the interface.

The 9 volt a.c. output from the user port is capacitively coupled by C1 and C3 to two rectifier and smoothing circuits which produce the positive and negative supply rails. The unloaded supply voltages are approximately plus and minus 12 volts, but both reduce by about 2 volts or so when loaded. This gives an ample voltage swing from the line drivers (IC2) since RS232C standard requires minimum signal levels of only plus and minus 3 volts. There is a significant amount of ripple on both supplies, but this is perfectly acceptable in this application.

IC1 is the MC1489 line receiver, and this needs only a single +5 volt supply. A suitable supply is available from the user port, and this is used to power IC1.
be connected to the CTS (clear to send) or DSR (data set ready) handshake input of the Commodore 64's RS232C interface. The handshake line is then used by the printer to indicate when it is not able to process data, and a software loop in the computer halts the outflow of data during these periods.

The Commodore 64 provides RTS and DTR outputs so that it can operate with handshaking when it is receiving data, although in most cases it will be able to keep up with the sending rate and handshaking will then be unnecessary.

The DCD (data carrier detect) is an input which enables the sending device to indicate to the Commodore 64 that the communication link has been established, but this is only utilised in automatic systems, and is unlikely to be needed.

When using the Commodore with a number of pieces of RS232C equipment it was always necessary to have the input and output data signals inverted. With the handshake lines things seem to be less universal, and it is usually necessary to experiment a little to find the method of connection that gives correct operation. TR1 and TR2 are used in simple inverter circuits which give non-inverted CTS and DTR lines, and this is likely to be the most useful arrangement in practice. However, if necessary it would not be difficult to reconfigure the circuit slightly.

CONSTRUCTION
Details of the printed circuit board and component layout for the interface are shown in Figs. 5 and 6.

While the board is quite straightforward and simple to construct, it is important to take great care not to make any mistakes. In particular, ensure that the electrolytics and rectifiers are connected with the correct polarity, and do not accidentally swap over the two integrated circuits!

The connection to the user port of the Commodore 64 is made via a piece of 14 way ribbon cable, one end of which connects to the printed circuit board. It is easier to make these connections by way of Veropins, but this increases the risk of accidental short circuits unless sleeving is used over the connections, and it is probably better just to make the connections direct to the board. A 2 x 12 way edge connector is fitted to the other end of the cable, and this must be a

Fig. 5. Printed circuit board layout

Fig. 6. Component layout

<table>
<thead>
<tr>
<th>COMPONENTS . . .</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistors</strong></td>
</tr>
<tr>
<td>R1,R6</td>
</tr>
<tr>
<td>R2,R4</td>
</tr>
<tr>
<td>R3,R5</td>
</tr>
<tr>
<td>All resistors</td>
</tr>
<tr>
<td><strong>Capacitors</strong></td>
</tr>
<tr>
<td>C1,C3</td>
</tr>
<tr>
<td>C2,C4</td>
</tr>
<tr>
<td>C5</td>
</tr>
<tr>
<td><strong>Semiconductors</strong></td>
</tr>
<tr>
<td>IC1,IC2</td>
</tr>
<tr>
<td>TR1,TR2</td>
</tr>
<tr>
<td>D1,D2,D3,D4</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
</tr>
<tr>
<td>Case about 119 x 99 x 44mm</td>
</tr>
<tr>
<td>Printed circuit board</td>
</tr>
<tr>
<td>5 way DIN socket (see text)</td>
</tr>
<tr>
<td>2 x 12 way 0.156 inch edge connector</td>
</tr>
<tr>
<td>14 way ribbon cable</td>
</tr>
<tr>
<td>BBA fixings, Veropins, wire, etc.</td>
</tr>
</tbody>
</table>
Fig. 7. The connections to the 2 x 12-way edge connector

0.156 inch type (not the more common 0.1 inch variety). Fig. 7 shows the connections to the edge connector (which is viewed looking onto the pins at the rear of the connector). There are two slots in the Commodore 64’s printed circuit board which can take polarising keys in the edge connector, but a suitable connector might be difficult to obtain. It would probably be possible to add these keys to an ordinary edge connector, or, alternatively, the top and bottom of the connector could be clearly marked as such.

The prototype is housed in a plastic box having approximate inside dimensions of 115 by 95 by 37mm. The RS232C lines are taken to a 5 way DIN socket, with the DCD, RTS, and DSR lines being left unused, but obviously any desired connector having a sufficient number of ways for the lines in use could be utilised. The lid and main part of the case are filed away to produce an exit slot for the ribbon cable. The board is mounted inside the box using M3 or 6BA fixings.

IN USE

In some applications it will merely be necessary to connect the ground and signal in/out terminals of the interface to the other item of RS232C equipment. If (say) a printer is driven from the interface it will be necessary to use handshaking, with the DTR output of the printer being connected to the CTS input of the interface perhaps. However, it may be necessary to experiment a little to find which handshake input/output combination gives the desired effect. Taking the CTS line high enables the output from the port. If the DSR line is used this is taken low to enable the output, but this can only function if the CTS line is taken high, or if TR1 and R1 to R3 are omitted from the board.

If data is fed into the port from (say) another computer it may be necessary to connect either the DTR or RTS line to the CTS or DSR line of the other computer, even though handshaking will normally be unnecessary in this type of application. This is simply because many serial interfaces cannot output data unless the appropriate handshake line is activated. For example, the CTS line on the BBC model B computer must be taken high to enable the outflow of data. The RTS output of this interface is normally low and the DTR output is normally high.

In order to use the interface a file must be opened, and the baud rate/word format must be specified. The baud rate is simply the rate at which data is sent, and 300 baud for instance, transmits data at 300 bits per second. The data is transmitted together with additional bits, and one of these is the start bit. There is always just one start bit at the beginning of each byte. One or two stop bits are added at the end of each byte. Some systems use parity checking, and this

The RS232C Interface mounted in its case, showing connections to the DIN socket (right), and the ribbon cable (left)
The number used for Y sets the number of data bits, the number of stop bits, and the baud rate. The table given below shows the numbers that are used to select the desired word format and baud rate:

<table>
<thead>
<tr>
<th>Number of Data Bits</th>
<th>Number of Stop Bits</th>
<th>Baud Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>32</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>600</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>1200</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>2400</td>
</tr>
<tr>
<td>1 stop bit</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2 stop bits</td>
<td>128</td>
<td></td>
</tr>
</tbody>
</table>

For example, 7 data bits, 1200 baud, and 2 stop bits would require Y to have a value of 168 (32 + 8 + 128).

Odd, even, or no parity is selected by setting Z at the appropriate value, as follows:

- No parity: 0
- Odd parity: 32
- Even parity: 96

If handshaking is to be used 1 should be added to the value of Z.

To list a program through the RS232C interface the command:

```
CMDX: LIST
```

is used. Here X is the file number, and is the same as the file number used in the OPEN command which opened the RS232C channel. Data can also be sent using `PRINT#X, "data"`.

When a program is listed and handshaking is utilised it may be found that the final part of the listing is not flushed from the Commodore 64's RS232C buffer. One or two `PRINT#` commands should flush the buffer and complete the listing.

Data can be fetched from the RS232C port using `GET#X, A$`.

In both these examples X is again the file number used in the OPEN command which set-up the RS232C channel.

A final point to bear in mind is that the 255 bytes below RAMTOP are used as the RS232C buffer when the RS232C channel is opened, and any data stored there will obviously be lost.

Further information on using the Commodore 64's RS232C interface can be found in the "Commodore 64 Programmer's Reference Guide" which is published by Commodore.
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- Folds into Compact Case With Wrist Strap

Features include fuse and surge-absorber protection, banana-type probe jacks and 4" 3-colour mirrored meter with automatic shunt protection (when folded shut). DC Volts: 0 to 1200. AC Volts: 0 to 1200. DC Current: 0-60µA. 3-30-300 mA. Resistance: 0-2-20-200K-2 megohms (centre scale 24). dB: -20 to +63 dB. Requires "AA" battery. 22-211

## Micronta Clamp Meter

£27.95

- Overload Protected
- Pointer Lock Switch

Measure AC current without disconnecting or breaking the line being checked. Large range selector is conveniently positioned for one-hand operation. Has a pointer lock switch holding the pointer in position for reading later. AC current: 0-6-15-60-150-300 amperes. Accuracy ±3%. Size 7'1/16 x 2'11/16 x 1'5/16". With carry strap. 22-160

---

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A LOCAL cub scout pack had been asked to host a competition which was to be based on the BBC programme Mastermind. The cub scouts were to be asked a series of questions and had to answer as many as possible in two minutes. To keep the young audience interested, it was decided that time keeping should be more spectacular than that which can be achieved by a clock or stopwatch. It was then that I was approached and asked to design an alternative timekeeping system. On pressing the start button, nine lamps are illuminated in sequence after every twelve seconds. During the final twelve second period, an additional lamp is flashed on and off to warn the contestant that his time is nearly finished. At the end of the 120 seconds a buzzer sounds for 6 seconds and then all the lamps extinguish ready for the next contestant.

CIRCUIT DESCRIPTION
The circuit diagram of the timer is shown in Fig. 1. An oscillator is formed by a CMOS 4093 Schmitt NAND gate (IC1a) and is followed by a CMOS 4040 12 bit binary counter (IC2) wired as a divider. This gives a square wave with a 12 second period at the output on pin 1. This combination was chosen as oscillators running at higher frequencies are usually easier to keep stable than those running at lower frequencies. Even so, this type of Schmitt oscillator must have a well regulated supply, such as that provided by the 78L05 used in this design. The output of IC2 is passed through another NAND gate wired as an inverter to correct the phase of the clock for the shift register IC3 and IC4. It is these two integrated circuits and their interlinking that forms the heart of the Mastermind Timer. To understand their operation it may help to refer to the timing diagram (Fig. 2) and the i.c. pinout diagram (Fig. 3).

When the timer is switched on, the register will take up a random state and start clocking. After a time (maximum of 2 minutes), pin 12 of IC4 will go high and force the reset line high. This clears both stages of IC3 and the first stage of IC4 and consequently extinguishes all the lamps. It also holds the divider (IC2) in the non-operating mode.

On pressing the start button (S1) the second stage of IC4 clears and the RESET line goes low. IC2 starts counting. After 12 seconds, the clock causes the first shift in the registers IC3 and IC4. The first output (pin 5) of IC3 goes high, having clocked the input (pin 7) which is tied to +5V. After a further 12 seconds another shift occurs and the second output (pin 4) also goes high.

At 96 seconds, all the outputs of IC3 are high. The final output of IC3 acts as the input of IC4 (pin 7) and so after another 12 seconds (108 seconds total) the first output of IC4 goes high (pin 5). During the 12 seconds a lamp is flashed at 3 second intervals by using the 3 second period output of IC2 (pin 14) gated with period “9” (IC1b and IC1c).

At 120 seconds the second output of IC4 (pin 4) goes high, causing the buzzer to operate. This output also acts as the input to the second stage of IC4 (pin 15) which is being...
clocked at 3 second intervals (pin 1). Six seconds was thought to be sufficient time for the buzzer operation so the second output of the second stage of IC4 (pin 12) is used to stop the buzzer by causing a reset. The timer is now automatically back in the “Ready” state. A “Hold” push-button (S2) can be used to introduce pauses in the timing if required. This may, however, affect the timing slightly as C1 will continue to charge.

LAMPS AND LAMP DRIVERS

To economise on the transformer and rectifier, and to keep the cost of the power as low as possible, the bulbs were of the T1½ LES type as these have a current demand of less than 10mA. They were still bright enough however to be seen in a reasonably large room. Similarly, the buzzer was chosen carefully for current demand versus audibility but a bell could easily be substituted. If this were done, it would be essential to use the ULN2003 to drive a relay to switch a separate power supply to drive the bell. Failure to do this could cause excessive interference in the CMOS circuits.
Fig. 4. Layout of timer board. Both boards are shown below, mounted in the case.


COMPONENTS . . .

Resistors
- R1: 33k
- R2, R3: 10k (2 off)
- R4: 3k
- VR1: 20k pre-set
- All 1W 5% Carbon

Capacitors
- C1: 47n polyester
- C2, C4: 220n polyester (2 off)
- C3: 1000µ axial elect.
- C5: 470n polyester

Semiconductors
- IC1: CMOS 4093
- IC2: CMOS 4040
- IC3, IC4: CMOS 4015 (2 off)
- IC5, IC6: ULN2003N (2 off)
- IC7: 78L05

Miscellaneous
- T1: 240V (prim) 12V (sec) 12VA
- REC1: 1A 200V p.i.v.
- FS1: 1A
- LP 1 to 10: 14V LES T1½ (10 off)
- Veroboard: 60 × 40mm and 120 × 90mm
- Fuse holder: P.c.b. mounting
- Lamp holders: as required
- Case: ABS plastic (as required)
- Lamp mounting: aluminium angle
- S1, S2: N/o momentary
- Wire and cable: as required
- WD1: Buzzer (as required)

CONSTRUCTION

In the prototype shown in the photographs, the power supply (excluding transformer) was assembled on a 60 × 40mm Veroboard and the timer circuit on a 120 × 90mm Veroboard. These two boards plus the transformer were mounted in a large ABS plastic box with the switches and the buzzer fitted in the lid.

Fig. 4 shows the layout used for the timer board and the link wires between tracks. The other interconnecting wires are loomed together down the sides of the board to produce as neat an appearance as possible given the relatively large number of connections.

The power supply board is shown in Fig. 5 with its board-mounting fuse holder. This board is quite simple and few problems should be encountered with its assembly. However, it is important to ensure the cabling is sound and adequate, especially if it is to be used by young and inexperienced people. Earthing and fusing arrangements should also be strictly adhered to.

The lamps should be mounted in a display panel with enough cable to ensure it can be seen. If possible multicore cable should be used to connect the box to the lamps but failing that instrument wire will suffice if fastened down securely. In the prototype, I had a desk mounted display consisting of an angle of aluminium (50 × 50mm) which was 600mm long drilled at 50mm intervals to take the lamps as shown in the photograph. Aluminium will oxidise very quickly after being handled producing the dull white colour normally associated with this metal. However, to prevent this the metal can be cleaned with a brillo pad (to take out the scratches and finger marks) and then, after rinsing and drying, by spraying with p.c.b. lacquer. The lamp which flashes should ideally be a different colour from the other nine to make it stand out clearly.

![Fig. 5. Layout of power supply board](image)

TESTING

The only test equipment required is a high impedance voltmeter.

1) Turn on the supply and check that the +15V and the +5V are on the correct pins. Also check the 0V pins are wired correctly.
2) Turn off and insert the integrated circuits.
3) Turn on; some lamps will be on and some off, but eventually all should extinguish. If this does not occur then the system is not clocking. Check that the output of IC2 (pin 1) is giving an output of approximately 6 seconds on and 6 seconds off. If it is, then follow the clock across through IC1d, IC3 and IC4. Check that pin 7 of IC3 is wired to +5V. If there is no output from IC2, check the input (pin 10): If IC1a is oscillating then a voltmeter will average the square wave and read approximately 2.5V. If the reading is either +5V or 0V then check the components around IC1a.
4) If all is working, adjust VR1 to give the right frequency by timing the two minutes between pressing "START" and the buzzer sounding.

Practical Electronics  August 1984
Field Measurements using a Cassette Recorder

T. P. Manning

DESPITE the ease with which data may be digitised and stored the real requirement of a lot of environmental experiments is a graph of change against time. Chart recorders are expensive items and schools and research establishments tend not to have an abundance of them, particularly d.c. powered models for use in the field. What is required is to provide as many students as possible with the means of collecting and examining their own data as cheaply as possible. I therefore adopted the policy some three years ago of advocating the collection of data on cassette tapes and obtaining the curves from the chart recorder in laboratory conditions. The advantages are many fold. The student only has to be provided with an ordinary, standard cassette recorder, the batteries and cassettes for which are obtainable almost anywhere; plus a simple converter. An expensive chart recorder is not used in "messy" environments and problems of lack of paper pens clogged etc. can no longer hamper the collection of field data and hence the ruination of a field trip. The system has been successfully used to record wave height, water and air temperatures and wind speed. The application decided upon for description, since it was slightly more specialised, is for attachment to a kite to measure air temperatures up to 300 metres, over a scale of −5°C to 30°C.

TECHNIQUE

The basis of the device is the 9400 CT, a 14 pin d.i.l. chip which as a voltage-to-frequency circuit provides 0-10kHz for a d.c. input of 0-10 volts and can be used in the reverse manner, as a frequency-to-voltage circuit. Thus the transducer’s range must be converted for an output of 0-10 volts, and the chip accomplishes the rest. Obviously in the described application weight is a prime consideration. A kite payload of 1lb was specified. The cassette recorder used is one of the miniature dictaphone types using MC60 cassettes. The machine and batteries weighs 8ozs. leaving ample allowance for the p.c.b. and PP3 batteries. The internal microphone is disconnected and the output from the V-to-F fed via the level divider and capacitor as shown. (The amplitude of the pulses coming from the V-to-F chip is 5 volts, and this level is reduced to approximately 200mV.) Although the tape recorder used has switched speeds of either 1.2 or 2.4 cm/sec (1 or 2 hours recording time) the faster speed setting was far superior. To read back the data the signal is taken from the earpiece output and fed through a pulse shaping circuit. (The chip requires a bipolar signal input of greater than ±200mV, but less than ±2.5 volts). The output will be 0-4V for 0-10kHz input. Thus scaling is arranged to individual requirements.
Fig. 1. Voltage-to-Frequency converter in the guise of temperature sensor. This circuit produces temperature-related frequencies in a range suitable for domestic cassette recorders.

Fig. 2. Attenuator network for input to MIC socket.

Fig. 3. Level correcting circuit to adapt the cassette recorder output to the F-to-V circuit input.

Fig. 4. The 9400CT configured as a Frequency-to-Voltage converter.

Fig. 5. Potentiometer is used to match F-to-V converter's output to a chart recorder.
REALTIME DATA LOGGING

Fig. 7 (below). Temperature-to-Frequency circuit p.c.b. layout (actual size)

Fig. 8 (foot of page). Temperature-to-Frequency board component layout

COMPONENTS...

RECORD UNIT

Resistors
- R1,2 4k7
- R3,4 1k8
- R5,6,12,15,16 10k
- R7,8,11 100k
- R9,10 1k
- R13 470k
- R14 1M
- R17 Platinum detector -385 ohm/°C,
  1000 ohm/0°C (RS158-244)

All resistors 1/2W 5%

Potentiometers
- VR1 200 preset
- VR2,VR3 10k preset (2 off)
- VR4 22k preset
- VR5 50k preset

Capacitors
- C1,3 220n
- C2,4 470n (2 off)
- C5 150p
- C6 600p

Integrated circuits
- IC1,2 741N
- IC3 9400CT
- IC4 78L05
- IC5 79L05
In the instrument described the requirement was a range of -5°C to 30°C. The tape recorder has a response of 315 to 4000Hz. Therefore the system was bridged to give 500Hz for -5°C and 4000 for 30°C. This frequency fed to the playback unit produces a range of 0 to 1.6V so a series resistor is used to adjust the scale to 0 to 1V to be fed to the chart recorder.

CONCLUSION
This method is flexible, economic and simple. The transducer must be bridged and amplified to appear in the scale 0 to 10V ensuring that its range is within the frequency range of the recorder and its output range set as previously described. Cheap domestic recorders have proved adequate.

<table>
<thead>
<tr>
<th>COMPONENTS . . .</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLAYBACK UNIT &amp; PSU</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistors</td>
<td>Capacitors</td>
<td>Semiconductors</td>
</tr>
<tr>
<td>R1,2</td>
<td>C1,2</td>
<td>IC1</td>
</tr>
<tr>
<td>R3,5</td>
<td>C3,5</td>
<td>IC2</td>
</tr>
<tr>
<td>R4</td>
<td>C4,6</td>
<td>IC3</td>
</tr>
<tr>
<td>R6</td>
<td>C7</td>
<td>REC1,2</td>
</tr>
<tr>
<td>All resistors 1W 5%</td>
<td></td>
<td>9400CT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>78L05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>79L05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W005 (2 off)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potentiometers</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1 50k</td>
<td>As required neons, switches, plastic boxes, diodes, tape recorders, battery connectors.</td>
</tr>
<tr>
<td></td>
<td>T1 0-6, 0-6 mains transformer</td>
</tr>
</tbody>
</table>
ZX80

Sir—The aim of this program is to convert a number in any base to its equivalent in any other base. Any number (or letter, A=11, B=12, C=13 etc), subject to the one proviso that the decimal number produced in line 220 does not exceed the machine’s limit of 32,767, otherwise error code 6 will be displayed.

Unfortunately the final number produced cannot be used in further calculation due to the method used for displaying it, although in the unexpanded ZX80, there would probably not be enough memory remaining for any further calculation.

This program has been particularly useful for converting binary, decimal and hex into each other’s bases.

Lines 160 to 260 convert the number in base (N) to its equivalent in decimal and lines 270 to 400 convert and display the number into its base (M) equivalent.

This program could be run on the ZX81, provided that the following points are taken into account:

Lines 160 to 190 could be replaced by LET A$ = LEN A$.

Line 340 should read LET D = INT (ZIY).

The character set should be checked that 0=28 and that 9 is followed directly by A, if these are not the same, suitable modifications should be made to lines 200 and 360.

Graham Lattin.
South Norwood.
London.

Note: ** denotes "to the power of" (shifted 'H')

10 PRINT "BASE(N) TO BASE(M)
20 PRINT "CONVERTER"
30 PRINT "INPUT BASE OF NUMBER YOU HAVE"
40 INPUT N
50 PRINT
60 PRINT "INPUT BASE TO WHICH YOU WISH TO CONVERT"
70 INPUT M
80 PRINT
90 PRINT "INPUT NUMBER TO BE CONVERTED, IF BASE >10, A=11, B=12 ETC."
100 INPUT B$  
110 PRINT
120 LET AS = TLS(A$)
130 LET X = X + 1
140 IF A$ = " " THEN GOTO 200
150 GOTO 160
160 LET A$ = TLS(A$)
170 LET X = X + 1
180 IF A$ = " " THEN GOTO 200
190 GOTO 160
200 LET A$ = CODE (B$) - 28
210 LET Y = A(N)(X - 1)
220 LET Z = Z + Y
230 LET X = X - 1
240 LET B$ = TLS(B$)
250 IF X = 0 THEN GOTO 270
260 GOTO 200
270 LET X = X - 1
280 LET Y = M**X
290 IF Z < Y THEN GOTO 320
300 LET X = X + 1
310 GOTO 280
320 LET X = X - 1
330 LET Y = M**X
340 LET D = Z/Y
350 LET Z = Z - (Y * D)
360 LET D$ = CHRS (D + 28)
370 PRINT D$;
380 IF X = 0 THEN GOTO 400
390 GOTO 320
400 PRINT "IS THE BASE (";M;") EQUIVALENT OF";C$;"IN BASE (";11;")"
410 INPUT X$
420 CLS
430 GOTO 10

MICROCONTROLLER

Sir—In response to your request for program material for PE computer projects, other than the UK101, I present below a program for the Microcontroller. This is part of a much longer program used for timed control of central heating and other processes.

In the original program "ky" was a subroutine located above B100 and the table only left on page 1. The program reproduced here will run as it stands, but may be modified to be used as a subroutine simply by replacing out: with $39 and 005E,005F with $39,$00. It can be seen that "setApia" is only accessed once and the rest of the program is continuously polled, facility being provided to get out and make modifications through the "cancel" key.

Thus you can override timed outputs with the keyboard one at a time without clearing or upsetting existing output states.

To test the program a I.e.d. display as described in PE Oct '82 was used. Each I.e.d. being lit by one numeric key press and extinguished by first pressing "H" and while it is held down pressing the appropriate numeric key.

C. Gardiner.
Brighton.

KEYBOARD

keyboard = SF82C
TABLE located on page 1 (0000–0007) at $71$

PIA Preparation Subroutine

Keyboard polling and PIA output modification routine

Get monitor keyboard subroutine. Has a key been pressed? Has a key been pressed?... Set all user pia... Is keypress doubtful?... Is key any hex number key?... Is key the # key?...Send key code to H key memory. Go back to main program. Retain hex number value. Set Table-I to zero... Only 8 functions are required (Change if necess)... Reject any other keys. Raise key value so 0 key can be used... Point I.R. to next Table value... Reduce key value by 1... Test if key value now zero... Get the binary mask from the table and... store it then... invert it. Retain the complement of the mask... Enter the $H$ key code and... check $H$ store to find if $H$ key down. Yes—so set selected output to off. Make complement of the mask zero instead. Get current pia output status. Modify pia output by... one bit selected by the key pressed. Send modified status to pia. Back to beginning. Clear $H$ key memory. Back to beginning.

Practical Electronics August 1984
0250 A57B LDA $7B
0252 8558 STA $58
0254 A57C LDA $7C
0256 8559 STA $59
0258 A966 LDA $E6
025A 8D1B02 STA $0218
025D A902 LDA $02
025F 8D1902 STA $0219
0262 A960 LDA $60
0264 8503 STA $03
0266 A559 LDA $59
0268 C57E CMP $7E
026A 9019 BCC $0285
026C D006 BNE $0274
026E A558 LDA $58
0270 C57D CMP $7D
0272 9011 BCC $0285
0274 A94C LDA $4C
0276 8503 STA $03
0278 A9BA LDA $BA
027A 8D1B02 STA $0218
027D A9FF LDA $FF
027F 8D1902 STA $0219
0282 4C0000 JMP $0000
0285 A202 LDX $02
0287 A93F LDA $3F
0289 8513 STA $13
028B A000 LDY $00
028D B158 LDA ($58),Y
028F 20EEFF JSR $FFE
0292 8514 STA $14
0294 C8 INY
0295 B158 LDA ($58),Y
0297 48 PHA
0298 297F AND $7F
029A F006 BEQ $02A2
029C 20EEFF JSR $FFE
029F 9513 STA $13,X
02A1 E8 INX
02A2 68 PLA
02A3 1018 BPL $02BD
02A5 A000 LDY $00
02A7 B9DB02 LDA $02DB,Y
02AA F00E BEQ $02BA
02AC C8 INY
02AD 9513 STA $13,X
02AF E8 INX
02B0 D0F5 BNE $02A7
02B2 B9DB02 LDA $02DB,Y
02B5 F00B BEQ $02C2
02B7 20EEFF JSR $FFE
02BA C8 INY
02BB D0F5 BNE $02B2
02BD A93D LDA $3D
02BF 20EEFF JSR $FFE
02C2 A558 LDA $58
02C4 18 CLC
02C5 6906 ADC $06
02C7 8558 STA $38
02C9 9002 BCC $0CD
02CB E659 INC $59
02CD A000 LDY $00
02CF 9413 STY $13,X
02D1 840E STY $0E
02D3 A212 LDX $12
02D5 68 PLA
02D6 68 PLA
02D7 68 PLA
02D8 68 PLA
02D9 8A TXA
02DA 60 RTS
02DB 24 $
02DC/43 C
02DD/48 H

initialisation starts here

copy 7B,C into 58,9 to be variable pointer

make input vector point to variable list

routine, A

make variable pointer point to next

variable

put marker at end of BASIC input buffer

put in BASIC input buffer

put ?(PRINT) into BASIC buffer

find first character of variable

print it

put in BASIC input buffer

find second character of variable

is it a string variable?

YES—put $CHR$(34) into input buffer

print $="

NO—print =

are there any variables left to print?

disable OK

are there any variables left to print?

actual program starts here

put in BASIC input buffer

print it

are there any variables left to print?

restore input vector

DOF5 $24/00

WEMON monitors and should work with any monitor if the input vector is at

0218,9(Hex) and points to $FFBA(Hex). The table of variables used by BASIC are stored
directly after the last line of BASIC and the address of the start of the table is held in

Page zero locations 7B,C. Location 7D,E holds the first free address after the table.

Locations 13(H) to 58(H) form the BASIC input buffer.

When the program is first called, by

setting the input vector to point to 0250,

the initialisation routine: disables the OK

which would be output after printing each

variable; copies the contents of 7B,C to

58,9 which acts as the pointer to each

variable; and makes the input vector point

to the start of the actual program which

first compares 58,9 with 7D,E to see if

there are any variables left to list. If there is

none left it resets the input vector back to

$FFBA, restores OK and executes a WARM

START to get back to BASIC. If there is a

variable left to list, say AB, it will print

AB=", put ?AB into the BASIC input buffer

and return to BASIC to print the value of

AB. On the screen you will see AB=1 (or

whatever). If it is a string variable, say ABS,

it prints ABS=" and puts ?ABSCHR$(34)

into the buffer (character 34 is a quotation

mark) giving the output

ABS="WHATEVER". The quotation marks

were put in to show up string variables

made up of spaces and also to allow

variables to be saved on tape by setting the

save flag and running the list variables

program: if there were no quotation marks

on string variables it would give a type mis-
mach error when loading in immediate

mode. To run the list variables program

type POKE 536,80:POKE 537,2 in

immediate mode. Incidentally, RESET WARM

START does not destroy variables. The

following program lists all variables except

arrays.

Sir—While working on a 380Z at school I

found that I used the LVAR command a lot

when writing or testing programs, and that

I missed this when working at home on a

UK101. To put this right I wrote this

machine code routine (left) which lists all

the variables which have been created by

BASIC. It works with the UK02 and

WEMON monitors and should work with any

monitor if the input vector is at

0218,9(Hex) and points to $FFBA(Hex). The table of variables used by BASIC are stored
directly after the last line of BASIC and the address of the start of the table is held in

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immediate mode. Incidentally, RESET WARM

START does not destroy variables. The

following program lists all variables except

arrays.

David Rogerson,

Morpeth,

Northumberland.
The Economy

Optimism has been bursting out all over following first quarter results and forecasts for the future. Both CBI and Institute of Directors surveys of business opinion revealed high levels of confidence. In our own industry a major indication is the level of component sales. The Association of Franchised Distributors of Electronic Components (AFDEC) sees 1984 as a bumper year, so much so that there will be a shortfall in some component categories and principally i.c.s.

The manufacturers are responding with gusto. Texas Instruments is only one of many stepping up output. TI is spending £10 million to more than double output of linear i.c.s. by 1985, in the plant with the prospect of another 400 people employed by next April. A group of companies from California is setting up a new company, Integrated Power Semiconductors, at Livingston, Scotland. Funding of £15 million guarantees an immediate start on plant construction and IPS will eventually employ about 500 people.

On the R & D front the Alvey programme is at last getting off the ground with a £3.6 million award for a prototype project. Defence electronics is moving smartly ahead with major contracts. Pessey's Partmigan secure tactical radio communications system has won a second phase contract worth £200 million of which £34 million goes to STC as a principal subcontractor.

Marconi Space and Defence Systems (MSDS) has scooped a £100 million contract to provide a new airborne electronics counter-measure system. Called Zeus it is initially to be carried by RAF Harrier close support aircraft. Partner in the deal is Northrop Corporation of Chicago who will supply the jamming transmitters but MSDS has total responsibility for design and engineering.

Zeus is a good example of Anglo-American co-operation and justified if only because the American-built version of the Harrier, the AV8B, has commonality with the British-built GR5 Harrier of the RAF. Northrop is undertaking joint marketing of Zeus in the USA and other countries so the £100 million order could just be the beginning. Meantime that alone will keep 500 people busy at MSDS plus those employed at over a hundred outside suppliers.

Critics of defence spending often overlook two important factors. First is the ultra-high technology content which keeps our designers on the frontier of development and second is the high value added.

Very roughly if a military aircraft and its electronics cost, say, £10 million, the cost of raw materials would be under £1 million with the difference made up entirely in design and manufacturing skills. Very few countries have this measure of engineering capability whereas any country can press out kitchen utensils and similar everyday products which have low added value.

Salaries

Studying the situations vacant columns it is clear that the demand for qualified electronic engineers remains insatiable. According to a recent membership survey by the IEE 98.9 percent were in employment. Salaries in the 35-39 age group (i.e. at typical career midpoint) have risen from an average of £3,280 in 1973 to £14,470 in 1984. A young Associate should command over £6,000 on his/her first appointment while senior Members and Fellows can achieve £28,000 late in their careers and £30,000 and over in senior management.

It is a tragedy that so few young people are motivated towards getting the admittedly high qualifications needed for professional status and too few of the schoolteachers must bear some blame. When we learn that half of all employers who recruit school leavers are dissatisfied with educational attainment there must surely be cause for concern.

The brighter students of course will have moved on to further education but even here we could do with more in science and engineering and fewer in arts. It is to be hoped that the increase in computer studies in schools will fire the imagination in favour of electronics. It is also true that many successful engineers have had no formal training but have succeeded through enthusiasm and love of the subject. Nevertheless, other things being equal, the certificated engineer will always influence a potential employer to the disadvantage of a competitor less qualified.

Footlights and Whisky

Two unlikely topics for Industry Notebook but both worth a mention first. I was not surprised to hear that Evan Steadman, owner and organiser of the "All Electronics Show" and other trade and technical exhibitions, has branched out into popular entertainment as a backer of the musical 'Pag' in London's theatreland. Evan has always been a showman and it was always on the cards that he would succumb to the heady scent of greasepaint and the dazzle of footlights. We wish him success with his investment.

Less predictable was GEC's purchase of 10 million shares in Distillers. It seemed hardly likely that Lord Weinstock was planning a takeover and, in fact, his £45 million investment made over a lengthy period amounted to only some 3 percent of Distillers capital. GEC is still sticking to what it knows best. But with a cash mountain in the region of £1.5 billion Lord Weinstock has decided to invest in other companies and as a bonus is willing to give management advice.
THE digital dice described in this article has several novel design features not usually available with electronic dice:

a) Single push-button operation for each ‘throw’ of the dice which provides two independent readouts for games such as backgammon and monopoly.

b) Seven segment displays for an easily readable display format.

c) No power on/off switch. The dice display remains active for over five minutes after the push-button has been depressed.

d) A l.c.d. for clear readout in all lighting conditions.

e) Minimal power requirements. Hence the dice is totally portable using a PP3 battery as a power source.

PRINCIPLE

Most designs of electronic dice use six independent l.e.d.s to display the numbers one to six rather than using a more readable seven segment display. Looking at the extensive range of i.c.s currently available, particularly counters and display decoder drivers, it seems surprising that dice using seven segment displays are not more common. However, consideration of the counting modes of i.c. counters shows only a binary range of 0 to 15 or a binary coded decimal range of 0 to 9 is available. A range of 1 to 6 can only be achieved by a complex gating arrangement using standard counters and a variety of NAND and NOR gates.

This particular design of digital dice overcomes these problems by using only a four bit down counter which interfaces directly to a binary coded decimal to seven segment display driver. The basic ‘secret’ of the design is simply to use a presettable binary down counter which presets to six and then counts down to 0. On reaching 0 the borrow output pulse is used immediately to preset the counter to 6 again. Fig. 1 shows the block diagram of the digital dice.

The oscillator operates at a frequency of approximately 3kHz which is divided by two, series connected, divide-by-six counters. Hence a final frequency of around 65kHz is available to drive the l.c.d. directly and hence ensure correct operation of the display. As this low frequency drive must be continuous for the time the display is active, the oscillators and counters must be permanently enabled when the display is active.

When the push-button is depressed, which is equivalent to a ‘throw’ of the dice, the display drivers are disabled, which blanks off the display for the period the push-button is depressed. At the same time the clock input to the two divide-by-six counters is disabled and the binary output from the counters at that instant is stored in the display decoder drivers. When the button is released the new ‘throw’ of the dice is displayed.

As the oscillator and counters are free running most of the time there is no possibility of cheating by pushing the button for a known period of time, or by pushing the button at defined intervals. That is, unless you can depress the switch to an accuracy of less than one thousandth of a second.

The push-button is also used to charge a large capacitor directly from the PP3 battery. This capacitor drives a transistor which connects power to the digital dice circuit. The capacitor takes approximately five minutes to discharge and switch off the transistor which consequently removes power from the digital dice circuit. As only CMOS i.c.s are used and the l.c.d. power requirement is negligible, the total power consumption is only around 2mA. Hence a PP3 battery is quite adequate to power the dice, making it totally portable.

CIRCUIT DESCRIPTION

The circuit diagram of the digital dice is shown in Fig. 2. The two NOR gates IC1a and IC1b form a 3kHz oscillator using negative feedback with the capacitor C6 and resistor R4 controlling the frequency of oscillation. Although the
exact frequency is not critical resistor R3 is included to give stability to the output of the oscillator which is buffered by IC1c before being connected to the clock input of the first divide-by-six counter (IC2).

The borrow output from this counter, as mentioned earlier, is connected to its preset load input (pins 13 and 11) to ensure the counter presets to six immediately it reaches 0. Capacitor C5 is included to ensure that the borrow output is of sufficient duration to load the counter correctly. The binary coded decimal output from IC2 is connected directly to BCD seven-segment decoder driver IC4.

The divide-by-six output from IC2 pin 6 is connected to the second divide-by-six counter (IC3) via the NOR gate IC1d. This counter and its BCD seven-segment decoder IC5 are connected in an identical manner to IC2 and IC4. The output from pin 6 of IC3 is approximately 65Hz which is used to drive the I.C.D. and the decoder drivers IC4 and IC5.

The OV from the battery is connected directly to the OV of the logic. The positive terminal is connected to the emitter of TR1. This transistor is switched on only when capacitor C1 is charged to a value greater than the base/emitter junction voltage of 0-7V. The collector of TR1 is connected directly to the Vcc of the logic. When the change-over, push-button switch is depressed the battery is connected directly across capacitor C1 which fully charges it, turning TR1 hard on. The battery voltage is then connected to the logic. The change-over switch also disconnects the enable earth to the clock buffer gates IC1c and IC1d which disables the clock to the counters and hence inhibits counting. At the same time the display drivers are disabled and hence the I.C.D. goes blank. The display will remain active for the time it takes capacitor C1 to discharge through R1. With the particular values of R1 and C1 chosen, the display will remain for approximately 7 minutes before switching off.
CONSTRUCTION

The p.c.b. design for the dice is shown in Fig. 3 with the component overlay shown in Fig. 4. Sockets or soldercon pins should be used for mounting all the i.c.s and special care should be taken with the orientation of the i.c.s as their positions alternate. The push-button switch S1, which is mounted directly onto the p.c.b., secures the board to the lid of the case.

Although a 3½-digit l.c.d. was used in the prototype a 4-digit display would also be suitable as it is pin-for-pin compatible. The l.c.d. is mounted onto the board by using three soldercon pins, one soldered inside the other, on each l.c.d. pin. This gives additional height to the display above the p.c.b. The electrolytic capacitor C1 is mounted on the copper side of the board and care should be taken that the body of the capacitor is clear of the tracks.
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Of ever increasing interest and importance are robotics, and PE has been at the forefront of this subject, having featured as constructional projects the first educational servo controlled robot and the first low pressure hydraulic robot. These robots are now a common sight in the education institutions and R & D laboratories throughout this country and abroad.

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THE BEGINNING

Fifty three years ago Karle Guthe Jansky became the first radio-astronomer. He had graduated from the University of Wisconsin and taken up a post with the Bell Telephone Laboratories. The company posted him to a field station in New Jersey. There he was assigned to the investigation into the causes of interference on trans-oceanic links. During the course of these observations he noticed certain peculiarities on a band of frequencies between 20MHz and 21MHz. He then built an aerial on an old Ford chassis which enabled him to point the system in azimuth.

At the time of these experiments there were many unknowns both in regard to receiver sensitivity and the origins of the signals. After many trials and modifications to his apparatus he noticed that there was a change in the position of a band of noise which he had first thought to be coming from the Sun. As time went by it was clear that the source was not the Sun as Jansky was eventually receiving signals in the middle of the night. From this he concluded that the source was outside the solar system and situated in the direction of the Milky Way. He offered two thoughts on the subject. Firstly, that the radiations must be coming from a body in space that was emitting radio waves in a greater amount than light and heat. Secondly, the sounds that he heard from the output of his receiver were very similar to those produced by thermal agitation in a resistor carrying a current.

He considered that a mechanism of this kind, where charged particles were in constant agitation such as in stars, would explain the origin of this radiation. The temperature required to produce this kind of radio emission would be in the region of 15,000 to 20,000 degrees Kelvin. Later observations by those who came after Jansky fully confirmed this view.

Jansky gave his famous paper in 1932 and caused a considerable stir with broadcasts of the noises from his receiver. However, except for a few amateurs his efforts did not succeed in inspiring the professional astronomers. It is impossible to overestimate the importance of Jansky’s work for here is another example of a turning point in history where research directed to one goal, opens up an entirely new avenue of discovery. His ability to recognise the unusual brought light to a new area of scientific thought and revolutionised an industrial horizon. It is perhaps fitting that the last paragraph of Jansky’s paper published in 1932 reads, "In conclusion, data has been presented which shows the existence of electromagnetic waves in the Earth’s atmosphere which apparently come from a direction that is fixed in space. The data obtained gives the coordinates of this direction as a right ascension of 18 hours and a declination of -10 degrees. This was the part of the Milky Way toward the galactic centre."

Soon after the publication of his paper Jansky was transferred to other duties and did not pursue the subject further. He was not in fact a very robust man and he died before the full impact of his early work was recognised. However, one of the amateurs who was inspired was a radio engineer, Grote Reber, who decided to work at frequencies higher than those which Jansky used. He reasoned that he could expect better results. He chose a frequency of 160MHz. In fact his reasoning was incorrect. There were in those days severe limitations in the techniques available and a lack of sensitivity with receivers. Reber built himself a 30 foot diameter dish of wood and aluminium for 160 to 170MHz. He caused some considerable disturbance to his neighbours for as the dish cooled down at night the contraction of the metal sounded to them like gunshots, and when it rained the water poured down through the centre hole provided for the aerial, they thought he was making rain.

Reber succeeded in making a map of the sky and this map is still valid to this day. He continued his own work and was concerned with the development of the new high frequency valve techniques. After the second world war he devoted much of his time to very low frequencies, working in Tasmania. Reber’s dish was in fact the first of the parabolic aerials used for radio astronomy. It is now at the Bureau of Standards site in Virginia.

It would be an unjustified omission if an even earlier link with the past was not mentioned. The first indication of the existence of electromagnetic waves came from the publication of Maxwell’s theory in 1865 though it was not till some 23 years later that Hertz was able to obtain sufficient evidence to confirm it. This article is published as a tribute to Frank W. Hyde who died recently — an obituary was published in Spacewatch, June issue.
possible to receive solar radiations by connecting a sensitive Receiver, the electronics and a Recording system. In fact it is an arrangement which can be shown as analogous with respect to THE TECHNIQUES positive fact is now of course abandoned. Astronomy in Reading textbooks of the 1920's helps a little to put matters of astronomy, X-Ray astronomy and Gamma -Ray astronomy become large enough to have sub-divisions such as Infra -Red from those who entered the field that now 40 years on it has come to accept their new sister and such was the enthusiasm the war was over. It was inevitable that the professional astronomers should come to accept their new sister and such was the enthusiasm from those who entered the field that now 40 years on it has become large enough to have sub-divisions such as Infra-Red astronomy, X-Ray astronomy and Gamma-Ray astronomy using the techniques of radio to expand horizons even further. Reading textbooks of the 1920's helps a little to put matters of Astronomy in perspective for much that is given there as positive fact is now of course abandoned.

THE TECHNIQUES
The principle of the radio-telescope is a simple electronic arrangement which can be shown as analogous with respect to its optical counterpart. It consists of a Collector, the aerial, a Receiver, the electronics and a Recording system. In fact it is possible to receive solar radiations by connecting a sensitive receiver to a directional aerial pointed at the Sun, many people began that way. With the amateur now at an advanced state of electronics, there is another fascinating hobby that is available to individuals as well as schools and colleges or youth centres.

WARTIME ADVANCEMENT
The advent of the second world war changed many things, more sensitive receivers, more efficient aerials and many more people were engaged in searching in the atmosphere for enemy activity. Quite a mass of data was available but of course could not be published. Not surprising then was the fact that people gravitated toward this new window to the universe. One significant name here is that of J. S. Hey who in 1942 proved the existence of the radiations from the Sun. In this instance a sun-spot was visible to the naked eye so both visual and radio recording was available. This was confirmed by G. C. Southworth of Bell Telephone Laboratories some six months later. These observations were taking place while both Hey and Southworth were operating at government establishments and consequently no information was available to the public.

Hey was troubled by an incident in the English Channel. Considerable apprehension existed during February 1942 as to an imminent German invasion. It was the sudden interference with radar performance which made it necessary for Hey to be sent to investigate. Since the radar aerials were highly directional and could be pointed to any part of the sky it was easy to discover the source of the interference. At this time it became clear to Hey, as Nordmann had stated, that radio waves were associated with sun-spots. The radio frequency involved in Hey's work was between 55MHz and 80MHz. Southworth was using frequencies between 3,000MHz and 10,000MHz.

It is accepted now that Solar emissions are extremely complex and there is still much work to be done. This applies to many of the areas of the sky where so much has been accomplished but only serves to show that man has still only just touched the fringe of understanding. With the building and expansion of radio-telescopes the name of Radio Astronomy replaced the old definition of Radio Physics and things moved apace even before the war was over.

It was inevitable that the professional astronomers should come to accept their new sister and such was the enthusiasm from those who entered the field that now 40 years on it has become large enough to have sub-divisions such as Infra-Red astronomy, X-Ray astronomy and Gamma-Ray astronomy using the techniques of radio to expand horizons even further. Reading textbooks of the 1920's helps a little to put matters of Astronomy in perspective for much that is given there as positive fact is now of course abandoned.

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Fig. 1 compares a reflecting optical telescope with a simple radio-telescope using a parabolic reflector and receiver with recorder. A typical recording from a radio-telescope is shown in Fig. 2. This recording is of the Sun as it passed through the aperture of the aerial main lobes. The frequency of the system was 81MHz. It is a good example of the change of level that occurs when the Sun comes 'into view' against the background. The straight lines of the pen on the paper indicates overloading of the receiver at meridian passage of the Sun. There are several basic designs which can operate separately or in combination. These are shown in Figs. 3, 4 and 5 (overleaf).

The simple radio-telescope shown in Fig. 1 would of course be used depending on the frequency of the radiation. However, since the resolution of the energy depends upon the resolving power of the system radio-telescopes are in the main large when compared with the optical system, other methods are necessary in order to obtain satisfactory data. Fortunately there is a solution based on the Michelson optical interferometer.

Michelson used two mirrors twenty feet apart mounted on the
100 inch Mount Wilson telescope. The purpose of this arrangement was an attempt to measure the diameter of stars. The mirrors were so arranged that the light from the stars would be reflected into the telescope so that it travelled by differing paths. This would produce fringes at the eyepiece. Optical theory indicates that the diameter of a star is a function of the wavelength of the width at which it is examined and the distance between the two mirrors. Increased resolution was obtained, the effective aperture of the telescope being extended to the width of the two mirrors.

Utilising this principle Ryle and Vonberg used two separate aerials on a long base line. The energy collected by the two aerials was fed into a receiver simultaneously. With such an arrangement, the aerial system as a whole has a polar diagram beam in the shape of a fan (Fig. 3), in which occur a number of interference patterns or lobes. The width of each lobe will be dependent upon the angular separation between the points of minimum signal. The angular separation decreases as the distance between the aerials is increased, so if the aerials are separated by 20 wavelengths the minimum points of the lobes will be separated by approximately 3 degrees at the half-power points. A further separation will reduce the width between these minimum points. If now a radio source is of smaller diameter than the width of the lobes, the output from the receiver will maintain a fairly constant level. From this it will be appreciated that the resolution of the telescope is increased enormously.

The aerials are usually set up on an East to West baseline and the rotation of the Earth serves to sweep the beam across the heavens. Each individual aerial system can be moved in altitude thus enabling successive strips of the sky to be studied. Though valuable work can be done with this arrangement there is one drawback. Local interference could obscure weaker input signals. Ryle and Vonberg took their version of the Michelson interferometer a stage further so that it could overcome the principal difficulties of positional identification of radio sources. If an extended source of radiation is near to a smaller source it may become difficult to resolve the two, the larger source causing ambiguity. The new system was a method of phase switching which in effect moved the lobes of one of the aerials against those of the other. The method of doing this was to insert a half wavelength section of cable between one aerial and the input to the receiver (Fig. 4.—The phase-switched interferometer). It is usual to use a particular circuit design which switches the half-wavelength alternately in and out of circuit. This produces a lobe pattern which is only present when a source is intercepted. When no source is above the sensitivity of threshold the recording is a straight line and when a source is encountered the result is shown in Fig. 4.

So far the system receivers that have been described are used for the location of sources. In order to give an exact value to energy being received it is necessary to have a standard source as a comparator. This type of telescope can, in its basic form, search for and locate sources with an additional facility to evaluate their power. This is accomplished by switching a comparison signal, from a calibrated source, rapidly from the radio source to the standard. Such a system was devised by Dicke in America and modified by Ryle and Vonberg at Cambridge. The block diagram of the layout is shown in Fig. 5. Each system used is selected or designed for the job such is the sophistication of present day instruments. From the simple pen recorders of the earlier days it is now possible with the latest plotters to make maps of areas showing size and power of the sources which look like 3-dimensional views.

Fig. 3. (a) Simple interferometer
(b) Polar diagram
(c) Output from recorder chart in presence of source

Fig. 4. (a) Phase-switched interferometer
(b) Output from recorder chart in presence of source
LOOKING OUT FROM THE EARTH

The Earth is but a small speck in the Solar System. It is also very young and for many people it is difficult to accept the fact that looking outwards into the sky means looking always into the past. Though new stars are coming into being every second (areas like the Nebula in Orion) it takes time. Glance at the Sun (with suitable eye protection of course) and it is seen as it was 8 minutes previously. A look at the Spiral Galaxy in Andromeda reveals its condition as it was 2-2 million years ago. Even to look at the Moon is to see it as it was 1.25 seconds before. Radio-astronomy opened up so much to the astronomer that comparing before and after is nearly impossible. The meticulous work in observation by those who were eminent in their fields has not been wasted, for at many points the conjectures offered by them have been confirmed. The vastness was recognised but the contents of that vastness are still to be catalogued. Sufficient classification has now been made to title broad divisions.

RADIO EMISSION FROM THE SUN

With a minor star for our Sun (and close by) there naturally has been a concentration of radio-observation. It is interesting to compare the types of emission for the greater part of the Sun's energy is given out in the visual part of the spectrum. Over the band there is little change in level. Variations of the luminous flux alters by no more than a few per cent. In contrast to this the radio-emission changes all the time. There is a constant quiet component which is relatively unchanged and superimposed on this are slow enhancements and sharp bursts whose intensity can reach several million times that of the quiet component. The bursts and slow variations are manifestations of the activity of the G-type star which commands all the life of planet Earth. The energy is given out in the visual part of the spectrum. Over the band there is little change in level. Variations of the luminous flux alters by no more than a few per cent. In contrast to this the radio-emission changes all the time. There is a constant quiet component which is relatively unchanged and superimposed on this are slow enhancements and sharp bursts whose intensity can reach several million times that of the quiet component. The bursts and slow variations are manifestations of the activity of the G-type star which commands all the life of planet Earth. The whole of the electromagnetic spectrum is involved.

The apparent visible size of the disc, the photosphere, is in constant turmoil and what appears to be brightly shining smooth surface is in fact made up of small areas of constantly varying temperature. These areas are in the order of 600 to 700 miles in extent. Occasionally the surface has areas which are dark against the bright surface. These are the sun-spots which sometimes have a disastrous effect on radio communications and the atmosphere of the Earth. These sun-spots appear in cycles and were observed in ancient times, and so a complete mythology now surrounds them.

Scientific observations have been carried out since the year 1610 by J. Fabricius of Holland. These were direct observations. Galileo was the first to observe them by the projection method. Newton also used the method in his study of the colour spectrum. These spots have a variable rhythmic cycle between 10-2 and 11-2 years and is also overlaid with longer overall variation between 170 and 200 years which is not yet entirely accepted. The effect on communications is such that superimposed on radio and television in the 1948 peak the taxi drivers in New York were heard in the British Isles and the enhanced Aurora Borealis brought disturbance of the television picture and spectacular visual display as far as 35 degrees latitude. If the very large spots, sometimes a single group could cover hundreds of Earths, are observed on a large projection screen the changes which are taking place all the time can be directly observed. This was done at the author's observatory where for the first time in history sun-spots were shown on the BBC programme 'Sky at Night' with Patrick Moore.

So far as the Earth is concerned the Sun is the most powerful source available for observation and is ideal for the amateur since only a minimum of apparatus is needed. From the radio point of view it matters not whether the Sun is actually visible optically for the atmosphere, no matter how clouded, is transparent to radio emission except at certain special very high frequencies. Simple aerial systems can even be operated from a block of flats or a bungalow in the suburban areas. If the system is set up properly then multiple observations by interested amateur astronomers whether as individuals or in groups would be a valuable contribution to the data banks, or merely pursued for the hobby interest. Some of the systems can be arranged to double up for the observation of satellites and space stations.

There are two other powerful sources that are available for study with simple units, these are in the constellation Cassiopeia and the Crab Nebula. There is also the planet Jupiter but this needs greater physical space and would be suitable for those living in the urban and country districts, though of course schools and colleges are better able to cope in built-up areas. It is important to accept that radio-astronomy does not require that the observer be present at the telescope. It is a hobby therefore which...
does not upset normal routine. This means that having decided on the plan of a project all systems can be put on time control and allowed to operate automatically. However, if the observation is being carried out on the Sun then it will come to meridian passage every day at midday. With other sources the time of meridian passage will change each day. This of course also means that the conditions are reversed if the observatory is south of the equator. This would naturally mean that there could be a world ‘net’ of observers. However, whatever the horizon seen by a single enthusiast the motivation in the pursuit of this hobby is not necessarily a direct interest in radio-astronomy, much of the progress in optical-astronomy for instance was made by enthusiasts who sought to improve the techniques themselves. That is to say the improvement in the making and polishing of mirrors, the manner of mounting the assembly, the control system, the improvement in photographic techniques and processing. This is still an on-going activity in the whole of the astronomical world.

Naturally it follows that readers of Practical Electronics are concerned largely with electronics but the mechanical precision of robotics has also become a part of the design considerations for new astronomical endeavour. The problems that need to be solved always should be directed to the main requirement and constant up-dating of the design specification. It has taken many years to reduce the weight of the large reflector telescope. Indeed one highly respected optical-astronomer was always somewhat vociferously critical of such items as the Questar table top reflector, condemning it as a toy for the dilettante and that there was only one rule to be followed and that was that the weight of the assembly shall not be less than ‘Half a ton per inch of diameter of the main mirror’. An average size of mirror for an amateur would be some 8 inches diameter to do any effective observation. Thus these ‘standard?’ rules of thumb need looking at more closely. The modern electronics field offers great scope for innovation. Much of the technology already available is highly sophisticated but the challenge is still there to improve, whether it is to reduce cost, number of components, size and so on. Radio-astronomy, though, it has become in a sense an opener of wide horizons, must of necessity become wider, and clearly the lesson of the twentieth century is a support of Einstein’s words that the universe is ‘finite but boundless’. It follows that the technology must therefore be the same.

Orbiting Observatories: The various types of orbiting telescopes were originally directed at special objects alternatively special arrangements were made for the attitude control of the vehicle. The latest of these was the IRAS satellite which was featured in the May issue of Practical Electronics. This was a purpose built telescope for short term observations in a special area of the infra-red spectrum. There will be later in this decade a very large optical telescope launched into orbit and this will no doubt open up further vistas and bring surprises. The electronics associated with such a project are very varied and complicated for not only has the guidance system to operate to extremely close limits but accurate re-setting will be of prime importance. Where very distant sources are concerned such re-setting will involve only microscopic changes in positional orientation, and all this in free space. This again emphasises the accuracy of the electronics. On Earth the control of the large telescope at Mauna Kea Hawaii is now capable of being controlled from a chair in an office of the Edinburgh Observatory. This is largely over standard links of communication networks and again emphasises not only the versatility of the electronics but also indicates again the need for faster operating switch networks. This is a major area of research at the moment. Now it is of course true that this is a matter which has been tackled already and at least three major companies are looking for a solution. So in a very short time the limit of silicon chip technology is holding up the innovations which are already waiting. Forward movement in all technology seems to be logarithmic, the periods between each new level of advancement get shorter and shorter.

X-Ray and Gamma-Ray Astronomy: Here again the special needs of the detectors require sophisticated electronics to provide a means of translating the observations. This area of operations is not really accessible to the amateur and perhaps should not strictly speaking be referred to as radio-astronomy, the electronics still apply.

CATALOGUES OF THE RADIO SKY

The Cambridge catalogue was the first comprehensive attempt and is the accepted standard. Over the years a series has appeared. At Cambridge under Prof. Martin Ryle (Sir Martin Ryle, Nobel Laureate, a Fellow of the Royal Society and Astronomer Royal) together with a team who have themselves become household names, Professor Anthony Hewish FRS and Ryle, Nobel Laureate, a Fellow of the Royal Society and who became Head of the Royal Greenwich Observatory who has now taken over Jodrell Bank from Sir Bernard Lovell FRS to mention only three of many who have passed through Cambridge and contributed to these records. In the early 1950’s a catalogue was compiled in which the sources that are accessible with the simplest radio-telescope are marked. Since that time the improvements in electronics have enabled the amateur to deal with many more sources. Indeed there is a challenge here for a design of a sidereal clock which should be able to show the incremental change of ten seconds per hour in sequential display which has a read out in Hours/Minutes/Seconds. (A design by J. S. B. Dick was published in our October ‘81 issue—photostats available for 75p from the editorial offices—Ed.)

In concluding this short review of the potential for the amateur it is possible that there are readers who are looking at the future for an entrepreneur package radio-telescope. Could it be that another Sinclair could arise?
work carried out in the United States. Let us become headline news because of important home-a subject which has caused endless wrong?

am glad to have known him. missed, but he will certainly not be forgotten. I gift for imparting knowledge, will be much impressive.

med with technical equipment, and was most

in a Martello tower near Clacton. It was cram-

radio astronomy observatory which he set up

humour. I well remember my first visit to the

respects he was unorthodox, which is no bad

to the science of radio astronomy. In some

the value of the contributions which he made

Frank, with his genial personality and his

gift for imparting knowledge, will be much missed, but he will certainly not be forgotten. I am glad to have known him.

QUASARS: COULD WE BE WRONG?

Now, something much farther from home—a subject which has caused endless discussion since 1963, and which has again become headline news because of important work carried out in the United States. Let us turn to those enigmatical objects, the quasars.

Quasars were identified originally because of their radio emissions. Superficially they look like bluish stars, but they are much more dramatic than stars, because according to most astronomers, they are the nuclei of very active galaxies, and there may be an evolutionary link between quasars, Seyfert galaxies (systems with condensed centres and weak spiral arms) and more normal radio galaxies. But how do we measure quasar distances? There is only one way: by using the Doppler effect. A receding object has its light slightly reddened, because the effective wavelength is increased, and the spectra show this well, because the lines are moved over toward the red or long-wave end of the spectrum. The greater the red shift of the spectral lines, the greater the velocity of recession; and since recession velocity is linked with distance, the distance of the object can be worked out. On the conventional picture, PKS 2000-330 is racing away at well over 90 per cent of the velocity of light.

But . . . could there be a serious mistake? If the red shifts are not pure Doppler effects, we could be grossly overestimating the distances. And this is what is believed by some very eminent scientists, including Sir Fred Hoyle and, in America, Halton C. Arp.

RADICAL ALIGNMENT

Arp has drawn attention to significant lining-up arrangements of quasars and galaxies. Such alignments indicate genuine association—and yet the red shifts are different; those of the quasars are much greater than those of the galaxies. From this, Arp has concluded that the red shifts are giving spurious results, and that the quasars may be fairly close—not on our doorstep of course, but perhaps only a few million light-years away instead of hundreds or even thousands of millions of light-years distant.

Everything hinges upon whether these alignments are fortuitous or not. If they are genuine, we must do some radical re-thinking. Up to now few astronomers have believed this, and have dismissed Arp's alignments as sheer chance, but new evidence has now come to hand which could very possibly change the whole picture.

Working at Mount Wilson in California and the Las Campanas Observatory in Chile, Arp has been busy noting the numbers of quasars in different parts of the sky. He has found a marked concentration in the direction of the centre of our Local Group of galaxies—a system which is made up of our own Galaxy, the Magellanic Clouds, the Andromeda and Triangulum Spirals, and more than two dozen much smaller galaxies (plus, probably, the large elliptical Maffei 1, about which little is known because it is so heavily obscured by dust lying in the main galactic plane). Using the standard red shift—distance relationship, this indicates that the area in which quasars are concentrated measures 1300 million light-years by 4875 light-years. On the other hand, there is a paucity of observed quasars in the direction of the Virgo super-cluster of galaxies, some 65 million light-years away.

COSMOLOGICAL DOUBTS

If quasars are really as remote as is usually believed, there certainly should not be any marked concentrations or quasar-poor regions (it is hardly necessary to add that Arp has taken into account complications such as the absorption of light in space). And if there really are more quasars than expected in the direction of the centre of the Local Group, it seems only logical to assume that the Local Group itself is responsible in some way, and that the red shifts are not purely "cosmological," i.e. produced solely by the overall expansion of the universe.

There seem to be only a few alternatives, all of which have marked disadvantages and all of which will add to the already heated controversy:

1. Arp's red-shift measurements are wrong. This seems unlikely to the highest degree, because Arp is an extremely skilled and experienced observer.

THE SKY THIS MONTH

Unlike most modern professional astronomers, I like to keep a close eye on the sky, and I think it may be helpful if I begin these articles by giving some brief notes about the objects on view. During July and August the brilliant Venus starts to move outbound from the Sun, and by the end of July it should be visible for a short while after sunset.

Mars, which is still above magnitude 0 even though it is well past opposition, is visible before midnight in the constellation of Libra, but by the end of July its apparent diameter has decreased to less than 12 seconds of arc, so that small telescopes will not show much on its surface. Up to the present time there have been no major Martian dust storms this opposition, but one may start at any time; with Mars, one never knows.

Saturn is also in Libra, with a magnitude of 0-7, and since the rings are wide open the planet is a glorious sight through even a modest telescope. Jupiter, lower down in Sagittarius, is also imposing, with its yellowish, flattened disk, its cloud belts and its four bright satellites which have turned out to be such remarkable worlds. The Great Red Spot has not been at all prominent recently. I have seen it, using the 15-inch reflector in my Galaxy observatory, and have measured its longitude (029 degrees), but it

is only slightly pink.

Among the stars, for the brilliant blue Vega, almost directly overhead during July evenings; this was one of two stars which was observed from last year's infra-red satellite IRAS, and found to be associated with material which may be a planetary system in the process of formation, though it would be premature to jump to any conclusions; Fomalhaut was the second star. Vega, Deneb in Cygnus, and Altair in Aquila make up a prominent triangle. Very low in the south look for Antarès in the Scorpion, which is distinguished by its strong red colour; its very name means 'the Rival of Mars'.

Scorpio is a superb constellation, though unfortunately it is always so low from Britain that we never see it to advantage. Following it round is Sagittarius, the Archer, now grazed by the presence of Jupiter, and of course, the lovely star clouds which lie in the direction of the centre of the Galaxy.

I must mention Halley's Comet, which will be so very much in the news from now until late 1985. It is 'on course' but still so faint that it is beyond the range of any but the world's most powerful telescopes. It will brighten steadily, coming within the range of amateur-sized telescopes some time after mid-1985, and I will keep you fully informed.

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TIME FOR A CHANGE

For what seems like several hundred years now I have been scanning new British patents and reporting them in these columns (Patents Review). I will be continuing the scan, but with a different approach. Instead of taking patents one at a time and analysing them in depth, we'll look more briefly at more patents. We will also jigsaw them into the overall picture of modern consumer electronic information technology. In other words we will be casting the net wider in The Leading Edge.

Perhaps it is opportune that the Science Reference Library, which is housed in the building of the London Patent Office, has just announced its full-scale commitment to electronic technology. SRL has linked up with Telecom Gold, the electronic mail service (more of which in a future column). SRL also has telex and facsimile facilities. So anyone with a credit account with SRL (which is easy to arrange) can now order copies of technical documents, including patents, by electronic mail and have them either posted off or immediately sent down the line by facsimile.

The get-up-and-go attitude of the Science Reference Library makes a fascinating contrast with the sleepy goings-on at the Patent Office, in the same building. Searching through Patent Office lists these days would be funny if it weren't so annoying. To take just one example, the Patent Office killed off its system of written card indexing and replaced it with a modern computer system. How sensible and exciting! The computer indexing before ironing the bugs out in their software. The top brass civil servant who organised the system switch admitted to me that he had never actually tried to use it. As a result some patents are listed under the name of the company that filed them, while others from the same company are listed under T for "The"!

The value of patents as a source of information is still not widely recognised. But just before Christmas Dr. Robin Nicholson, Chief Scientific Adviser to the Prime Minister, published a Green Paper on the subject. "Overall the impression given is of an arid world rather than that of modern technological Britain" he wrote. "The lack of awareness of their (patents) importance to innovation and wealth creation is at its peak within Whitehall."

Nicholson was particularly critical of the Patent Office and its love of jargon. Taking up the gauntlet the Prime Minister asked for written comments to be sent to the Secretary of State for Trade and Industry, the Minister ultimately responsible for patents. I did just this, for instance mentioning the nonsense of filing company inventions under T for 'The'. But I doubt that anything will change. What I received back was an acknowledgement letter signed by the man in charge at the Patent Office.

VOICE OF PROGRESS

Nicholson is right when he says that patents are an important source of information. Take for instance the recent state of innovation in the area of speech recognition. The patent record shows all too clearly that the Japanese are investing heavily in this new technology. Expect, for instance, the next range of cars from Nissan to use speech control switching for some functions, like headlights, ventilation and door latching. European patent 100773 from Nissan is just one of a string of similar patents from the same company.

The basic technique of speech control is well known. The operator, in this case, owner or driver of the car, speaks several key phrases while the recognition circuit is in "record" mode. The circuit analyses and stores the spoken phrase, which thereafter triggers a switch whenever it is recognised as input. Analysis is of duration, between peaks and of voice power sliced across the frequency band. Storage is in digital code on a simple memory chip. The practical snag is that when the command phrase is uttered, there is a good chance that background noise in the car will drown it out. To confuse the issue further, the background noise could well be changing, as for example when another car is overtaking or blowing its horn.

The trick, says Nissan, is to use band pass filtering and separate speech components from the major components of engine noise. These cluster around the frequencies of 200, 400 and 800Hz depending on engine speed. These bands are tightly notched out and speech passed in the bands 500—600Hz, 900—1200Hz and 1200—2200Hz. There is also high frequency boost to compensate for natural attenuation of speech at high frequencies.

The Nissan research work makes an interesting parallel with research work which I know the airlines are carrying out. Their speech recognition starts in the Far East. Thorn Ericsson has just shown off a telephone, which connects a caller to the right extension, by listening out for the spoken name and comparing it with "library".

Casio has recently patented a computer controlled by voice input (UK patent application 2121217). It's an office computer that you quite literally shout at from across the room, to change programme function. Toshiba has filed a European patent application (99476) on a verification system that is based on speech pattern recognition. The idea could let credit card owners identify themselves by speech. The idea sounds attractive, but the snag is that human voices change quite considerably from day to day, especially when the owner has a cold or sore throat.

Not all consumer electronics work on speech recognition starts in the Far East. Thorn Ericsson has just shown off a telephone, which connects a caller to the right extension, by listening out for the spoken name and comparing it with "library".

Perhaps most exotic of all, Swiss company Asulab (in British patent 2125990) offers up the answer to every traveller's dream; a watch that can be altered by talking to it.

The patent describes a speech sensitive watch in detail. The extent of detail suggests a prototype has been built. The watch can be set to give an alarm call or jump hours when travelling through time zones, all under direct speech control. If Asulab can make the system work reliably, and sell it at reasonable price, this could be a long overdue shot in the arm for the Swiss watch industry. But one of the inventors named on the patent does have a decidedly Oriental name, Ngoc Chau Bui.
FLOOD ALARM

The detector and circuit shown in the diagram have been used as an alarm for floods caused by faulty washing machines, leaky water-cooled systems etc. The transistor TR1 requires a base current of a few microamps to turn on, and is then latched on by the regenerative action of TR2. Current to drive a sounder or relay is provided by TR3. If desired, the relay can cut off the power to a heavy duty relay feeding the machine, or to a water valve fixed direct to the tap.

The circuit is reset by interrupting the battery supply momentarily, assuming the conductive path at the detector has been cleared. The battery should have at least 2A/hr capacity, e.g. a PP9 type.

Dr. C.J.D. Catto, Elsworth, Cambs.

VOLTAGE CONTROLLED AMPLITUDE

It is sometimes useful to be able to represent a varying DC voltage in the form of an audio tone whose volume varies with the value of the voltage. This circuit provides a simple and economical means of achieving this.

Essentially it consists of a C-MOS 4007UBE wired as a two-way switch, driven at audio frequency and switching between the input voltage and the negative supply. The drive tone should be a squarewave, and it is differentiated by C1 and R1 before application to the switch input. This causes the output to appear in the form of short pulses, which are ideal for creating lots of noise from small loudspeakers with fairly economical power consumption. It also prevents any chance of transistors TR1 and TR2 being held “on” for sustained periods, which would cause heavy current consumption and possible damage. These transistors buffer the output pulses, whose voltage is equal to that of the input signal, to a current capability sufficient to drive the speaker. The overall volume is set by the value of R3. R2 and C2 serve to keep the effect of the heavy spikes of output current from affecting the positive supply rail.

This circuit is not only simple; in use it has a much smoother response than many others tried, and virtually no problems of any kind have been experienced with it.

A Flind, Taunton, Somerset.
AM not a violent man but I have managed to break a couple of joysticks whilst playing Meteoroids on my Dragon 32. This sent me on a search for a robust digital joystick. The best one I could find is the "Altai R.18353B". The only problem with this joystick is that it is not compatible with the Dragon. The following circuit is an interface between the Dragon 32/64 and a digital joystick normally used on Commodore Vic-20, Atari 400 and 800 home computers, Sears arcade game and Atari home video game. The settings for VR1 and VR2 are easily set by using the program, in the Dragon manual, designed for checking the joysticks.

Tony M. Gooding (G6TMG), Dorset.

LOW POWER VOLTAGE REGULATOR

DESPITE the scores of integrated regulators now available, it can still sometimes be worth designing your own, particularly where batteries are to be the main power supply. The circuit shown has the following advantages; it draws only 1.25mA quiescent current, it operates down to just 0.1V difference between supply and output voltages, and it provides both positive and negative rails, useful for circuits containing op-amps.

The zener reference voltage is applied to both amplifier inputs. The op-amp IC1b is connected as a source follower, the output being termed "0V", so that supply negative can become -5V. The feedback to op-amp IC1a causes it to drive transistors Tr1 and Tr2 so that the collector voltage of Tr2 is maintained at twice V ref., this being termed +5V. The zener is somewhat under-run at 0.5mA: this reduces its voltage slightly but doesn't affect stability so long as it is supplied with a reasonably constant current, so this is taken from the regulated rail. Under some conditions this could prevent the circuit starting up when switched on, so DI and R2 eliminate this possibility.

As shown the circuit can supply around 20mA, the limit being set mainly by the dissipation rating of Tr2, which could be replaced by something more substantial. No more than 10mA should be sourced or sunk by the 0V rail, but this can easily be uprated by adding a pair of transistors as shown, and possibly increasing the values of the three smoothing capacitors to 470µF.

A Flind, Taunton, Somerset.
POWER SUPPLY FAST SHUT OFF

During the testing of prototype audio equipment it was found necessary to provide a power source which was capable of totally disconnecting itself from the load in the event of a short-circuit or excessive current drain.

The set up of TR3 and R3 form a current sensing circuit, which when switched due to excessive current will operate TR1 and thus fire the thermistor CSR1. The thermistor will operate the relay RLA1 causing the supply to be disconnected. Once the relay has been operated it can only be reset by switching off the power supply.

Although T3 could fire the thermistor directly it was found to be too slow when operating a "heavy relay". In practice the use of a 24V relay ensures fast operation with a 36 volt supply.

This circuit can be added to most power supplies and can be set up to "trip" at a specific current by selecting the correct value of R3. Assuming a forward bias base emitter voltage of 0.6V, then the trip current would be 0.6V/R3; thus for 1.2A, R3 would be 0.5Ω.

G. V. Whitney, Sale, Cheshire.

INFRA-RED SHOP DOORBELL

This circuit was designed for a shop door where a mechanical switch on the door has proved to be unreliable. To avoid using any moving parts, the triggering device is an infra-red emitter and detector, and the "bell" is the SAB0600 i.c. featured in PE May 1983.

D3 is an infra-red detector which allows a current to flow when infra-red falls upon it. It is very sensitive, however, so it is made to switch on SCR1 via TR1 only when infra-red light falls directly upon it. This occurs when D2, which is mounted on the door, passes over it. D2 can be any infra-red emitting LED, the one used having a lensed top to focus the light.

The SAB0600 was chosen as it only requires a momentary pulse from SCR1, and once switched on, goes through its chime sequence of three descending notes.

R5 and C4 were selected to give a high frequency sequence of notes to be heard easily at the back of the shop. Increasing the value of C4 reduces the frequency and lengthens the notes. With the chosen values, the sequence is finished before the door is closed, so the i.c. is triggered again when the door closes.

The capacitors C2 and C3 should be mounted as close as possible to the i.c. to ensure stability of the bell circuit. D1 can be any ordinary LED and is simply an on/off indicator.

This circuit was built for my father's pharmacy and has been working satisfactorily since installation in May 1983.

A. R. W. Hall, Huntingdon, Cambs.
INTERNAL RESISTANCE METER

This circuit represents a different approach to checking the state of single cells, or batteries up to 9 volts, giving a reading which is complementary to the time-honoured measurement of open-circuit voltage. In determining the utility of a battery, some indication of its performance under load is needed, and hence many battery checkers incorporate a dummy load, normally a resistor. However, on designs for checking various batteries, an active current sink is often used which draws a constant current irrespective of battery voltage. Ideally, a cell requires a load current in proportion to its capacity and so with a fixed load current, a meaningful result may not always be obtained. In this instance, the load applied is a current sink, but rather than simply reading the on-load voltage, it is the drop in terminal voltage that is measured. With the choice of a suitable load current, a direct readout of internal resistance can be made on an external voltmeter.

Three sections make up the circuit shown: a switchable precision current sink, a sample and hold subtractor and timing generation logic. A standard circuit is used for the current sink (IC1b and TR1) though with a VMOS FET as the current controlling element. This is used in preference to a bipolar transistor as it gives better linearity over a greater range of battery voltages, since the drain-source channel acts as a pure resistance. IC1a allows us to detect when the current sink is no longer in its active region—as the voltage across TR1 drops, the transistor is turned on harder and harder until the OP-AMP saturates at the positive supply. IC1a lights D2 under these circumstances, giving an indication of an invalid reading. IC2a and b are alternately energised, switching the voltage at pin 5 IC1b between ground and a preset reference, hence switching the current sink off and on. D1 is a 1.23V bandgap reference which gives superior performance over a zener at around one-tenth the bias current. A low voltage zener could be used instead with a suitable reduction in R1 and R2. IC3 forms an astable RC oscillator and two monostables arranged to have their pulse-widths slightly less than one half-cycle of the oscillator. The pulses from IC3c and d direct the on-load and open-circuit voltages respectively, through the analogue gates IC2c and d, to separate capacitors. Buffers IC1c and d prevent loading the stored voltages, which have been attenuated by R8 and R9, permitting batteries up to 9 volts to be tested without saturating the buffers. If higher voltages are likely to be tested, the values can be altered with a suitable adjustment of the test current.

In its present form, the circuit gives a full scale reading of 20Ω for 200mV output: thus a resolution of 1/100Ω is achieved with a 3½ digit voltmeter. For this range, VR1 is set up to give a sink current of 13±ImA though TR1, and this must be checked with C2 shorted with a temporary link. Calibration accuracy then rests on the tolerance of R8 and R9. In order to minimise offsets when measuring low resistance cells, a four-wire probe arrangement is used so that negligible current flows through the voltage sensing wires.

In use, it was found that even the very low internal resistance of nickel-cadmium cells could be resolved—these typically exhibit values of a few hundredths of an ohm. At the other extreme, lithium button cells were found to have values greater than 20Ω. To extend the measurement range of the circuit it is necessary to reduce the test current through TR1 since increasing the range on the external voltmeter will increase the likelihood of the 'invalid reading' LED illuminating for the lower voltage, higher resistance cells.

R. P. Dudley,
Newtown,
Southampton.
The circuit shown is for an interface, which allows logic circuitry to be driven by audio tones, recorded on cassette tape. The design is based upon a single LM 392 op-amp/comparator chip, and will operate with input levels as low as 60mV peak, over a supply range of +3V to +32V.

The op-amp is configured as a multiple-feedback bandpass filter, with its gain, at this frequency, being twenty, and rolls off at a rate of 6dB per octave. This gives effective discrimination of both switching transients and mains hum. The output from this stage feeds the comparator, whose threshold is set at 1.2V by a bandgap reference diode.

The comparator output switches virtually from supply rail to supply rail, making it suitable for use with either CMOS, T.T.L. or the 555 timer.

P. Thompson,
Glasgow, Scotland.

A SIMPLE VCO

This cheap, simple circuit was designed to indicate the value of a changing DC voltage by varying the pitch of an audio tone. It consists in essence of an integrator followed by a schmitt trigger. A positive input to the integrator causes its output to ramp downwards until the schmitt changes state; the output of this then pulls the input to the integrator almost to negative supply, and its output then ramps back upwards until the schmitt returns to the original state.

The four inverting gates are formed from a C-MOS 4011BE with its four pairs of inputs linked. Two of them make up the schmitt trigger, the remaining pair are paralleled to form a buffer for the feedback circuit. Almost any op-amp could be used, the original was tried with both \( \frac{1}{2} \times \text{LM358N} \) and \( \frac{1}{2} \times \text{LM324N} \).

Resistor R4 sets the centre frequency. Since the ear detects changes in pitch as an “octave” shift for each doubling or halving of frequency, the network R2, R3 and D1 was added to make the output sound (fairly!) linear over the input voltage range. R1 and C1 provide input noise smoothing, if required.

A PROBLEM with the Sinclair Spectrum is its tendency to get hot, after periods of prolonged use. This is due mainly to the power being dissipated by the internal +5V regulator IC.

The input voltage to this comes from the ZX power supply unit, which provides a raw d.c. that varies according to the current drawn. This gives a nominal +9V on full load, but rises to +10.5V when used with a 48K spectrum, taking its average of 0.6A. Under these conditions, the power dissipated is:

\[(10.5 - 5) \times 0.6 = 3.3 \text{ W (continuous)}\]

The circuit shown was designed to reduce this power dissipation, by stabilizing the output from the ZX supply at the minimum voltage required for the computer.

Two zener diodes, one with a positive temperature coefficient, the other with a negative temperature coefficient, are used to provide a stable +8.6V at the base of the series pass transistor. This is a power switching type that features a low collector-emitter volt drop. The output from this is the reference voltage less the 0.6V base-emitter volt drop, which equals +8V. This is more than sufficient for the on board regulator, a 7805, and also provides adequate drive for the circuits that produce the +12V and −5V supplies.

With the component and supply voltage values shown, and driven by the output of an LM358N (minus 5 to plus 3.5V) the circuit gave an output of about plus and minus one octave with a centre frequency of approximately 350Hz. The output consists of pulses, about 300 microseconds wide, both polarities being available.

A. Flind,
Taunton,
Somerset.
LOW COST KEYLESS LOCK

UNABLE to track down the LS7225 Keyless Lock IC, I built my own Keyless lock using spare components. The resulting circuit was cheaper and boasts a better specification than the LS7225 IC.

Keyless locks have numerous security applications in, for example, burglar alarms and door entry systems where the correct entry of a 4-figure number on a keypad will arm or disarm an alarm or activate a door-opening solenoid.

The diagram shows 10 keypad switches connected to a 10 x 4 selection matrix. This was easy to implement using stripboard and low-profile IC sockets. The selected keys are “patched in” to each flip-flop using single strand cable. All un-selected keys are commoned and connected as shown.

When S5 is depressed, IC1a’s clock input (C) momentarily changes from logic ‘0’ to logic ‘1’. This transition transfers logic ‘1’ on the data input (D) to its Q output. This procedure repeats for the other 3 flip-flops until the output of IC2b changes to logic ‘1’ for the correct 4-key entry. The RC circuit between flip-flops is quite novel in that it allows each keypad switch to bounce for up to 10ms without clocking the output of two consecutive flip-flops for one key depression, as shown for IC1a and b.

Two features make this lock virtually fool-proof: pressing an unselected or out-of-sequence key will take each flip-flop reset input (R) high resetting the opening sequence. The combination of C4 and R8 will suppress any momentary AND gate (IC3) output transitions that may occur while allowing the opening sequence to be externally reset. D1-D3 are essential to prevent the logic ‘0’ output of any AND gate from sinking current when a legitimate reset pulse occurs.

VENETIAN BLIND INTRUDER SENSOR

When a large window needs protection, I used a sensor at each end of the blind, so that it would not be possible to intrude without one or other switch being tripped. The two reed switch arrangement must be wired such that the two reeds are in series.

Gordon E. Lumley, Richmond, N. Yorks.
OBSVIOUSLY, construction of the analyser is a matter of choice, however, if the diecast box approach of the prototype is made, the photographs in Parts One and Two indicate a suitable layout.

CONSTRUCTION
A wiring diagram is provided: see Fig. 2.1. The circuit diagram given last month shows a filament lamp across the mains transformer secondary winding to act as a pilot light. An alternative is to wire an I.e.d. (in series with a 270Ω resistor) across OV and +5V. This method is employed in the wiring of the prototype unit illustrated in the wiring diagram, except that a self-current regulating I.e.d. has been used so that no series resistor is necessary.

KEYPAD
The keypad used was an RS Components unit (see components list) and the diagram shows how this is wired. Almost any matrix Hex keypad will suffice, but reference to the 74C922 (IC1) data sheet will be necessary to arrive at the correct wiring arrangement.

DISPLAY BOARD
The display board is shown in Fig. 2.3. Some links are necessary, but assembly is straightforward. Be sure to insert the displays in the correct orientation. The displays TIL311 incorporate internal decode and drive logic, and as such are referred to as i.c.s.

8-BIT/16-BIT SWITCH
The Eight/Sixteen Bit change-over switch, S2, requires a small alteration to its connections as portrayed in Fig. 1.2. If the wiring diagram of Fig. 2.2 is followed this will be automatically taken care of, but to correct the circuit diagram, make the following corrections to S2c: IC14 pin 8 and IC15 pin 8 line goes to the upper contact (the switch position illustrated as “closed”) leaving the lower contact open circuit instead. In addition to moving this line it should also incorporate a 4k7 pull-up resistor to +5V (shown in Fig. 2.1 as R8).

WHOOPS!
The circuit diagram in Part One shows a 2k2 resistor connected to S2b which should be called R7, not R1. In fact, R1 is a 2k2 pull-up resistor wired between IC6 pin 1 and +5V. Note also that the line linking IC18 pin 5 and IC19 pin 5 to IC5 pin 2 (STROBE) can be interrupted with a biased on/off toggle switched marked HOLD DATA. The switch should be wired so that ICs 18 and 19 (pins 5) can be isolated from the remainder of the circuit. Referring to the main board component layout, note that the capacitor linking the STROBE output to OV is C10, not C9. Also the annotations C7 and C8 should be transposed.

One final addendum which should clear up confusion appears below, and it pertains to the correct Data input pins to IC18 and IC19.

No setting up procedure is required prior to use.
Fig. 2.1. Wiring diagram. Some corrections to Part One are referred to in the text, and these are already taken into account here.
Fig. 2.2. Display board printed circuit layout (actual size)

Fig. 2.3. Display board component layout

Frontal view of the display board. A double-sided board is featured in the photograph, although, as presented above, a single-sided board only is necessary.
MICROWAVE ALARM SYSTEM...

Built into a hi fi speaker cabinet, this microwave doppler intruder alarm has a range of 8m, yet is completely self-contained, requiring no external wires. The unit measures only 245 x 155 x 155mm.

KITCHEN APPLIANCE TIMER...

Ever needed a third hand in the kitchen? This is it—a useful project with lots of practical applications. A timer which can switch mains appliances up to 5A, with a fully adjustable time setting.

TEMPERATURE INTERFACE for BBC...

Using the machine's own four channel A to D converter this article shows how a simple temperature interface can be made with good linearity and accuracy over a temperature range of -50° to +150° Centigrade.

FEATURE ARTICLE: WHAT IS RADIATION?

EVERYDAY ELECTRONICS and computer PROJECTS

AUGUST 1984 ISSUE ON SALE FRIDAY, JULY 20
How far the employee is supported by the employer in this respect I do not know. But I think it is safe to assume that the employer, similarly influenced by the prevailing need for realism, recognises that practicality is the prime consideration. Unless, that is, he happens to be one of the leading lights of a professional society himself.

"I do not write without experience"

Another contributory factor of this switch of attitudes may be the reluctance of many August bodies to acknowledge that they no longer hold the sway they did. Many still cling, blinkered and ostrich-like, to their assumed standing, blindly confident that without membership of their fold, an operator in their particular area might just as well give it up and get a job stacking shelves in Tesco’s.

Speaking from the touchline and basing my views entirely on superficial impressions—which means that I have resigned myself to a hail of indignant fire—I would cite the Institution of Electrical Engineers as a case in point.

I do not write without experience. I have had contacts with the IEE for more than 20 years and have the deepest respect for the talents and inventiveness it enshrines and the work it has accomplished. None the less, isn’t its image a bit out of date?

Even its headquarters in Savoy Place, London, grand and imposing as they are, epitomise an age which ought to be decently buried. All that marble—enough to equip a dozen Victorian super-loos. Those lofty wood-panelled chambers—highly conducive to nodding off on a warm afternoon. And, most off-putting of all, that larger-than-life statue of Faraday, looking thoroughly cheesed-off in the entrance hall.

This, I submit, is hardly the way to attract the young engineer whose only aim in life in the 1980s is to get himself a good job which will pay the mortgage and keep his kids decently fed, clothed and shod. Insularity and the academic concept have no place outside universities. Maybe not even there either.

I don’t want to rub it in, but here’s another example of how outfits like the IEE tend to wrap around themselves the shawl of yesteryear. They don’t hold meetings, debates and conferences. No. They have seminars, or what is even more unacceptable, conversations.

I cannot believe that the latter affectation is meant as a compliment to the Italians. After all, the IEE and others have been at this form of nonsense since long before Italy joined the Common Market. Let’s remember the words of Winston Churchill: “Foreign words were made for Englishmen, not Englishmen for foreign words.”

Attitudes have altered just as dramatically in yet another zone. Twenty years ago your aspiring subject expert would have drooled like an infant presented with the teat at the offer of writing—for free, mind you—a 10,000-word article for a professional journal. The sordid matter of money never crossed his mind. The kudos was in itself worth a king’s ransom. Brothers, we now exist in another age and your prospective author needs to be coaxed and cajoled and everything depends on the answer to the question: “How much?” It must be very hard for those who have opted to dwell in the past.

In spite of all this sniping at the professional institutions, I am still convinced that they have a place, even if a modified one, in the scheme of things. Their demise would be the loss of yet another of those traditions which are part of our heritage. I would like to see them becoming more of an advisory force rather than a rigid didactic one. There is no room in modern society for the Star Chamber attitude, with membership restricted to those who graduated from Oxford or who turned in an examination paper without error or blemish.

It is as well to bear in mind that your average engineer or technician is today a responsible and dedicated person who has studied hard and worked just as hard to gain his laurels. He is professionally motivated by instinct and he has a natural respect for the requirements and ethics of his calling. The only control function a professional society needs to exercise is against the cowboys of electronics who, like the poor, will probably be with us for a long time.

Given this new approach, one could expect budding engineers and technicians to present themselves for membership in ever-increasing numbers. And, as their ranks swell, one could also hope for less prohibitive annual fees.

Tell me, Tony. Is this any help?

If you thought from the foregoing that the professional association movement was a bit rocky, here’s news of one of the latest. The Association of Diagnostic Engineers (ADE) is to hold its first annual convention in September. Formed in April 1981, it now has a membership of 3,000 worldwide. They come from the UK, Brazil, Canada, Australia, Egypt, Greece, Poland, Sri Lanka and Nigeria.

The ADE publishes a monthly newsletter with technical and annual convention to defect recognition and diagnostic techniques. It even has a “trouble shooters” dining club, which is aimed at exchanging experiences between fellow-members under, as they put it, “conditions of friendship and progress”.

If you will forgive me, isn’t that just what I’ve been talking about?
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PK15: 5 x 0.1R Resistors £0.75

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55
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T HE use of electronic sensors to replace old electromechanical devices is widespread, bringing benefits in reliability, smaller size, and lower cost. Some types of sensor are easier to implement as a purely electronic system than others, and one of the most straightforward of these involves the detection of liquid levels. During the past year in Semiconductor Circuits we’ve looked at two applications circuits designed to measure moisture levels in soil. This month we feature the LM 1830N, a bipolar i.c. specifically designed for detecting the presence of water or any other conductive fluid in containers or enclosures.

BLOCK OPERATION

The pinout and specification of the i.c. is shown in Fig. 1 with the basic block diagram shown in Fig. 2. An internal oscillator passes an audio frequency signal via an internal resistor, R_ref, to one half of a probe, the other half of which is connected to ground. A detector determines whether the liquid is present or not by measuring the level of signal on the probe; a low level infers that the liquid’s own resistance is shunting the probe signal to ground, i.e. 0 volts, whereas a high level suggests that no such shunting is taking place, i.e. the liquid is not present. Hence, the detector effectively compares the resistance of the fluid to R_ref. When the detector is triggered it passes the signal directly to the base of an npn transistor, which then provides an open collector current sinking capability for loads of up to 20mA. This transistor turns on when the liquid is NOT present, i.e. it is a ‘low level’ warning arrangement.

Because the transistor is turned on by an audio frequency a.c. signal, it will sink current from the load as a series of pulses. This is ideal for driving a loudspeaker via a suitable load resistor, as shown in Fig. 3, or for driving an i.c.d., but could be unsatisfactory for feeding into a relay, or as part of a logic system. To avoid any problems, the collector of the detector transistor is brought out to the ‘filter pin’, pin 9. Connecting an electrolytic capacitor from pin 9 to 0 volts will smooth the a.c. signal, causing the output transistor to turn on continuously in the absence of any liquid. The use of this capacitor is also recommended for incandescent lamp driving applications, or when using any form of inductive load.

Because the detector works on a level sensing principle, it is important that the oscillator signal amplitude and the detector threshold are unaffected by supply voltage variations. For this reason, an internal voltage regulator is provided to stabilise the internal supply.

OTHER EXTERNAL COMPONENTS

An external capacitor must be provided for the oscillator (C2 in Figs. 2, 3, and 4), and should normally be 1nF, giving a typical frequency of 7kHz. The output at pin 13 is usually a.c. coupled to the probe via a 47nF capacitor, preventing any problems of electrolysis or plating that would occur with d.c. polarisation. The surface area and spacing of the probes can affect the effective resistance seen to ground, and it may be necessary to adjust the sensitivity of the detector to compensate for different probes or liquid resistivities. This can easily be achieved by using an external reference resistor as shown in Fig. 3. Although the i.c. is primarily used to detect liquid levels, it can also be used to sense changes in resistance of other devices. Fig. 4 shows the arrangement used to detect heat or light levels with a suitable thermistor or opto-detector. No 47nF coupling capacitor is shown since these sensors are usually d.c. coupled. Again, an external reference resistor can be used to change the range of sensor resistances which the i.c. will respond to.

Also shown in Fig. 4 is a filter capacitor connected to pin 9, since the output drives a relay via an external npn transistor. The transistor is arranged to invert the output signal, such that the relay turns on when the sensor resistance is low, corresponding to a high liquid level warning system. Other arrangements of output transistor could give the opposite effect, of course. If the output of the i.c. is to feed into logic circuitry a pull-up resistor to the logic system’s own supply must be provided. This should be typically 1k to +5V for TTL, and 10k to 1M up to Vdd (the +ve supply rail) for CMOS. The LM 1830N need not share the same positive supply rail as the logic.

PRACTICAL USES OF THE I.C.

The i.c. depends on the resistance of the liquid in question; unfortunately, some liquids are non-conducting, which prohibits the use of this technique. Table 1 shows a list of conducting and non-conducting liquids. If a conducting container, e.g. a stainless steel sink or tank, is used to hold the fluid, then this can be

---

**FLUID DETECTOR (LM 1830N)**

**Fig. 1. Pinout and specifications**

---

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Notes</th>
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<th>Typically</th>
<th>Max. value</th>
<th>Units</th>
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<td>mA</td>
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<td></td>
<td>°C</td>
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<td>Low level voltage</td>
<td>Measured at pin 5</td>
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<td>High level voltage</td>
<td>Oscillator capacitor = 1nF</td>
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<tr>
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<td>13</td>
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<td>mV</td>
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<td>Detector threshold</td>
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<td>10</td>
<td>15</td>
<td>kΩ</td>
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<tr>
<td>voltage</td>
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<td>Detector threshold</td>
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<tr>
<td>resistance</td>
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<td>at pin 12</td>
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<td>mA</td>
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<td>Output saturation</td>
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<td></td>
<td>V</td>
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<tr>
<td>voltage</td>
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<tr>
<td>Output leakage</td>
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<td>Output leakage</td>
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<td>Power dissipation</td>
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</tr>
</tbody>
</table>

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**Fig. 2. Pinout and specifications**

---

Practical Electronics  August 1984
OSCILLATOR

OUTPUT

51.1

l.1

PROBE

Fig. 2. Block diagram

ROSE SUPPLY

TO REST OF IC

+VE SUPPLY

TO REST OF IC

VOLTAGE

REGULATOR

C2

In

Fig. 3. External R_{eq} and direct driving of a loudspeaker

APPLICATIONS CIRCUIT

The circuit diagram of a low water level alarm is shown in Fig. 5, with Fig. 6 giving the Veroboard layout. This circuit can be used in many water level detection applications, and is ideal for use in vehicles; a good example is to give early warning of a low windscreen wash water level. The LM 1830N is used as already described, with a filter capacitor to ensure that the output transistor is turned on with a d.c. signal. A 'low level' warning i.e.d., D1, illuminates as soon as the water level drops to an appropriate point. As soon as this occurs D2 becomes reverse biased and C4 starts to slowly discharge via R3. After several seconds the voltage across C4 becomes sufficiently low to cause the output of IC3a to go to logic 1 (a high level), assuming that pin 1 of IC3a is at logic 0 (a low level), too. This turns on an audio frequency oscillator formed by IC2c and IC2d with R9, R10, and C7. The oscillator, in turn, causes WD1 to sound, driven by spare gates IC3b, IC3c, and IC3d in parallel to ensure a more than adequate current capability. IC2a and IC2b form a latch or flip-flop, which is set when power is first applied to the circuit by R6 and C8, and is reset by S1. When set it allows IC3a to operate normally and the tone to sound, but when reset it feeds a logic 1 to IC3a, preventing any tone being heard until the power is turned off, then on again.

In use, the warning i.e.d. illuminates as soon as the liquid level goes low. The tone is only heard after a few seconds, to allow time for the i.e.d. to be noticed and remedial action taken, or to prevent false alarms caused by momentary drops in level; for example, due to liquid

connected to 0 volts directly, and the probe need only consist of a single conductor held in the vessel. In other cases the probe should be a two conductor arrangement; a piece of glass fibre p.c.b. material, suitably etched, could suffice, as could many configurations of metal and insulator.

<table>
<thead>
<tr>
<th>Conducting Liquids</th>
<th>Non-Conducting Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary water (the majority of water)</td>
<td>Pure water</td>
</tr>
<tr>
<td>Sea water</td>
<td>Whisky</td>
</tr>
<tr>
<td>Weak acid</td>
<td>Petrol</td>
</tr>
<tr>
<td>Weak alkali</td>
<td>Oil</td>
</tr>
<tr>
<td>Coffee</td>
<td>Alcohol</td>
</tr>
<tr>
<td>Wet soil</td>
<td>Dry soil</td>
</tr>
<tr>
<td>Copper sulphate solution</td>
<td>Paraffin</td>
</tr>
<tr>
<td>Water and Glycol mixture</td>
<td>Brake fluid</td>
</tr>
<tr>
<td>Household ammonia</td>
<td>Ethylene glycol</td>
</tr>
</tbody>
</table>

Table 1. Conducting and Non-Conducting Liquids
The LM 1830N is not a new i.c. by any means, but it offers a simple, economical, and interesting solution to many problems in liquid level sensing, and is very straightforward to design with and use. It is available from Maplin Electronic Supplies Ltd.
BOTH internal and external alarms have been left to the preference of the constructor.
The relays in both the Comparator and the Two Timer have 24 volts d.c. at 1 ampere local contact capacity. The internal warning might well be a bell or buzzer or indeed the door gong. If a more exotic sound is sought, the Warbler described later in this article will probably suffice. A variety of alternatives present themselves including the lighting of a door gong. If a more exotic sound is sought, the Warbler described later in this article will probably suffice. A variety of alternatives present themselves including the lighting of lights. In such a case use will be made of a power triac or second relay since the relays given are limited to 100 V a.c.

Of all the external alarms the electric bell is very economic in both price and power terms but years of discredit due to bells ringing for long periods due to badly designed alarm systems false triggering rather rules them out as effective. A very good and economic alternative has been located by the writer. This is a little 'Micro-Siren', which is quoted by the manufacturer as producing over 90dB at 3 metres, audible at 400 metres at least and requiring 850mA with an input supply of 12 volts. This little howler is small enough to either hide away or build into a box along with a power supply and other devices such as flashing beacons. Setting the Two Timer is a case of personal feeling but is surely a question of common sense; if the internal alarm has fired, followed by the external alarm which is allowed to run for a full three or four minutes, it is very unlikely that there is any intruder hanging around after that. Perhaps a flashing beacon might be desired after the cessation of the siren; this could be achieved by picking up the i.e.d. output from the Two Timer and by suitable amplification and relay, flash a lamp or Zenon tube.

CONSTRUCTION OF THE COMPARATOR BOARD
The p.c.b. design for the Comparator is shown in Figs. 2.1 and 2.2 with the component layout in Fig. 2.3. The board is double sided and Veropins are used as lead throughs. Be careful to tin both sides of any lead through circuits. Usually these are foil pads soldered to through pins but there are some which consist of the pins of d.i.l. sockets or potentiometers. Lead through Veropins not used as terminals can be cut off short after soldering. The 10n disc ceramic capacitors soldered close to the supply pins of those i.c.s listed are very important in the suppression of 'glitches' which would cause false triggering.

A sub-panel is made to carry the switches and i.e.d.s along with the Compensator sub-assembly. The details are in Figs. 2.7 and 2.8. The drawing can be used for both the sub-panel cutouts and the lid of the box. The slide switches are not screwed but glued to the sub-panel and when the sub-panel is screwed to the box lid, they are held fast. The details of the Compensation panel should be followed closely using a scrap of Vero board to carry the resistors. Use a d.i.l. socket for the d.i.l. switch for ease of assembly and to avoid damage to the switch. The top pins of the d.i.l. switch are commoned and the outside ends of the resistors are commoned on the Vero strip left on the board. The other ends of the resistors go each to a free pin on the switch (socket if used). Make sure the assembly is well fixed as it will see considerable use.

POWER UNIT
The p.s.u. described fits the 2006 box and is intended to supply the Comparator board and the Two Timer board. The circuit diagram is in Fig. 2.4 and a p.c.b. layout in Fig. 2.5 with a component layout shown in Fig. 2.6.

It is not intended that the p.s.u. shall supply extra circuitry, although the specified transformer and rectifier combination is capable of doing so. The main restriction is in the regulation provided by the Zener diodes. Replace these with appropriate voltage regulators and another 50mA would be available; however, since the project philosophy is to leave the audible warning devices to the choice of the constructor, it is necessary to note the design limits of the p.s.u. as it stands.

The two Ni-Cad PP3's are charged at just 1 to 3mA by adjusting the two associated variable resistors. The batteries must have been on charge for some two days before the final adjustment is made, or alternatively they could be charged on a normal charger at a normal rate first.

When the system is triggered, a state of discharge will be seen if the batteries are monitored. This is intentional and cycles the batteries at least whilst testing the installation. The charge/discharge currents are monitored by lifting one side of the battery connector and placing a milliammeter in series. (About 30mA from one PP3 and 20 from the other.)

The 240 volt mains input must be wired with care, covering terminal pins with systoflex or shrink sleeving. Use a fused plug at 2A and fit a 500mA fuse in the internal holder.
Fig. 2.1. P.c.b. design (track side)

Fig. 2.2. P.c.b. design (component side)

Fig. 2.3. Component layout

SECURITY PROJECT

COMPONENTS . . .

COMPARATOR BOARD

Resistors
R1,R2 1 M (2 off)
R3,R10,R11 1k (3 off)
R4 100
R5,R6 150k (2 off)
R7 470
R8 100k
R9 470k
VR1,VR2 100k hor. preset (2 off)
VR3 1M5 hor. preset
All resistors \( \pm 5\% \) carbon

Capacitors
C1,C3 47µ 16V elect (2 off)
C2,C4,C5 10n (3 off)
C6 470µ 16V elect

Semiconductors
D1,D2,D3 1N4001 (3 off)
D4 BZY88 5V6
TR1 BC109
IC1 LF353
IC2 4049
IC3 CD4011
IC4 741

Miscellaneous
8-pin d.i.l. low profile i.c. socket;
14-pin d.i.l. low profile i.c. socket;
16-pin d.i.l. low profile i.c. socket;
Relay 9 volts 225 ohms Kuit A
(Ambit 46-80001); P.c.b. double sided board; Veropins.

SUB-PANEL

Resistors
R1 to R8 470k \( \pm 5\% \) carbon

Semiconductors
D1,D2,D3 5mm red l.e.d. (3 off)
D4 5mm yellow l.e.d.
D5 5mm green l.e.d.

Miscellaneous
S1,S2 d.p.d.t. slide switch (2 off)
S3 push switch single pole push to make
S4 to S11 Octal d.i.l. switch (Maplin XX27E), Veroboard, Veropins, 16-pin d.i.l. i.c. socket.
* Reed switches (10 off).
SX1,SX2,SX3 2-way LS type DIN sockets (3 off)
** If reed switches complete with magnets are used then it will be necessary to insert a 470k resistor in series with the reed.
INTERWIRING

The various p.c.b.s are connected together using the interconnection diagram in Fig. 2.9. Ribbon cable was used but constructors may wish to use singles. Use stranded interconnecting wire, not solid core, and enough length should be used to enable all p.c.b.s to be withdrawn from the box.

The adjustment is simple enough. If all the external circuits have been installed, these may be used, otherwise connect a resistor of value equivalent to the parallel value of the proposed external network, to the input DIN socket. (Compensators switched in are the equivalent of sensors.)

If the external network or its equivalent resistor is used, switch out all compensators. Adjust VR1 on the comparator to about mid position and adjust VR2 so that half Vcc appears at pin 3 or 6 of IC1. S1 must be switched to Auto-Reset.

The green I.e.d. should now be lit.
Switch in a compensator at the d.i.l. switch. The green I.e.d. should extinguish and the yellow I.e.d. should light.

The next step is to set up the delays. Only the Comparator delay is described at this stage, the Two Timer will be covered later.

COMPONENTS

POWER SUPPLY UNIT

Resistors
R1,R2,R3,R4 330 Ω 5% carbon (4 off)
VR1,VR2 250 vertical presets (2 off)

Semiconductors
D1,D2 10V Zener
BZY88 (2 off)
D3,D4,D5,D6 1N4001 (4 off)
REC1,REC2 Bridge rectifier
50V p.i.v. (2 off)

Miscellaneous
Ni-Cad rechargeable battery (2 off); Mains transformer 12V-0-12V @ 140mA (Ambit 57-10052); Fuse clips p.c.b. mounting (2 off); Fuse 500mA; P.c.b.
Set the delay control VR3 to minimum. Set the input network to 'Alert' and all Compensators off. The green l.e.d. should be on.

With a stopwatch or similar timer, measure the delay from the point of switching in a Compensator to the point where the red l.e.d. lights and the relay closes. Switching in a Compensator is the equivalent of a tamper condition when the external network is 'All Intact'.

The adjustment of the delay can now be made, based on the minimum period just obtained. It will be very roughly about 8 seconds. See if the delay arrived at is adequate to leave the house and close the door. It will need to be if 'Lock-On' is to be used when the premises are vacated.

Switch to Lock-On and retrigger the Comparator using the Compensator. The green should extinguish and the yellow light up. Wait until the red comes on then remove the input

Fig. 2.7 (above). Sub-panel assembly and layout diagram (full-size). Fig. 2.8 (right). Front panel assembly diagram (half-size)

Fig. 2.9. Wiring diagram for the Alarm System
by switching out the Compensator. The yellow and the red I.e.d.s should persist until the 'Auto-Reset' mode is applied and the Compensator removed.

The Width Control is all that remains to be set. It is necessary to either use the external network or simulate it. Use 'Auto-Reset' mode, then with all sensors (or simulated sensors) in circuit and all compensators out, green I.e.d. lit and previous settings (VR2) correct, switch in one compensator and the yellow I.e.d. should light. Switch out the compensator and the green should replace the yellow. Now open circuit one sensor (remove one 470k from the network) or reduce the number of simulated sensors by one, whereupon the yellow should light again and the green should extinguish.

Turning the Width Control anti-clockwise narrows the Width and therefore the system will appear more sensitive; try a pair of wet fingers across the external network when all compensators are out and all sensors in. If it proves impossible to trip the system either by decreasing the number of sensors in circuit or putting in one extra 470k by using the compensator, the system is too insensitive and the Width Control should be turned anti-clockwise. A point can generally be found where the system is so sensitive that the green and yellow I.e.d.s tend to flutter on and off. This state must be avoided. By and large set the system to that Width where either an open circuit sensor or an additional compensator will trigger the I.e.d.s.

Alternatively, a more accurate method may be used. By plotting the necessary change in input voltage for each of several settings of the Width Control, it can be ascertained which value of VR1 is stable and yet sensitive enough. A 100k potentiometer across the input socket but set to equal the setting of VR2 (say 47k) and a high impedance voltmeter to measure the change in input voltage, can be used to check the increment and decrement necessary to trigger the system for each of say five settings of VR1.

EXTERNAL NETWORK (INSTALLATION)
Little can be said about the external network as much depends on the building and its occupier. The wiring need not be concealed because of the anti-tamper facility. One very important point however, great care must be taken to ensure that moisture cannot make ingress at any point, since the Comparator would see this as a tamper state. Any junction blocks are best filled with wax or resin (paraffin wax or Araldite).

TESTING THE TWO TIMER
When the whole system is complete and the Comparator has been set up, it will be necessary to adjust the delays in the Two Timer. The procedure is simple, there are two potentiometers in the Two Timer, one for the Delay before...
the external siren starts and the other for the period of operation of the siren. Remembering that both are initiated simultaneously by the Comparator and each independent of the other, set first the delay time to somewhere around 45 seconds after the yellow i.e.d. in the Comparator lights; this will mean that the external siren relay will close after that period. Next set the other potentiometer to establish the duration of the external warning. A length of time up to about four or five minutes is adequate, since if no action has been taken by then, there would seem to be little chance of the intruder being around or indeed catching him.

In addition to an external siren, some users might like to include a flashing beacon with the siren. There are possibilities with Zenon Tube beacons or more simply, just a red lamp powered from the 12 volt siren supply.

**WARBLER UNIT**

It is possible to construct a unit which produces a warbling note for use as the internal warning. When a piezo horn is connected to the Warbler, adequate noise is generated to put off most intruders before the external siren is activated.

The circuit diagram of the Warbler Unit is shown in Fig. 2.10 with the p.c.b. and component layout shown in Figs. 2.11 and 2.12.

The output relay of the Comparator which is available at the socket SK2 is used to switch external power (batteries perhaps up to 18 volts) to the Warbler which should be located out of reach. The normal house offers a good position high up in the stair well, with leads running down from the loft. The object is to avoid leading the intruder to the electronics.

The components specified will suit most horns but as they are frequency conscious, experiment a little with the timing components C1/C2 and C4. C1 should be chosen to generate a tone which coincides with the peak resonance of the horn, usually around 2 to 2.5kHz. This is easily sensed by ear. Do not be too persistent, the noise can become quite painful. A fine tune on the warble can be made by replacing the 1M2 (R4) by a variable. C4 is important in that it forms part of an integrator which shapes the modulation waveform. The housing of the Warbler is left to the constructor. Any box which could also house the dry batteries and even the horn could be used.

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The process of invention is perpetual but it is fascinating to note how it has galloped over the past 30 years. There are no prizes for guessing the reason. Who would have thought that widespread ownership of powerful, miniature computers and digital watches would arrive so soon—and at prices we can all afford.

Transistor action was discovered in 1949 but a good few years were to elapse before the delicate ‘point contact’ device evolved into a really dependable component which was both inexpensive and available in quantity.

Twenty years ago the transistor had gained widespread acceptance. There was another important event taking place at that time: the Publisher and his Editor were planning the launch of a new magazine. Practical Electronics made its debut in November 1964.

Then, as always, P.E. was forward-looking, with the semiconductor its main preoccupation. In those early issues there were occasional references to valve circuitry, which may seem strange in retrospect, but the long-term reliability of transistors was still being proved. A number of organ manufacturers were very conservative in this respect, understandably so as their good names were at risk if they made a wrong decision.

Gulbransen was the first manufacturer to produce a fully-transistorised instrument but competitors were often slow to make the change from proven valve circuitry. Organs were just about the most expensive piece of electronic equipment you could own, were extremely well-made and built to endure many years of use. A close look at the cabinet work of vintage instruments will show that this aspect was better than it is today.

**Ageing**

Being built to last, many valve organs are still in existence today and work quite happily. There were no ‘frills’ such as rhythm units or synthesizers though possibly a simple form of percussion might have been embodied. A straightforward instrument of this type is suited to secular music and is often found in a chapel or small church today. A good number of church organists take an interest in electronic music and nurse their instruments over the years.

If an old valve organ works reasonably well and up-to-date facilities are not essential, why bother to replace it? Provided the owner takes care to keep a set of spare valves, it might as well be used until it gives its last gasp. At the same time, valve circuitry does suffer from *anni dominii* and needs occasional attention. Taking the back off will reveal some ‘CEGB’ engineering as the steel chassis had to be used to support large transformers. The valve filament current alone may well have been in the region of 25A if tone generation was electronic rather than mechanical. The h.t. supply was perhaps some 400V for the output stages and all the discrete components had to be suitably rated and were consequently bulky.

Being interested in electronics, you will naturally be considered very expert by anyone knowing less than you—so you can get saddled with curious tasks from time to time! Being asked to look at an ageing electronic instrument is a possibility so it may be useful to consider what you could encounter.

**Unfamiliar**

The impressive armour-plated innards may look forbidding but the circuitry was far less complex than it is today. The circuit diagram may have been lost years ago, to add to the problems, so you may have to (as at the keyboard) play it by ear.

Basically, a block diagram of an average instrument was as shown in Fig. 1. If the instrument works tolerably well but appears to lack punch and volume, the chances are that the h.t. voltage is well below par. This is fairly typical and will be due to the rectifier valve losing its emission and the state of the electrolytic capacitors in the power supply section. We tend to forget the enormous difference between working voltages today and in yesterday’s circuitry.

Large electrolytics suffer particularly from being bombarded by high voltages year after year: it used to be the practice to put the date of manufacture on these large capacitors so you may be surprised by what you find when you remove the dust.

![Fig. 1. Block diagram showing basic layout of an average instrument of yesteryear](image)

**Fig. 2. Typical power supply**

Resistors in this part of the organ are probably wire-wound and will not have altered in value, but lift the chassis and examine the tags of the capacitors and you may well find that electrolyte is oozing out.

**Generators**

These were often mechanical and will need to be lubricated carefully. Compton generators can seize through lack of oil but take care not to spill oil on the drive belt. Hammond tone wheel instruments have fine capillary threads which feed oil to the bearings and can be accidentally broken quite easily. This type of generator should not be over-oiled as drips will fall directly onto the valves below.

The circuitry used for electronic tone generation was varied and even neon tube dividers were not uncommon. If a frequency is missing at all points on the keyboard whatever the chosen pitch, look first at the valve itself. High voltages collect dust and dirt which, together with traces of oil, can get into the valveholder. Clean everything—valve pins and socket—with carbon tetrachloride and see if that helps before changing the valve.

Another source of trouble in valve equipment are resistors that go high, Long use with high voltages will ‘in effect give a change in the colour of the multiplier band! For example, a 220k resistor can increase its value to 2M or more and if it happens to be the anode load it will stop the valve working.

Fig. 3 shows a typical amplifier stage. Unsolder and check the resistor connected to the anode of any valve that appears to be working at a very low voltage: anode volts for generators and amplifier stages are in the region of 150V. If the resistor has gone high, replace it with a hi-stab of the correct rating: ordinary carbon resistors were often used through the generator and later stages, but hi-stabs are preferable in being less noisy.
WIRING

Under chassis wiring should not be disturbed more than necessary as there is a real risk of inducing heater hum in doing so. Flexible wiring and cables should be examined carefully, especially the mains lead. The colour-coding of the mains cable will indicate its age and, if it happens to be rubber-covered, the chances are that the insulation is turning to powder. Replace this lead to eliminate fire hazard.

Co-ax cable of the same age often had a bare screen and rubber insulation for the inner. I would replace this type of cable for two reasons. If the bare outer touches anything it can cause trouble—hum, for example, if it contacts the chassis. Old co-ax can also produce an elusive fault where the audio signal evaporates without an apparent reason. What happens is that flexing the cable powders the insulation, which earths out the signal.

KEYING

If a generated frequency is missing somewhere, a test amplifier and speaker can be used to check whether the fault lies in the generator or with the keying. Traced to a keyswitch the problem will probably be dirt on the contacts and nothing more. A small brush will usually help to clear it, in stubborn cases, moistened with carbon tetrachloride.

Precious metal-to-metal contacts were usual and their wiping action kept them clean. Some organs used progressive resistance switches for earthing out a generator signal (extremely prone to ciphers!) but any problem with these systems can usually be traced to dirt. Rotating busbars were fitted to some models to allow a new switching surface to be presented in the event of the precious metal plating wearing through.

One very obvious precaution with valve instruments is to keep a set of spares as valves are becoming increasingly hard to find. When you buy them, the £ 6 ·95 price is often still marked on the box—and bears no relationship to what you will pay today! If unfamiliar with valve circuitry, renovating one of these old instruments is an interesting challenge and there is great satisfaction in injecting new life into a worthy instrument.

As it is some time since valve circuitry appeared in this magazine, there is one final tip: if delving into the works with the organ switched on, keep one hand in your pocket!
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<th>Pack No</th>
<th>Qty</th>
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<th>Price</th>
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<td>12</td>
<td>RED 5mm LED</td>
<td>£1.00</td>
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<tr>
<td>TF12</td>
<td>30</td>
<td>500u Farad ZENERS 5%</td>
<td>£2.00</td>
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<tr>
<td>TF13</td>
<td>100</td>
<td>IN4148 Diode</td>
<td>£1.00</td>
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<td>TF14</td>
<td>100</td>
<td>IN4151 Diode</td>
<td>£1.00</td>
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<tr>
<td>TF15</td>
<td>50</td>
<td>1 amp Rect Diodes in 4000 series</td>
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<td>1 amp Bridge Rect.</td>
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<td>Transistor pads</td>
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<td>20</td>
<td>A/S Fuses 20mm</td>
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<td>3A Rect. Diodes</td>
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<td>ORP 12</td>
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<td>TF23</td>
<td>10</td>
<td>IC's all different</td>
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<td>BFR6</td>
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<td>8 pin DIL sockets</td>
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<tr>
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<td>20</td>
<td>10mm Hori. Pre set (10 values)</td>
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<td>TF27</td>
<td>200</td>
<td>47uf 16v Polyester cap</td>
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<td>£2.00</td>
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<table>
<thead>
<tr>
<th>SWG</th>
<th>1 lb</th>
<th>5 oz</th>
<th>4 oz</th>
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<td>48</td>
<td>15.36</td>
<td>9.25</td>
<td>9.18</td>
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| 14 to 30 | 3.57 | 2.41 | 1.39 | 0.34 |

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### RESISTORS
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<th>Month</th>
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<th>Price</th>
<th>Details in Catalogue</th>
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<td>75W Mosfet Amp Module</td>
<td>LW51F</td>
<td>£42.95</td>
<td>Best of E&amp;M &amp; M</td>
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<tr>
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<td>Car Burglar Alarm</td>
<td>LW78K</td>
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<td>Spectrum Easyload</td>
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<td>Spectrum Keyboard</td>
<td>LW29G</td>
<td>£28.50</td>
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