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AUGUST 2001

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Cover illustration by Jonathan Robertson

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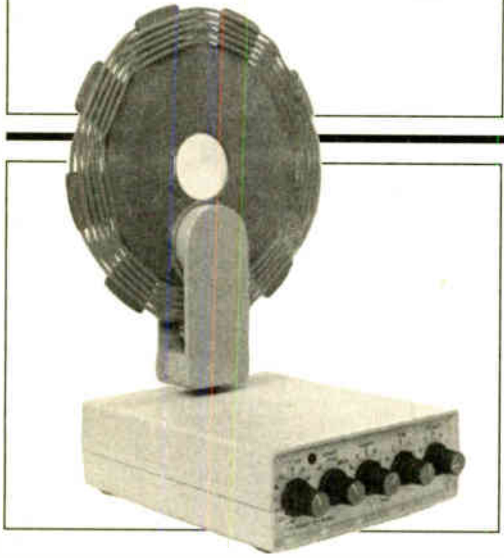

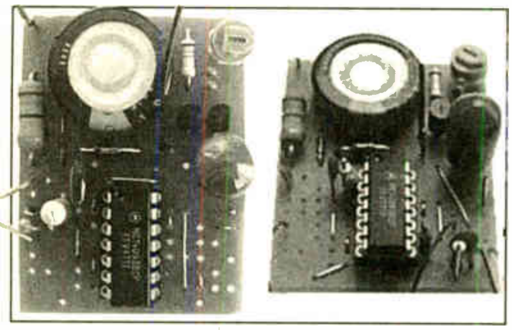

Projects and Circuits

Series and Features

Regulars and Services

WE HAVE MOVED!

Please note our new address and phone/fax numbers – see page 543

Our September 2001 issue will be published on Thursday, 9 August 2001. See page 535 for details

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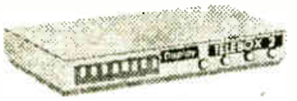
Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER CABLE COMPATIBLE*

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors or AV equipment which are fitted with a composite video or SCART input. The composite video output will also plug directly into most video recorders, allowing reception of TV channels **not normally receivable on most television receivers*** (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND as used by most cable TV operators.** Ideal for **desktop computer video systems** & PIP (picture in picture) setups. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard. Brand new - fully guaranteed.

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TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6 mHz sound specification
*For cable / hyperband signal reception Telebox MB should be connected to a cable type service. Shipping on all Telebox's, code (B)

NEW State of the art PAL (UK spec) UHF TV tuner module with **composite** 1V pp **video & NICAM** hi fi stereo sound outputs. **Micro electronics** all on one small PCB only 73 x 160 x 52 mm **enable** full tuning control via a **simple 3 wire link** to an IBM pc type computer. Supplied complete with **simple working program and documentation**. Requires +12V & + 5V DC to operate.
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All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a full 90 day guarantee. Call or see our web site ***www.distel.co.uk*** for over 2000 unlisted drives for spares or repair.

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5¼" **HP** C3010 2 Gbyte SCSI *differential* RFE tested	£195.00
8" **NEC** D2246 85 Mb SMD interface. *New*	£199.00
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00
8" **FUJITSU** M2392K 2 Gb SMD I/F RFE tested	£345.00

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Mitsubishi FA3415ETKL 14" SVGA **Multisync** colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including **IBM PC's** in CGA, EGA, VGA & SVGA modes, **BBC, COMMODORE** (including Amiga 1200), **ARCHIMEDES** and **APPLE**. Many features: Etched faceplate, text switching and **LOW RADIATION MPR** specification. Fully guaranteed, in EXCELLENT little used condition.

Tilt & Swivel Base £4.75 **Only £119** (E) Order as MITS-SVGA
VGA cable for IBM PC included.
External cables for other types of computers available - CALL

Ex demo 17" 0.28 SVGA Mitsubishi Diamond Pro monitors, Full multisync etc. Full 90 day guarantee. Only £199.00 (E)

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors. Good SH condition - from £299 - CALL for info

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with <u>both</u> **RGB and standard composite** 15.625 Khz **video inputs** via **SCART socket** and separate phono jacks. **Integral audio power amp and speaker for all audio visual uses.** Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security applications** with **direct connection to most colour cameras.** High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¼" x 15½" D. **Only £99.00** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered **Only £79.00** (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13½" x 12" x 11". Good used condition. **Only £125** (E)

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20"....£135 22"....£155 26"....£185 (F)

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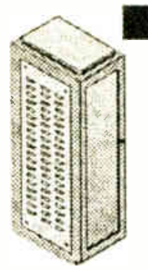
19" RACK CABINETS



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

Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd**. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the ***most versatile we have ever sold.*** Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays. Overall dimensions are: 77½" H x 32½" D x 22" W. **Order as:**

OPT Rack 1 Complete with removable side panels.	£345.00 (G)
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Over 1000 racks, shelves, accessories 19" 22" & 24" wide 3 to 46 U high. Available from stock !!

32U - High Quality - All steel RakCab

Made by **Eurocraft Enclosures** Ltd to the **highest possible spec,** rack features **all steel construction** with removable side, front and back doors. Front and back doors are **hinged for easy access and all are lockable** with five **secure 5 lever barrel locks.** The front door is constructed of double walled steel with a **'designer style'** smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack **features fully slotted reinforced vertical fixing members to take the heaviest of 19" rack equipment.** The two movable vertical fixing struts (extras available) are pre punched for standard **'cage nuts'. A mains distribution panel** internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin **switched utility socket.** Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvres. The top panel may be removed for fitting of **integral fans** to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W (64" H x 25" D x 23¾" W)

Sold at LESS than a third of makers price !!

A superb buy at only £245.00 (G)

42U version of the above only £345 - CALL

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A special bulk purchase from a **cancelled export order** brings you the most **amazing savings** on these ultra high spec **12v DC 14 Ah** rechargeable batteries. Made by **Hawker Energy Ltd, type SBS15** featuring **pure lead** plates which offer a far superior shelf & guaranteed 15 year service life. **Fully BT & BS6290 approved.** Supplied **BRAND NEW** and boxed. Dimensions 200 wide, 137 high, 77 deep. M6 bolt terminals. Fully guaranteed. Current makers price over £70 each ***Our Price £35 each*** (c) ***or 4 for £99*** (E)

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Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
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Marconi 2022C 10KHz-1GHz RF signal generator	£1550
Marconi 2030 opt 03 10KHz-1.3 GHz signal generator, New	£4995
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Fujitsu M3041D 600 LPM printer with network interface	£1250
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Perkin Elmer 597 Infrared spectrophotometer	£3500
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LightBand 60 output high spec 2u rack mount Video VDA's	£495
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ADC SS200 Carbon dioxide gas detector / monitor	£1450
BBC AM20/3 PPM Meter (Ernest Turner) + drive electronics	£75
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Overall dimensions 66 mm wide x 117 deep x 43 high. Supplied BRAND NEW & fully guaranteed with user data. 100's of applications including Security, Home Video, Web TV, Web Cams etc. etc.

Web ref = LK33 ***ONLY £99.00 or 2 for £180.00*** (B)

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NT4 WorkStation, complete with service pack 3 and licence - OEM packaged. ***ONLY £89.00*** (B)

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DOS 5.0 on 3½" disks with concise books c/w QBasic .	£14.95
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Wordperfect 6 for DOS supplied on 3½" disks with manual	£24.95

shipping charges for software is code B

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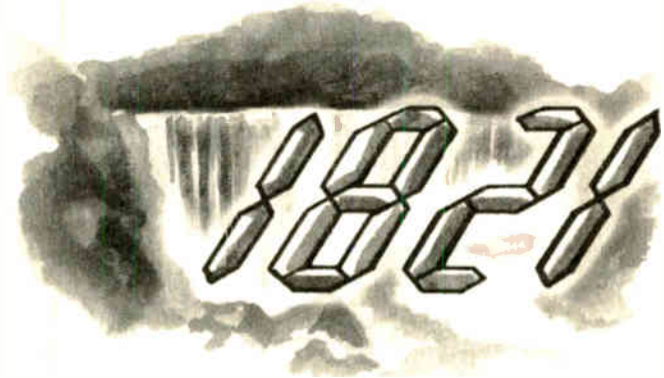
NEXT MONTH

GARDEN WATERING MONITOR



This monitor tells you not only the cost of the hose-piped water that has been used to keep your grass green and your blooms blossoming, but also allows the water to be cut off after a preset period.
The design is PIC controlled and includes a 32-digit alphanumeric liquid crystal display.
The Water Company's charge per cubic metre of water used is entered via pushbutton switches and is automatically stored for future recall.
The l.c.d. shows the elapsed time since watering started, the number of litres used and their cumulative cost.
Watering duration can be set in steps of 10 minutes up to a total period of nine hours 50 minutes. It can be manually terminated earlier than the preset period if desired. The facility can be bypassed to allow unlimited water flow. The preset time is also stored for future recall.

HI-TECH L.E.D. TORCHES

Presenting a brace of l.e.d. torches, for the intrepid camper or youthful illicit bed-time under-the-blankets reader! One is super-hi-tech, the other – well, less so . . .
The simplest of the designs, using ultra-bright red l.e.d.s, was put together using parts which happened to be available in the author's workshop. It is cheap and simple to construct, using inexpensive l.e.d.s and semiconductors.
The sophisticated design uses white l.e.d.s and is very impressive, being extraordinarily bright. The l.e.d.s emit a very high intensity blue light, but are backed by a phosphor which glows brilliantly white under this stimulation. Using three of these brilliant sources of light, the torch looks like no other currently on the market.
It is really possible to walk along a rural footpath at night with it, and it is far more economical to run than a conventional torch. Unlike the red version, colours are clearly visible in its light. It definitely has novelty value, as well as being highly useful.

PERPETUAL PROJECTS – 3

How about "forever" keeping burglars at bay? Our solar-power Loop Burglar Alarm next month could certainly put you well on the road to doing so. We also have a project to help you find the keyhole on a dark night (even darker if you've had a power failure!) – a high-intensity l.e.d. Door Light. And, not that we would wish perpetual raining on you – we add a perpetual Rain Alarm as well.
Then, as if that's not enough for one issue, we make the offerings into a real "solar-powered" bumper bundle, with seven variations on these themes. (We are, of course, renowned for providing you with "perpetual interest"!)

PLUS ALL THE REGULAR FEATURES

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SEPTEMBER 2001 ISSUE ON SALE THURSDAY, AUGUST 9

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The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

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- Detects gold, silver, ferrous & non-ferrous metals
- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

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PORTABLE ULTRASONIC PEsT SCARER

A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

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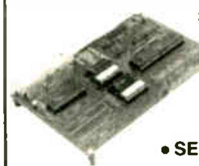

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- PSU £6.99
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Kit includes case, P.C.B., coupling coil and all components.
High coil current ensures maximum effect. L.E.D. monitor.

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KIT + SLAVE UNIT. £32.50

WINDICATOR

A novel wind speed indicator with LED readout. Kit comes complete with sensor cups, and weatherproof sensing head. Mains power unit £5.99 extra.

KIT 856. . . . .£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

Magenta have prepared a FULL KIT for this excellent new project. All components, PCB, hardware and electrodes are included.
Designed for simple assembly and testing and providing high level dual output drive.

KIT 866. . Full kit including four electrodes £32.90

1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.
Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848. . . . . £32.95

EPE TEACH-IN 2000

Full set of top quality *NEW* components for this educational series. All parts as specified by *EPE*. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.
**Batteries and tools not included.*

TEACH-IN 2000 -

KIT 879 £44.95
MULTIMETER £14.45

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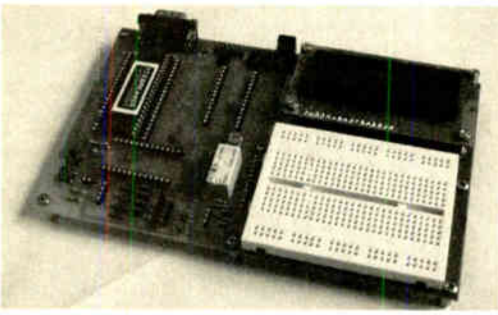

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TIME OUT

Occasionally technology overtakes us, it has with this month's *Digitimer* project. Before undertaking the design, the author asked Sky if this was a facility which they were likely to add to their digital service, they told him they had no plans to do so. However, within days of us accepting the project for publication Sky introduced a similar, though not so versatile, function within their software.

So what should we do, scrap the project or go ahead? As you can see we have decided to go ahead with publication. This decision was made on the basis that the technology and programming used in the *Digitimer* will be of interest to readers in their own right. We do know that few readers build projects exactly as published, many people customise our designs or use bits of circuits or programs in their own projects. A number of aspects of the *Digitimer* lend themselves to use in this way, including the RTC timing circuit, IR and RF interfaces etc. Our project is also more versatile than the system offered by Sky so it is worthwhile for that reason alone.

TIME BEFORE

One well-known occasion when we were previously overtaken by technology was way back in 1972 when *Practical Electronics* published a series of eleven articles describing the *PE Digi-Cal*, a TTL-based digital calculator using some 140 logic i.c.s. The design cost about half the price of the £250 commercial ones available at the time. However, before the series of articles describing the project was past the fourth part, the single chip calculator i.c. had arrived and prices for calculators dropped dramatically almost overnight. Not only were ready made hand held calculators available for half the price of the *PE* project, before the series was completed kits had appeared for around £40.

A number of *Digi-Cals* were built by readers. The design was also welcomed by those in education because it showed exactly how a digital calculator worked. As Fred Bennett (the then Editor) said at the time, we could sit back and wait for the "ultimate" design to appear and therefore publish very little.

I guess almost everything we publish will be superseded by "better" designs within a few years (or even a few months), but that is not what our hobby is all about.

AVAILABILITY

Copies of *EPE* are available on subscription anywhere in the world (see below) from all UK newsagents (distributed by COMAG) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). *EPE* can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased and downloaded for just $9.99(US) per year available from **www.epemag.com**

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Constructional Project

DIGITIMER

STEVE CHALLIS

An add-on VCR record timer unit for Sky digital satellite TV.

AFTER many months of resisting, the author was finally persuaded to "upgrade" his motorised Pace satellite system to Sky Digital.

Once the system was installed, it soon became apparent that the Sky Digibox did not have a record timer feature. Just imagine your frustration if you carefully set your VCR and the satellite to record the match and return home only to find an episode of *Sabrina* instead!

With this in mind he set about investigating a suitable solution. The Digibox is far too complex to even think about internally modifying so a stand-alone external unit was decided upon.

The basic concept behind Digitimer is that at a preset time the Digibox is sent a series of remote control commands to change to the desired channel. These commands can be either via IR (infra-red), as per the remote handset, or r.f. (radio frequency) via the Digilink connector on the rear of the Digibox.

BLOCK DIAGRAM

The basic block diagram of Digitimer is shown in Fig.1. The heart of the unit is a PIC16F876 microcontroller running at 3·58MHz. This handles the operation of the unit, interfacing with the peripheral devices. User input is catered for by a keypad and operational status is displayed on an alphanumeric liquid crystal display (l.c.d.).

> **TECHNOLOGY ADVANCES**
>
> Since accepting the Digimeter for publication, Sky have introduced their own programmed timing options, thus replicating part of this design. However, Digimeter also offers other facilities not provided by Sky and its overall design technology is interesting in its own right. Consequently, we have concluded that the design is still very worthy of publication.

Time keeping functions are controlled by a dedicated Real Time Clock chip (RTC). This is battery backed to preserve the time should the mains power fail. Timer settings and favourite channels are stored in the internal EEPROM (electrically erasable read-only memory).

Remote control commands are conveyed to the Digibox either by an IR signal or on a 7MHz r.f. carrier to the Digilink connector. During timer operation a relay operates and disables the d.c. supply to the Digilink remote "eyes" thus stopping inadvertent changing of the channels from other rooms of the house.

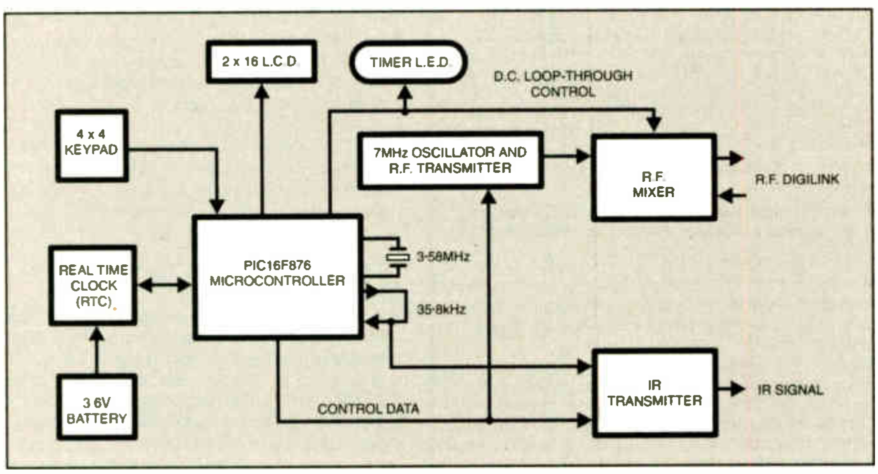


Fig.1. Block diagram for the Digitimer.

The Digitimer is split into two separate circuit boards – a main control board and an r.f. board. The main control board is mounted horizontally in the bottom of the case and contains the power supply and logic control functions.

CONTROL CIRCUIT

Referring to Fig.2, the heart of the main circuit is the PIC16F876 microcontroller, IC2. At power up, the PIC initialises the RTC (IC3) and the liquid crystal display (l.c.d.).

The l.c.d. is used in conventional 4-bit mode and is fed data from PIC port pins RB4 to RB7. Its control signals come from port pins RC5, RC6 and RC7. Preset VR1 sets the display contrast to an acceptable level.

The l.c.d. backlight is switched by transistor TR1, which is controlled by port pin RC4 via current limiting resistor R4. Resistor R1 provides current limiting for the backlight.

After power on, the RTC device needs to be initialised to the desired 24-hour mode. By default the INT pin is set to toggle at a 1Hz rate. This is applied to the PIC via pin RA1 and causes it to flash the colon in the time display, as well as trigger some internal timing functions. Communications with the RTC are handled by I^2C serial data from PIC pins RA2 and RA3.

The RTC basically comprises an oscillator and a series of counters for years, months, days, hours, minutes, seconds, and day of the week. It requires very few external components – just a 32·768kHz crystal (X1) and an 18pf load capacitor (C9). A data sheet can be found on the Philips Components web site at:

www.semiconductors.philips.com/.

In order to maintain the correct time during a power outage, the RTC has a backup battery. This is a NiMH device which during normal operation is trickle-charged from the 5V rail via diode D4 and resistor R15.

KEYPAD

A matrixed 4 × 4 keypad is used to input user commands to the PIC, via pins RB0 to RB3. Pins RB4 to RB7 are configured as outputs to the keypad (multiplexed with the l.c.d. display).

Referring to Fig.3, keypad monitoring is performed as follows: first the PIC sets

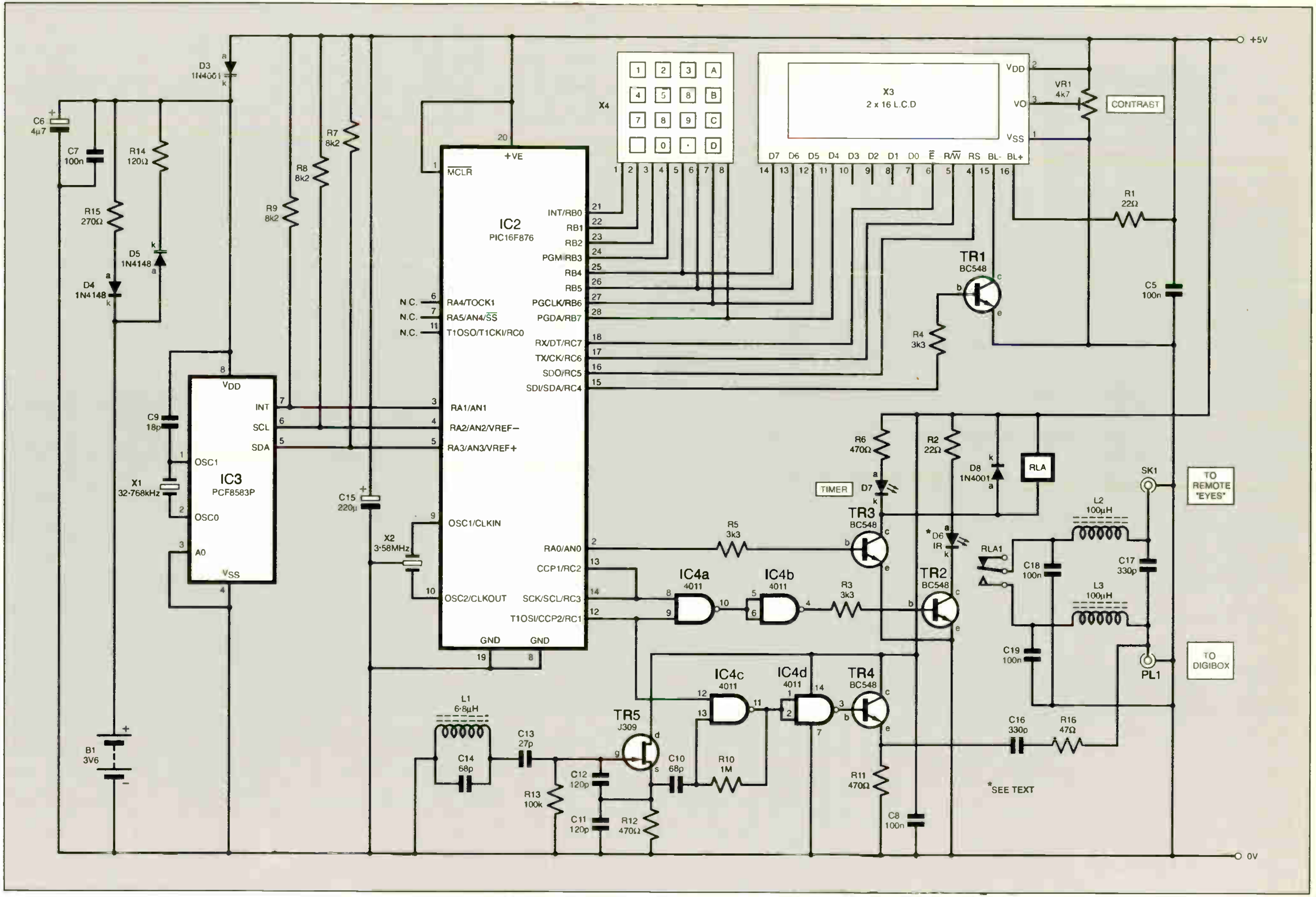


Fig.2. Main circuit diagram for the Digitimer.

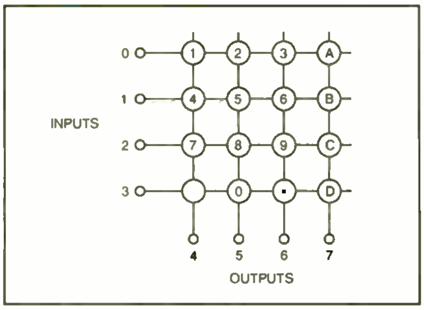


Fig.3. Keypad matrix connections.

input 0 high. It then checks outputs 4 to 7 in turn to see if any of these are high. If not, it then sets input 0 low and input 1 high. It again checks outputs 4 to 7 in sequence. This sequence continues until either an output is found to be high, or all inputs have been set and all outputs checked.

If, for instance, key "B" is pressed, when input 1 is set high there will also be a high on output 7. The PIC reads this status and knows that this key has been pressed and takes the appropriate action.

The keyboard is continually scanned in this way during normal operation so that it is ready to respond to any keypress. Each time a key is pressed the l.c.d. backlight is illuminated for about 12 seconds.

REMOTE CONTROL

The remote control data requires careful and accurate timing. The PIC has three internal counter/timers: RTCC (TMR0), Timer 1 and Timer 2. Here Timer 2 is used. This is configured to effectively divide the X2 crystal frequency by 100 and provide a 35·8kHz output clock signal at pin RC2. This is fed back into RC3 and is internally counted to provide a control data stream at RC1. A logic 1 on the data stream is equal in length to 16 of these pulses.

To successfully transmit data, an IR l.e.d. must have a carrier signal. The clock signal at RC2 is combined with the data stream at RC1 by NAND gate IC4a, and with IC4b re-inverting the output. The result is represented in Fig.4.

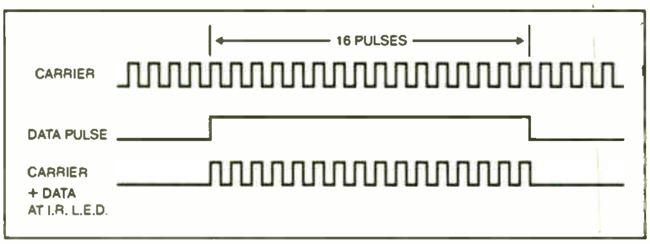


Fig.4. IR pulse generation waveforms.

The composite signal from IC4b is fed via R3 into the base of TR2, turning it on and off. The collector of TR2 drives the IR l.e.d. which sends signals to the Digibox. R2 limits the current through the IR l.e.d.

DIGILINK

A useful feature of the Digibox is the ability to change channels and be viewed in another room of the house. This is performed by the Sky Digilink system. A separate u.h.f. (ultra high frequency) output on the rear of the Digibox is used to feed an additional TV receiver. Along this cable can also pass remote control information. Instead of using a 35·8kHz carrier as in the IR l.e.d. circuit, the Digilink uses a 7MHz r.f. carrier.

A Digilink "remote eye" positioned next to the additional TV receiver picks up the commands from the remote control and encodes them onto the r.f. carrier. The coaxial cable then feeds this information back to the Digibox. Also present on the coaxial cable is about 9V DC, which is used to power the "remote eye".

The circuitry around transistor TR5 forms a 7MHz oscillator that is used to provide the r.f. carrier. The output of this is combined with the remote control data stream from RC1, by NAND gates IC4c and IC4d, to form a composite data stream, in a similar way to the IR l.e.d. circuit. This is buffered by TR4 and then fed to the r.f. board.

R.F. CIRCUIT

The circuit diagram for the r.f. section is shown to the right in Fig.2. The 7MHz composite data from TR4 is coupled by capacitor C16 and resistor R16 to socket SK2 from where it is output to the Digibox.

In order to stop the satellite channel from being changed during a timer event, the d.c. supply from the Digibox to the "remote eye" is disconnected. This is achieved by using relay RLA. Normally, the d.c. feed from the Digibox travels through inductor L3, via the normally-closed contacts of RLA, through L2 and then out via socket SK1.

When a timer event occurs, RLA is energised and the contacts open. The d.c. feed to the "remote eye" is thus removed and it no longer functions. There are two points to note, however. First, it is still possible to change channel using a remote control pointed at the Digibox or by using the buttons on the front of the Digibox.

Secondly, if a distribution amplifier is used that relies on the power from the Digibox then this will also cease to function. This was not the case with the author's installation, however. Inductors L2 and L3 serve to isolate the r.f. signals that need to pass from the Digibox to the second TV receiver. Diode D8 suppresses the back-e.m.f. generated by the relay coil when it is de-energised.

POWER SUPPLY

The power supply is fairly basic and its circuit diagram is shown in Fig.5. Transformer T1 reduces the mains voltage to about 8V to 10V r.m.s. This is full-wave rectified by diodes D1 and D2 to provide about 15V d.c. across reservoir capacitor C1. This is fed to the input of regulator IC1 which delivers an output voltage of 5V.

Capacitors C2 and C3 inhibit the regulator from oscillating and C4 provides extra smoothing.

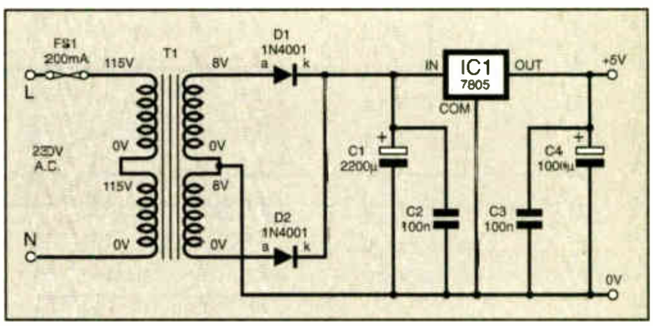


Fig.5. Power supply circuit diagram.

CONSTRUCTION

Digitimer is constructed on two printed circuit boards, which are available from the *EPE PCB Service*, codes 311 (Main) and 312 (R.F.).

Before fitting any components to the main board, use it as a template to mark out the four corner fixing holes on the base of the case. Ensure the board is located such that there is sufficient clearance for the l.c.d. on the front panel and the r.f. board on the rear panel.

Assemble the main board first, referring to the layout in Fig.6. Carefully fit the components to the board observing the correct

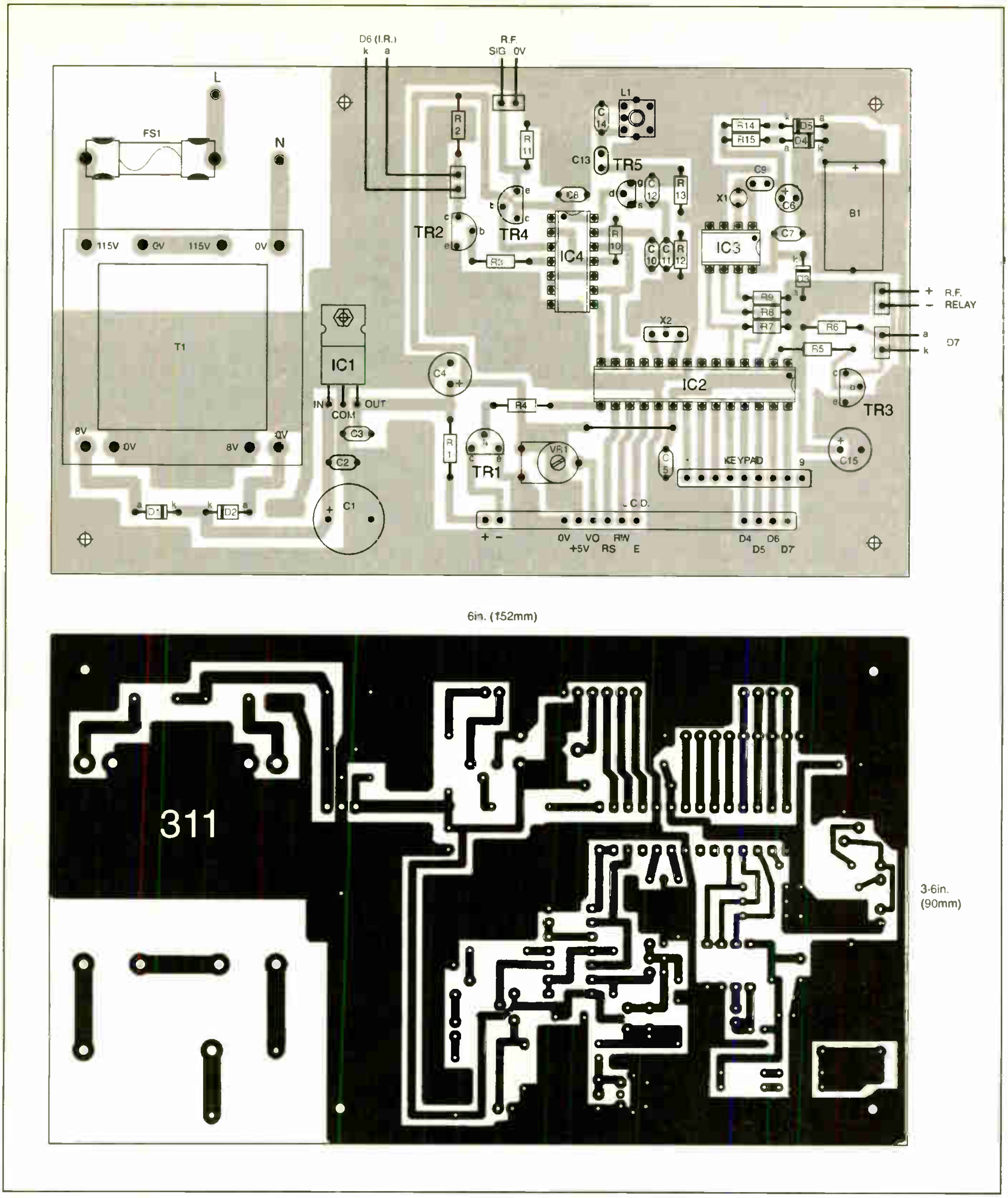


Fig.6. Component layout and full size master track pattern for the main p.c.b.

polarity of the semiconductors and the electrolytic capacitors. The order of fitting is not important, although it is advisable to leave the transformer and the battery until last.

Since the unit consumes so little power, regulator IC1 does not require a heatsink and is simply bolted to the board for mechanical stability. Use sockets for the other i.c.s. but do not insert the i.c.s or connect the display until the power supply section has been tested.

FIRST TESTS

Once construction is completed, recheck for correct component orientation and solder splashes. If you are satisfied, testing of the power supply section can commence.

Mains voltages are present in this unit. Utmost care must be taken to treat them with respect, they can be lethal!

Using a multimeter set to the Ohms range, first check across capacitor C4 to ensure that there is not a direct short. A brief reading may be obtained as C4 and C15 charge. If all is OK, continue. If not, do not attempt to apply mains power as IC1 and the transformer may be damaged.

Taking care, place the main board on an insulated surface and connect up a temporary mains lead, but do not turn on the supply yet. Tracks on the bottom of the p.c.b. will be carrying mains voltage.

Connect the multimeter, set to a suitable d.c. volts range, between the 0V and +5V output terminals of the regulator. Keeping your fingers clear of the board, switch on the mains supply. The meter should read 5V, within a few per cent.

Switch off the mains supply and disconnect it from the socket outlet. If the 5V rail is not present, carefully check around IC1

COMPONENTS

Approx. Cost Guidance Only **£90** excluding case.

Resistors

R1, R2	22Ω (2 off)
R3 to R5	3k3 (3 off)
R6, R11, R12	470Ω (3 off)
R7 to R9	8k2 (3 off)
R10	1M
R13	100k
R14	120Ω
R15	270Ω
R16	47Ω SMD 0805 format

All 0·25W 5% carbon film or better, except R16.

See SHOP TALK page

Potentiometer

VR1	4k7 min. horiz. skeleton preset

Capacitors

C1	2200µ radial elect. 25V
C2, C3, C5, C7, C8	100n ceramic, 5mm pitch (5 off)
C4	1000µ radial elect. 16V
C6	4µ7 radial elect. 50V
C9	18p ceramic, 5mm pitch
C10, C14	68p ceramic, 5mm pitch (2 off)
C11, C12	120p ceramic, 5mm pitch (2 off)
C13	27p ceramic, 5mm pitch
C15	220µ radial elect. 10V
C16, C17	330p SMD 1206 format (2 off)
C18, C19	100n SMD 1206 format (2 off)

Semiconductors

D1 to D3, D8	1N4001 rectifier diode (4 off)
D4, D5	1N4148 signal diode (2 off)
D6	IR l.e.d., with leads
D7	red l.e.d. with chrome bezel
TR1 to TR4	BC548 *npn* transistor (4 off)
TR5	J309 *n*-channel f.e.t.
IC1	7805 +5V voltage regulator
IC2	PIC16F876 microcontroller, pre-programmed, see text
IC3	PCF8583P real time clock (RTC)
IC4	4011 quad NAND gate

Miscellaneous

B1	3·6V NiMh battery, p.c.b. mounting
F1	100mA 20mm fuse and p.c.b. mounting holder
L1	6µ8H Toko inductor
L2, L3	100µH inductor (2 off)
PL1	coax plug, chassis mounting
PL2	3·5mm stereo jack plug (see text)
RLA	s.p.c.o. sub. min. 5V relay, p.c.b. mounting
SK1	coax socket, chassis mounting
SK2	3·5mm stereo jack socket (see text)
T1	8V-0-8V 4VA mains transformer, p.c.b. mounting
X1	32·768kHz crystal
X2	3·58MHz ceramic resonator
X3	alphanumeric 2 x 16 l.c.d. module
X4	4 x 4 data keypad

Printed circuit boards, available from the *EPE PCB Service*, codes 311 (main), 312 (r.f.); plastic case, Vero 2-piece 180mm x 120mm x 90mm; terminal pins or pin headers for off-board connections; 8-pin d.i.l. socket; 14-pin d.i.l. socket; 28-pin d.i.l. socket; M3 x 8 threaded spacer (10 off); M3 x 6 panhead screw (10 off); M3 x 6 countersunk screw (10 off); M3 washer (14 off); M2·5 x 12 countersunk screw (4 off); M2·5 nut (12 off); M2.5 washer (4 off); M3 x 10 countersunk screw; M3 nut (2 off); mains cable locking grommit; M3 crimp-on eyelet; solder, connecting wire, etc.

for construction errors. The voltage across C1 should be around 15V.

Once you are happy that the power supply is functioning correctly then the front panel components can be connected to the main board.

R.F. BOARD ASSEMBLY

The r.f. board is only required if you are planning to connect the Digitimer to the Digilink socket on the rear of the Digibox. Construction of this board is a little trickier than the previous board because it involves surface mount components. You need a good magnifying glass, a small pair of tweezers and a steady hand, not to mention a small soldering iron. The board's layout details are shown in Fig.7.

As before, use the unpopulated p.c.b. as a template to mark out the mounting holes and locations of the sockets on the rear of the chosen case. Note that for good r.f. loop-through performance the rear panel should be metal and the p.c.b. mounted on metal stand-off pillars.

Temporarily assemble the r.f. sockets and p.c.b. pillars on to the rear panel and then check that the p.c.b. lines up correctly. It is important that the r.f. board is not stressed once completed as the surface mounted components are easily damaged. A hairline fracture will not be noticeable to the eye and may cause a lot of heartache later.

Populate the p.c.b. and use only the minimum amount of solder necessary to provide a good joint. Not only does a large blob of solder look untidy, it is more likely to place stress on the delicate components when it cools.

If possible, get someone to hold the component in place whilst you solder it. With a little patience, however, it is possible to create a neat layout that will function correctly.

Leave the fitting of the relay until last as this may get in the way. Carefully bend the legs of the relay out so that they align with the pads on the board and then solder in place.

INITIAL CASE ASSEMBLY

Using the photographs as a guide, mark and drill/cut out the case panel to suit your components. All holes should be countersunk to suit the screw heads, except for the l.e.d. mounting hole which should be the correct size for the l.e.d. chosen.

Mount the l.c.d. to the front panel using 8mm stand-off pillars and fit the keypad and the timer l.e.d. Referring to Fig.8, wire the keypad, l.e.d., and l.c.d. to the main board.

The functionality of the main board can be tested at this stage. No connections are necessary to the r.f. board. Insert the i.c.s into the sockets, including the pre-programmed PIC, turn VR1 fully clockwise and connect the front panel.

Switch on the power supply. If all is well the display will show "Digitimer" for one second whilst the PIC's internal EEPROM is initialised. Adjust VR1 for good display contrast. If nothing appears, switch off immediately and check for construction errors.

If the display correctly shows "Digitimer" and then goes blank this indicates a fault associated with the RTC chip.

Don't worry if the display starts normally then shows garbage. This will be corrected when the time is set.

KEYPAD CHECKING

To test the keypad functionality, set the clock, as follows:

- Press the "blank" key repeatedly until "Set Clock" appears on the display.
- Press the "." key. A flashing cursor will appear next to the Day.
- Key in the correct date, in the order DDMMYY.
- After each key press, the cursor will increment to the next digit.
- Continue until the date and time have been set.

Lastly, the day of the week needs to be set. Regarding Sunday as Day 1, press the corresponding number key.

The clock should now be showing a sensible display of day, date and time. Switch off the unit. Wait a couple of minutes then switch on again. "Digitimer" should be displayed followed by the correct date and time. This proves-out the back-up battery circuit. Switch off.

Next the IR l.e.d. can be connected and the IR functionality tested. Switch on and point the IR l.e.d. towards the Digibox. It should be possible to change channels by pressing the number keys on the keypad. If nothing happens try getting closer to the Digibox. Should there still be no results, switch off and carefully check the circuitry associated with the IR l.e.d. and its driver transistor.

If all appears OK switch off. Initial testing of the main p.c.b. is now complete.

CASING COMPLETION

Mount the main p.c.b. in the case, whose plastic standoff pillars will need to be removed. The main p.c.b. is mounted on 8mm threaded spacers.

The r.f. p.c.b. is mounted directly to the r.f. sockets on the rear panel. On the

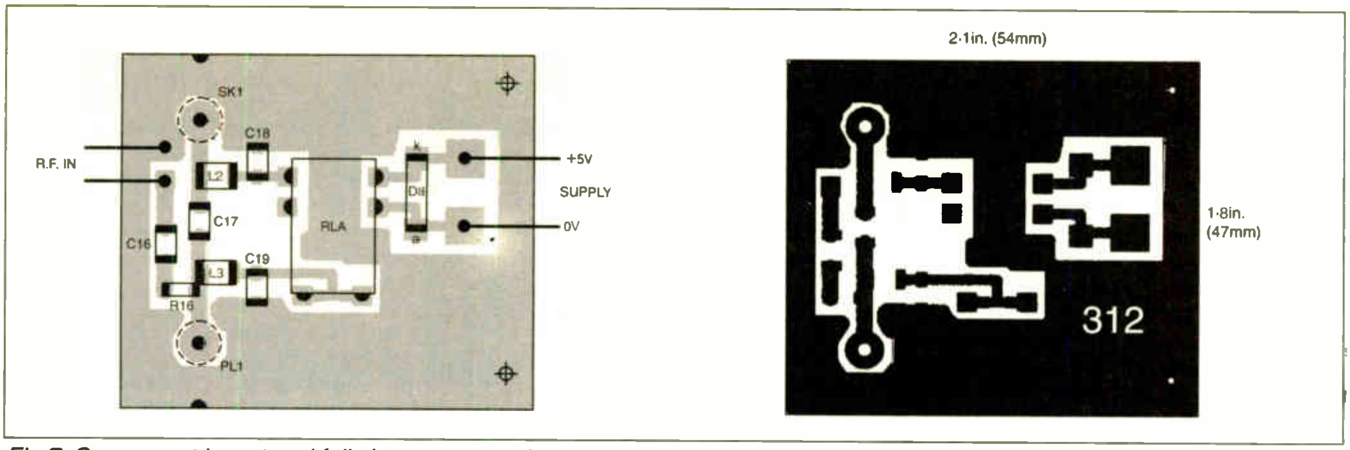


Fig.7. Component layout and full size master track pattern for the surface mount r.f. p.c.b. Note that SK1 and PL1 require holes to be drilled in the board to accommodate their connecting pins.

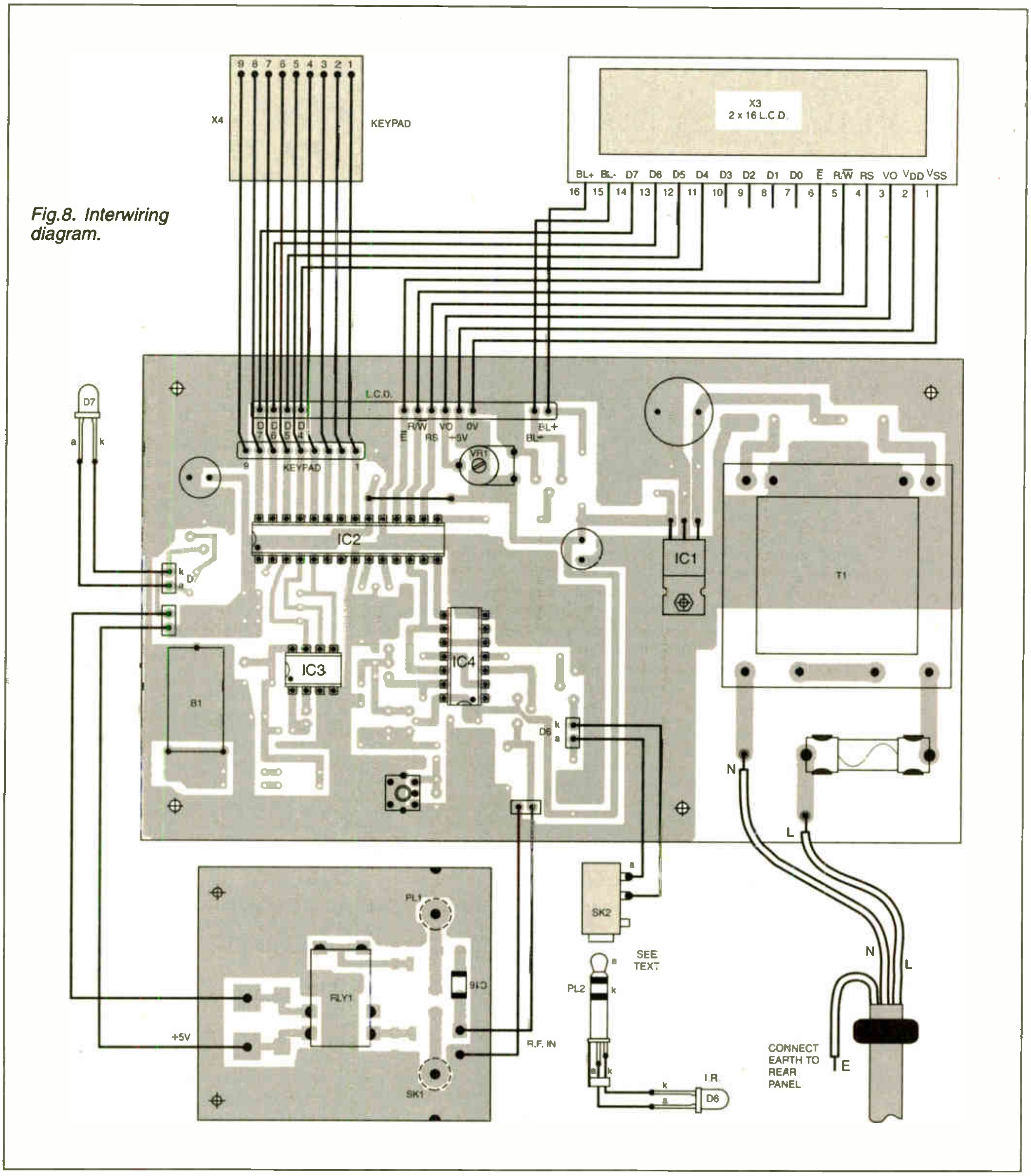
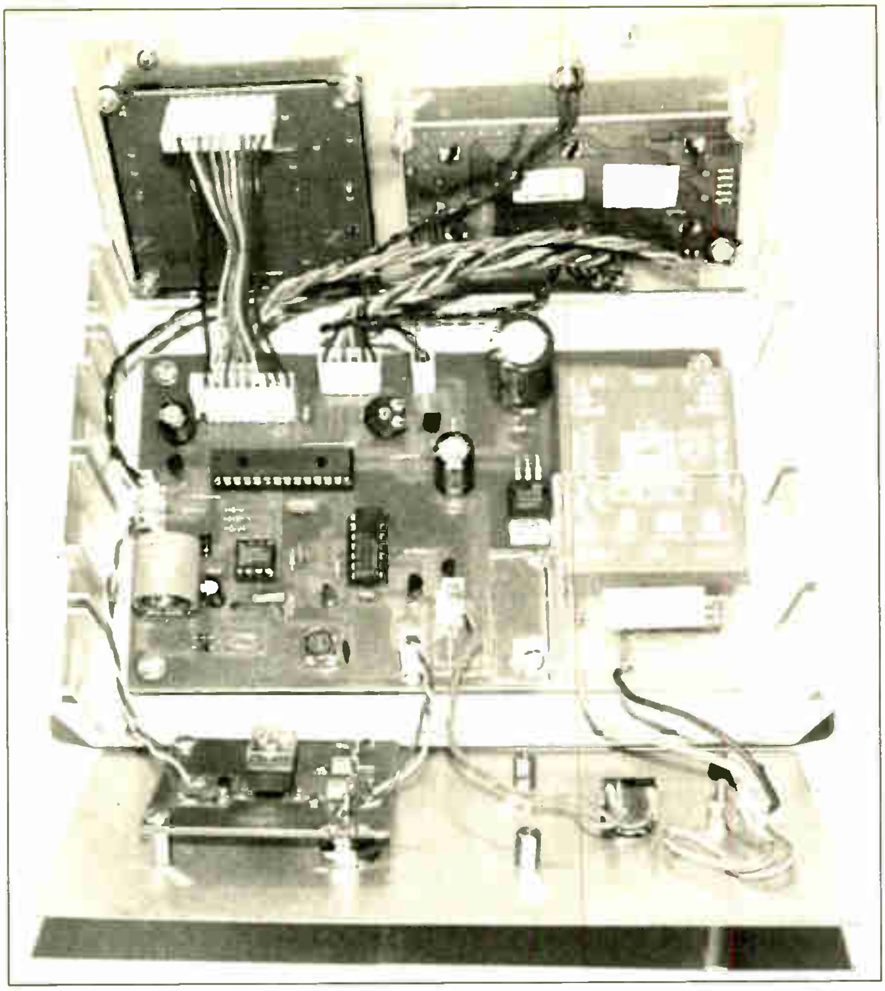


Fig.8. Interwiring diagram.



prototype the board was mounted using 8mm threaded spacers with a couple of 3mm flat washers to provide enough clearance. As stated earlier, it is important not to put strain on the surface mounted components.

The tag washers from the sockets are bent up and soldered to the ground plane of the p.c.b., see Fig.9. Depending upon the length of the tag washers, a small extension using single strand wire may be necessary.

In the prototype the connection to the IR l.e.d. D6 is via a 3·5mm jack plug and socket (PL2/SK2 – not shown in Fig.2 but illustrated in Fig.8). Diode D6 may be hard-wired to the rear panel if preferred, using a suitable mounting clip. Choose a suitable location for the socket or clip and mount this on the rear panel.

Complete the wiring-up of the unit. Connect the earth lead from the mains cable to a solder tag and screw this to the rear panel using a screw and lock washer.

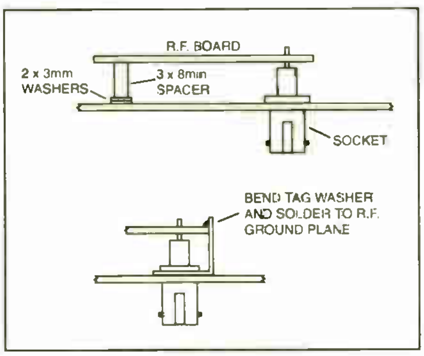


Fig.9. Mounting detail for the r.f. board.

Finally, check all connections are good and that there have been no construction errors.

On the prototype a small Perspex cover was made to shield the mains input fuse and connections so that they could not accidentally be touched.

FINAL TESTING

Switch on the mains supply. The display should light and display "Digitimer". If not, then switch off immediately and re-check the connections. If all appears OK then the time will be displayed (correctly if the previous tests have been conducted and the battery is charged).

Press the "blank" key and the following menu items should be displayed:

"Check Timer", "Set Timer", "Set Clock" and "Set Fav Channels".

Press the "blank" key repeatedly until "Set Clock" is displayed.

Press the "." key. A flashing cursor will appear under the date. If necessary, set the correct date, time and day of the week as described earlier.

After the day has been set the unit will exit the clock-setting mode.

To re-test the IR functionality point the IR l.e.d. at the Digibox and press a number key. The display on the TV should show a number in the same way as if its normal remote control had been used.

The range of the IR signal will not be as great as the normal remote control because the Digitimer was designed to be used next to the Digibox, with a range of possibly only a meter or two. This will vary depending upon the sensitivity of the actual receiver in the Digibox.

FAVOURITE CHANNELS

Once the IR unit has been proven, your favourite channels can be set. Press the "blank" key until "Set Fav Channels" is displayed. Then press the "." key. The display will show "Favourite?". Press one of the letter keys A, B, C or D. The display will change to:

Favourite?
A _

Key in the three digits of the desired channel.

To enter another favourite channel press the desired letter key and enter the three digits. To exit this mode press the "." key.

If no keys are pressed within about six seconds the display will revert to showing the time. The l.c.d. backlight will also switch off about 12 seconds after the last key press.

Now test each of the favourite channels. Press key A, B, C or D. The Digibox will briefly switch off then tune to the desired channel.

R.F. TESTING

If you have built the r.f. board this can be tested next. Set the core of inductor L1 so that it is flush with the top of the can. This position worked fine on both the prototypes. Connect the Digitimer lower socket via a short coaxial lead to the Digilink output on the rear of the Digibox.

Disconnect the IR l.e.d. to ensure that this does not interfere. Press any number key or favourite channel button on the Digitimer and the Digibox should respond accordingly. If it does not try turning on the Digilink output, as follows:

- Using the Digibox remote control, press the "Services" button.
- Choose "System set-up option (4)". Press 0 then 1 then "Select".
- Choose the "RF outlets option (4)" then select "Second outlet power supply".
- Select "On", then "Save settings".
- Press "Backup" to return to "TV viewing".

Now try again. If this does not work you will have to debug the r.f. section. An oscilloscope is probably an essential item here to trace the r.f. signal pulses from the oscillator, TR5, through to the output socket SK1.

TIMER SETTING

If all tests have been successful, then close up the unit's case and set the timer to a few minutes in the future:

- Press the "blank" key until "Set Timer" is displayed.
- Press the "." key and the display will change to the timer setting screen, showing:

00:00 00:00 Sun
C=000 Repeat=No

The cursor will be flashing under the first 0 of the start time. Enter the start time, followed by the stop time. Now enter the day required, via a numeral key as before.

Enter the desired 3-digit channel number. The cursor will now move to the

"Repeat=No". For weekly repeat press 1, for a one-off timer event press 0. Finally press the "." key or wait six seconds to exit the timer setting menu.

When the timer event occurs the timer l.e.d. will illuminate and the relay on the r.f. board will energise. At the same time the channel on the Digibox will change. If a Digilink remote eye is connected then this should not function for the period of the timer event.

To cancel a timer event in progress, press the "." key and the l.e.d. will go off.

CHECKING TIMER SETTINGS

To check the timer settings, proceed as follows:

- Press the "blank" key until "Check Timer" is displayed.
- Press the "." key and the display will

show "Timer 0" followed by a screen showing the settings.

By repeatedly pressing the "." key it is possible to scroll through all the currently set timers. If a timer has not been set then "Timer n Empty" will be displayed. Where "n" is the timer number.

To erase a timer, follow the above procedure until the unwanted timer is displayed then press the "C" key. "Timer n Empty" will then be displayed.

To exit this menu either press the "blank" key or wait six seconds.

Whilst there is a degree of error checking incorporated into the software, take care when setting timer events. If you set timers that overlap then the results will be unpredictable. The same goes for start times that occur after stop times in the same timer.

SOFTWARE

The software for Digitimer was written in "C" and compiled using the excellent Custom Computer Services PCM "C" compiler (**www.ccsinfo.com**). Development of the software was aided by the use of an RF Solutions ICEPIC2 in-circuit emulator (**www.rfsolutions.co.uk**).

A detailed description of the software is outside the scope of this article. The software, including the "C" source code, is available from the *EPE* Editorial office on 3·5-inch disk (for which there is a nominal charge), or free from the *EPE* ftp web site. For more details see this month's *Shoptalk* page. ☐

SHOP TALK
with David Barrington

Digitimer

Most of the components used in the *Digitimer* project are RS components and readers should be able to order them through any local *bona fide* RS stockist, including some of our advertisers. They can also be ordered through **Electromail** (☎ ***01536 204555*** or ***http://rswww.com***), their mail order outlet. The following items were obtained from them: p.c.b. mounting, 8V-0V-8V 4VA mains transformer, code 201-6934; miniature 4 x 4 Hex keypad, code 331-304; high-power 5mm infra-red l.e.d., code 267-8380; the J309 *n*-channel f.e.t., code 290-8451; 5V d.c. 56 ohm coil, p.c.b. mounting, sub. min. relay, code 248-526; p.c.b. mounting 3·6V 70mAh battery, code 228-6379.

The PCF8583P real time clock (RTC) chip was obtained from **Farnell** (☎ ***0113 263 6311*** or ***www.farnell.com***), code 403-908. One component which may prove difficult to find is the 6·8μH Toko inductor, which, we understand, was obtained from **BEC Distribution** (☎ ***01753 549502***) as a sample as they only deal in quantity orders. The author informs us that **Sycom** (☎ ***01372 372587***), **PO Box 148, Leatherhead, Surrey, KT22 9YW**, handle Toko products and may be able to help. The Toko part reference is A119ANS-T10312.

For those readers unable to program their own PICs, a ready-programmed PIC16F876 microcontroller can be purchased from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta2000.co.uk***) for the sum of £10 inclusive p&p (overseas *add* £1 p&p). They are also able to supply a suitable 2 x 16 character alphanumeric display module at a very reasonable price. The software is available on a 3·5in. PC-compatible disk (EPE Disk 4) from the *EPE* Editorial Office for the sum of £3 each (UK), to cover admin costs (for overseas charges see page 601). It is also available *Free* from the *EPE* web site:

ftp://ftp.epemag.wimborne.co.uk/pubs/PICS/digitimer

The two printed circuit boards are available from the *EPE PCB Service*, codes 311 (main) and 312 (R.F.), see page 601.

Lead/Acid Battery Charger

No problems should be encountered when shopping for parts for the *Lead/Acid Battery Charger* project. The specified Darlington transistor and the L200CV voltage and current regulator should be stocked by most of our component advertisers. This also applies to the 100 ohm 2 watt resistor.

The components list calls for a 18VA mains transformer with twin 9V 1A secondaries, but most catalogues seem to list/stock 20VA types which will be satisfactory. The transformer used must be generously rated and be capable of giving 1A minimum. The author's model uses a Stantronic TF00076 25VA type.

The two-part, hammertone metal case came from **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code XY45Y (case 222). They also supply the 3V to 24V d.c. 10mA piezo buzzer, code KU56L.

The printed circuit board is available from the *EPE PCB Service*, code 309. Finally, do not forget to order an insulation kit for the regulator chip.

Compact Shortwave Loop Aerial

There are two possible sources for the Varicap tuning diodes used in the *Compact Shortwave Loop Aerial* project. The dual KV1236 type can be obtained from **JAB Electronic Components** (☎ ***0121 682 7045***), **PO Box 5774, Birmingham, B44 8PJ**. We understand they prefer orders by "mail order". The other source is **Mainline Surplus Sales** (☎ ***0870 2410810***), ***PO Box 5783, Leicester, LE3 2QL***, who have large stocks of the triple KV1235 version Varicap at a very reasonable price.

In case of difficulty, the specified BF981 dual-gate MOSFET, together with a range of low-cost diecast boxes, can be purchased from **J. Birkett, Radio Component Supplies** (☎ ***01522 520767***). The article covers quite a range of suggestions for the other semiconductor devices.

The HT7291 low drop-out regulator and the panel mounting coaxial socket are listed by **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***). The codes for these are PV13P and HH08J.

The printed circuit board is available from the *EPE PCB Service*, code 310 (see page 601).

Perpetual Projects 2 – L.E.D. Flasher and Double Door-Buzzer

Only three items could be of concern in this month's *Perpetual Projects*. The solar panel was dealt with last month.

The 5mm extreme brightness blue l.e.d., used in the *L.E.D. Flasher*, came from **Electromail** (☎ ***01536 204555*** or ***http://rswww.com***), code 235-9922. The Motorola MC14093B quad 2-input NAND Schmitt i.c. also came from them, code 640-765.

The low profile wire-ended piezo sounder, used in the *Double Door-Buzzer*, also came from the above company, code 249-889. You could try one of the standard disc type piezoelectric sounders.

The "Uniboard" printed circuit board is obtainable from the *EPE PCB Service*, code 305 (see page 601).

PLEASE TAKE NOTE

Toolkit Mk 2 *(May/June '99)*

A bug has come to light in the Send Hex and Convert Hex to OBJ routines. It has now been fixed and the revised software is available as Toolkit **V2.4d**. See *PCB Service* page (601) for software ordering details.

News . . .

A roundup of the latest Everyday News from the world of electronics

HIGH-RESOLUTION L.C.D. FLAT SCREENS

Barry Fox reports that it's all done with mirrors and prisms.

PHILIPS has taken the wraps off a large flat screen monitor that displays bright, high resolution images, is much lighter and consumes less power than a cathode ray tube and costs half the price of an l.c.d. or plasma panel. The monitor looks like a CRT set but contains a compact rear projector with a Liquid Crystal On Silicon light valve and scrolling prism light that adds full colour to a monochrome image.

Monitor designers are currently trapped in a tangle of compromises. CRT screen size is limited by the weight of the glass needed to stop the vacuum tube imploding under atmospheric pressure. *(See the "Truly Flat CRT" item opposite – Ed.)* The electron beam guns waste power as heat. L.C.D. screens run cool but factories have great difficulty making large panels because a single faulty cell creates a permanent blip on the screen. Plasma panels are bulky, gobble power and cost over $10,000.

Rear-Projection

The new trend is to use a rear-projector instead of a direct view screen. A cabinet has a translucent screen and a bright lamp which beams white light onto a light valve panel the size of a large postage stamp. The panel displays the graphic or TV image and modulates the light beam before it goes through a projection lens behind the translucent screen. "Folding" the light path with mirrors keeps the cabinet small.

The light valve panel can be a miniature version of a conventional l.c.d. screen, with a matrix of cells each containing liquid crystal and switched by a thin-film transistor. Three separate panels, and red, green and blue light beams, are needed to get full colour on the screen. The images must be very accurately aligned for pure colours. The transistors on the l.c.d. panel block light and dull the image.

So some rear projectors use a light panel made from a matrix of tiny mirrors which switch position to form a video picture which then reflects light through the lens. Colour is added by borrowing an idea from TV pioneer John Logie Baird and spinning a wheel with red, green and blue filters in the light beam. Texas Instruments is the sole supplier of Digital Micromirror light valves.

Philips uses a new kind of l.c.d. panel made by depositing liquid crystal cells directly onto a slice of silicon, topping the sandwich with a transparent electrode sheet and backing it with a reflective layer. Light is shone through the top sheet, modulated by the cells and reflected by the backing into a projection lens. The projected image is very bright because there are no transistors in the light path. Resolution is high because the cells can be very small and just two micrometres apart.

Dichroic Mirrors

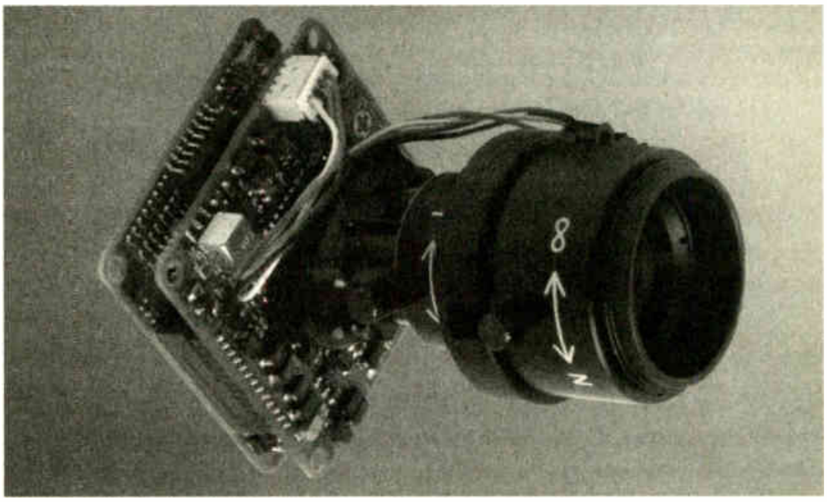
To avoid the cost and complexity of using three precisely aligned panels, Philips's researchers at Briarcliff Manor, New York devised a clever new way of getting colour from a single panel. Dichroic mirrors split white light from an arc lamp into three beams, red, green and blue. Each beam is shaped as a rectangular strip, one third the height of a TV or PC image. The three strip beams then pass through a rapidly rotating prism which continually scrolls red, green and blue strips of light down the LCOS panel. So the LC cells are sequentially reflecting red, green and blue light.

The video signal fed to the panel is sequentially switched in synchronism so that cells bathed in red light display only the red content of the picture, cells in blue light display blue content and so on. The prism scrolls at 200Hz which fools the eye into full colour without flicker.

Philips frontman for the project Ad de Vaan says 100cm displays will be ready by 2003 and cost under $3000. "Until now it has not been possible to make the silicon substrate flat enough, but factories making D-RAM chips now have polishing equipment that can do it."

Says de Vaan, "Philips owns LCOS. We have 85 per cent of all LCOS patents and 95 per cent of the important ones".

CCD CAMERA MODULE



An extremely high-quality dual-board colour CCD camera module has been added to the established Pecan range of CCTV cameras from Stortech Electronics.

Stortech state that the camera sets a new standard in price-performance for products of its type and that it offers very high levels of flexibility, excellent picture quality, true colour and high reliability. The camera is suitable for wide range of applications, both indoors and outdoors, where p.c.b. cameras would not previously have been considered.

Designed around a Sony 1/3-inch (8·5cm) CCD imager, the Pecan CB60H offers horizontal picture resolution of 450 lines and will deliver quality images in light levels as low a 3 lux. Power consumption is typically around 1·85W, the p.c.b.s measure 38mm x 78mm and the module is supplied with an integral varifocal lens with d.c.-controlled auto-iris. We are advised that the price is basically around £170 but various dealers may be offering good discounts.

For more information contact Stortech Electronics Ltd., Dept EPE, Unit 2, Spire Green Centre, Pinnacles West, Harlow, Essex CM19 5TS. Tel: 01279 419913. Fax: 01279 419925. E-mail and Web addresses not quoted.

TRULY FLAT CRT

By Barry Fox

PATENTS reveal that IBM's research laboratory at Greenock in Scotland has spent seven years developing the world's first truly flat cathode ray tube, for use as a TV or PC screen. The CRT can be at least 45cm in size, while only 2cm or 3cm thick. It is cheaper to make than an l.c.d. panel, more robust and uses permanent magnets instead of coils. So hackers will find it far harder to sit outside a secure building and pick up leaking signals to reconstruct on-screen data.

The original invention was made by John Beeteson and Andrew Knox in 1994. The work is so novel that Patent Offices have been unable to find anything similar that has been previously patented. Knox (who has won more patents than anyone else in IBM's UK and Irish laboratories) recently completed three years at Glasgow University on a PhD for the enabling technology.

The flat tube is a sealed device, like a large rectangular button, with a flat cathode plate on the bottom, and a slightly curved glass plate at the top. The inside of the glass top is coated with red, green and blue phosphor stripes. A large permanent magnet plate is sandwiched between the cathode and the glass, and the magnet is peppered with small holes.

Electrons emitted by the cathode plate are pulled towards the magnetic plate, channelled through the perforations and accelerated and focussed into tight beams by the intense magnetic field inside the perforations.

As the electron beams leave the plate perforations, and rush towards the glass, they pass anodes on either side of each exit hole. When a switching voltage is fed to the anodes on both sides of an exit hole, the beam accelerates straight and hits a green phosphor stripe. If one anode is on and the other off, the beam is slightly deflected to left or right, and hits a red or blue phosphor stripe.

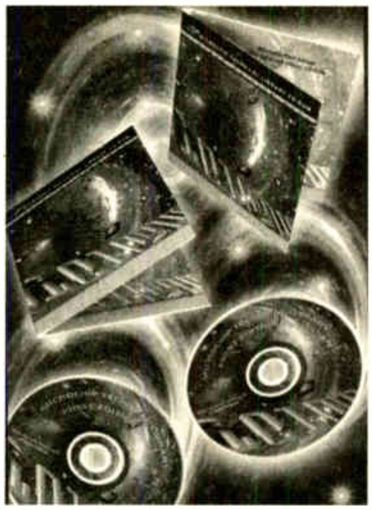
So when a digital video signal is fed to the anodes, the beams paint a full colour picture on the screen glass.

Because the beams travel only a few centimetres from cathode to glass, the tube need only contain a small volume vacuum. So the glass can be much thinner and lighter than needed for a conventional, large volume CRT.

Conventional CRTs use electromagnet coils to deflect the beams, and these coils leak electromagnetic radiation. The perforated plate in the IBM tube leaks only steady magnetism and the beam switching anodes leak only weak electrostatic fields. Inventor Andrew Knox says this will reassure anyone worried about the health risks, and also makes it much harder for hackers to eavesdrop electronically.

John Beeteson retired at Christmas when IBM shut its Advanced Displays Technology laboratory. Andrew Knox still works in an office under a sign which proclaims "The World is Flat", but fears there is little chance of IBM finishing the job he started – the design is up for sale and has already been offered to a Far Eastern manufacturer.

MICROCHIP TECHNICAL CD-ROM



MICROCHIP have introduced their revised Technical Library CD-ROM 1st Edition 2001. This is a complete compilation of technical documentation on the company's PIC microcontrollers and associated development tools. Other related products are covered as well. Microchip's product line includes more than 230 stand-alone analogue and interface products that complement their existing PIC microcontroller products.

The information on the two CD-ROM set replicates Microchip's popular web site and can be viewed with an HTML browser. For more information contact Arizona Microchip Technology Ltd., Microchip House, 505 Eskdale Road, Winnersh Triangle, Wokingham, Berks RG41 5TU. Tel: 0118 921 5858.
Fax: 0118 921 5835.
Web: www.microchip.com.

TIME-SLIP VIDEO

Videos with simultaneous read-write modes allow you to view one recording while making another. Barry Fox reports.

YOU STILL haven't had time to watch the TV programme you taped last week, and now it's time to record the next episode. Then, while you are watching, a long-lost friend phones and interrupts.

New technology which goes on sale for Christmas, solves both problems. A recorder will capture live TV on a blank DVD, with a laser which continually switches so fast between write and read modes that it seamlessly plays a previous recording while making a new one. The viewer can watch either the old or the new programme, as the new recording is made – and pause playback to answer the phone, while the disk continues to record.

Japanese company Matsushita, maker of Panasonic VCRs, gave a sneak preview of its Time Slip DVD technology recently at a European trade seminar in Greece, ahead of official unveiling at the Berlin electronics show in late August. Matsushita's rivals in DVD recording, Pioneer and Philips, are already saying they can develop their own versions.

Disk Not Tape

VHS VCRs rely on tape and can either record or play back, but not at the same time. The TiVo Personal Video Recorder from the US uses a computer magnetic hard disk instead of tape and can play back while recording. But TiVo needs separate recording and playback heads, and the disk cannot be removed from the recorder to shelve in a home library. TiVo recordings must be erased before new ones are made.

Panasonic's Time Slip uses blank erasable DVDs instead of a magnetic disk. The recorder has a laser which continually switches between high power mode to "burn" a recording, and low power mode to read it. At the same time the laser skips fast between different physical positions on the disk. To let all this happen without gaps on screen, the video data streams into buffer memory at 22Mbps and comes out at 11Mbps.

If someone comes to the door, or phones, while the recorder is making a new recording and playing an old one, the viewer just presses "pause". The recorder goes on recording but temporarily stops playing.

Matsushita says Time Slip DVD recorders will cost around £1000 or $1500 and be in the shops in time for Christmas.

Maplin Electronics Sold

MAPLIN Electronics has been sold in a £42 million transaction. The sale represents a huge opportunity for Maplin, with Graphite Capital, the independent private equity provider formerly known as F&C Ventures, providing the backing to further develop and expand the business.

For almost 30 years Maplin has been providing business customers, hobbyists and enthusiasts with a reliable source of good quality electronic products. The range covers 15,000 products, available via 59 high street stores, mail order catalogue and online shopping site. The company employs over 800 people in the UK.

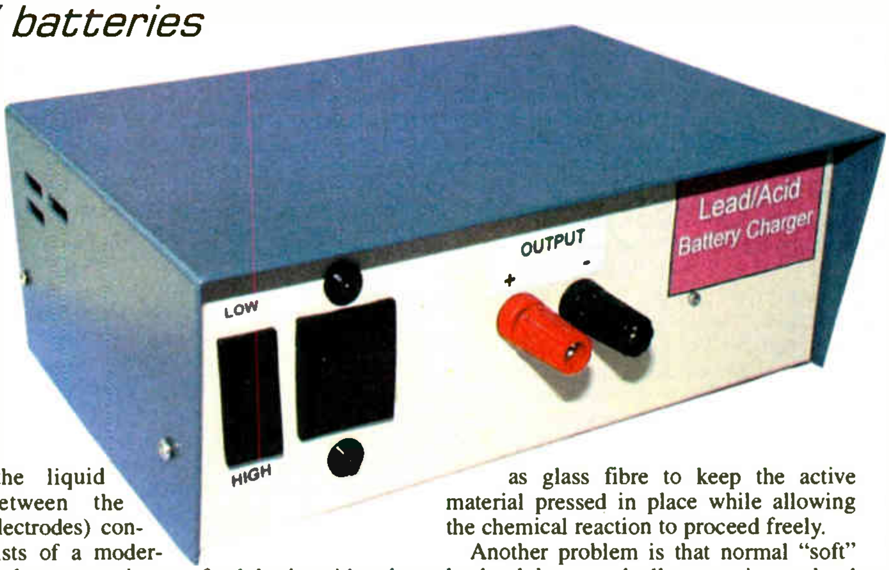
Keith Pacey, Maplin's Managing Director, said "This transaction represents a very important and positive step in Maplin's development. With Graphite's backing we now have the appropriate structure and resources for the future, and this represents an excellent opportunity for our management team to grow the business. We are looking to expand the retail network to 100 stores over the next few years and further develop our e-commerce operations"

For product information contact Maplin Electronics Ltd, Dept EPE, Valley Road, Wombwell, Barnsley S73 0BS. Tel: 01226 751155. Fax: 01226 340167. Web: www.maplin.co.uk.

LEAD-ACID BATTERY CHARGER

TERRY de VAUX-BALBIRNIE

Keep those 6V or 12V batteries properly charged!



THIS article describes the construction of a charger specially designed for small lead-acid batteries.

Lead-acid batteries are found in many pieces of electronic equipment. The small type provides a convenient and relatively inexpensive means of storing a useful amount of energy.

Unlike nickel-cadmium cells, they do not suffer from the "memory effect" which results in the gradual loss of capacity when they are not fully discharged before re-charging.

In fact, they provide their best service life when used in "float" applications where the charge is kept "topped-up" rather than allowing it to fall to a low state.

One particular advantage of this type of battery is its very small self-discharge rate. All batteries are subject to some loss of charge even when not delivering current to an external circuit. However, the lead-acid type will still hold some 50 per cent of its charge after a year or more (in a reasonably cool climate – at higher temperatures, the charge falls much more quickly).

The low self-discharge rate makes the lead-acid battery attractive to use in devices which are needed only occasionally – for example an emergency hand lamp. If one of these was powered using nickel cadmium cells (and they often are) and it was left in the boot of a car without regular charging, it would probably be "flat" when you needed it most.

LEAD-ACID TECHNOLOGY

The principle on which the lead-acid battery is based is very old and practical examples have been in use for many years. However, the materials used in their construction and the technology of the manufacturing process have improved greatly.

In a lead-acid cell, the negative electrode is made of metallic lead and the positive one, lead dioxide. In practice, these are made in a spongy form pressed into a grid in lead-alloy plates. The electrolyte (the liquid between the electrodes) consists of a moderately strong mixture of sulphuric acid and water. Passing current between the electrodes causes a chemical reaction to occur and this stores energy. The process is reversible and, after charging, current may be drawn from the cell.

During the discharge process, both the lead in the negative plate and the lead dioxide in the positive one are converted into lead sulphate. As this happens, the density of the electrolyte falls. During charging, current is forced to flow in the opposite direction. The materials return to their original form and the density of the electrolyte rises again. The nominal terminal voltage of a single cell is 2V but this rises to 2·2V approximately when fully charged and drops to 1·8V when discharged.

In theory, it should be possible to repeat the charge/discharge process any number of times. However, with each cycle, the working material tends to work loose from the plates and a small amount is dislodged. This happens very quickly when an excessive current flows through the cell (whether during charging or discharging) because the plates become warm and expand.

A very large current buckles the plates and ruins the battery very quickly. In normal use, the effect is gradually to reduce its capacity. Manufacturers use materials such as glass fibre to keep the active material pressed in place while allowing the chemical reaction to proceed freely.

Another problem is that normal "soft" lead sulphate gradually turns into a hard form. This insulates the plates, impedes the flow of current and eventually ruins the cell. Such "sulphation" happens very quickly when the cell is discharged below a certain level (nominally 1·8V), especially when it is left like that for a time.

Single cells are available. However, most practical units consist of an outer case containing several cells connected in series internally. The most popular types contain three or six cells, providing a nominal 6V and 12V output respectively.

TOPPING-UP

The original type of lead-acid battery needed regular topping-up with de-ionised water. This was to make up the loss due to evaporation and electrolysis (the sulphuric acid remains inside). During charging, some electrolysis takes place whereby the water splits into its constituent gases, oxygen and hydrogen. In the traditional design, the gases are allowed to escape through vent holes.

The modern type of battery is constructed as a sealed unit. The gases are re-combined within it so no water should be lost. In fact, in the larger types there is often some means to allow topping-up in case a little water does "disappear". In the small ones, no such facility exists.

However, although sealed, the battery does have a venting system which allows gases to escape if the internal pressure rises (probably due to over-charging). When the pressure falls, the vent closes again.

As well as being maintenance-free, small batteries have the electrolyte formed into a jelly-like consistency. This allows the unit to be mounted in the case with any orientation, which can simplify the design of a piece of equipment.

When freshly charged, a nominal 12V battery will develop a terminal voltage of a little over 13V (that is, 2·2V per cell). When discharged, it will be some 11V (1·8V per cell). The practical low point is often regarded as slightly below the "discharged" value – say 10·5V for a 12V battery.

The corresponding figures for a nominal 6V battery are, of course, half those for a 12V unit. Since discharging the battery below the low point will result in serious sulphation, it is important to re-charge it promptly and, if possible, before it reaches the "discharged" level.

STORAGE CAPACITY

The amount of charge a battery can store is usually expressed in amp-hours (Ah). When considering what capacity is needed for a given application, it is necessary to consider two factors: the current required (in amps) and the period over which this is needed (in hours). Multiplying these two figures together provides a measure of the capacity required, the Ah value.

In practice, a battery having a somewhat higher capacity than required would then be used. Note that the capacity is based on discharging the battery to its nominally discharged level, not to the point where it becomes dangerously "flat".

If a 12V battery has a capacity of 6Ah, in rough terms it can supply one amp for six hours, 500mA for twelve hours or any other multiple of current and time which makes six.

However, the capacity appears smaller for large discharge currents. The battery used in this example could not, in practice, supply six amps for one hour, so the figure is standardised for a 10-hour rate (or for some other stated discharge time). Thus, the battery could supply 0·6A (600mA) for ten hours.

Conversely, the capacity appears to increase with decreasing load. The battery would be found capable of supplying 100mA for more than 60 hours.

When assessing the amp-hour capacity required, it is therefore necessary to uprate it if the current required is greater than that at the specified rate.

GET A LIFE

For the reasons given earlier, the capacity of a lead-acid battery decreases over time to the point where it fails to deliver a useful amount of charge. It has then reached the end of its service life. Even when carefully used, it is likely to have lost a significant fraction of its original capacity after a few years. If mistreated, it will fail much more quickly.

If a battery is subjected to repeated fully discharging before re-charging (so-called cyclic use), it will provide a much shorter life compared with one used in "float" applications. Note that some batteries are designed specifically for cyclic use and perform better in this respect than the ordinary kind (but are more expensive).

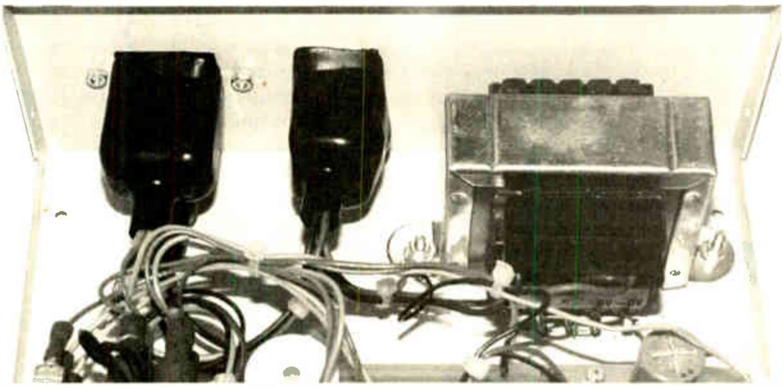
With only a small discharge (a small "depth of discharge"), one thousand or more cycles may be expected from a typical battery. With deeper degrees of discharge, it may be found that fewer than 200 cycles are possible.

CIRCUIT OVERVIEW

This circuit has been designed for charging 6V and 12V lead-acid batteries of 1Ah capacity and above. It will be found most convenient for units up to 8Ah capacity. With larger ones, the charging times become rather long.

The completed unit is shown in the photographs. On the front are voltage select and current limit switches, plus a pair of terminals to which the battery is connected. On the back is a mains input plug, on-off switch and fuse. The switches on the front will be set according to the battery being charged, more on which will be said later.

If the battery is forgotten and left connected beyond its normal charging time, it will not be harmed in the short term because the current eventually falls to a very low value. Note, however, that it is not designed to be connected continuously – so called, "trickle" charging (the circuit



COMPONENTS

Approx. Cost Guidance Only **£30** excluding case.

Resistors

R1	100Ω 2W (2 off) (see text)
R2	1k
R3	1Ω
R4	8Ω2 (see text)
R5	1Ω8 (see text)
R6	3k3
R7	1k5
R8, R10	220k (2 off)
R9	560Ω
R11	220Ω
R12, R13	10Ω (2 off) (see text)

All 0·6W 1%, except R1.

See SHOP TALK page

Potentiometers

VR1, VR2	1k min. multiturn preset, vertical (2 off)

Capacitors

C1	1000µ radial elect. 63V
C2	220n ceramic
C3	100n ceramic

Semiconductors

IC1	L200CV adjustable voltage and current regulator
REC1	W01 bridge rectifier, 100V 1·5A
D1	1N4148 signal diode
D2, D3	1N4001 rect. diode (2 off)
D4	red l.e.d., 5mm
D5	green l.e.d., 5mm
TR1, TR2	MPSA14 low power *npn* Darlington transistor (2 off)

Miscellaneous

T1	mains transformer, twin 9V 1A secondary windings (18VA)
WD1	piezo buzzer 3V to 24V d.c., 10mA
FS1	1A ceramic fuse plus fuseholder, panel mounting
FS2	2A 20mm quick blow fuse plus fuseholder, chassis mounting
S1	d.p.s.t. rocker switch, mains-rated
S2	d.p.d.t. rocker switch, 1A
S3	s.p.d.t. rocker switch, 1A
TB1	terminal post, panel mounting, red
TB2	terminal post, panel mounting, black

Printed circuit board, available from the EPE PCB Service, code 309; aluminium instrument case, 200mm x 125mm x 75mm; TO220 semiconductor insulated mounting kit; l.e.d. panel mounting clip (2 off); mains inlet connector, male, panel mounting; insulating boots for mains inlet connector, mains on-off switch and mains fuseholder; insulating shield for transformer primary tags; spade receptacle connectors; connecting wire; solder tag; solder etc.

may be adjusted to allow this but the charging time is increased).

If the charger is switched off (or the supply interrupted) with the battery still connected, there will be a very small discharge current. However, this should represent only a negligible drain even over a day or two.

CONSTANT VOLTAGE

The most usual way to charge a lead-acid battery is from a constant voltage source and this is the method used here. The value of the voltage must be greater than the highest voltage developed by the battery or, when they are equal, no current will flow into it.

It is generally accepted that charging at between 2·30V and 2·50V per cell is appropriate. A nominal 6V battery will therefore need a charging voltage somewhere between 6·9V and 7·5V, while a 12V unit will require between 13·8V and 15V.

These values are highly significant. Suppose a nominal 12V battery is put on charge at an actual terminal voltage of 11V. The difference between the charger output voltage and that of the battery would be quite large – between 2·8V and 4V. This difference in voltage is available to drive current through the battery and charge it.

The actual value of the current can be found by dividing the voltage difference by the resistance of the output circuit (that is, using Ohm's Law). The resistance will include the output impedance of the actual charger circuit, the internal resistance of the battery, that of the connecting wires and so on.

The total resistance is likely to be very small so the current would be correspondingly high. This could be destructive either to the battery itself (because of excessive internal heating) or to the charging circuit.

DAMAGE LIMITATION

To prevent excess current flow, some form of current limiting is therefore essential. A practical value may be regarded as 0·25 multiplied by the amp-hour capacity of the battery. Thus, a 4Ah unit would be limited to a charging current of 1A. A smaller current, of course, simply extends the charging time. In this circuit, the current limit switch on the front panel may be set to either 250mA or 500mA.

As the battery charges, its terminal voltage rises so the difference between the charger output voltage and that of the battery becomes smaller. For a time, it remains sufficient to maintain the current at the limiting value. At some point, this cannot be done and the current begins to fall. It then continues to drop more slowly until the end point is reached. The end-point current was measured at 10mA in the prototype unit.

In Fig.1 is shown a graph of current plotted against time for the prototype unit charging a 3Ah battery set for a 500mA limit. This is illustrative only and is not reproduced exactly to scale. There are three distinct phases and a typical percentage of charge acquired during each of them is given.

It will be seen that almost 90 per cent of the charge is given during the first two phases. It may therefore not be thought worthwhile leaving the battery connected for longer than that. A practical charging time could be regarded as three hours per amp-hour using a 500mA limit, or six hours per amp-hour using a 250mA limit. It would need twice as long for a near-100 per cent charge.

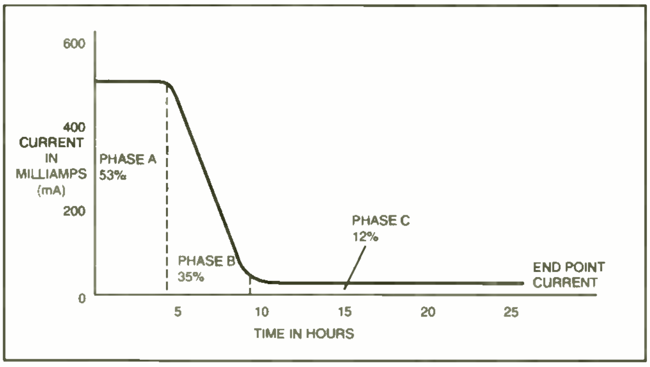


Fig.1. Graph of current plotted against time for charging a 3Ah battery set for a 500mA limit.

The advantage of using a low charger output voltage (say, 2·3V per cell) would be a very small end-point current and the battery could be left connected indefinitely (trickle charging) if required. The disadvantage would be an extended charging period.

A high charger voltage (2·5V per cell) would reduce the charging time but the end point current would be too great to allow the battery to be connected continuously.

Although the output of the circuit may be adjusted at the setting-up stage to any value between these limits, 2·4V per cell is recommended. This is a reasonable compromise. The overall charging time is not much affected yet if the battery is forgotten and left connected, it will not be harmed in the short term.

DESIGN CONSIDERATIONS

If the charger achieved a current limit of, say, 1·5A (which would be appropriate for batteries of 6Ah or more) the size and cost would be increased compared with using a lower limit. This is mainly because the transformer would need to be more substantial.

Trying to achieve the minimum charging time is often not important when balanced against cost. This was why an upper limit of 500mA was chosen for this circuit. This is the maximum for a 2Ah battery.

For a smaller unit (down to 1Ah), it will need to be limited still further, so a 250mA limit is also provided. The current select switch on the front panel sets the limit required.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Lead-Acid Battery Charger is shown in Fig.2. The a.c. mains supply is connected to the primary winding of transformer T1 via fuse FS1 and double-pole on-off switch S1.

The transformer has two 9V secondary windings which are connected in series. With voltage selector switch S2a in the 6V position, only one winding is used. In the 12V position, both are in circuit giving a nominal 18V. The higher voltage is used for charging 12V batteries while the lower one is used for 6V units.

Note that the labelling of switch S2 refers to the nominal voltage of the battery being charged rather than the actual voltage existing there.

The a.c. output from the transformer is applied to the conventional arrangement of bridge rectifier REC1 and smoothing capacitor C1. The capacitor charges up to the peak of the a.c. waveform (minus the forward voltage drop of the diodes within the bridge rectifier) – giving some 11V d.c. and 24V d.c. on the 6V and 12V settings respectively.

The rectified voltage is then applied to the input of the voltage and current regulator IC1. This i.c. has a maximum rated output of 2A so in this circuit it is being used well below its capacity.

Current flowing from output pin 5 passes through either resistor R5, or the parallel resistors R3 and R4, according to the setting of current limit switch S3. The value of the R3/R4 parallel combination is approximately 0·9Ω.

With current flowing through the appropriate resistor(s), a voltage is developed across the resistance according to Ohm's Law. This voltage is detected by IC1's limiting input, pin 2. When it rises above a threshold value of 0·45V, the device "turns down" and the output current is reduced. The current is

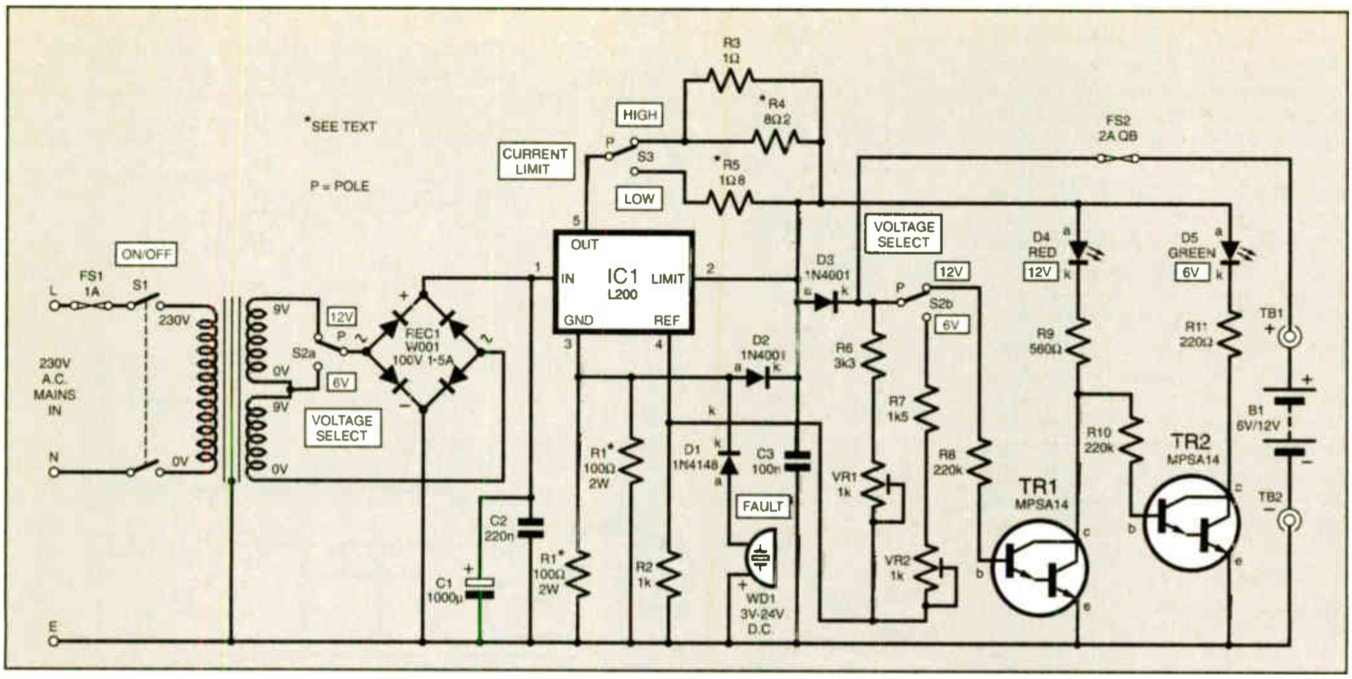


Fig.2. Complete circuit diagram for the Lead-Acid Battery Charger. The labelling of switch S2 is the nominal *voltage of the charging battery B1.*

therefore maintained at the value required according to the formula:

$I = 0{\cdot}45/R$

With the specified resistors, the current will be 500mA (with S3 in the High position) and 250mA (in the Low one). These are nominal values only because the threshold voltage is subject to a fairly wide tolerance. Also, it may be necessary to reduce the value of these resistors at the testing stage to take account of stray resistances such as those of the relevant copper tracks on the p.c.b. and the wiring to switch S3.

Note that the practical output of IC1 may be regarded as at the common junction of resistors R3, R4 and R5.

If IC1 becomes too hot in operation, it has the effect of lowering the threshold voltage. The current is then reduced which allows it to cool down. This could happen if the output terminals were short-circuited and the heatsink was inadequate.

For the moment, disregard the pair of resistors (both labelled R1) in parallel and connecting IC1 pin 3 to the 0V line. Ignore also diodes D1, D2 and the audible warning device, WD1. These have little effect on normal operation. They are part of the reverse-polarity detection system which will be explained later.

OUTPUT VOLTAGE

The output voltage from IC1 is jointly determined by the value of resistor R2 connected between IC1 pin 4 (the reference input) and the 0V line, and the resistance appearing between pin 4 and pin 2. This is the purpose of the series potentiometer/resistor arrangements VR1/R6, VR2/R7 and voltage select switch S2b.

Preset potentiometers VR1 and VR2 allow the voltages to be slightly adjusted as required. Note that diode D3 is placed within the voltage regulation loop so its effect is taken into account by the i.c. The purpose of this diode will be explained later.

When switch S2 is in the 12V position as shown, R6 and VR1 only are connected in series between IC1 pins 2 and 4. With the switch in the 6V position, R7 and VR2 are connected in parallel with the R6/VR1 combination. This reduces the overall loop resistance value. The presets are multiturn devices which simplify adjustment of the operating voltages.

L.E.D. FUNCTIONS

With switch S2b in the 12V position, current flows into the base of Darlington transistor TR1, through resistor R8. This turns it on and the collector goes low. Current then flows from IC1 through the red ("12V") light emitting diode D4 via current-limiting resistor R9. At the same time, the low state of TR1 collector holds Darlington transistor TR2 turned off and so the green ("6V") l.e.d. D5 is therefore off also.

When S2b is in the 6V position, no current enters TR1 base and the transistor remains off with its collector high. This allows current to flow into the base of TR2 via the path D4, R9 and R10, causing it to turn on. Current then flows through l.e.d. D5 via current-limiting resistor R11.

The current flowing into TR2 is extremely small due to the high value of R10. It is therefore not sufficient to allow D4 to operate.

Current-limiting resistors R9 and R11 have different values because each l.e.d. operates from a different voltage as set by switch S2. The l.e.d.s provide confirmation of which voltage setting is being been used. Also, the fact that one of them will be on during operation confirms that the circuit is connected to the mains. Note, however, that if the output is short-circuited (which is not harmful in itself due to the current-limiting), both l.e.d.s will be off.

Since the path for current to reach the l.e.d.s is made before diode D3, if the charger is switched off and the battery left connected, neither l.e.d. can operate. This is because current cannot flow to them from the battery because diode D3 is now reverse-biased.

REVERSE POLARITY

A problem could arise if the battery were to be connected with incorrect polarity. Doing this by accident is certainly a possibility and cannot be ruled out. The usual way of protecting against this type of eventuality is to include a diode in the positive output feed. If the battery were connected in the wrong sense, the diode would be reverse-biased and nothing would happen.

In this application, the above method is not really appropriate. This is because the diode develops a voltage of about 0·7V across its ends while conducting. This cannot be simply taken into account when the output voltage is being adjusted because the forward voltage drop will vary to some extent depending on such factors as the load. It would therefore affect the operating conditions. However, without any form of protection current would flow through IC1 in reverse entering at pin 3, and this would ruin it.

Here, reverse-polarity protection is provided by the two low-value resistors (both labelled R1) in parallel connected between IC1 pin 3 and the 0V line. Diode D2 then connects pin 3 to the charger output. In normal operation, resistors R1 have little effect (because only a very small current flows through them). Any small effect on the output voltage is taken into account when VR1 and VR2 are adjusted. Diodes D1 and D2 do nothing because they are reverse-biased.

FAULT CONDITION

If the polarity of the battery is reversed, a circuit will be formed through the path R1, D2 and D3. Diode D2 shunts the current around IC1 and protects it from damage. The fault current flowing through resistor(s) R1 develops considerable power (more than two watts) and they will become quite hot. It is essential, therefore, that they are adequately rated. Note also that they should, preferably, be of the 1% tolerance type (although 5% tolerance will be reasonably satisfactory).

With resistors R1 carrying the fault current, a large voltage is developed across them. Current then flows through the audible warning device, WD1, via diode D1. WD1 sounds and draw the user's attention to the fault condition.

There could be a further problem if the charger is switched off with the battery still connected. This should not happen because it would normally be removed at the end of the charging period. However, it would occur if there was a failure of the mains supply. Current could then flow back into the regulator circuit and discharge the battery.

Diode D3 prevents this because it is reverse-biased. The battery can still discharge through resistor R2 and the networks R6/VR1 or R7/VR2, but their values are relatively high and, in practice, the current only amounts to 3mA approximately on the 12V setting.

HEAT DISSIPATION

It will be seen that the difference between the voltage applied to IC1 input (pin 1) and that at the output (pin 5) will result in heat being generated within the device. The worst case (in normal operation) is on the 12V setting while delivering 500mA. With an input voltage of 24V and an output of 14·4V, the voltage difference is 9·6V.

The power developed in IC1 will then be almost five watts. This needs to be removed using a heatsink. In practice, this is provided by attaching the i.c. to the aluminium case, which effectively dissipates the excess heat into the air. On the 6V setting, the power dissipation is much less.

If the output terminals are short-circuited, the entire input voltage appears between IC1 pins 1 and 5. On the 12V setting, this is 24V approximately and with 500mA flowing the power dissipation will be some 12W. This will make the case quite hot around the area of IC1.

SAFETY

The circuit *must* be constructed in an earthed metal case. Since mains connections need to be made, seek competent advice if you are not sure how to do this safely.

All mains connections must be completely shrouded so that it is impossible to make conductive contact with them. Even so, the lid of the case must always be on while the unit is plugged into the supply and the case *must* be earthed.

The transformer must be generously rated. It is not good enough to use a unit rated at 500mA. When a transformer is connected to a load which is not simply a resistive one, it must be up-rated. The transformer used must be specified as supplying 1A minimum (18VA rating).

CONSTRUCTION

Construction is based on a single-sided printed circuit board (p.c.b.). The topside component layout and full size underside copper foil track master are shown in Fig.3. This board is available from the *EPE PCB Service*, code 309.

Begin by drilling the two fixing holes. Solder fuseholder FS2 in position. Add all resistors (including preset potentiometers VR1 and VR2) and capacitors. Note that capacitor C1 is an electrolytic device

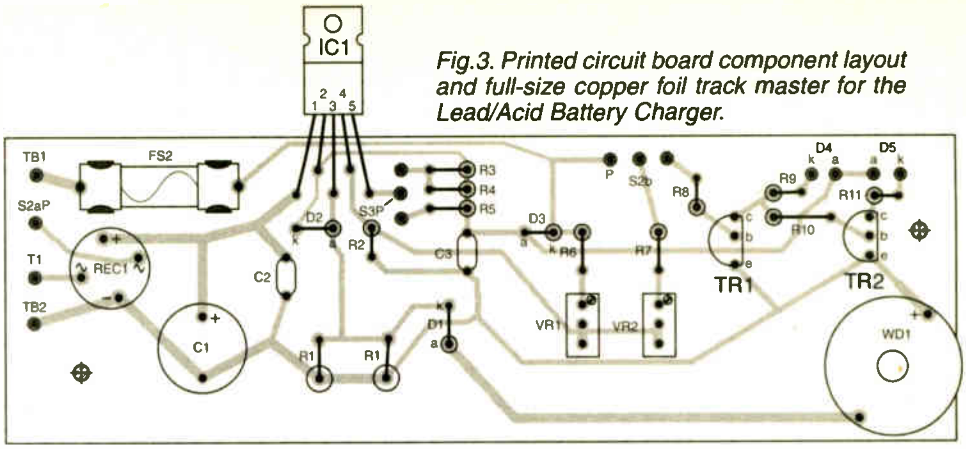
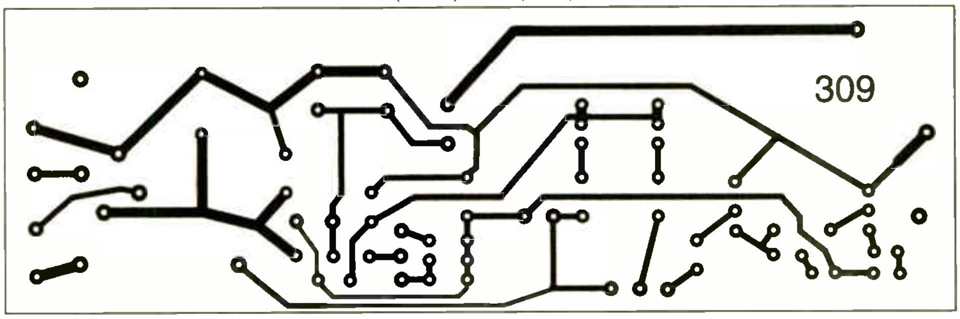
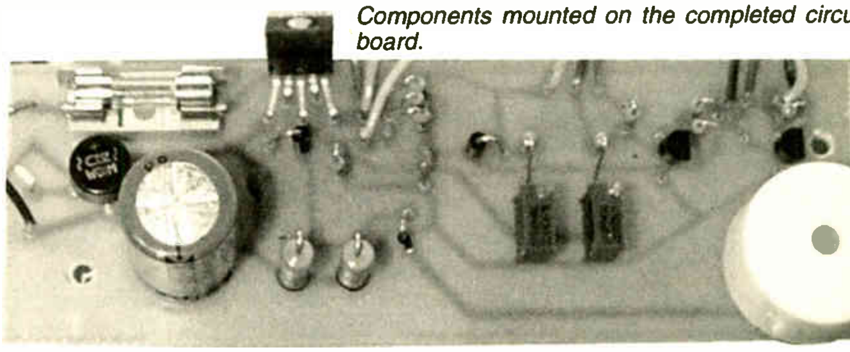


Fig.3. Printed circuit board component layout and full-size copper foil track master for the Lead/Acid Battery Charger.

5in. (125mm) x 1·6in. (40mm)



Components mounted on the completed circuit board.



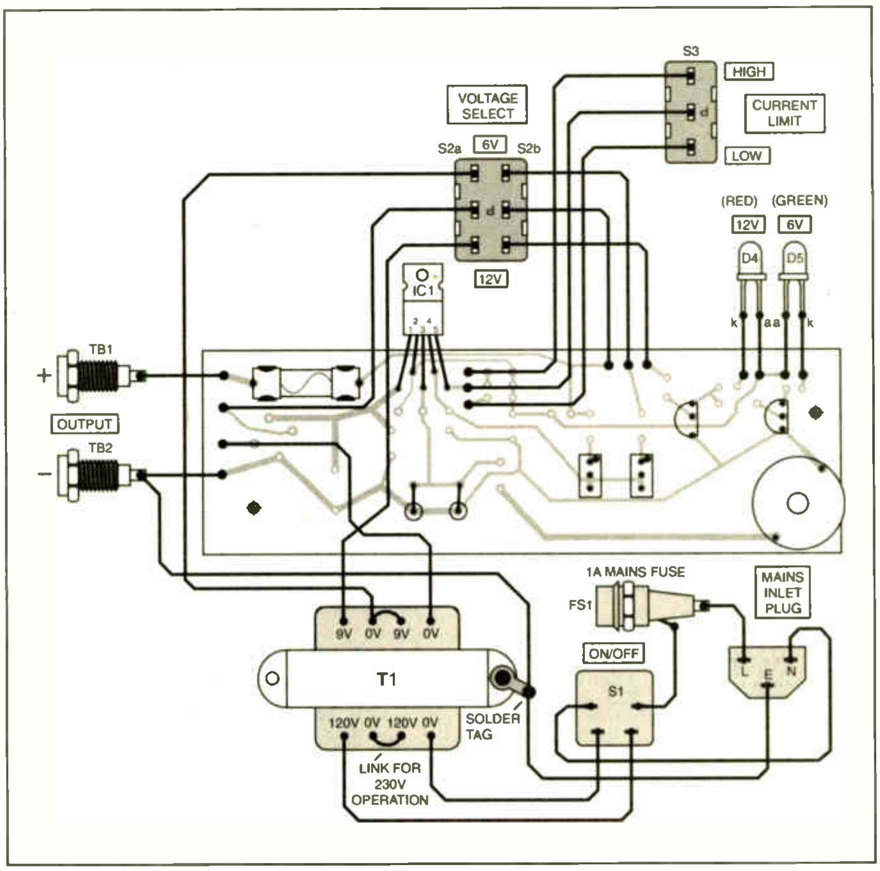


Fig.4. Interwiring between the off-board components and p.c.b.

and must be mounted with the correct orientation.

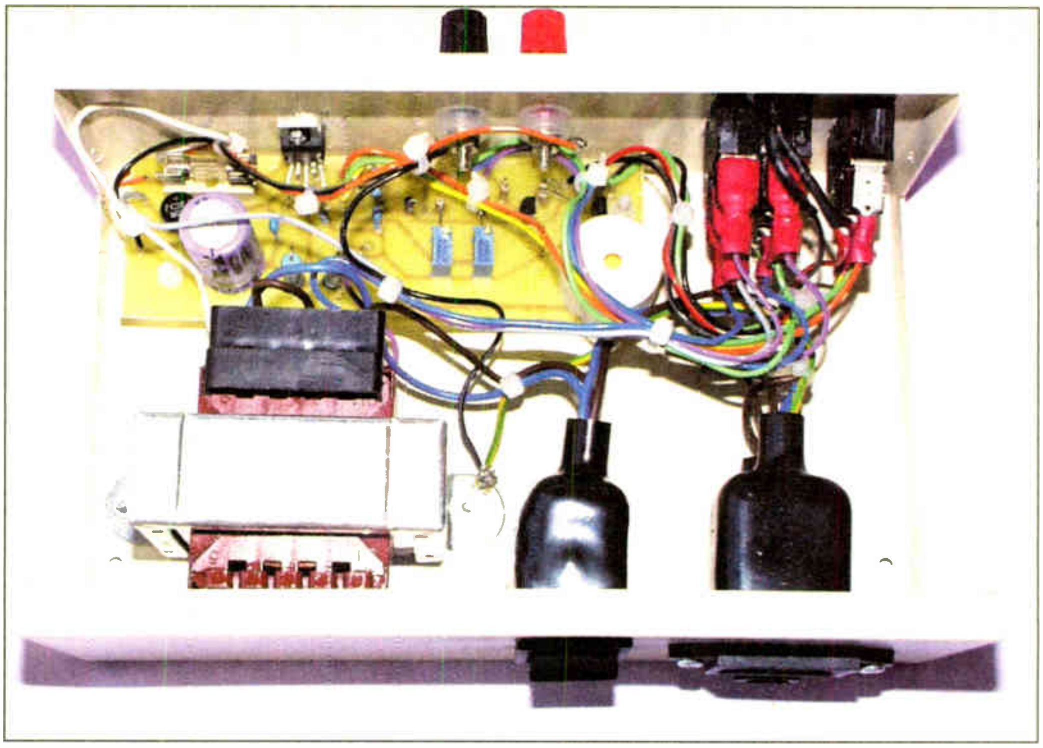
The adjustment screw on VR1 and VR2 should be placed at top right as shown in the photograph and Fig.3. The adjustments will then increase the operating voltages with clockwise rotation.

It would be a good idea to solder two short wire "stalks" to the R4 and R5 positions (although this was not done in the prototype unit). The resistors would then be soldered to these. This would enable the values to be easily changed if the current limits needed to be adjusted. Note that for the 500mA limit, resistor R3 is left as it is, changing R4's value if required.

Solder bridge rectifier REC1 in position using about 8mm of its end leads. Add diodes D1 to D3, transistors TR1 and TR2, regulator IC1, and the audible warning device WD1, taking care over the orientation of all these components.

Note particularly that the polarity of WD1 is correct as shown – remember, it operates under conditions of reverse polarity of the battery.

Adjust VR1 and VR2 to approximately mid-track position. Insert the fuse in fuseholder FS2.



Internal arrangement of components inside the prototype metal case. All mains connections must be shrouded with insulating sleeves or boots. Also cover the mains transformer wiring tags with some form of insulating material.

INTERNAL LAYOUT

Plan the internal layout of the case by placing the p.c.b. and transformer on the base. Leave a clear space around the transformer to allow air to circulate.

Keep the mains connections well away from the low voltage components. Drill mounting holes as appropriate.

Before attaching the transformer, scrape off the paint on the outside of the case around the area of the fixing bolt heads. Use self-grip washers and a solder tag to help ensure that good metallic and earthing contact is made with the case.

Attach the p.c.b. using 5mm plastic stand-off insulators on the bolt shanks. It must be positioned so that the metal tab of IC1 can be bolted to the case.

Rear-mounted male mains connector, mains switch and fuseholder.

If necessary, scrape away the paint on the inside of the panel around the area of contact with IC1 tab, to allow good heatsinking contact. Attach IC1 to the panel using a small nut and bolt **and an insulating kit**.

The positive output terminal (TB1) ***must*** be electrically isolated from the case using the insulating kit usually supplied with it.

INTERWIRING

Referring to Fig.4, complete the internal mains wiring using flexible mains-type wire of 3A rating. Fit insulating boots to the connector, on-off switch S1 and fuse FS1. Fit a protective shield on the exposed transformer primary tags.

Complete the low-voltage wiring, preferably using multi-coloured wire. Sleeve the connections to the l.e.d.s.

Check that all mains connections are completely insulated. Attach the lid of the case, checking that no wires are trapped.

TESTING

Insert the fuse into fuseholder FS1. Set the mains switch off, the voltage selector to 12V and the current limit to 500mA. Connect the unit to the mains using a 3-core (earthed) lead with a 2A or 3A fuse in its plug.

Switch on and check that the 12V red l.e.d. operates. Using a multimeter, note the voltage across the TB1/TB2 terminals. It should read somewhere between 12V and 20V d.c..

Unplug the unit from the mains and remove the lid. In a series of steps, replacing the lid of the case each time, adjust VR1 to provide an output of between 13·8V and 15V, as required. Clockwise adjustment of VR1 sliding contact raises the voltage and vice versa. From this point leave VR1 alone.

Now set the voltage selector to 6V. Check that the green 6V l.e.d. glows. In a similar manner, adjust VR2 to provide between 6·9V and 7.5V.

If VR1 or VR2 cannot be adjusted to obtain the correct value, either resistor R6 or R7 will need to be changed, as appropriate. A smaller value reduces the output voltage.

TESTED TO THE LIMIT

The current limit values should now be checked. Switch the unit off and set switch S2 to 6V. Twist together the end leads of the two 10 ohm test resistors (R12, R13) so that they are connected in parallel. Connect one end to terminal TB1. Connect a multimeter, set on a current range, between the other end of the resistor pair and TB2.

Switch on and observe the reading on both the high and low current limits. Note that the test resistors will become quite hot when passing 500mA so do not touch them. Also, switch off immediately afterwards.

If the current limit values are found to be too low or too high (more than about 10 per cent), you could change the value of R4 (for 500mA) or R5 (for 250mA). Reducing the value will raise the current and vice versa. Only small changes should be necessary.

Make up a connecting lead for the battery, using spade receptacle connectors or crocodile clips. Test the unit with a battery connected to the output. Check that the unit does not become excessively hot when left operating for several hours.

FINALLY

It only remains to make labels for the switches. The charger is then ready to be put into use. Remember, check the voltage, current limit and polarity of the battery first and make the appropriate adjustments. Connect the battery then switch on the mains. Check that the correct l.e.d. operates. □

New Technology Update

Nano-technology is showing signs that it may be a major player in the electronic device scene in years to come, reports Ian Poole.

RESEARCH into nano-technology has been progressing for some time. This column last reported on it in Dec '99. A considerable amount of the initial work has been undertaken at the Georgia Institute of Technology. In early work they made some nano-tubes from carbon. These had inside diameters measuring less than ten nanometres

The investigations performed on these minute tubes led researchers to believe they could ultimately have important applications in microelectronics where extremely small conductors and other structures are required. It was seen that these tubes were capable of carrying very high levels of current and offering very low levels of resistance. This prompted further work into the technology.

As a result other solid structures called nano-wires were discovered and fabricated. These were made from a variety of materials including carbides and nitrides.

Nano-tubes were also developed for use in transistors. These nano-tubes were subtly different, forming a semiconductor rather than an ordinary conductor and having carbon walls made up from hexagonal shaped matrices and just a single molecule thick. Essentially, they were vaporised carbon that had been condensed into a series of hexagons.

To give a better view of them, they could be considered as a very thin strip cut out of a graphite carbon plane which has been rolled up and sealed at either end. The dimensions were naturally extremely small, with figures measured in atomic proportions.

The carbon hexagons that were used to make the tubes had a natural tendency to curl. The way in which they curled determined the electrical characteristics of the nano-tube. Fortunately, it was possible to control the way in which this curling took place. By rolling it in a way that gave a straight molecular alignment it was found that the nano-tube behaved like an ordinary conductor. However, if the curl was arranged so that molecular structure was twisted then the nano-tube behaved like a semiconductor.

Nano-belts

Now researchers at the Georgia Institute of Technology led by Dr Zhong Lin Wang have created a new form of nano-structure. It is envisaged that it might be used in a variety of applications including flat panel displays, ultra-small sensors and a variety of other devices.

The new flat structures are termed nano-belts as a result of their appearance under an electron microscope. Effectively they are ribbon like structures having a narrow rectangular cross section. They are unlike the previous nano-tube structures that have been based around carbon. Instead the new structures are formed from oxides of zinc, tin, indium, cadmium and gallium. Like the nano-tube structures, these new nano-belt structures also conduct electricity.

The nano-belts appear to have significant advantages over their hexagonal tubular counterparts. The carbon nano-wires and nano-tubes suffer from oxidation whereas the new nano-belts do not suffer from this. They have much "cleaner" surfaces that are free from defects and this enables them to provide a high level of performance in view of their atomic level structure.

Chemically the nano-belts are very pure, and the atomic structure is uniform. They are composed of a crystal with specific surface planes. This is a distinct advantage and as a result of their uniform structure this may enable the mass production of nano-scale electronic and optical devices.

Production

The techniques for fabricating the nano-belts are based on the thermal evaporation of oxide powders under carefully controlled conditions and without the use of a catalyst. In experiments to produce the nano-belts the required oxide powders were placed at the centre of an alumina tube that was inserted into a furnace. This was brought to the right temperature and evaporation was allowed for a controlled period of time.

The temperature was determined on the basis of the melting point of the oxide being used. To enable the new nano-structures to be deposited, a small air flow in the chamber was maintained and the nano-belts were deposited on a small alumina plate placed downstream from the evaporating oxides.

Analysis of deposited nano-belts was undertaken using a variety of techniques. X-ray diffraction, scanning electron microscopes, transmission electron microscopy and energy-dispersive X-ray spectroscopy were all used.

Results

A variety of materials were used during the experimentation work. The deposit from zinc oxide, collected on the alumina plate, was found to be a wool-like material. This consisted of a quantity of wire like nano-structures. These ranged from several tens to several hundreds of micrometers in length, some were even a millimetre or more. Analysis showed that they had a distinct belt-like structure. The width was uniform along its length, and was found to be in the range 50nm to 300nm.

Other oxides produced similar results, although the conditions under which they were created varied slightly to accommodate the different temperatures required. For example, tin oxide was used and very long belts were produced – lengths of several millimetres were common. The widths varied between 50nm and 200nm with a width to thickness ratio of between 5 and 10.

In a further example, the nano-belts made with Indium oxide were found to be very interesting. Like the others they produced nano-belts with a uniform width and thickness along their length. However, some exhibited a sharp shrinkage in width whilst the thickness was preserved. Further investigations into the mechanism behind this are being undertaken.

Applications

The technology is still very much in its experimental stages. Any applications must naturally be thought of only as possibilities at this early stage in their development. However, the very well defined geometry and perfect crystallinity of the structures make them ideal for further experiments to discover their electrical, thermal, optical and ionic transport properties. These have the advantages of having perfect structures with no dislocations and defects.

It is thought that the nano-belts could be doped with different elements and used in a variety of applications. These could include minute sensors, optical devices and possibly many more devices and applications that have not even been conceived. Although the technology is still very young it is likely that it could be very important in the years to come as more is understood about these interesting structures, and more applications are found for them.

It will be particularly interesting to see what electronic devices might come out of these nano-belts and to see just how many applications are found for them. Any devices made with this technology are likely to be many years away, but, many years of investigations into semiconductor materials had to be undertaken before the first devices were made, the same is true for these new structures. Whatever happens from these early indications they appear to be another useful and important tool in the electronic device manufacturer's toolkit.

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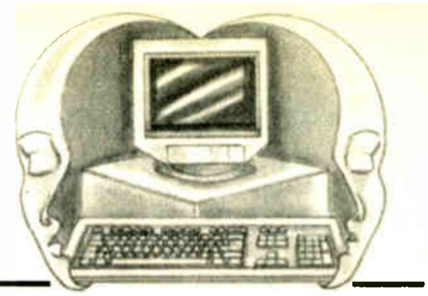
INTERFACE

Robert Penfold



LOGIC I.C. MONITORING VIA A PC

PREVIOUS *Interface* articles have shown the ease with which large digital readouts and analogue displays can be produced using a visual programming language such as Delphi or Visual BASIC. If you require large digits you simply specify a large point size for the label used to provide the display.

If an analogue display is required, just draw it on the screen and alter the appropriate set of co-ordinates to make the display respond to readings from your add-on circuit. This will usually require some mathematical manipulation to get the scaling just right, but the mathematics is easily achieved using a high level programming language.

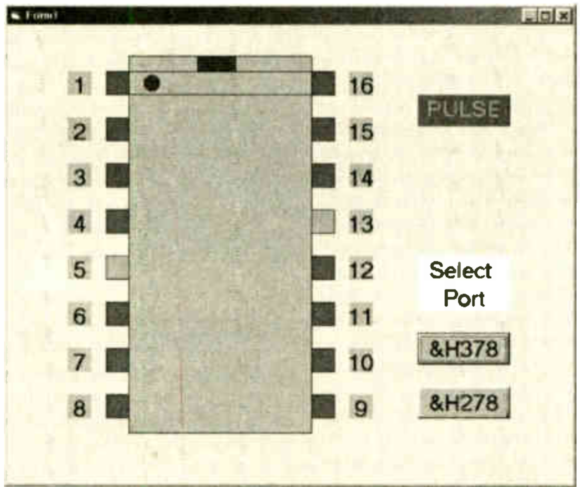


Fig.1. Logic i.c. monitoring program in action.

Getting In Shape

Using the graphics capability of a programming language such as Visual BASIC it is possible to produce displays of various types, making programs easier and more fun to use. The program shown in operation in Fig.1 is designed to show the logic state at each pin of a 16-pin logic integrated circuit. It will work just as well with a 14-pin type by leaving the bottom pair of pins unused.

Although it does not require any advanced graphics, this type of thing can be very time consuming to produce using conventional programs. With Visual BASIC it is very quick and easy. The shape tool is used to draw a rectangle to represent the body of the chip, and another is drawn to represent the notch at the top. The dot and line used on some integrated circuits in addition to the notch can be added using the shape and line controls.

The shape tool produces rectangles by default, but once in place it is possible to change the shape by altering the setting of the Shape property. The colours of the shapes can be altered using the FillColor property, but this will probably have no effect if you try it. This is due to the FillStyle being set at Transparent by default. Change this to Solid and any colour changes should be then implemented.

The 16 "pins" are produced using further rectangle shapes, and these should be renamed to "Pinl", "Pin2", etc., for easy identification when writing the software. They are set to have a solid fill, but the fill colour used is unimportant, as the program will set this.

Highs and Lows

The idea is to have one colour for a high logic level and another for a low level. The FillColor property, in common with practically all properties of every component, can be placed under program control. The fill colour for "Pinl" for example, is controlled via the variable called "Pin1.FillColor". Setting this to the appropriate value will give the required colour.

If you select a fill colour from the palette in the Properties window, its value will be added beside the FillColor property. This provides an easy means of finding the right value to produce any of the standard colours. In this case bright red (&HFF) and green (&HFF00) are respectively used to indicate logic 1 and logic 0 levels. This method enables the logic level at any pin to be seen at a glance.

Line Interface

It is clearly necessary to have 16 input lines for this monitoring system to work properly, which is more than a single PC parallel port can provide unaided. However, as pointed in previous *Interface* articles, the eight data lines of a bidirectional printer port can be used to provide 16 inputs with the aid of a handshake output and some external hardware.

The 16-bit input port circuit diagram of Fig.2 uses two octal tristate buffers (IC2 and IC3) to double the number of inputs available. With the ALF (auto linefeed) output set high, IC2 is activated and couples its inputs through to the printer port while IC3 is switched off. Taking the ALF output low reverses the states of the two buffers, with IC3 coupling its outputs to the printer port and IC2 being switched off.

Inverter IC1 ensures that the two buffers are operated out-of-phase. All 16 pins of the test device can therefore be monitored, but as two separate bytes of data.

The circuit requires a +5V supply, which is not available from the printer port. However, this supply can be obtained from a standard game/MIDI port, the keyboard port, or a USB port, as explained in a number of previous articles. Note that this interface will only work with a standard bidirectional printer port, which must be set to a suitable mode such as the SPP mode.

Pinhead

Some means of simultaneously making all 16 connections to the integrated circuit "under test" is required. Integrated circuit test clips are manufactured, but can be difficult to track down these days.

If a suitable test clip cannot be obtained it is possible to improvise something. One of the more expensive integrated circuit holders having stout pins does the job quite well if the pins are all bend slightly inwards. It is then possible to press the pins of the holder against the tops of the test device's pins. With any form of improvised connector be careful not to slip and accidentally short-circuit any pins of the test device.

The connections to the integrated circuit holder can be made via a 16-pin d.i.l. header plug. Note that the lead from the test connector to the interface should be no more than about 400 millimetres long, and the lead from the interface to the printer port should be no more than about one metre in length.

On the Pulse

The trouble with any simple monitoring system of this type, whether PC based or otherwise, is that short and intermittent pulse signals will not be indicated. Signals having a mark-space ratio of around 1-to-1 tend to produce random levels, resulting in the on-screen indication rapidly alternating between its two states. It is then pretty obvious to the user that the input is pulsing. Short and intermittent pulses can be missed though, as they may not occur during the periods when the interface is monitoring the test device.

A simple solution to the problem is to use a pulse stretcher to elongate input pulses. This ensures that the intermittent monitoring of this system cannot overlook the pulses. A simple monostable circuit is all that is needed, and the circuit diagram of Fig.3 is a simple 5V CMOS compatible design.

This circuit uses a couple of 2-input NOR gates from a 4001BE connected to operate as a positive edge triggered monostable. The output pulse duration is approximately 500 milliseconds, which is more than adequate to ensure a clear indication from the on-screen display.

One way of handling things is to have an additional 16 input lines plus 16 monostables so that each pin can be continuously monitored for pulses. Each pin would then have its own on-screen pulse indicator.

Although a very good way of doing things, it also turns a simple idea into a rather large piece of electronics. The lower cost approach is to have one monostable and one onscreen indicator that can be used to tests any pins that should be pulsing. In this case the Error input of the printer port is used to monitor the output of the monostable.

Software

The program listing for this system (see Listing 1) is quite short because drawing objects on the screen does most of the work. The main routine is assigned to a timer component that updates the screen about 25 times per second. Initially the timer is not operational, and it is started by operating one of the onscreen pushbuttons. This also selects the appropriate base address for the port in use. This is normally &H378 for port 1 and &H278 for port 2.

The first line of the main routine sets the printer port to operate as an 8-bit input and it selects pins 1 to 8 of the test device by setting the ALF line high. Although a value of zero is written to the ALF line, there is a hardware inverter on this line so it actually goes high. Each bit of the value returned from the port is then tested by two If . . . Then statements which set the fill colour of the appropriate rectangle to red if a bit is high or green if it is low. Next the ALF line is set low, and the process is repeated for pins 9 to 16.

A change of colour is also used for the pulse indication. The background colour of the label is set to green, which is the same colour that is used for the lettering. Therefore, the word "PULSE" is not displayed. The last line of the routine checks the state of the pulse stretcher's output, and it sets the background colour of the label to red if a pulse has been detected and the output is high. The green lettering then shows up clearly on the red background. Incidentally, the colour of the lettering can be altered via the ForeColor property, so the lettering, background, or both can be changed under program control.

For those wishing to experiment with this system the source files are available from the *EPE* web site, together with the compiled EXE file. Note that the **inpout32.bas** file must be loaded into Visual BASIC for the Inp and Out commands to work, and the **inpout32.dll** file must be available to the system for the compiled program to work.

Listing 1: Monitoring System Program

```
Dim Port1 As Integer
Dim Port2 As Integer
Dim Port3 As Integer

Private Sub Command1_Click()
  Port1 = 888:   Port2 = 889:   Port3 = 890
Timer1.Enabled = True
End Sub

Private Sub Command2_Click()
  Port1 = 632:   Port2 = 633:   Port3 = 634
Timer1.Enabled = True
End Sub

Private Sub Timer1_Timer()
Out Port3, 32
If (Inp(Port1) And 1) = 1 Then Pin1.FillColor = &HFF&
If (Inp(Port1) And 1) = 0 Then Pin1.FillColor = &HFF00&
If (Inp(Port1) And 2) = 2 Then Pin2.FillColor = &HFF&
If (Inp(Port1) And 2) = 0 Then Pin2.FillColor = &HFF00&
If (Inp(Port1) And 4) = 4 Then Pin3.FillColor = &HFF&
If (Inp(Port1) And 4) = 0 Then Pin3.FillColor = &HFF00&
If (Inp(Port1) And 8) = 8 Then Pin4.FillColor = &HFF&
If (Inp(Port1) And 8) = 0 Then Pin4.FillColor = &HFF00&
If (Inp(Port1) And 16) = 16 Then Pin5.FillColor = &HFF&
If (Inp(Port1) And 16) = 0 Then Pin5.FillColor = &HFF00&
If (Inp(Port1) And 32) = 32 Then Pin6.FillColor = &HFF&
If (Inp(Port1) And 32) = 0 Then Pin6.FillColor = &HFF00&
If (Inp(Port1) And 64) = 64 Then Pin7.FillColor = &HFF&
If (Inp(Port1) And 64) = 0 Then Pin7.FillColor = &HFF00&
If (Inp(Port1) And 128) = 128 Then Pin8.FillColor = &HFF&
If (Inp(Port1) And 128) = 0 Then Pin8.FillColor = &HFF00&
Out Port3, 34
If (Inp(Port1) And 1) = 1 Then Pin9.FillColor = &HFF&
If (Inp(Port1) And 1) = 0 Then Pin9.FillColor = &HFF00&
If (Inp(Port1) And 2) = 2 Then Pin10.FillColor = &HFF&
If (Inp(Port1) And 2) = 0 Then Pin10.FillColor = &HFF00&
If (Inp(Port1) And 4) = 4 Then Pin11.FillColor = &HFF&
If (Inp(Port1) And 4) = 0 Then Pin11.FillColor = &HFF00&
If (Inp(Port1) And 8) = 8 Then Pin12.FillColor = &HFF&
If (Inp(Port1) And 8) = 0 Then Pin12.FillColor = &HFF00&
If (Inp(Port1) And 16) = 16 Then Pin13.FillColor = &HFF&
If (Inp(Port1) And 16) = 0 Then Pin13.FillColor = &HFF00&
If (Inp(Port1) And 32) = 32 Then Pin14.FillColor = &HFF&
If (Inp(Port1) And 32) = 0 Then Pin14.FillColor = &HFF00&
If (Inp(Port1) And 64) = 64 Then Pin15.FillColor = &HFF&
If (Inp(Port1) And 64) = 0 Then Pin15.FillColor = &HFF00&
If (Inp(Port1) And 128) = 128 Then Pin16.FillColor = &HFF&
If (Inp(Port1) And 128) = 0 Then Pin16.FillColor = &HFF00&
Pulse.BackColor = &HFF00&
If (Inp(Port2) And 8) = 8 Then Pulse.BackColor = &HFF
End Sub
```

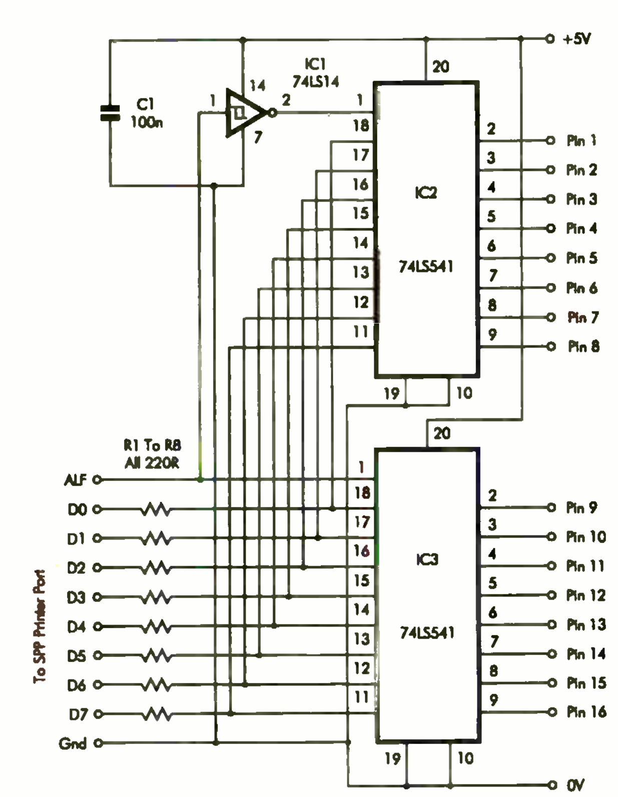


Fig.2. Circuit diagram for the 16-bit input port.

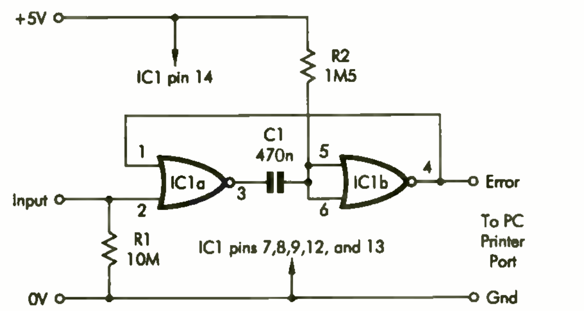


Fig.3. Circuit diagram for the CMOS pulse stretcher.

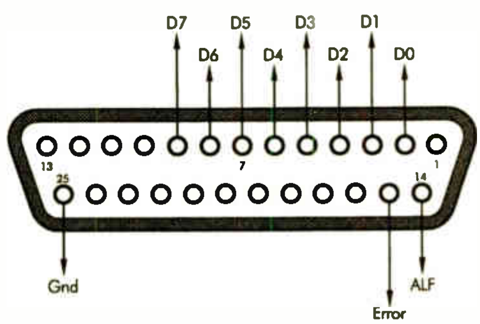


Fig.4. Connections to the PC's printer port.

Special Feature

CONTROLLING POWER GENERATION

OWEN BISHOP

Proportional Integral Derivative (PID) control systems help to reliably maintain our supplies of electrical power.

NESTLING in a steep-sided Shropshire valley, not far from Telford, the cooling towers of the Ironbridge Power Station come into view only as one actually arrives at the site. This is a coal-fired station with two turbines.

Although it is the turbines that produce the electrical power, it is the steam generation plant that converts the energy from burning coal dust into the energy of high-pressure steam to drive the turbines. In short, the control of power generation at Ironbridge depends mainly on the control of the steam boilers.

The theory of turbines and how they produce electrical power was described by Alan Winstanley in his *Power Generation from Pipelines to Pylons* (Aug-Sep '99).

In this article, we are concerned with the essential control system, the system that produces steam at a temperature of exactly 566°C and a pressure of exactly 150 bars, ready to drive the turbines.

The generator hall at Ironbridge, showing one of the two turbines and generators.

EARLY SYSTEMS

When the power station was first commissioned in the late 1960s, it was controlled by analogue electronic circuits. Later, the station was modified to use full Proportional Integral Derivative control (PID – see Panel 1). Like the early cheese-packing system described in *The World of PLCs* of July '01, it was implemented as relay logic.

By the early 1980s a DEC PDP11 minicomputer had been installed to control certain aspects of the plant. For this purpose, the Central Electricity Generating Board developed CUTLASS, its own programming language for boiler control.

Many large industrial organisations have good reason for developing their own computer languages. Another example is Lucas Aerospace with its flight control language, LUCOL.

Although developing a language is expensive and there are numerous general-purpose languages such as C or BASIC already available, a special language can include commands and functions applicable to the industry. This simplifies programming and, if the algorithms are rigorously tested, eliminates many or all possible causes of system failure.

By the middle of the 1980s the power station had installed about 120 programmable logic controllers working alongside the minicomputer. These too were programmed in CUTLASS. This system was operational until the late 1990s.

AUTOMATIC BOILER CONTROL

The most recent system, ABC (Automatic Boiler Control), comprises five individual computer control systems, all running under a central control system. Such an architecture is known as a distributed control system.

Each sub-system is autonomous and is told what to do by the central control system. From then on, it executes its own control algorithms, reporting its progress back to the central control system from time to time until it has completed its allotted task.

The five control systems of ABC comprise:

- Feed control: This controls the flow of feed water to the boiler. It is alternatively known as Drum Level Control.
- Superheater temperature control: Controls the final temperature of the steam as it passes to the turbine.
- Master pressure control: This acts by controlling the rate of burning of coal dust in the furnace.
- Load control: Controls the electrical load placed on the generator.
- Fan controls: There are two sets of fans for producing a current of air through the furnace.

These five systems work together to supply steam to the turbines at exactly 566°C and 150 bars. Given that one bar is equal to just over one standard atmosphere, 150 bars is the equivalent of 155kg/cm^2 (2204 psi).

FEED CONTROL

Water is pumped into the system by three pumps (Fig.1). The main boiler feed pump is steam driven and thus can only be used when the station is already generating. In practice, it is used when the generators are running at 200MW or more. The other two water pumps are the starting and standby boiler feed pumps. These are electrically driven, but have only half the pumping capacity of the main pump.

The output from the three pumps goes to a common line in which the water pressure is maintained at 160 bars. From this line, the water passes through six feed regulating valves. Two of these are used when the system is being started and the other four are brought into use as the system becomes operational. In this way, the amount of water delivered to the boiler is controlled by:

- Varying the speed of the pumps
- Adjusting the apertures of the valves
- Selecting which valves are open and which are closed

From the six valves, the water enters another common line in which the pressure is held at 154 bars. On its way to the main boiler, known as the drum, it passes through a number of preheater stages (including an economiser). These make use of hot exhaust gases from the main boiler to start raising the temperature of the water.

The heated water then enters the drum. The purpose of feed control is to keep a constant water level there. The drum has a sensor to measure the water level. It would be possible to mount a pressure sensor (see Panel 2) in a pipe leading from the drum, but a problem would arise when water collected or condensed in the pipe. The varying amount of water in the pipe would produce an error in the level reading.

To overcome this difficulty the sensor measures the pressure difference between two levels in the drum. There are two pipes, one above the typical water level and one below it. Both pipes are kept full of water, so that the difference of pressure in the two pipes is related to the level of water in the drum. The output from this sensor is fed back to the feed control system, which adjusts the water flow accordingly.

PANEL 1. CONTROL STRATEGIES

The analysis of control systems is a highly mathematical topic, particularly the analysis of regulators intended to maintain a constant temperature, pressure or rate of flow in a system. Explaining in words what is in reality a complex situation, there are four principal kinds of regulatory control system:

- Bang-bang control: A simple thermostat switches a heater on when the room is too cold and switches it off when it is too hot. This commonly used system is easily analysed. It uses negative feedback.
- Proportional control (P): The existing condition of the system is compared with the desired condition (the Set Point, Fig.4a). The difference is the error signal. The corrective action is in proportion to the error. For example, a heater of variable power is switched more fully on when the existing temperature is a long way below the set point. The heater is switched to lower powers as the temperature approaches the set point. Because the error signal is inverted and fed back into the system, the system never comes exactly to the set point. There is always an offset.
- Proportional + Integral control (P + I): The feedback includes an additional amount proportional to the time integral of the error signal. This ensures that the system eventually reaches the set point.
- Proportional + Integral + Derivative (P + I + D): P + I control alone does not allow the system to respond quickly to disturbances. In PID control, the feedback includes a third quantity, proportional to the derivative or rate of change of the error signal. The system is then able to respond effectively to sudden or large changes in its operating condition. A PID system is generally preferred to the other systems, though the control algorithms are necessarily more complex.

FAN CONTROL

There are two sets of fans, the forced draught set blowing air into the furnace and the induced draught set extracting air from the furnace (Fig.2). The forced draught fans blow coal dust from the mills, where coal is ground by 5cm diameter steel balls, into the ball of fire around the drum and superheaters. They also propel a supply of air to burn the coal dust.

The hot gases from this combustion heat the water in the drum and then pass on to warm the water flowing through the economiser toward the drum. The induced draught fans remove air from the furnace and, as it passes out, there are sensors that measure its oxygen content. The fan control system acts to keep the oxygen content to at least three per cent (compared with the normal content of 20 per cent in air) to ensure that combustion is efficient.

SUPERHEATER CONTROL

A rather unexpected feature of the system is that the furnace heats the steam above the finally required temperature and it is then slightly cooled by spraying water into it. This procedure gives finer temperature control and takes place in the desuperheater (Fig.3).

The spray water is taken from the 160 bars line between the pumps and the feed valves. The pressure in the desuperheater is lower than this (154 bars) so there is no difficulty in spraying. There is a temperature sensor on the outlet from the desuperheater and this feeds data back to the superheater controller.

There are two separate controllers in this part of the system. Controller 1 receives feedback from the temperature sensor on the outlet of the desuperheater and operates the spray valve accordingly. The steam passes on to the superheater stage and its temperature as it proceeds to the turbine is monitored by a second temperature sensor. This feeds back a signal to Controller 2.

The set point of this controller is manually adjustable, and is set to the required temperature of 566°C. Now comes a more unusual technique for temperature control, for the error signal from this controller is fed back to determine the set point of Controller 1.

Thus we have two control loops, the second of which controls the setting of the first. These are known as cascaded loops, and provide a finer degree of temperature control than a single loop.

A COMPLEX SYSTEM

The ABC system mentioned earlier is an example of multivariable control. As we have seen, there are several individual control systems but they all interact with one another. For example, if the fan control system lets the furnace get too hot, more water will be converted to steam and the feed control system will have to supply more water to the drum.

There are many such interactions, which are affected too by the amount of electrical power being generated at the time.

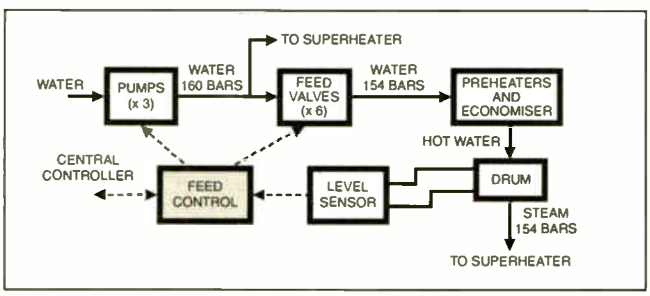


Fig.1. The feed control system regulates the level of water in the drum.

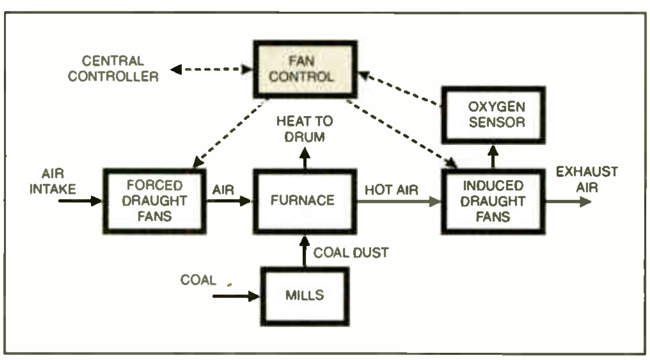


Fig.2. The fan control system is responsible for conditions within the furnace.

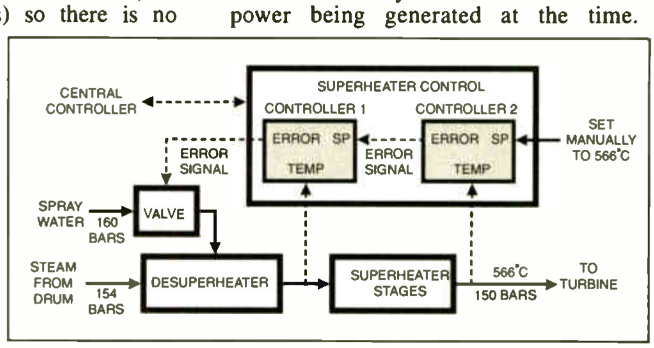


Fig.3. Superheater control comprises two control loops in cascade.

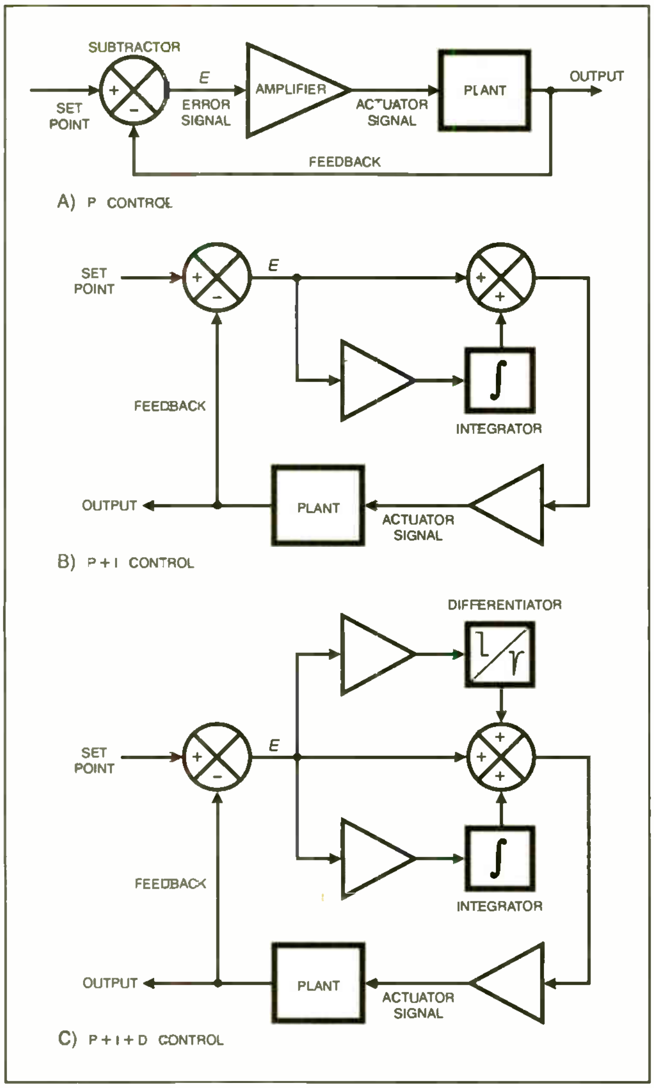


Fig.4. A range of control strategies of increasing complexity and effectiveness.

Computer models allow the operator to study how each system responds and how the different systems interact.

There are a few "unknowns" in the system, however, such as the energy being provided by a particular mixture of air and coal dust. This leads to inaccuracies in the model, and a human operator is needed to keep the whole system in balance.

CONTROL ROOM

Ironbridge has a new control room that well reflects the state of the art of control technology. Instead of a control panel laden with massive switches, rheostats and bulky meters for pressure temperature and current, the whole control panel is presented in virtual form.

The operator sits in front of a bank of four large colour monitors. On a diagrammatic plan of the whole system, these VDUs display critical data (mainly temperatures and pressures), and indicate the state of all pumps and valves. There are buttons and sliders on screen just like those we meet in typical Windows software.

There are no keyboards for these displays for the power station is controlled simply by using a mouse. The operator sweeps the mouse across the screen, calling up data here, adjusting a setting somewhere else. The four screens act as one, so that, as the mouse moves the cursor off the edge of one screen, it appears on the screen next to it.

In addition to these screens, the control room has large back-projection monitors that give a complete overview of the plant. As we all know, computers sometimes crash and, with a system that provides essential power for an appreciable area of the country, a back-up is essential.

Although not showing in the photograph, there is also a hard-wired manual control desk. This has real switches and real meters on it and, while it does not provide for the sophisticated control of the virtual control panel, it does at least allow the power station to continue operating (or to be rapidly shut down!) in an emergency.

PANEL 2. PRESSURE SENSORS

A fluid pressure sensor consists of a chamber with a diaphragm dividing it into two parts. Either or both parts may be filled with gas or liquid under pressure, and then connected by two tubes to the sources of pressure. In the power plant, the chamber on the two sides of the diaphragm is connected to the two levels inside the drum.

A strain gauge is mounted on the diaphragm and this consists of a pattern of parallel strands of thin metal foil. When a difference of pressure causes the diaphragm to bulge, the foil is distorted and its strands may become shorter and wider or longer and narrower. This alters their electrical conductivity and the change in resistance is measured by a bridge circuit. The change in resistance is interpreted as the difference in pressure between the two sides.

At the control desk, the operator uses a mouse to control the power station.

ACKNOWLEDGEMENTS

The author thanks Eastern Power Generation Ltd. for permission to visit their site and, in particular, thanks Dave Potter, Head of Process Control Section, for his helpful explanations of the control systems. □

Perpetual Projects – 2

PERPETUAL L.E.D. FLASHER

THOMAS SCARBOROUGH

● Solar-Powered – no batteries ● Uses a common – Uniboard – p.c.b. ●
● Will run indefinitely, without attention ● Ideal for the novice ●

WE CONTINUE this month with the second part of our four-part series of "perpetual" projects. All are based on one small printed circuit board (p.c.b.) called a Uniboard. Each is powered around the clock – perpetually – by a single one farad "Goldcap" capacitor and a small solar cell (no battery). Each is designed to run unattended for months at a time without attention – in fact for years!

The solar power supply and regulator constructed last month form the basis for all of the projects in this short series. This month we cover the following two Perpetual Projects:

☆ ***Perpetual L.E.D. Flasher*** ☆
☆ ***Double Door-Buzzer*** ☆

Besides these projects, suggestions are made for one variation – a Single Door-Buzzer.

L.E.D. FLASHER

This simple solar-powered flasher could be used as a thief deterrent almost anywhere – maybe on a dummy bell box or in an outbuilding etc. Or use it to mark a switch or keyhole so you can find it at night.

Last month we discussed the miniscule power requirements of the Perpetual Projects in this series. As with all the circuits in the series, the power requirement of the Perpetual L.E.D. Flasher needs to be extremely small to see it around the clock – in fact so small that, if it were run off AA batteries, it would live longer than the shelf life of the batteries (if that were possible)!

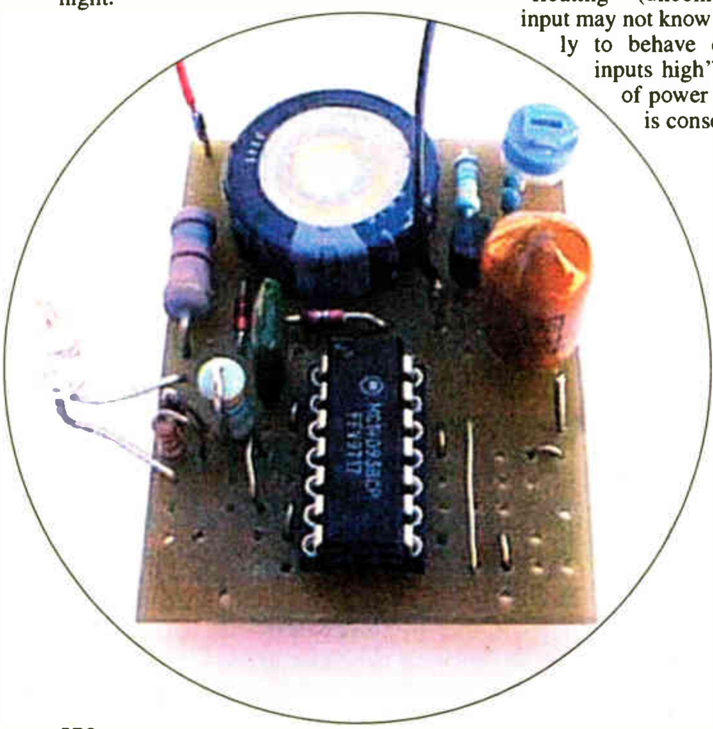
At the same time, this does not mean that the l.e.d. flasher is feebly dim. It is so designed that it will produce an extraordinarily bright flash for its minute current drain. Do not be disappointed if the l.e.d. flasher looks dim in the daylight – if the specified blue l.e.d. is used, it will flash brightly at night.

CIRCUIT DETAILS

The single most active component in this circuit (regulator components excepted), is IC1 – a 4093 quad 2-input NAND Schmitt trigger.

There are various manufacturers of the 4093 i.c., and the make used in this series is the Motorola MC14093BCP. The make significantly affects both the power consumption and characteristics of the 4093 i.c. – see last month.

Any unused inputs should not be left "floating" (unconnected), otherwise an input may not know what to do, and is likely to behave erratically. By "tying inputs high", a significant amount of power (as much as one third) is conserved.



The Perpetual L.E.D. Flasher circuit diagram shown in Fig.1 is based on a simple *RC* oscillator – also called a clock generator in digital circuits. (Note that the component reference numbers follow on from the *Solar-Powered Power Supply & Voltage Regulator* described last month.)

In this circuit, the basic oscillator includes one "innovation", namely the combination of diode D3 and resistor R6. These enable rapid charging of capacitor C3, while blocking current in the opposite direction, so as to give very brief pulses of light.

The operation of the oscillator is easily understood if one refers back to Part 1 of this series. As capacitor C3 charges, so gate IC1a is triggered to discharge C3 – as it discharges, so IC1a is triggered again to charge C3 once more. This sets up a continuous oscillation.

A feature of this circuit that is common to all the "Uniboard" projects in the series is the very high value of *R* (R5), as well as the small value of *C* (C3). This ensures that the oscillator draws only a minute amount of current.

EXTREMELY BRIGHT

An extreme brightness 5mm blue l.e.d. with a narrow viewing angle (15° or so) is used for D4. This is chosen not only for its brightness, but especially for its efficiency. These l.e.d.s produce a very strong light output. *Do not even think of using another l.e.d. in this position.* A standard l.e.d. is

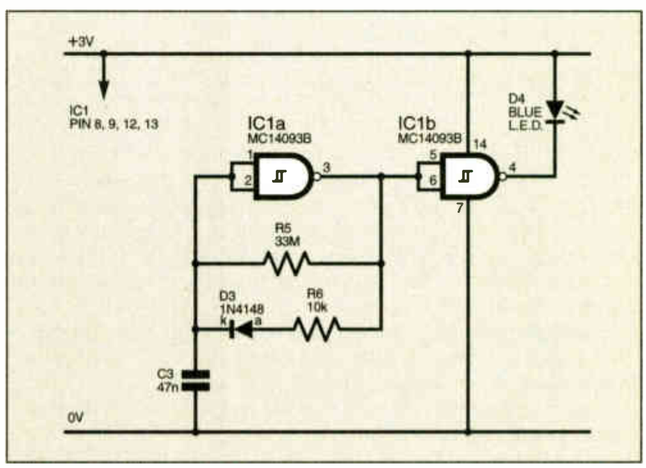


Fig.1. Circuit diagram for the Perpetual L.E.D. Flasher. Note component numbering continues on from last month's Solar-Powered Power Supply & Voltage Regulator.

likely to be virtually useless – and a wider viewing angle might seriously compromise brightness.

Extreme brightness red or green l.e.d.s with a narrow viewing angle may be tried, if a suitable ballast resistor is wired in series. The standard current limiting formula is used – the value of the resistance being calculated by subtracting the l.e.d.'s forward voltage from the regulator voltage, then dividing by 0·02 (which is current). This gives a value of about 39 ohms for green, and 56 ohms for red. A blue l.e.d. (rated at 3V) requires no ballast resistor, since the effective current flow is limited by the regulator.

Note that a buffer gate (IC1b) is employed in this circuit. This is good practice, particularly when very small currents are involved, as is the case with oscillator IC1a. Such a buffer gate isolates the small currents of the oscillator from the relatively heavy current drain of the load (that is, the l.e.d.), and ensures that capacitor C3 is able to fully charge (this would not necessarily be the case without a buffer – a red l.e.d., for instance, would stop the oscillator).

The l.e.d. flasher will flash at about 1Hz, which would easily take it through twenty-four hours of darkness. In fact in sunny climes, the spare gates within the MC14093BCP (IC1) might well be capable of flashing an additional l.e.d. flasher around the clock.

The brightness of the flash may be increased considerably by changing the value of resistor R6 to 47 kilohms, and the flasher circuit would still outlast a good night. However, its life-span would be reduced to about fifteen hours.

The *rate* of flashing may be increased by decreasing the value of resistor R5.

CONSTRUCTION

For the sake of simplicity and clarity, two features of the circuits throughout this Uniboard series is that pin 7 and pin 14 of IC1 are wired to 0V and $+V_E$ respectively (this was taken care of with the insertion of the d.i.l. socket last month). Also, the inputs of all unused gates are (or should be) wired to the positive rail. This is shown in all the circuit board layouts.

The Perpetual L.E.D. Flasher circuit is built up on the Uniboard p.c.b., which already holds the regulator and d.i.l. socket (see Fig.2 July issue). This board (*minus components*) is available from the *EPE PCB Service*, code 305. The topside component layout and copper foil master are shown in Fig.2.

Commence construction by soldering in position the link wires and resistors, continuing with the diodes and capacitor C3. The cathode (k) of D3 is banded. The cathode (k) of l.e.d. D4 has the shortest lead.

Finally, insert IC1 in the d.i.l. socket, being sure to observe the correct polarity (CMOS i.c.s in the 4000 series are easily destroyed by reverse voltages). Observe anti-static precautions with IC1 – the first of these being to earth your body (e.g. by touching a metal water tap – not the mains earth!) immediately before handling the i.c. Extreme brightness l.e.d.s may also be static sensitive, and should be handled with the same precautions.

Although some high-sounding descriptions are given for component types in the Components lists, these merely serve as a guide. In all the projects which follow, only the specifications of IC1 and the l.e.d.s are critical. Rough equivalents should work in every other instance without trouble.

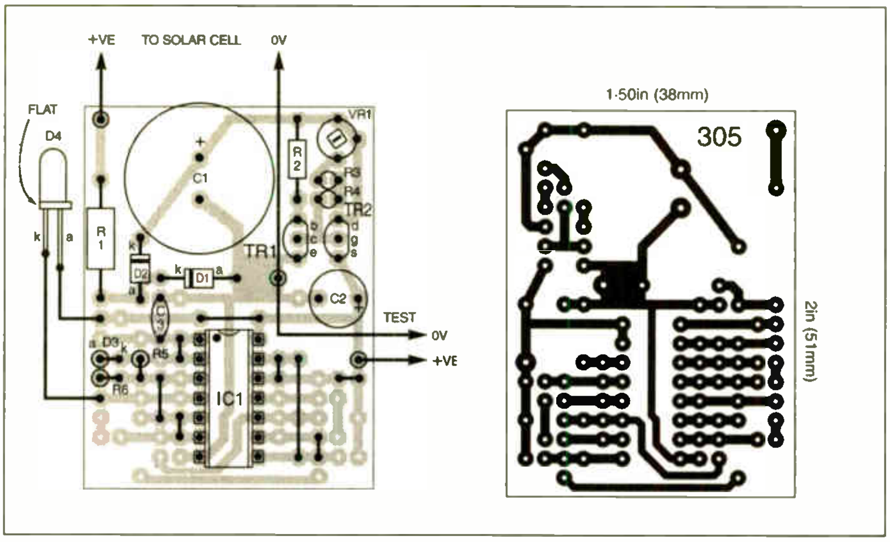
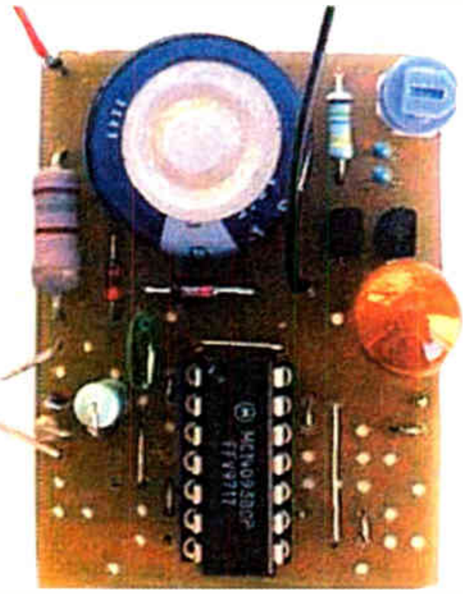


Fig.2. Uniboard component layout for the L.E.D. Flasher. Not all the holes/pads are used. The board includes the Power Supply from last month.



Completed circuit board.

CALIBRATION

Once C1 has been fully charged in the sun (see last month), adjust the regulator's preset trimmer VR1 until 3V is measured across electrolytic capacitor C2 (solder pins are provided for this purpose on both sides of C2). Remember that C2 causes a short delay to any adjustments that are made to the voltage.

Current consumption (excluding the regulator) is below 15µA. If you measure more than 20µA, or if the l.e.d. flasher fades too soon, make IC1 your prime suspect. A CMOS i.c. can be partially damaged by static, while seeming to function correctly. If the i.c. is not the one specified in the Components list, this will almost certainly be the problem.

Now place the solar panel (not the p.c.b., which should be protected from wide temperature swings) in a position where it will receive half an hour's direct sunlight each day. The sun should strike the *whole* solar panel, not just part of it.

COMPONENTS

L.E.D. FLASHER

Resistors

R5	33M metal film 0·25W	See SHOP TALK page
R6	10k carbon film 0·2W	

Capacitor

C3	47n polyester

Semiconductors

D3	1N4148 signal diode
D4	5mm 15° extreme brightness blue l.e.d.
IC1	MC14093BCP quad 2-input NAND Schmitt trigger (see text)

Miscellaneous

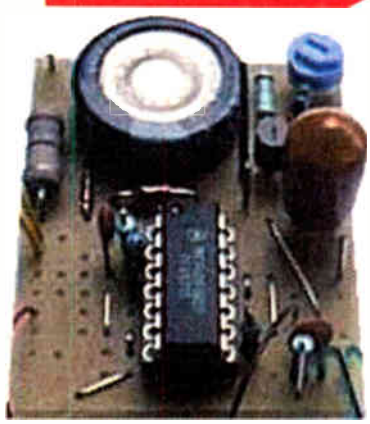
Printed circuit board (Uniboard) available from the *EPE PCB Service*, code 305 (see text); multistrand connecting wire; solder etc.

Note: Component designations run on from the Solar-Powered Power Supply & Voltage Regulator *described last month.*

Approx. Cost Guidance Only **£5**

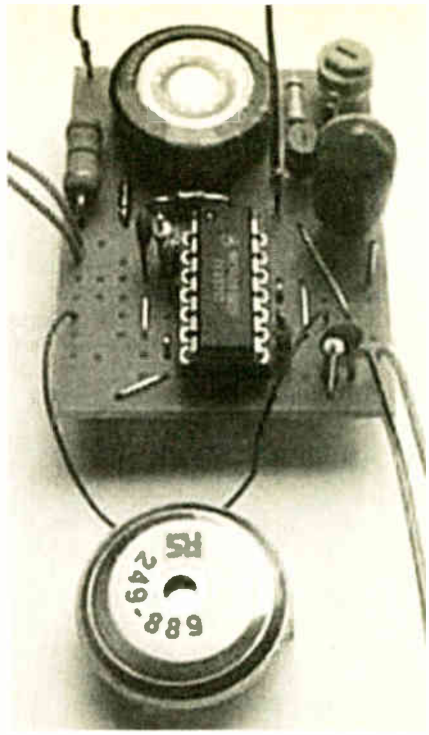
All being well, your l.e.d. flasher should flash continuously through the 21st Century and into the next!

IT'S A BUZZ



DOUBLE DOOR-BUZZER

Solar-powered, personalised call button



A CIRCUIT diagram for a simple Double Door-Buzzer is shown in Fig.3 and is ideally suited to a smaller space (e.g. one or two rooms), since its volume is quite modest. For instance, it would be ideal for an allotment "hut" where there may be no electricity supply, and where it would remain perpetually on standby to alert you to the presence of visitors.

A double door-buzzer will conveniently distinguish between a front door, a back door, or perhaps a gate by sounding a higher or lower tone, depending on which touch-switch button is pressed. It may also alert different occupants of the same house to who is required.

TAKE NOTE

The piezo disc, WD1, is wired between the output terminals (pin 4 and pin 11) of the output buffers IC1b and IC1d. This is an easy way to share one piezo disc between two oscillators. When buzzer No.1 (IC1a and ICb) sounds, buzzer No.2's output (IC1d) is low. When buzzer No.2 (IC1c and IC1d) sounds, No.1's output (IC1b) is low.

In each case, it is as though the piezo disc had been connected straight to the 0V rail. If both oscillators (IC1a and IC1c) sound at the same time, the two waveforms merge, so that the two "tones" are heard simultaneously.

Notice also that if each oscillator is activated alternately, the current reverses direction. This means that the piezo disc could be replaced with a bi-colour l.e.d., which would indicate a different colour depending on which touch-switch is pressed. If a bi-colour l.e.d. is used, remember to add a ballast resistor – the standard current limiting formula (see earlier) applies. The l.e.d. may be wired *in place* of the piezo disc, or *parallel* with it.

The tone of the "two" buzzers may be altered by changing the values of resistors R6 and R8 – choosing higher values for a lower tone, and vice versa.

The Double Door-Buzzer is so designed that only three wires are required for the two touch-switches S1 and S2.

TOUCH-TONE

We return now to the theory of the *potential divider.* Instead of taking an input directly to the positive or negative rails, the voltage at an input may be set anywhere *between* these extremes by means of a potential divider, see Fig.4.

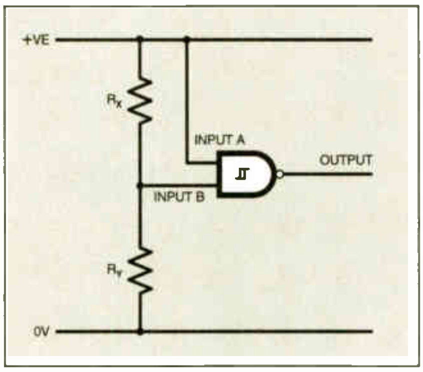
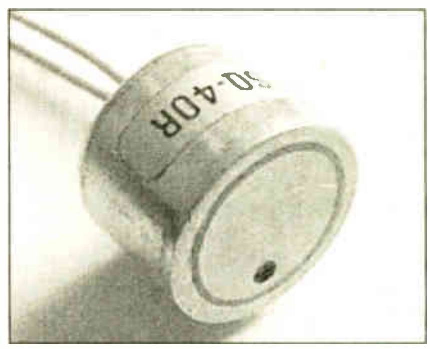


Fig.4. Potential divider.

In order for an input to go "high" (Logic 1), it needs to be *above* the hysteresis voltage upper threshold. In order for it to go "low" (Logic 0), it needs to be *below* the hysteresis voltage lower threshold. The hysteresis is typically about 0·5V above and below the midway voltage and we can safely assume that, referring to Fig.4, if the value of R_X is one-third or less of the value of R_Y, Input B goes high. If R_X is two-thirds or more of the value of R_Y, Input B goes low.

Now consider that the skin has a resistance of roughly one megohm (but this may vary considerably). Skin resistance may thus form one half of a voltage divider – serving more or less the same end as a 1M resistor would do. When the skin bridges (or touches simultaneously) the two sensor plates of a touch-switch wired between IC1 pin 1 and the positive rail (see Fig.3), IC1 pin 1 goes high.

Some circuits choose a value as low as 4·7 megohms (4M7) for resistors R5 and R7. However, the author found this undependable, and chose instead a value of 22M – the only problem here being that the touch-switches would be more sensitive to rain or dampness. The values of R5 and R7 may also be *increased* if the touch-switches are found to be too insensitive.



The author's "touch-switch" was made from a broken ultrasonic transducer.

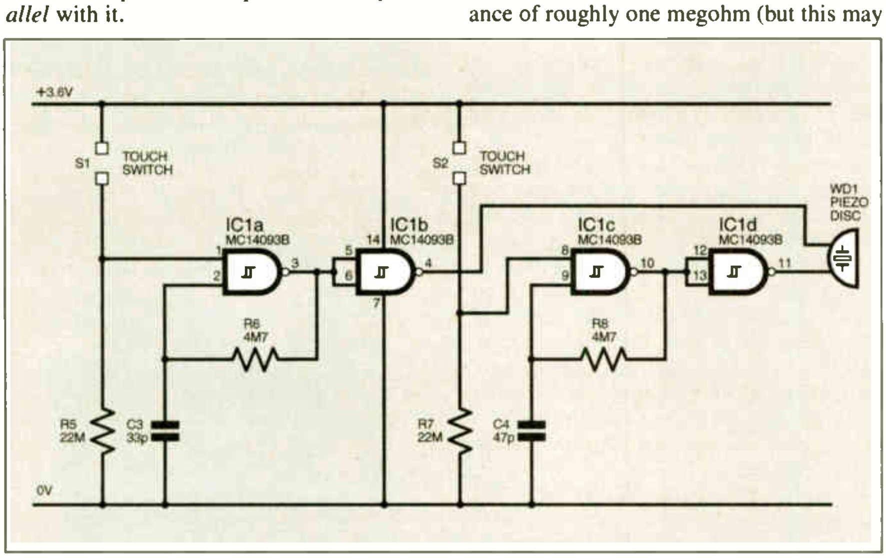


Fig.3. Circuit diagram for the Solar-Powered Double Door-Buzzer. Note: Component numbering continues on from the Solar-Powered Power Supply & Voltage Regulator *from last month.*

Mechanical pushbuttons (push-to-make, release-to-break) could be used in place of the touch-switches S1 and S2. In this case, R5 and R7 are replaced with 100k resistors, and the wires from two pushbutton switches are taken from the positive supply rail to IC1 pin 1 and pin 8 respectively.

Wherever a touch-switch is encountered in this Uniboard series, it may be replaced by a pushbutton switch in this way.

TOUCH-SWITCH

It was decided to use touch-switches throughout the series, since the symbolism of the "perpetual" might be compromised if any mechanical switches were included – particularly if these would interrupt the power supply. The option of mechanical

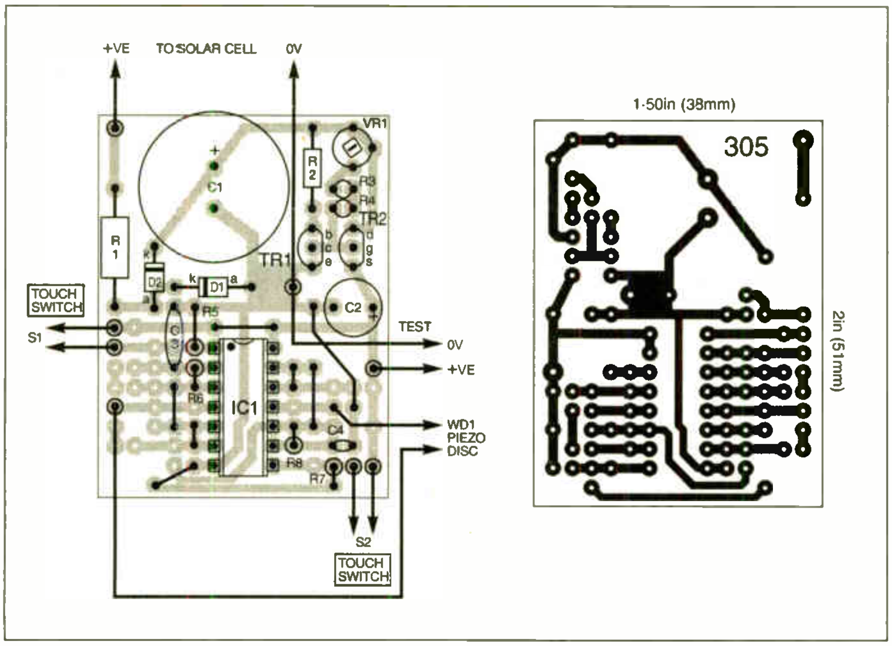


Fig.5. Uniboard component layout and full-size foil master for the Double Door-Buzzer. Includes last month's power supply.

COMPONENTS

DOUBLE DOOR-BUZZER

Resistors

R5, R7	22M metal film 0·25W (2 off)
R6, R8	4M7 carbon film 0·25W (2 off)

Capacitors

C3	33p ceramic plate
C4	47p ceramic plate

See SHOP TALK page

Semiconductor

IC1	MC14093BCP quad 2-input NAND Schmitt trigger

Miscellaneous

WD1	low profile wire-ended piezo sounder
S1, S2	touch-switches – see text

Printed circuit board available from the *EPE PCB Service,* code 305 (see text); multistrand connecting wire; solder etc.

Note: component designations run on from the Solar-Powered Power Supply & Voltage Regulator *described last month (July '01).*

Approx. Cost Guidance Only **£4**

switches is included, since touch-switches may become troublesome in a wet or damp environment.

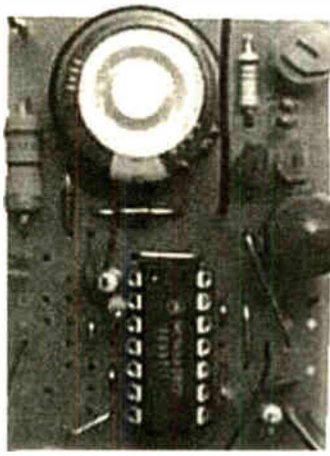
A touch-switch which was constructed by the author from the pieces of a broken ultrasonic transducer is shown in the photographs. The cavity was filled with "quick-set" putty (the connections in this case required aluminium solder). A touch-switch should preferably resemble a push-button switch, so that others can intuitively grasp its purpose. It should also be constructed in such a way that a finger is sure to close the gap across the two contacts.

It would be worth noting that touch-switches can pick up static. One way of protecting a CMOS i.c.'s inputs from such static is to wire a one megohm resistor (approx.) between the junction of a potential divider and an input. The author experienced no problems in this regard, so left out such protection.

A recommended simple means of protecting all the circuits in this series against static would be to wire a one megohm resistor *in series* with each touch-switch. This would be desirable especially if there is an expanse of carpeting near the touch-switch.

CONSTRUCTION

The Double Door-Buzzer is built up on the Uniboard p.c.b., as shown in the topside component layout details of Fig.5. Follow the same procedures as previously described, soldering the components to the



board in sequence, adding the piezo sounder WD1, and finally inserting IC1, observing anti-static precautions.

Adjust the regulator's voltage to 3·6V – while one buzzer is *sounding.* Current consumption is less than 1µA on standby, and about 250µA when one buzzer is sounding. Note that the current consumption of the Perpetual Projects is in some cases so low on standby (as in this case) that more than one project may be run off one "Goldcap" capacitor.

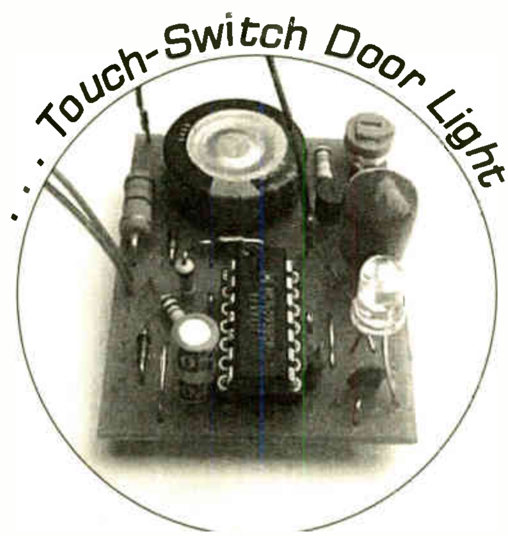
As soon as a finger bridges the plates of one of the two touch switches, a relevant buzzer tone will be heard.

Next month a Perpetual Projects bonanza: ***Loop Burglar Alarm, Door Light and Rain Alarm. Plus suggestions for: Broken Beam Beeper, Power Failure Alarm, Soil Moisture Monitor, Thermostat, Timer, Liquid-Level Alarm,*** **and** ***Wake-Up Alarm.***

SUGGESTION 1 – SINGLE DOOR-BUZZER

A Double Door-Buzzer might not be required for your purposes. Try making a Single Door-Buzzer:

- Remove all the components from IC1c and IC1d.
- Tie the inputs of IC1c (pins 8 and 9) and IC1d (pins 12 and 13) high – positive supply line.
- You may increase the volume, too. Instead of taking the piezo disc WD1 from pin 4 and to the negative rail, try taking it from pin 4 to pin 3. The reason for the increase in volume will be explained in Project 4 next month.



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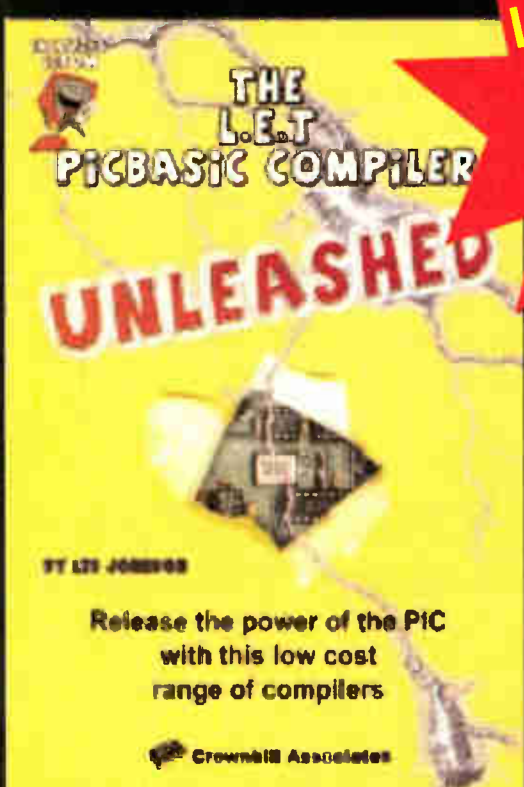

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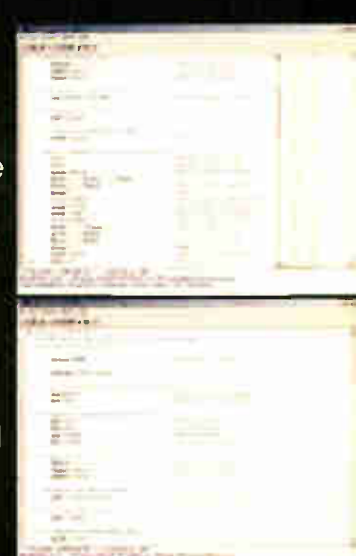

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READOUT

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John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

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★ LETTER OF THE MONTH ★

WHOSE COMPUTER IS IT ANYWAY?

Dear EPE,

I have been reading first *Practical Electronics* and then *EPE* together with *ETI* for quite a long time now. In fact, I started reading *PE* (at school!) in its second year of publication – but this is the first time I've ever written to you.

I have been using Microsoft products since the early days of the Amateur Computer Club (ACC), and since 1993 I have been a consultant to a retailer that sells Microsoft products – amongst many others.

Recently, my colleagues went to the Microsoft launch of the new XP Office product. They came back very angry. Apparently, they were not the only ones to be angered: many people (we are talking mostly of dealers, here) had walked out.

I have, after much discussion and pondering, arrived at a decision: if the information I have been given so far is in fact accurate and true, I am not going to promote (or buy, or sell, and eventually even use) Microsoft products any more. The reasons for this are very relevant to hobby and small-scale industrial electronics and are as follows:

There are two new product ranges coming shortly from Microsoft, the first – which has to all intents and purposes already been launched – is XP Office. Coming soon will be Windows XP the operating system. XP Office promises various interesting innovations, and will no doubt deliver some 30 to 70 per cent of them.

However, there is also a "Gotcha": XP office will not be supplied in functional form. It will be supplied in installable form, but to activate the product it will be necessary to register with Microsoft and get an "activation" key. This is an irritating but not altogether surprising innovation clearly designed to limit the activities of software pirates, at all levels.

But it doesn't end there. The activation key is tagged to the specific hardware setup of the machine – if more than three elements of the hardware setup of the computer are changed the key will expire. It will then be necessary to contact Microsoft again to get a new activation key.

Now it is evident that for a typical "office" user of Microsoft XP Office all this will have little effect – such users typically are not allowed to touch the insides of their computer anyway. But I have been known to make ten changes in my machine in a day – or more when I am messing around with some add-on and rebuilding and changing and reconfiguring and . . . well, use your imagination. I expect XP Office will not work well for me. And that's not all folks – there's more!

Windows XP is (as I understand it) the final amalgamation of the old Windows NT stream with Windows 95. Windows 95 was in my view a much underrated product: it was a brilliant expedient that managed backward and forward compatibility and, remarkably, it worked well enough. Windows NT, however, has always been a much more stable product. So the convergence of NT and 95 into one product should be welcomed – no?

Well, perhaps not. According to the information I have, Windows XP will *require* all executable software to have a digital signature before the operating system will run it. Yes, I did say "require". What is wrong with that? Obviously, virus packages, Trojans, worms and so on won't be digitally signed (if they were the author could be traced!) so the system will be protected against them – since they will not be executed.

So far, so good. And plainly, if you are a developer of mass-market software, all that is needed is to validate the product and get a digital signature. This is quite expensive, but amortized against sales of hundreds of thousands of units will lead to only a small cost increase.

But what if you are a small-scale manufacturer writing customised software for, say – machine tool fabrication? Or, specialised accounts packages? Garment manufacturer quality control? Production control of a small electronics fab? In that case, it is likely that no two of the packages you sell will ever be the same, and so you will have to enter into the expense of getting a validated digital signature for every single package you sell. And what if you are (shock horror!) a hobbyist?

Progressively, with each new version of Windows, operating security system has been improved – but at the same time making it harder and harder to actually use the machine for anything that is outside the narrow definition conceived by the package designers. Whose computer is it – anyway? Well the answer is – it is *my* computer, not Microsoft's computer, and I will do with it what I like.

Languages such as QBASIC are insecure because they can do anything on, and to, the machine. Languages such as Visual Basic are much more "secure", because all hardware access is restricted by the operating system kernel. But then you need to write/get a DLL to be able to talk to the hardware of the machine. Any security provisions are there to protect me and my data and my machine, and if they don't do that they are useless to me. These new provisions seem to have a lot more to do with protecting Microsoft.

There's still more! Not only are there changes to the office software and to the operating system, but there are also going to be changes to the whole development language structure that Microsoft has used to date. The ".net" initiative will replace all Microsoft development languages with new versions, significantly changing Visual Basic, Visual C++ (which now becomes C#) and replacing Visual Basic for Applications altogether, while dropping Java – Sun seem to have shot themselves in the foot with their recent court victory over Microsoft regarding Java.

So what to do? I have no doubt that Microsoft applications will continue to dominate the office and home application market for the foreseeable future, largely because they are in fact better than any of the alternatives in many respects. But I have decided to move to UNIX-style operating systems – perhaps Linux, perhaps Free BSD. They are now a viable and usable alternative.

I don't have to pay retail prices for my Microsoft software, but if I did I would have stopped upgrading with Word 6 and Excel 5 – none of the "improvements" since then have had anything to offer me. The level of the KDE and Gnome interfaces now is competitive with NT4. Word 6 and Excel 5.

Although I have been messing about with Linux since 1993, it is still going to be a wrench, but I will get back full control over my computing machinery. Back in 1979, when I built my first computer (a Nascom-2) from a bag of parts, the whole point was to have one's own computer under one's own control – unlike the IBM 360 I used by day. I want to get my computer back!

James Roberts, via the Net

We forwarded James' interesting but alarming letter to Barry Fox for his opinion. He responded:

Much of what James says is already making the PC press cross. I wouldn't disagree. Personally, having tried to install it and talked to others more PC clever than me, I do not believe that Linux is the answer for PCs. Better to stick with old versions Windows. Most people will, I bet.

Barry Fox

To which James comments:

I quite agree that many people will just not upgrade anymore – that's what I'm planning to do on a personal basis, stick with what I have.

But things will continue to move forward – what about in five years? I am not (heaven forefend) a "Linux activist" – but it's not (nowadays!) that hard to try it out . . . there are three easy ways to try it which don't involve messing about with partitioning drives and so on, all run in a standard FAT32 Win 98 partition:

1. Easiest: download Winlinux from:
www.winlinux.net/usa-index.html
and run the install. It installs in a Windows partition with a Windows setup and configure tool – completely problem-free setup in my experience. Just play about a bit, find out what the buttons do and so on – it *is* different from Windows, and it takes a bit of time to get the idea. Try the (card!) games, good start...

In the DOS properties for the "Start WinLinux" shortcut, change it to "Close on Exit" or you may get a blank screen on exit (not a problem).

2. Next easiest – Big Slack from:
www.slackware.org
Ditto more or less as above.

3. Red Hat 7.1 from:
www.redhat.org
Run the install, and elect to install on Windows partition.

The latest versions are as easy to install as (and detect hardware as well as) Windows 2000 – and believe me, I've done my share of both! (Err... best not use a major production machine!)

James Roberts

Thank you very much James, that's useful info. I for one shall look into your suggestions.

RIFE – THE AUTHOR RESPONDS

Dear EPE,

I've received numerous responses regarding my article *An End to All Disease* in the April '01 issue. It appears that some people have misread parts of the article or jumped to conclusions about what they think I meant as opposed to what I actually said! So I'd just like to clear up a few points that have been misinterpreted.

Firstly, the circuit described in the article is for a simple magnetic pulse device. It is NOT a Rife device and I have never made any claim to that effect. The only association with Rife's work is the fact that I personally tried it with Crane frequencies that have been (probably wrongly) attributed to Rife.

The article is designed to throw some light on several aspects of electrotherapy. Whilst Rife is the main focus of the article it is not exclusively about Rife – so the fact that various devices are mentioned does not imply that they are all forms of Rife device or that they have anything to do with Rife.

The reason I decided to try a magnetic pulse device was to test an initial theory of my own that it was the magnetic field from the Rife ray device that was responsible for the bactericidal effect. I have since found that I can duplicate the effect with pure electric fields, magnetic fields and even infra-red light.

I haven't tried electromagnetic fields – all the pure scientific research I have seen indicates that normal EM fields (i.e. radio waves) do NOT (in general – there are exceptions) exhibit the Rife effect. So to all the people who have commented to the effect that my circuit doesn't produce EM fields or is an inefficient EM transmitter – it is *not* an EM transmitter, it's just a crude prototype designed to create pulses of magnetic flux, nothing else.

As for the coil mentioned in the article, the one described measures at an inductance of 931μH. The 35mH coil referred to was a first prototype, the construction of which is not described in the article. As I did mention in the article, the circuit described is for my *second* prototype which was much simpler and more efficient than the first.

Some readers have asked me for therapeutic recommendations for the magnetic pulse device – I mentioned clearly in the article that I am *not* recommending medical treatment with this pulser. It was not designed as a proper therapeutic tool. It was meant to confirm some crude experimental results. I have no idea of what the long term effects of exposure to pulsed magnetic fields might be and recommend that anyone who wants to experiment with this should do so with extreme caution.

If you want to see if the Rife effect works, try it on a sample of mould or bacteria in a culture dish – don't go around trying to cure people with it. If you want to try it on yourself that's up to you, *but I didn't tell you to do it!* I did not comment anywhere in the article that I recommended this kind of treatment and that I thought it was unconditionally safe. On the contrary I clearly stated that I thought it could potentially be very dangerous.

I did mention that other people had claimed it was safe – but I didn't make that claim myself. There are many different forms of electrotherapy and many different kinds of devices – each should be independently assessed and treated on its own merits, something I didn't try to do in my article.

A few readers have commented that the super-regeneration wavelengths quoted from Rife's papers are higher frequencies than the carriers. This is true but one should not literally accept that an original Rife machine consisted of a simple modulated carrier – in fact the little information that does exist about those original machines indicates that they may have been more like mixers than simple modulators.

I believe I now know the significance of the "super-regeneration" aspect of Rife's original machine and intend to expand on that in a forthcoming follow-up article. With regard to how the Rife effect works, I believe that magnetic and electric fields are inducing electrochemical changes in cell membranes which affect electrochemical pumping mechanisms.

In particular I believe that the Rife type machines interfere with proton pumps that are fundamental to the operation of bacterial cells, but which are not present in animal cells. I have no idea how the Rife effect works on viruses and as yet I don't even have the basis of any theory because viruses are very different to animal/bacterial cells.

I am working on an expanded theory that may account for how infra-red pulses can produce the effect by photoelectrochemical absorbance, but I would like to clarify that I do not endorse the view that the Rife effect is due to mechanical resonance – Rife thought it might be, but I didn't say I agreed with that idea!

I do encourage readers to do their own research – look at proper published scientific research papers – don't just accept what you read on some web site or book or advert (or even magazine article!) either for or against – the only way to find the truth is to look for it yourself with an open mind.

Some people have commented that the only correct way to approach this is with skeptical thinking, but there is a flaw in that because a skeptic in my definition at least is someone who refuses to believe the facts before them unless they can be made to fit an accepted, conventional theory. But the facts are the facts, the theory needs to be modified to fit the facts, not the other way around!

Unconditional belief is just as bad because despite the best intentions of some of the "distributors", a lot of the material that one reads about Rife etc., on places like the web is unresearched and in many cases just plain wrong. But you can read from some of Rife's original papers, you can find proper scientific research papers and finally, best of all, you can do your own experiments and see it for yourself.

You can do historical research too. The full story is a lot more interesting than just my brief description. You can find information on the people mentioned and events referred to – look it up and decide for yourself what is true or not.

I recommend that readers read Barry Lynes book, look at James Bare's experiments, the reports on Peter Walker's Rife Information Web Site and also check out the recently available reproductions of audio tapes and video films of Rife himself talking about his work – but don't stop there, keep looking!

The true spirit of scientific method is to investigate something with no preconceived ideas about whether it's right or wrong etc. It involves simply looking at the facts, checking and verifying them, and then formulating a theory to fit them. The moment one makes any assumption either way, the scientific method has been lost. The same applies if you discard any facts you don't like or introduce unverified information as fact.

The fundamental reason why such a promising field of research is still in its infancy is simply because many people are more concerned with forming themselves into opposing camps of skeptics and believers than with simply looking for the truth for themselves. I have a couple of personal rules of thumb that are not strictly in accordance with the true spirit of scientific enquiry but may be valuable in general.

Firstly, if someone is trying to sell you something, then any information offered in support of their product should be treated with the utmost suspicion unless it can be independently verified.

Secondly, if anyone quotes a dozen pages of their professional qualifications in support of their pet theory whether for or against, that should also be viewed with suspicion, because facts speak for themselves – they don't need qualifications, accreditations, certifications and accolades to be facts. Anyone who needs to do this to promote their "facts" probably has a very weak case, because facts should stand on their own merits.

Aubrey Scoon

MORE PIC TRICKS

Dear EPE,

Thank you for publishing Alan Bradley's *PIC Tricks* in May's *Readout*, another useful snippet to add to my note book.

My offering, while not exactly a trick, is a very useful library routine which has been used on many occasions for scaling data. Many amateur programmers who do not fully understand binary numbers often find binary arithmetic a daunting prospect and may resort to cheating, i.e. using multiple additions and subtractions to perform multiplication and division.

The routine divides two 16-bit numbers, the dividend by the divisor, which have been preloaded into **dividl,h** and **divisl,h** respectively, and returns the result (quotient) in **dividl,h** with the remainder in **remdrl,h**. The original dividend is lost, being overwritten by the quotient.

Readers who are familiar with arithmetic routines will not find anything unusual in the listing, in fact it is a standard algorithm, optimised for the PIC instruction set. Lines 10 to 17 show how to compare two 16-bit numbers using the limited instructions of the PIC.

```
divide  movlw d'16'       ; 16-bit division
        movwf counter
        clrf remdrh       ; clear remainder
        clrf remdrl
dvloop  bcf status,c      ; set quotient bit
                            to 0
        rlf dividl,f      ; shift left dividend
                            and quotient
        rlf dividh,f      ; MSB into Carry
        rlf remdrl,f
        rlf remdrh,f
        movf dlvish,w     ; compare partial
                            remainder and
                            divisor
        subwf remdrh,w
        btfss status,z
        goto testgt       ; not equal, so test
                            if remdrh is greater
        movf divisl,w     ; high bytes are
                            equal, so compare
                            low bytes
        subwf remdrl,w
testgt  btfss status,c    ; Carry set if remdr
                            >= divis
        goto remrlt       ; remdr <divis
        movf divisl,w     ; subtract divisor
                            from partial
                            remainder
        subwf remdrl,f
        btfss status,c    ; test for borrow
        decf remdrh,f     ; subtract borrow
        movf divish,w
        subwf remdrh,f
        bsf dividl,0
remrlt  decfsz counter,f
        goto dvloop
        return
```

Peter Hemsley, via the Net

Another highly useful contribution from you Peter. Many thanks.

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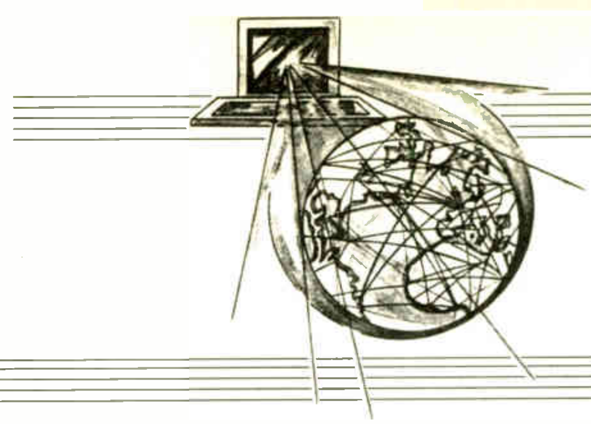


NET WORK

ALAN WINSTANLEY

WELCOME to this month's *Net Work*, our column for Internet users everywhere. Don't forget to browse the *EPE* web site (**www.epemag.wimborne.co.uk**), where you can join in on our Chat Zone message board and read a brief summary, complete with project photos, of current and previous issues. Of course, you can also subscribe or renew your subscription online using our secure order forms.

Our "Online Shop" is the place to go to buy all your *EPE* back issues, reprints, electronics books (including *Radio Bygones* selections), CD-ROMs and more, so hop over to **www.epemag.wimborne.co.uk/shopdoor.htm** to check service announcements or to enter the shop. We deliver worldwide and accept all the usual credit cards.

Software Overload

There is a massive amount of personal computer software available from high street retailers as well as box-shifting mail order suppliers. I have a heap of new software here vying for my attention, and usually the amount spent purchasing the software is often incomparable with the investment in time needed to install it, patch in any upgrades, learn the program and generally get the best out of it. Programs such as Microsoft Word have become over-elaborate for very many users and if you're hoping to start from scratch with, say, Corel Draw 10 or Paint Shop Pro 7 then a steep learning curve may await you!

As an antidote to this software overload madness, from time to time I will be highlighting some worthwhile examples of software which can be downloaded from the internet, either as freeware or for just a modest cost. They are hopefully undemanding and easy to use and will quickly pay for themselves (in terms of helping you keep your sanity if nothing else). Many programs are shareware – you can try them for a period without payment, and simply buy them online to continue using them. The sad thing is that more genuinely useful little programs never find their way into mainstream retail channels in their own right, but magazine cover-disks often contain a wealth of useful gems worth trying out.

Is it a bird . . . no it's SuperCat!

If you have an office wall anything like mine, covered in racks of CD-ROMs and Zip disks then trying to keep track of their contents can be a nightmare. Searching disks until you find what you were looking for, can be endlessly frustrating. If you have ever needed to fumble around with handfuls of disks trying to locate one file or another, then help is at hand in the form of SuperCat from No-Nonsense Software (**www.no-nonsense-software.com**), a great little cataloguing utility which is available direct over the internet.

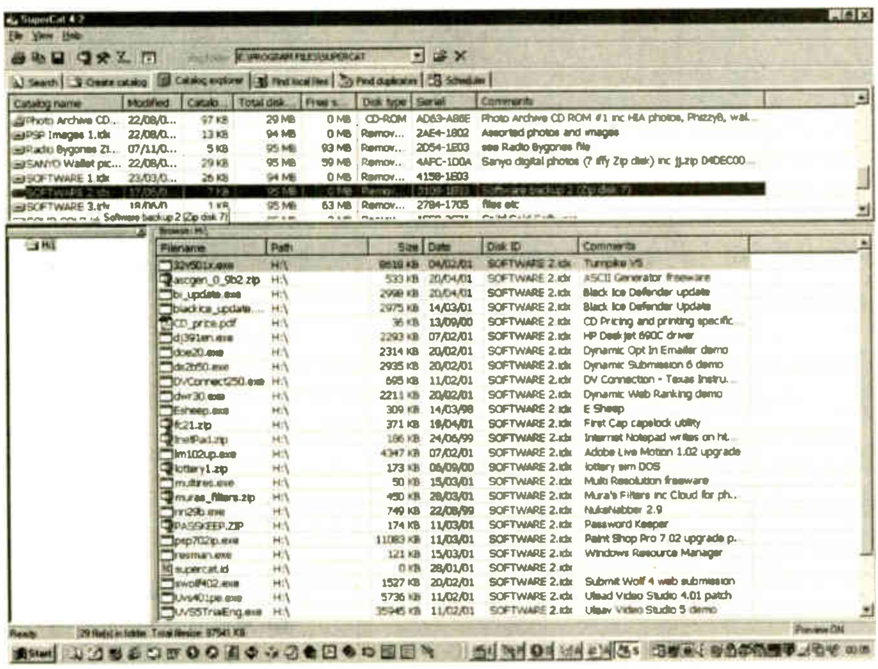
Supercat will index any removable drive as well as the contents of hard disks. The all-important advantage of doing this is to enable you to keep a "catalogue" of all your removable floppies, CDs and Zip disks on your hard disk. It is very easy to launch SuperCat and search the catalogue to locate a file (and the disk it is stored on), and Supercat is perfect for keeping track of software patches, upgrades, demos and all those other essential files (including driver updates) that you accumulate over time on a motley collection of disks.

Supercat for Windows downloads from the web as a simple *.exe* and soon you're ready to begin the process of indexing your disks. You do this by pointing to the correct disk or folder, then hitting the Catalog button. You can also type in your own notes and descriptions alongside each disk (and individual files themselves) in the catalog. I find this completely invaluable for annotating the functions of files. So now I can use SuperCat's Comments feature (F12) to remind me that *dvconnect250.exe* is (obviously) the Texas Instruments Digital Video driver and *32V501x.exe* is (of course) Version 5 upgrade of *Turnpike for Windows*. Any downloaded demos are also filed on Zip disks and then catalogued in SuperCat.

SuperSearch

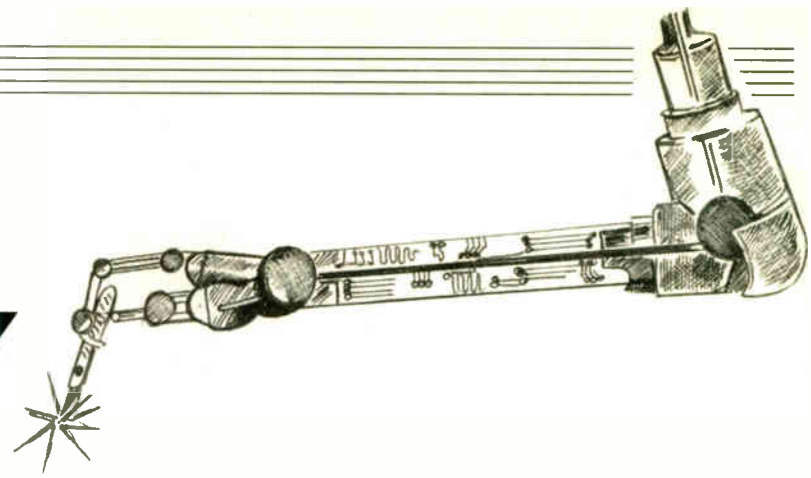
You can quickly search the SuperCat Catalog Explorer to turn up a filename. The program will search your Comments fields as well, which is a great boon – so I could search for "Video" or "Turnpike" and turn up the corresponding files. If you change a disk's contents at any time, or want to add more comments, simply re-index it using Update Catalog (right-click or hit F5). This will update Supercat's file data without deleting any existing notes relating to current files.

Other handy features include a simple unzip utility and an image preview function, and you can filter search results to a certain extent too. There are one or two "gotchas" to be expected in cheap and cheerful utilities such as SuperCat, but the folks at No-Nonsense have been friendly and responsive to suggestions. In particular, I found that it's possible to accidentally overwrite a catalogue index file by inserting the "wrong" disk and pointing to the "wrong" catalogue when you catalogue it. At worst, you would have to re-index the disk and type in your comments again, as the actual contents of the disks are unaffected. SuperCat by No-Nonsense Software is a genuinely handy must-have utility – download a trial and see for yourself! If you have any internet software recommendations of your own which you would like to share with readers, let me know by E-mail to: **alan@epemag.co.uk**



Screenshot of SuperCat (top window: list of all catalogued disks. Left: selected disk catalogued contents. Main window: files in catalogue plus comments.)

CIRCUIT SURGERY



ALAN WINSTANLEY and IAN BELL

Our consultant troubleshooters diagnose the pitfalls of the simple application of thyristors in d.c. circuits

A New Case Alarm

I am thinking of embarking on the project Case Alarm *in the Nov. '97 issue, but some advice would be appreciated.*

Instead of having all those components, why not just have a simple latching circuit, such as the C106D thyristor. This should only take one or two resistors and the mercury switch should still operate fine. Any ideas?" ***ACB*** via the Internet.

The *Case Alarm* is a compact electronic "tumbler" alarm which drives a small piezo disc with an alarm tone whenever the unit is moved. It can be used to protect luggage, briefcases and other possessions. It uses a couple of CMOS NOR gates and 4046 phase-locked loop chips (we covered PLLs in *Circuit Surgery*, March 2001) at the heart of the circuit.

Whilst it is true that there are many ways to implement this function, one of the tasks we undertake at *EPE* is to teach by example, so readers and novices learn differing aspects of practical electronics. Therefore we often suggest different ways of doing the same thing.

In the project itself, the use of CMOS logic meant that the power consumption was tiny and the alarm circuit is likely to be more practical than using, say, one of those bulkier vibrating reed sounders. The designer also incorporated a "delay on" circuit to ensure that the alarm is not immediately triggered when it is being armed and put into position.

Thyristor Alarm

Nevertheless, it is true that a simple alarm could be built using just a simple thyristor as you suggested. The circuit diagram of Fig.1a shows the most basic battery-powered alarm imaginable, using just four components! When the switch S1 is closed, the thyristor will be triggered into conduction so the alarm operates (I used a bulb LP1 for demonstration purposes), and it stays that way until you reset it.

There are two ways of doing this, shown in Fig. 1b – usually the power is interrupted by using (say) a normally-closed switch, or less commonly, you can temporarily short the anode to cathode using a switch, which causes the current through the thyristor to fall below its "holding" value (I_H in data sheets – 5mA in this case). The latter method is neat because the reset switch doubles as an "alarm test" button.

This simple circuit is a very good example of something that *should* work "on paper" but it's when you start experimenting with components that a number of practical issues arise, which the newcomer should take on board. The main problem is that of false triggering. Obviously this is undesirable in an alarm circuit.

If you quickly apply a d.c. supply voltage to many thyristors, they may be triggered into conduction at power up, as they are sensitive to the rate of voltage applied (dV/dt). Many a thyristor circuit has been built only to find that it operates immediately the power is applied, even though there is no trigger signal available!

One solution is to apply a large capacitor (say 470µF) across the supply to slow down the rate of voltage rise during power up. Another way is to use an *RC* network across the thyristor anode/cathode, say 100 ohms plus 100nF in series.

Noise

The other common problem is that of "noise" and if the gate terminal is left floating, the thyristor is wide open to false triggering. I have seen alarm circuits with very long wires connected directly to the gate terminal; these wires act as antennae and can feed spurious trigger signals into the thyristor.

How extra capacitors can be added to improve reliability is shown in Fig.1c. The downside is that the response time of the alarm must invariably be slowed down, but not appreciably so.

The C106D thyristor is always a handy device, having plenty of muscle to cope with the currents of larger loads, it's rated at 5A r.m.s. Of course, this circuit has none of the extra features that the original design had, but you can see how alternative approaches are indeed possible – the real answer is to use what works for you! *A.R.W.*

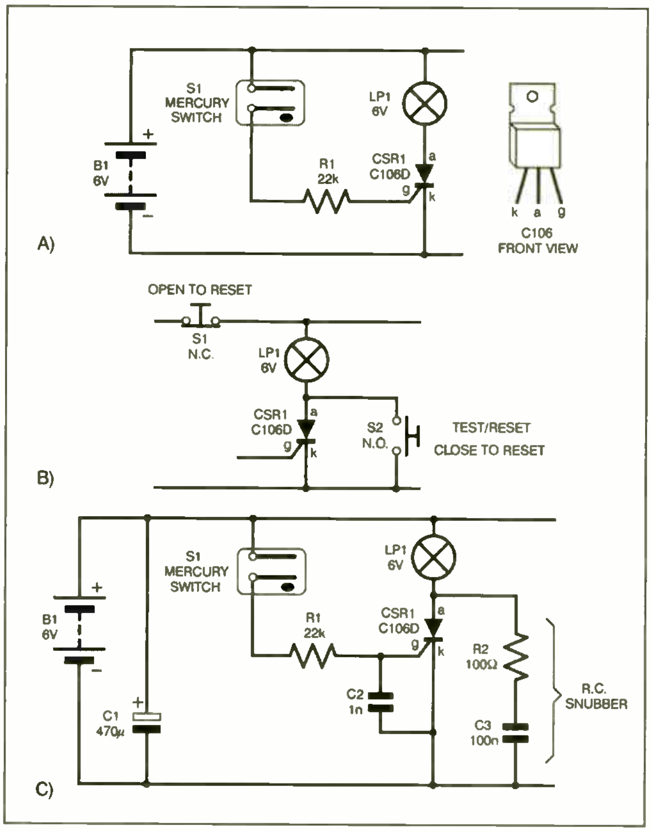


Fig. 1a. Circuit diagram showing the simplest possible application of a thyristor in an alarm system. (b) Two ways of resetting a conducting thyristor using simple normally-open or normally-closed switches. (c) The same circuit with capacitors added to prevent false triggering.

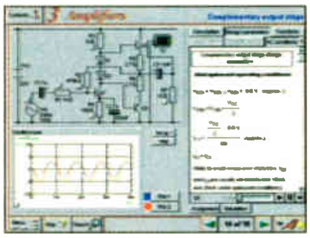
ELECTRONICS CD-ROMS

ELECTRONICS PROJECTS

Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK **schematic capture**, **circuit simulation** and **p.c.b. design** software is included.
The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

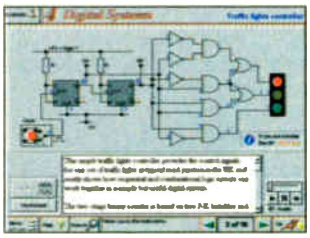
ANALOGUE ELECTRONICS



Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.
Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections),Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

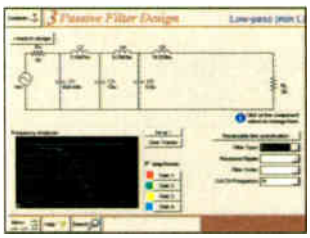
DIGITAL ELECTRONICS



Virtual laboratory – Traffic Lights

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

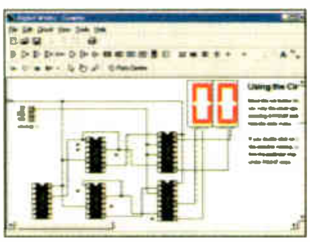
FILTERS



Filter synthesis

Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

DIGITAL WORKS 3.0

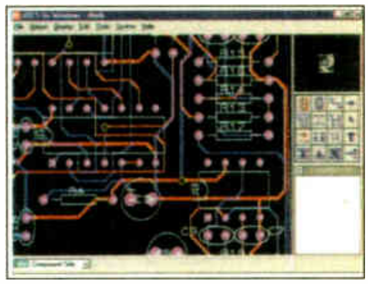


Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability.

- Software for simulating digital logic circuits
- Create your own macros – highly scalable
- Create your own circuits, components, and i.c.s
- Easy-to-use digital interface
- Animation brings circuits to life
- Vast library of logic macros and 74 series i.c.s with data sheets
- Powerful tool for designing and learning

ELECTRONICS CAD PACK



PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules: **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots. etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and even a **fully functional autorouter**.

"C" FOR PICMICRO MICROCONTROLLERS

C for PICmicro Microcontrollers is designed for students and professionals who need to learn how to use C to program embedded microcontrollers. This product contains a complete course in C that makes use of a virtual C PICmicro which allows students to see code execution step-by-step. Tutorials, exercises and practical projects are included to allow students to test their C programming capabilities. Also includes a complete Integrated Development Environment, a full C compiler, Arizona Microchip's MPLAB assembler, and software that will program a PIC16F84 via the parallel printer port on your PC. (Can be used with the *PICtutor* hardware – see opposite.)
Although the course focuses on the use of the PICmicro series of microcontrollers, this product will provide a relevant background in C programming for any microcontroller.

PRICES

Prices for each of the CD-ROMs above are:

Hobbyist/Student ....£45 inc VAT
Institutional (Schools/HE/FE/Industry)..............£99 *plus* VAT
Institutional 10 user (Network Licence)..........£199 *plus* VAT

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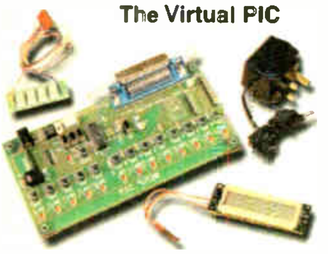
Interested in programming PIC microcontrollers? Learn with PICtutor by John Becker

The Virtual PIC



Deluxe PICtutor Hardware

This highly acclaimed CD-ROM, together with the PICtutor experimental and development board, will teach you how to use PIC microcontrollers with special emphasis on the PIC16x84 devices. The board will also act as a development test bed and programmer for future projects as your programming skills develop. This interactive presentation uses the specially developed **Virtual PIC Simulator** to show exactly what is happening as you run, or step through, a program. In this way the CD provides the easiest and best ever introduction to the subject.
Nearly 40 Tutorials cover virtually every aspect of PIC programming in an easy to follow logical sequence.

HARDWARE
Whilst the CD-ROM can be used on its own, the physical demonstration provided by the **PICtutor Development Kit**, plus the ability to program and test your own PIC16x84s, really reinforces the lessons learned. The hardware will also be an invaluable development and programming tool for future work.
Two levels of PICtutor hardware are available – Standard and Deluxe. The **Standard** unit comes with a battery holder, a reduced number of switches and no displays. This version will allow users to complete 25 of the 39 Tutorials. The **Deluxe** Development Kit is supplied with a plug-top power supply (the **Export** Version has a battery holder), all switches for both PIC ports plus l.c.d. and 4-digit 7-segment l.e.d. displays. It allows users to program and control all functions and both ports of the PIC. All hardware is supplied **fully built and tested** and includes a PIC16F84.

PICtutor CD-ROM

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HARDWARE

Standard PICtutor Development Kit . . . .**£47 inc. VAT**
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Deluxe Export Version . . . .**£96 *plus* VAT**

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ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).
Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

Price £19.95 inc. VAT

ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Sections include: ***Fundamentals:*** units & multiples, electricity, electric circuits, alternating circuits. ***Passive Components:*** resistors, capacitors, inductors, transformers. ***Semiconductors:*** diodes, transistors, op.amps, logic gates. ***Passive Circuits*** . ***Active Circuits***

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MODULAR CIRCUIT DESIGN

This CD-ROM contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects.
Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

Single User Version £19.95 inc. VAT
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Minimum system requirements for these CD-ROMs: PC with 486/166MHz, VGA+256 colours, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98, mouse, sound card, web browser.

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Note: The software on each version is the same, only the licence for use varies.

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INGENUITY UNLIMITED

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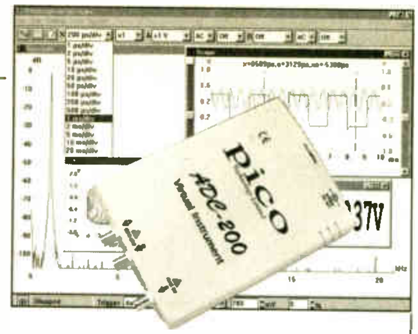
Your ideas could earn you some cash **and a prize!**



WIN A PICO PC BASED OSCILLOSCOPE

- 50MSPS Dual Channel Storage Oscilloscope
- 25MHz Spectrum Analyser
- Multimeter • Frequency Meter
- Signal Generator

If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC based oscilloscope could be yours. Every six months, Pico Technology will be awarding an ADC200-50 digital storage oscilloscope for the best IU submission. In addition, two single channel ADC-40s will be presented to the runners-up.

PC Sound System – Louder Computing

LIKE the writer, some readers may have encountered a problem with low sound output from their PC. The solution shown in Fig.1 may help. It is a stereo audio amplifier based on an LM358 dual op.amp and a Philips TDA7056B d.c. controlled 5W audio power amplifier.

The signal output from a typical PC was found to be 1V peak-to-peak. As the TDA7056B requires an input signal of approximately 5V maximum to give the required output, the preamplifier stage needed to have a gain of five.

Two identical circuits are used for the left-hand and right-hand audio channels, of which one is shown in Fig.1. The pin numbers in brackets around IC1 are the ones used for the second channel.

The input to the preamp is fed via socket SK1, capacitor C1 and resistor R2 to the inverting input of IC1a, pin 2. The gain of the preamp is set by the ratio of R2 and R5, i.e. R5/R2 = 4·7.

The output of the preamp is a.c. coupled by capacitor C2 to pin 3 of the TDA7056B power amplifier, IC2. Control of the output volume from the TDA7056B is achieved by varying the d.c. potential on its pin 5. A d.c. voltage control gives the advantage of there being no signal noise from the potentiometer, the smoothness of control being due to the decoupling capacitor C3. A dual-ganged stereo potentiometer should be used for VR1.

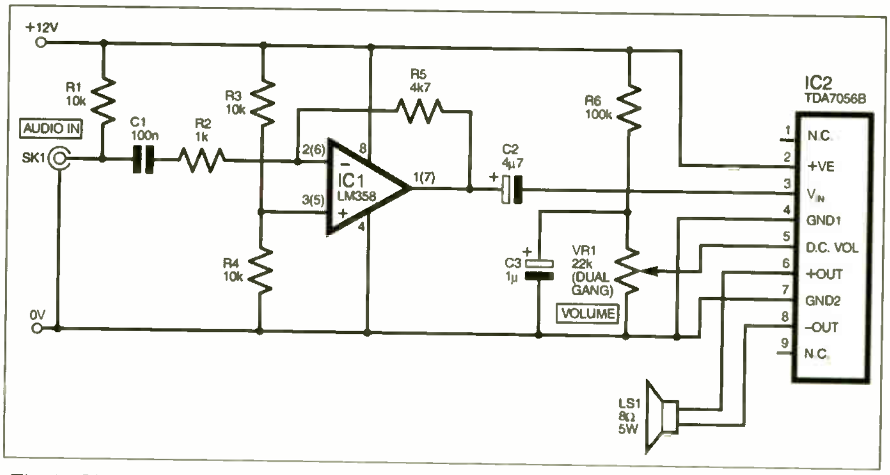


Fig.1. Circuit diagram for one channel of the PC Sound System Stereo Amplifier. The second channel is identical, but does share the dual op.amp IC1.

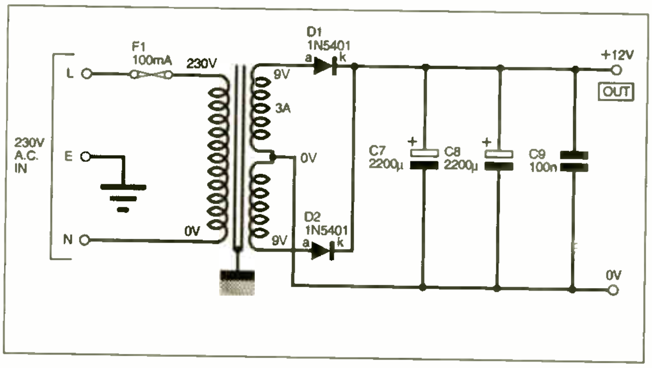
Power Supply

The power supply for the amplifier is a simple non-regulated 12V supply. This can be a ready-made 12V 3A d.c. external type, or as suggested in Fig.2. The design uses two 2,200μF capacitors, a provision which offers two advantages: firstly it gives a lower ESR (Effective Series Resistance), and secondly, it reduces physical size, advantageous when fitting the amplifier into a speaker enclosure. The usual precautions must be taken when dealing with mains voltages.

(If the TDA7056B is difficult to track down, the Philips web site offers plenty of alternative devices at **www.semiconductors.philips.com**. *ARW.)*

**Steve Cartwright,
Kilbarchan,
Renfrewshire**

Fig.2. Suggested power supply circuit diagram for the PC Sound System.



WHY NOT SEND US YOUR CIRCUIT IDEA? Earn some extra cash and possibly a prize!

Reliable Touch Sensitive Switch – Into Touch

THERE are different touch sensitive circuits around, most of them are based on the phenomenon that the human body can be considered as a capacitor to the earth or can accumulate a static charge during everyday activities. Having built several different touch controlled circuits, I have found the results to have been quite disappointing regarding the operational reliability, particularly when the circuits were battery powered.

For example, one circuit would only respond to a colleague's finger and not my own! Another would only respond to "fresh" touches and would gradually show a lack of sensitivity if I kept touching it.

By using a low cost piezo disc and a 555 i.c., a reliable touch sensitive monostable circuit can be constructed as shown in Fig.3. The piezo sensor is connected to the trigger through a capacitor C1. Resistor R2 provides a pull-up voltage to pin 2.

The time constant of the circuit is determined by R4 and C3; in this case it is set to about three seconds. When the piezo disc is touched, an a.c. voltage is generated across its terminals. The positive-going aspect of the a.c. cycle is clamped by diode D1, whereas the negative-going aspect triggers the monostable, which causes the l.e.d. to light for a preset period.

The circuit is very reliable and sensitive, and responds to a very light touch force. The circuit will find many applications including as a doorbell, vibration alarm, and a step bell or footswitch.

M. Yang, Cardiff

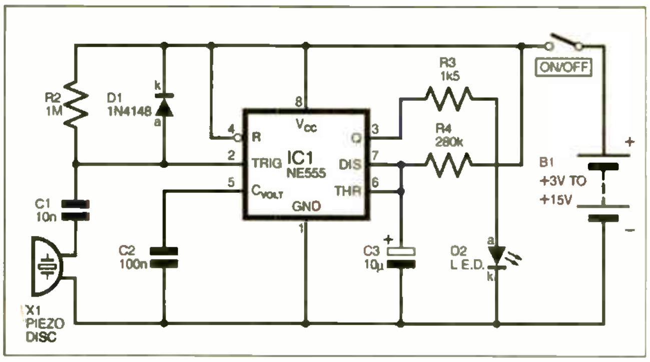


Fig.3. Circuit diagram for the Reliable Touch Sensitive Switch.

PICO PRIZEWINNERS – AUGUST 2001

It's time once again to award three lucky *Ingenuity Unlimited* contributors with prizes of excellent PC-based oscilloscopes, generously donated to *Everyday Practical Electronics* by PICO Technology Ltd., to whom we extend our thanks for their continued sponsorship of this column. You can obtain more details of these test instruments by checking the Pico web site at **www.picotech.com** or check their advert in this issue.

All entries published were judged on the basis of originality, ingenuity or novelty, technical merit, appropriateness and general completeness, with presentation of submissions being used as the tie-breaker. The final selection was made by *EPE* Editor Mike Kenward and *Ingenuity* host Alan Winstanley, drawn from the circuits published in the January to July 2001 issues.

WINNER – receives a superb first prize of a PICO ADC50-200 PC-based Digital Storage Oscilloscope worth over £450!

Kate Turner – MODEL POLICE CAR L.E.D.s by Kate Turner (April 2001)

We felt this was an appropriate use of discrete CMOS logic, carefully optimised to produce a double-strobe blue l.e.d. effect.

RUNNERS-UP – Two lucky runners-up each are awarded PICO ADC-40 single channel PC-based oscilloscopes.

Simon Guest – Electronic Tuning Fork (May 2001)

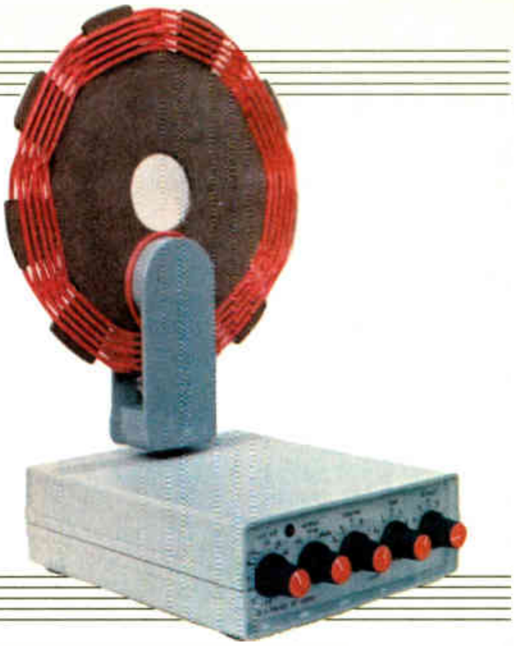
A well designed and considered circuit designed to generate an accurate musical tone using off-the-shelf components.

Richard Neil – Cupboard Door Monitor (July 2001)

A novel circuit which generates a warning sound when a cupboard door is opened.

Constructional Project

COMPACT SHORTWAVE LOOP AERIAL



RAYMOND HAIGH

This Q-multiplied loop will deliver as much signal as a long wire and null out local electrical interference.

SOME of the readers who constructed the *Active Ferrite Loop Aerial* (Sept '00) have asked if its coverage can be extended to long waves and through the shortwave bands.

Tuning to a lower wavelength presents no problems: simply increase the turns of wire on the loop to 144 for the main and three for the feedback winding. Use 38 s.w.g. (34 a.w.g.) enamelled wire arranged in four "pies" or piles of 36 turns to reduce self-capacity. Performance, in terms of signal output and depth of null, is very satisfactory at the lower frequency.

Extending coverage through the shortwave spectrum is not so easy. The performance of ferrite rods available to home-constructors deteriorates above 2MHz or 3MHz until, at around 10MHz, they are no longer of benefit. Moreover, the original loop was designed specifically for medium wave working and its efficiency and ease of operation diminish as frequency increases.

A new circuit has, therefore, been developed for reception between 1·6MHz and 30MHz. Although similar in concept to the medium wave version, plug-in air-cored loops are used, modifications have been made to the tuning and Q-multiplier circuits, and a second buffer stage has been incorporated. In addition to making the operation of the controls smoother at high frequencies, this extra stage also provides signal amplification.

TUNING ARRANGEMENTS

The circuit diagram of the Compact Shortwave Loop Aerial is given in Fig.1.

Signal pick-up is via loop winding (inductor) L1, which is tuned by a back-to-back arrangement of varicap diodes, D1 and D2. Connecting the diodes in this way halves the capacitance swing and ensures an acceptable *LC* (inductance-capacitance) ratio with the lower inductance shortwave loops. The reduction also makes it easier to obtain consistent *Q* multiplication at higher frequencies. More important, if the system is to tune to 30MHz, is the halving of the minimum capacitance to around 20pF.

Diode capacitance is controlled by a reverse bias voltage set by potentiometer VR2a (increasing the bias reduces the capacitance). Signal voltages are isolated from the bias circuit by resistor R1, and bypass capacitor C1 eliminates potentiometer noise.

A potentiometer of lower value, VR1, produces a small shift in the bias voltage and acts as a fine tuning control. Readers who are primarily interested in the amateur bands could usefully reduce the value of VR1 to 4k7 to produce a slower tuning rate.

Capacitance change is not linear: it falls off noticeably as the bias approaches its maximum value. Because of this, the shift produced by the fine tuning control is not constant. The arrangement does, however, make it much easier to adjust loop tuning when the *Q* control is set close to maximum.

Diode bias must be held absolutely constant or tuning will drift, particularly at higher frequencies. Accordingly, the voltage to the tuning potentiometers is regulated by IC1. Bypass capacitor C11 shunts broad-band electrical noise in the regulator's output to ground (0V).

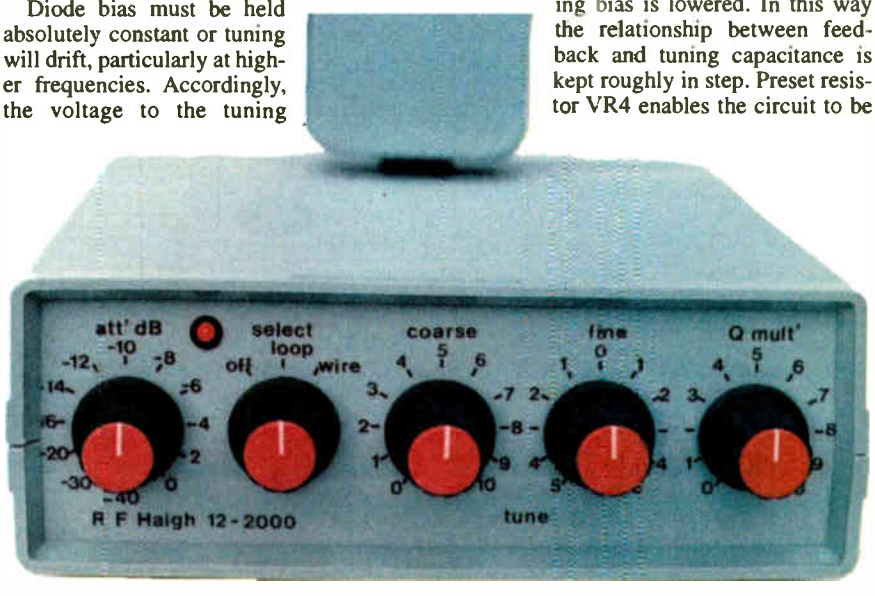
Q MULTIPLICATION

The performance of the unit is greatly enhanced by applying positive feedback to the tuned circuit. Dual gate MOSFET TR1 amplifies the signal developed across inductor L1, and a proportion is fed back by grounding its source via L2. Gain and feedback are preset by VR5, a variable source bias resistor located in the base of each loop unit. This preset, wired as a variable resistor, is bypassed by capacitor C2.

Potentiometer VR3 controls the amount of *Q* multiplication by setting the voltage on gate *g2* of TR1, thereby controlling its gain. Wiper noise is eliminated by C3.

As the capacitance across the tuned circuit increases (i.e., as frequency lowers), so does the amount of feedback needed to keep the *Q* of the tuned circuit high. This necessitates the constant adjustment of VR3 if the circuit is to be maintained in its most sensitive condition. The need for constant attention is reduced by potentiometer VR2b.

This component is ganged with VR2a, the tuning control, and connected so that the voltage on gate *g2* increases as the tuning bias is lowered. In this way the relationship between feedback and tuning capacitance is kept roughly in step. Preset resistor VR4 enables the circuit to be



optimised for different types and specimens of dual-gate MOSFET.

The stage is decoupled from the supply rail by R4 and C4, and R2 ties gate *g1* (and the gate of TR2) to the 0V rail when the loop is unplugged.

BUFFERS

The signal developed across the loop is extracted via buffer stage TR2. Configured as a source follower, the f.e.t. (field effect transistor) has a high input impedance and loading on the tuned circuit is minimal. The output is developed across source bias resistor R6, and R5 and C5 decouple the stage from the supply line.

Voltage gain of the stage is slightly less than unity. It does not provide sufficient isolation at high frequencies, and *Q* multiplication is excessively affected by the setting of the output attenuator and receiver input circuits.

A second buffer, TR3, eliminates the interaction, and provides a modest amount of gain. By arranging this transistor in the grounded base (*b*) mode, best use is made of its frequency response, there is good isolation between input and output ports, and no instability problems.

The low input impedance at TR3's emitter (*e*) roughly matches the impedance at the source (s) of TR2, but output impedance is high. During the development of the circuit, a broad-band toroidal transformer was used to match this to 50 ohms. However, no difference in performance could be discerned between the transformer and an r.f. choke as a collector load, and the simpler and less expensive circuit was adopted in the final version. The value of the r.f. choke, L3, is not critical: anything between 100μH and 1mH will be suitable.

COMPONENTS

Approx. Cost Guidance Only **£28** *excl. case and batts.*

See SHOP TALK page

Resistors

R1, R9	100k (2 off)
R2	1M
R3	4k7
R4, R7, R14	100Ω (3 off)
R5, R11	220Ω (2 off)
R6, R8	1k (2 off)
R10	22k
R12	150Ω
R13	120Ω
R15, R16	82Ω (2 off)
R17, R18, R19	47Ω (3 off)
R20	68Ω
R21	27Ω
R22	10Ω
R23	3k9

All 0·25W 5% carbon film or better.

Potentiometers

VR1, VR3	10k rotary, lin. (2 off, see text)
VR2	100k dual-gang rotary, lin.
VR4	47k preset, min. round
VR5 (Range 1)	4k7 preset, min. round
VR5 (Range 2, 3)	2k2 preset, min. round (2 off)
VR5 (Range 4)	1k preset min. round

Capacitors

C1, C4, C5, C7, C8, C13	100n ceramic, 5mm pitch (6 off)
C2	1n ceramic, 5mm pitch (4 off)
C3	1μ radial elect. 16V
C6, C9, C10	10n ceramic, 5mm pitch (3 off)
C11	4μ7 tantalum bead, 35V
C12	100μ radial elect. 16V

All 16V working or greater.

Semiconductors*

D1, D2	KV1236 varicap diode
D3	red l.e.d. low current (2mA)
TR1	BF981 dual-gate MOSFET transistor
TR2	2N3819 *n*-channel f.e.t.
TR3	BF494 *npn* transistor
IC1	HT7291 +9V voltage regulator

*See Text

Miscellaneous

L1, L2	tuning coil (see text)
L3	470μH min. r.f. choke (see text)
S1	4-pole 3-way rotary switch
S2	1-pole 12-way rotary switch (see text)
SK1	6·35mm stereo jack socket
SK2, SK3	aerial and earth terminals to suit
SK4, SK5	coaxial aerial socket (2 off)
PL1	6·35mm stereo jack plug, (4 off)

Printed circuit board, available from the *EPE PCB Service*, code 310; metal case (see text); control knobs (5 off); l.e.d. holder; battery holder and connectors to suit (see text); hardboard for formers and supports; 300mm length of 21mm x 21mm hardwood strip for base blocks; 12 metres of two core and earth house wiring cable (1.5mm^2 conductors, 15A); hook-up wire, solder, solder pins, nuts, bolts, washers, screws, stand-offs and adhesives.

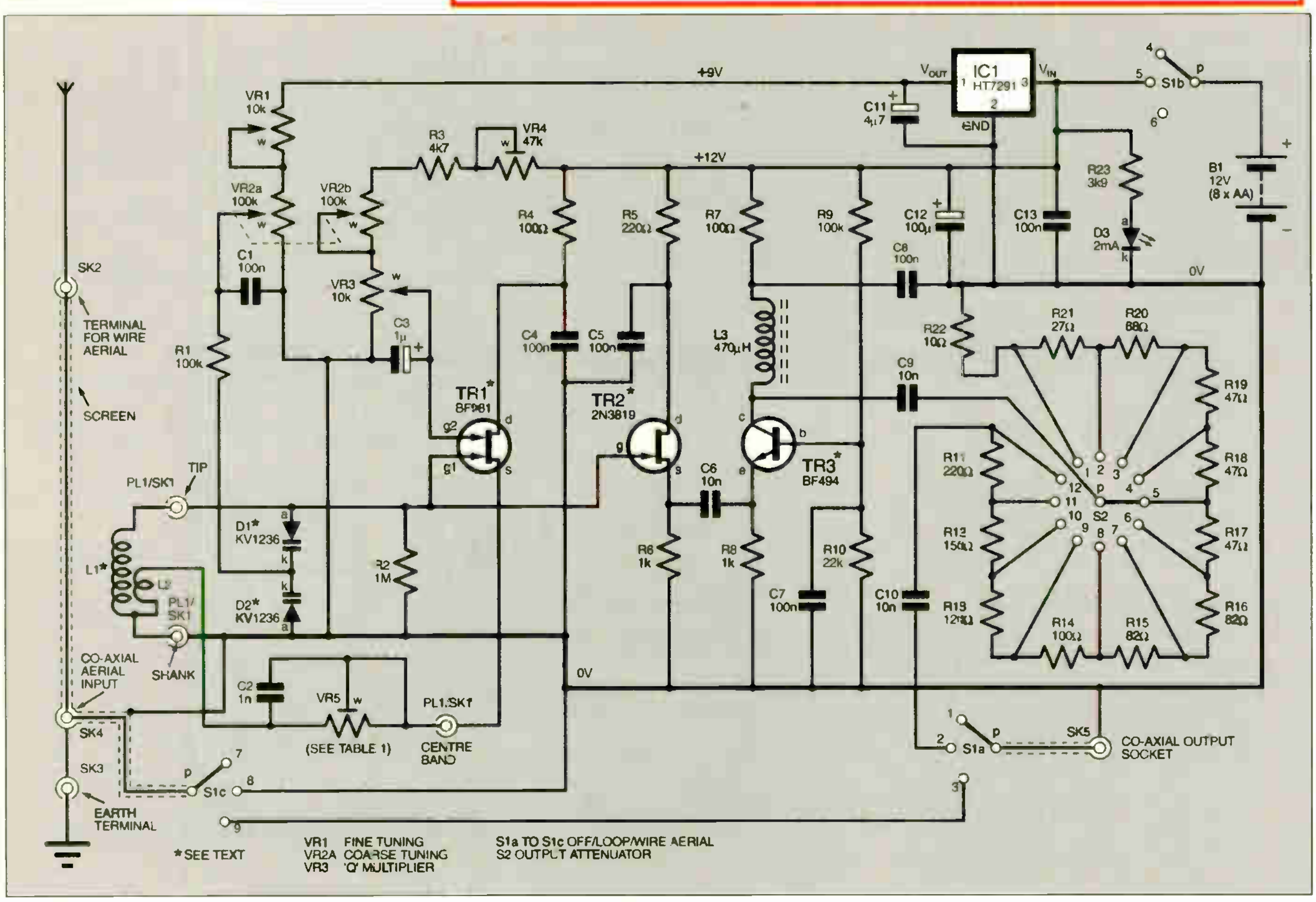


Fig.1. Complete circuit diagram for the Compact Shortwave Loop Aerial. PL1/SK1 are a jack plug and socket linking the coil assembly to the unit.

Signal is applied across emitter resistor R8, via d.c. blocking capacitor C6. Transistor TR3 is biased by R9 and R10, capacitor C7 grounds the base at radio frequencies, and R7 and C8 are supply line decouplers.

ATTENUATOR

Signal output from the unit will overload simple receivers, and an attenuator is essential. Volume-control type potentiometers can be noisy and erratic when they are used in low-level circuits operating at high frequencies. For these reasons a 12-way rotary switch, S2, connects the output along a chain of resistors, R11 to R22, to produce varying amounts of attenuation. A make-before-break type is preferred but is not essential.

The resistor values have been calculated to give logarithmically scaled voltage ratios, and the approximate attenuation levels, in decibels (dB), are given in Fig.4, later.

The arrangement is simple and the quoted attenuation figures take no account of capacitance effects or the change in the loading of TR3. It does, however, work well, and enables differences in performance between the loop and other aerials to be roughly quantified. (Assuming, of course, that the output of the loop is greater than that of the other aerial.)

Blocking capacitors C9 and C10 prevent disturbance of the d.c. voltage levels in the loop unit or the receiver (some miniature shortwave receivers carry power and control voltages to add-on pre-selectors via their aerial sockets).

AERIAL SWITCHING

Provision for switching between the loop and the station's wire aerial, so that an instant comparison can be made, is a great operating convenience. Three-way rotary switch S1a to S1c combines this function with the on-off switching.

POWER SUPPLY

Current consumption is a modest 6mA, and battery powering the unit reduces the possibility of mains interference. Although the circuit will work well with a 9V supply, provision has to be made for a voltage drop across the regulator, IC1, and a pack of eight AA cells, delivering 12V, powers the prototype unit.

Stability of the circuit, particularly as the battery pack ages, is ensured by bypass capacitors C12 and C13. Low current light emitting diode (l.e.d.) D3, with its voltage dropping resistor R23, affords a visual indication that current is being consumed.

SEMICONDUCTORS

Any varicap diodes intended for medium wave tuning with a 9V maximum reverse bias should prove suitable for D1 and D2. These devices are usually retailed in snap-apart packs, the KV1235 (three diodes) and the KV1236 (two diodes) probably being the most common.

A number of dual-gate mosfets, including the BF961, BF980, BF981, 3SK81, 3SK85, MFE201 and 40673 were tried in the TR1 position and they all worked well. The type of f.e.t. used in the source follower buffer stage, TR2, does not seem to be particularly critical, and the BF244A,

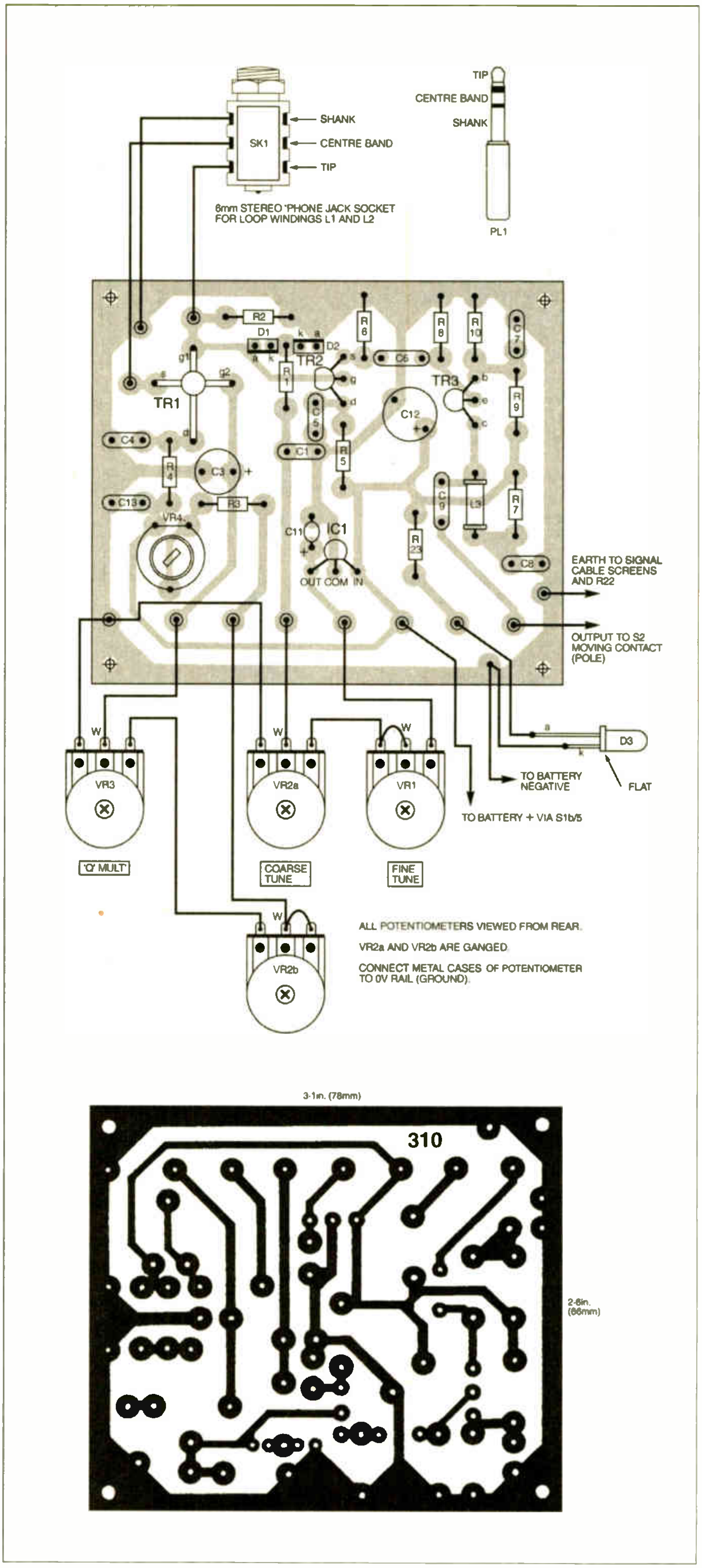


Fig.2. Loop Aerial printed circuit board component layout, wiring and full-size copper foil track master pattern.

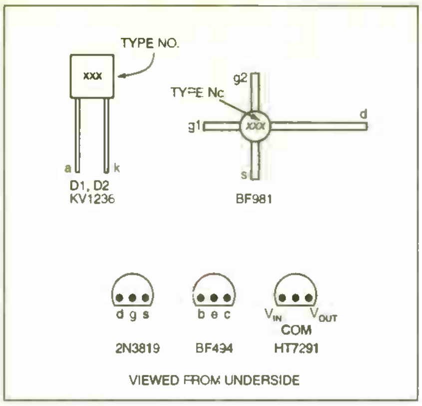


Fig.3. Pinout details for the varicap diode, voltage regulator and transistors.

BF245, MPF102, TIS14, 2N3819 and J310 all proved suitable.

Most *npn* r.f. transistors will function as the final buffer, TR3. For good results select a device which combines an f_T in excess of 250MHz with an h_{FE} of at least 70 at collector current levels of 1mA or 2mA. The BF199, BF240, BF241, BF494, 2N3904, 2N3866 and 2N5179 all worked well in the prototype unit.

Low drop-out voltage (100mV) and power consumption make the HT7291 +9V voltage regulator (IC1) a natural choice for battery powered equipment, but any 9V positive output regulator will be suitable. The more common 8V types can be used, but the high frequency coverage of each coil range will be slightly curtailed.

Connections to the above mentioned devices vary and should be checked.

CONSTRUCTION

Most of the parts are assembled on a printed circuit board (p.c.b.), the component and copper track sides of which are illustrated in Fig 2. This board is available from the *EPE PCB Service*, code 310.

Commence construction by soldering the smaller items into place first, and the semiconductors last. Solder pins inserted into the connection pads for transistor TR1 will enable this device to be mounted on the component side of the board. It is a wise precaution to use a small crocodile clip, or a pair of tweezers, as a heat shunt when soldering the f.e.t.s into circuit. Solder pins inserted at the various lead-out points will make it easier to carry out the off-board wiring.

Details of the wiring to the potentiometers is also given in Fig.2, and the wiring between the switches and aerial and earth sockets in Fig.4. Use 50Ω or 75Ω co-axial cable to link switches and sockets, and keep the co-axial cable between loop unit and receiver below one metre in length to avoid excessive losses.

HOUSING THE UNIT

Printed circuit board, sockets and controls can be mounted in a shallow aluminium case or chassis, at least 150mm wide × 175mm deep × 50mm high.

Locate the loop jack socket SK1 at the rear to space it as far as possible from the controls, see photograph opposite.

The unit is not particularly susceptible to hand-capacity effects, but spacing helps when the *Q* multiplier is set close to maximum.

Alternatively, the p.c.b. and loop socket can be enclosed within a smaller aluminium or diecast box and the controls and sockets mounted close to it. This is the arrangement adopted for the prototype unit which has a plastic outer case. If this method is chosen, remember to connect any electrically isolated front panel and the potentiometer cases to the 0V rail.

Readers wishing to duplicate the arrangement in the photographs will need an aluminium or diecast box no smaller than 80mm × 100mm × 30mm internally plus an outer plastic case at least 150mm × 175mm × 50mm.

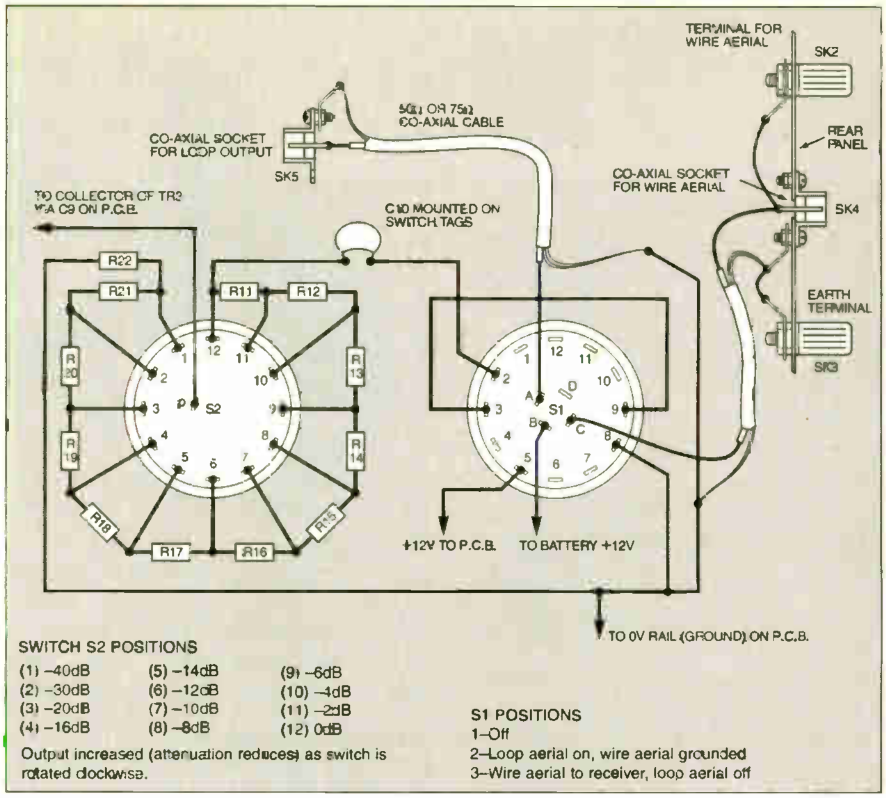
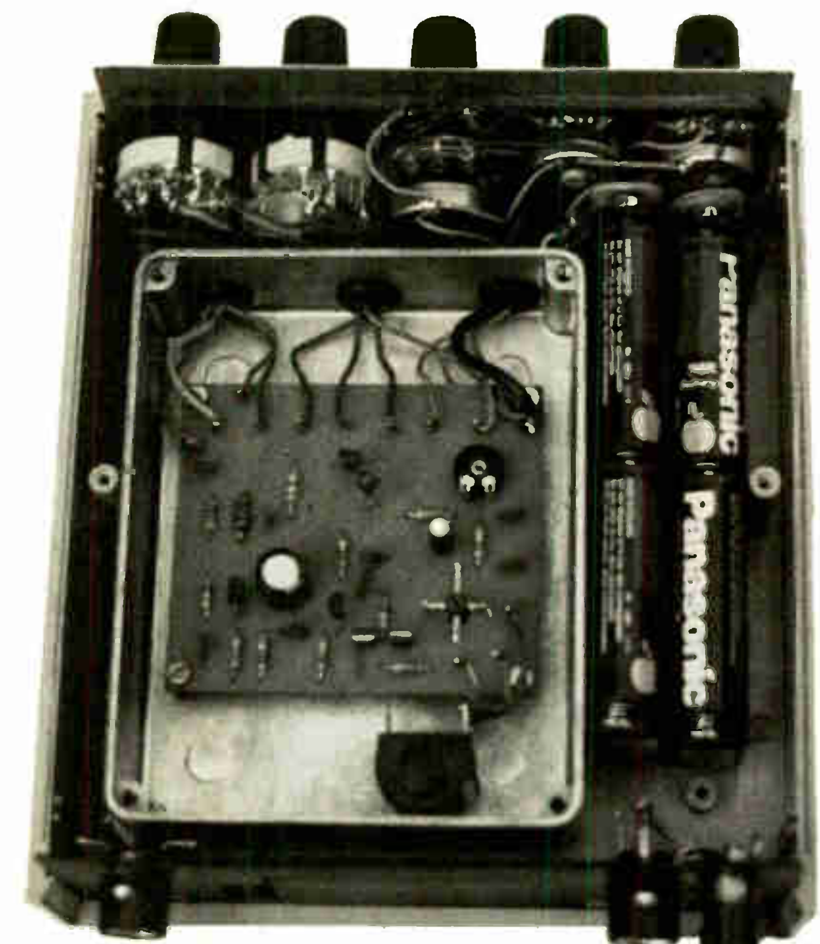


Fig.4. Interwiring between rotary switches, coaxial sockets and terminal post/sockets.



Completed prototype unit showing the p.c.b. and loop aerial jack socket mounted inside a diecast box.

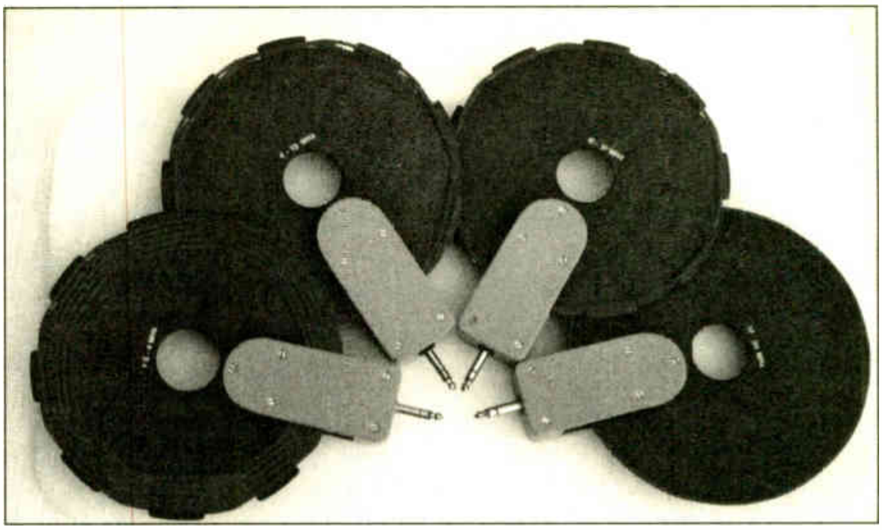
LOOPS QUANTITY

Coverage from 1·6MHz to 30MHz can be obtained with only three loops, but performance is improved if four are used as this ensures better *LC* ratios. Details of the number of turns and frequency coverage are given in Table 1. Loop construction is illustrated in Fig.5.

Hardboard (Masonite in the USA) or fibreboard discs, 3mm thick, support the windings which are connected to 6mm jack plugs so that they can be rotated.

The large discs for the tuned windings, L1, can be cut out with a coping or fret saw. The smaller discs which carry the feedback windings, L2, and space the loop assembly, can be produced with a hole saw mounted in an electric drill.

The odd number of notches formed around the perimeter of the large discs results in a "basket weave" effect. This is necessary to reduce the self-capacitance of the winding and extend high frequency coverage. The single-turn Range 4 coil is held in a groove filed around the perimeter of the disc.



Tuning into the shortwaves could not be easier with these four plug-in loops covering the ranges of: 1·5MHz to 4MHz; 4MHz to 12MHz; 6MHz to 17MHz and 12MHz to 30MHz.

LOOP WINDINGS

Plastic insulated house-wiring cable is used for the loop windings. The type with a solid core of 1·5mm^2 cross-sectional area and a 15A rating is rigid enough to stay in place on the former. Its thick insulation separates the turns, again keeping self-capacitance low and extending the high frequency coverage.

The cores have to be stripped from their outer grey PVC covering, but wire obtained in this way is cheaper than enamelled copper wire of comparable gauge, and performance is enhanced by the thick insulation.

Sky wave propagation dominates reception on the shortwave bands. The vertical angle is often high, and polarisation of the signal, at the receiving aerial, is usually random. Directional effects are, therefore, usually less pronounced, and the deep nulls achievable on medium and long waves, by rotating and tilting the loop, are no longer evident.

However, tests revealed that by simply rotating the loop, local electrical interference can be effectively nulled out.

Because of this, provision is not made for tilting. The additional mechanical complexity was considered not worth while in a unit intended only for reception on the high frequency bands. (More complex loop aerials used for shortwave direction finding often incorporate a tilting mechanism.)

FEEDBACK

The feedback winding, L2, is a single 50mm diameter turn for all of the loops. It must, of course, be connected to give in-phase or positive feedback.

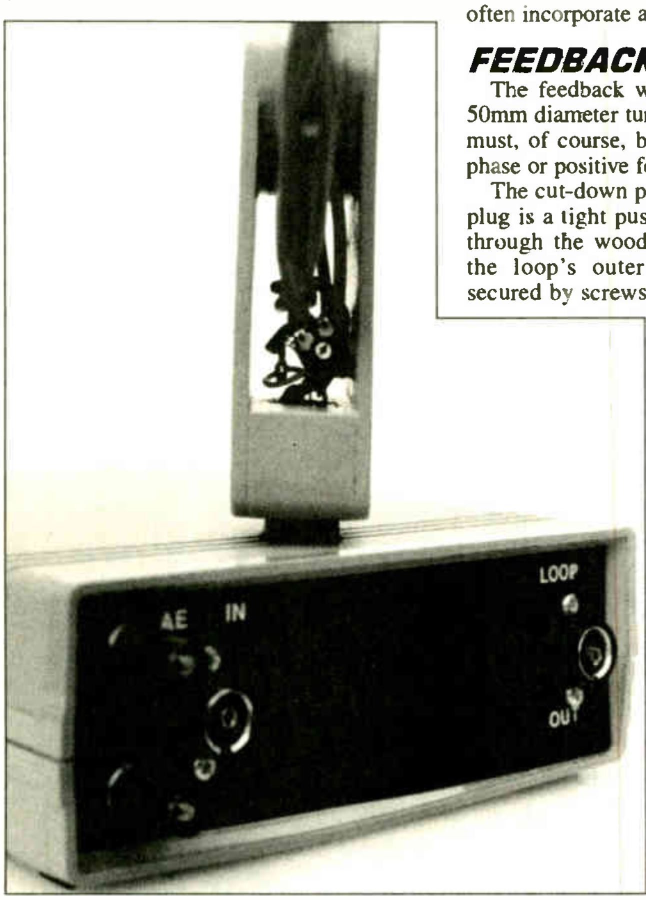
The cut-down plastic cover of the jack plug is a tight push fit into a hole drilled through the wooden base block. One of the loop's outer supporting plates is secured by screws to permit access to the winding connections and to preset VR5 and capacitor C2. The other plate, feedback winding discs and loop disc are glued together with Durofix or similar. On completion, two or three coats of clear cellulose will firmly secure the windings in place and make the hardboard more impervious to moisture.

SETTING UP AND TESTING

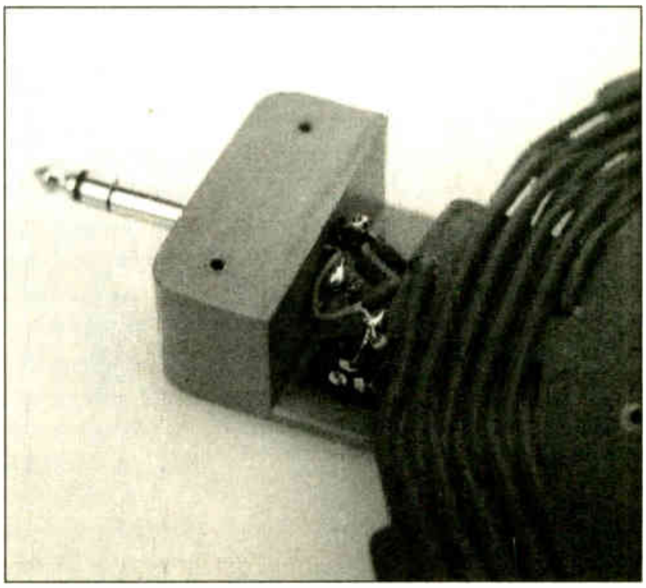
Check the orientation of the semiconductors and polarised capacitors, then check the p.c.b. for badly soldered joints or bridged tracks. Set VR2 for zero bias, connect the 12V battery pack and check that the output from the regulator, IC1, is 9V, and the current drawn from the battery is in the region of 6mA.

Set preset VR4 to minimum resistance, rotate the slider of VR3 to the 0V end of the track, switch S2 to maximum output, and set preset VR5 in the Range 2 loop unit to mid travel. Insert the loop into the jack, connect the unit to a receiver and, using a wire aerial, tune in a station around 9MHz.

Switch in the loop aerial and adjust VR2 to tune it for maximum signal. Advance *Q* multiplier control VR3. Output should rise dramatically and loop tuning will need

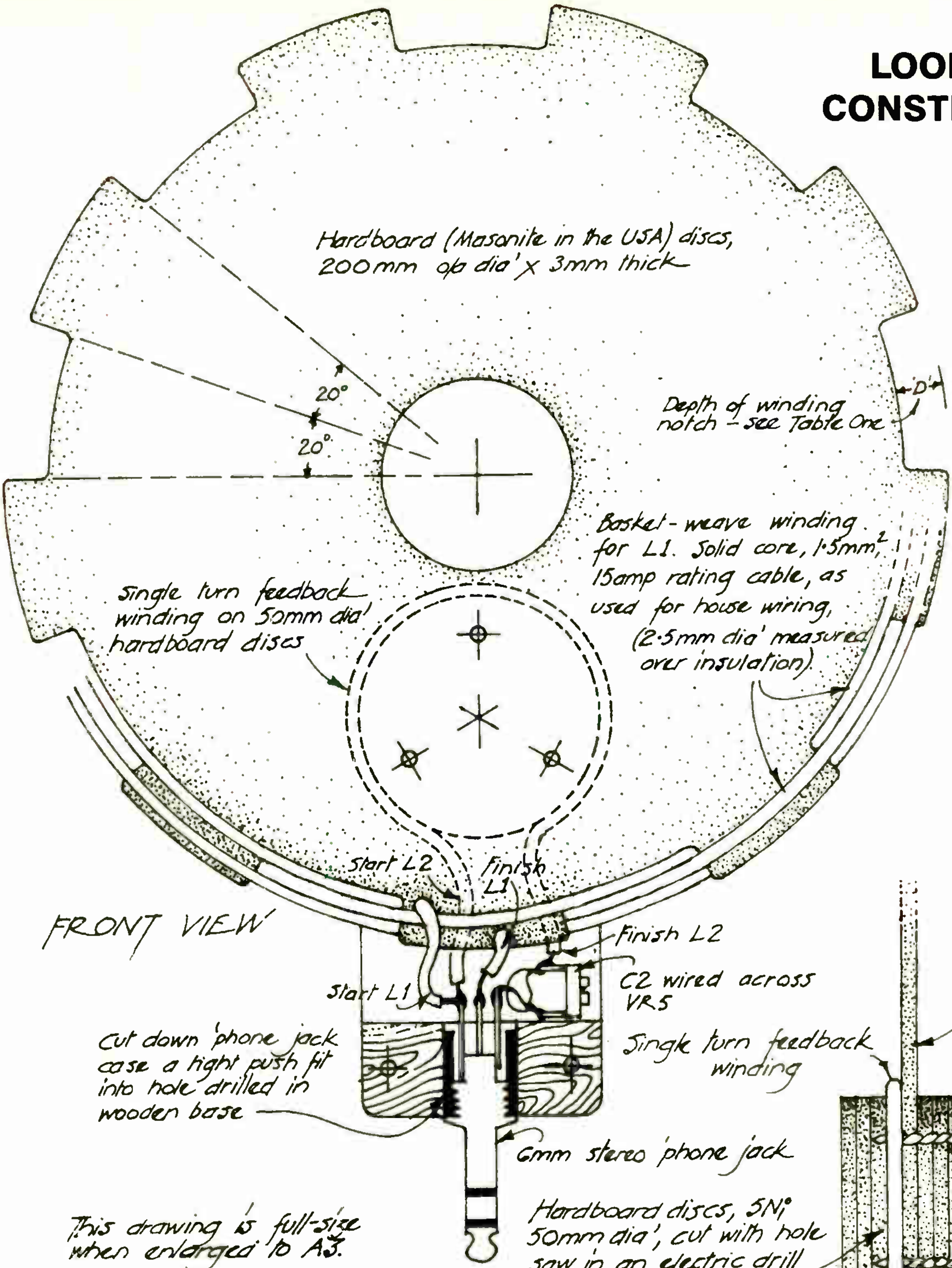


Range feedback components (VR5, L2, C2) located in the base of an aerial loop.



Cutdown jack plug embedded in a wooden base block and wiring to the feedback components.

LOOP AERIAL CONSTRUCTION



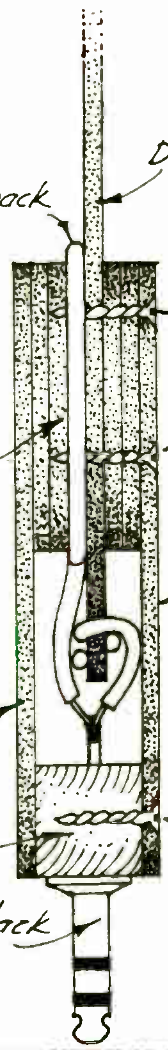
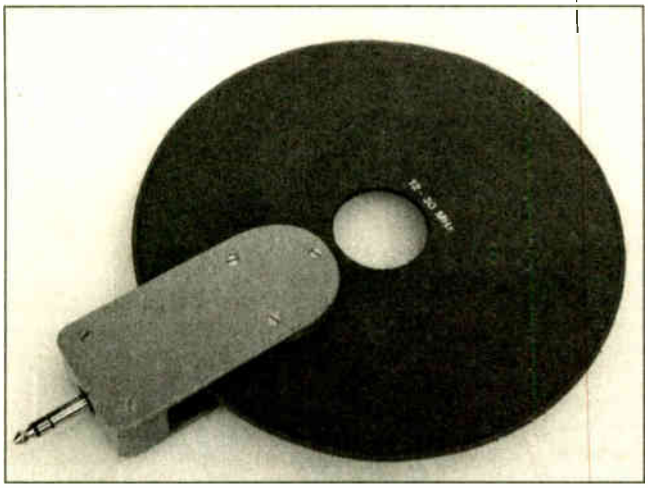


TABLE 1: Loop Winding Details

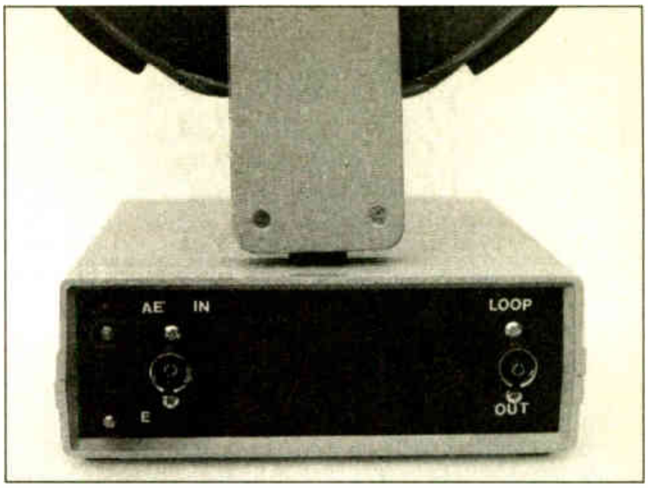
Range	Coverage (MHz)	No. of turns	Inductance (μH)	Notch D(mm)	VR5 (ohms)
1	1·5 to 4	10	30	26mm	4k7
2	4 to 12	3	3·75	9mm	2k2
3	6 to 17	2	2	6mm	2k2
4	12 to 30	1	0·75	*nil	1k

*The Range 4 winding is held in a groove filed around the circumference of the disc.

Fig.5. Construction details for the plug-in loop aerials, L1 and L2. For winding details see Table 1 above.



The single-turn Range 4 (12MHz to 30MHz) plug-in loop aerial.



Input and output socket positioning on the rear panel.

refining as selectivity increases. If there is only a modest signal increase, reduce the resistance of VR5 (mounted in the loop unit) until the circuit comes close to the point of oscillation when the Q multiplier control is set at maximum.

Repeat this procedure with the remaining loops, setting VR5 so that maximum Q multiplication can be obtained over the full tuning range (the full sweep of VR2a) for each loop. Preset potentiometer VR4 determines the maximum voltage which can be applied to gate $g2$ of TR1, and is included so that the circuit can be optimised for different types and samples of MOSFET.

If VR5 is set to ensure maximum Q multiplication (circuit just short of oscillation) when the loop is tuned to the lowest frequency (VR2a slider at the 0V end of the track), the amount of feedback will usually be adequate for the whole of the tuning range.

Should the type or sample of dual-gate MOSFET have a comparatively low gain, it may be necessary to wire a 100 kilohm (or lower value) resistor in parallel with VR2b in order to ensure effective Q multiplication on all loop ranges and at every setting of the tuning control.

The procedure is not critical, but a little time spent adjusting VR4 and each preset VR5 will be repaid by a smooth Q control which is completely free from back-lash. If the unit can be tuned but the Q multiplier function does not appear to be working, the cause is almost certainly the out-of-phase connection of the feedback winding, L2. Reversing the connections should resolve the problem.

RESULTS

Selectivity is good even without Q multiplication, and loop and receiver tuning must be kept in step. When the Q control is advanced, selectivity and output increase dramatically, and the loop has to be very precisely tuned. Fine tuning control VR1 will be found useful under these circumstances.

Directional effects are sometimes pronounced, and the loop should be rotated for best reception. It is not balanced, and the signal maxima and minima are not 180° apart.

The loop has been tested with regenerative receivers, direct conversion receivers, simple superhets and communications receivers of advanced design. The aerial used for comparison purposes comprises 20 metres of wire mounted 10 metres above ground and connected into a screened down-lead via a broad band transformer.

Output from the loop with little or no Q multiplication is invariably equal to that delivered by the long wire. With the Q multiplier control well advanced, but some way short of the critical maximum, output is usually 20dB to 30dB greater (measured on a calibrated signal strength meter). Adjustment of the controls becomes more critical as the frequency of operation increases, but it is not too difficult to focus in on individual amateur stations on 14MHz if the value of VR1 is reduced to about 4k7, as suggested earlier.

ENHANCED PERFORMANCE

The performance of simple receivers is greatly enhanced by the high degree of front-end selectivity imparted by the loop, and loop output has to be set low to avoid overloading. Broadcast station breakthrough on the amateur bands, which can be troublesome with direct conversion receivers, is eliminated by the unit.

Spurious responses in simple superhets and overloaded regenerative receivers, which become increasingly evident as the operating frequency increases, are heavily suppressed. With the wire aerial connected, responses of this kind can make an almost empty band seem crowded. When the loop is switched in and correctly tuned, the images and unwanted responses disappear and only stations actually transmitting on the band remain.

Complex, high-performance receivers do not have faults of this kind, and the difference in performance between wire and loop is hardly noticeable. (Under quiet conditions, the additional noise introduced by the loop amplifier is just discernible when a weak signal is being received). The loop is, however, invaluable for eliminating local electrical interference no matter what type of receiver is used.

Whip aerials with untuned amplifiers are sometimes used by shortwave listeners who lack the space for a long wire. Although the complete absence of controls makes these units easier to use, they cannot match the performance of the Compact Short Wave Loop, especially at frequencies below 20MHz or so.

Digital dials emit electrical noise which can be picked up by the loop. Locating the loop towards the rear of the set and about 300mm distant avoids the problem.

LOWER FREQUENCIES

The shortwave loop will work at lower frequencies if the inductance of L1 is increased. However, the reduced maximum tuning capacitance curtails coverage and the action of the Q multiplier is much too fierce.

Readers interested in medium wave reception, which calls for a loop that tilts as well as turns, are urged to consider the earlier article which details the construction of a loop designed specifically for this purpose. □

ELECTRONICS SERVICE MANUAL

EVERYTHING YOU NEED TO KNOW TO GET STARTED IN REPAIRING AND SERVICING ELECTRONIC EQUIPMENT

SAFETY: Be knowledgeable about Safety Regulations, Electrical Safety and First Aid.

UNDERPINNING KNOWLEDGE: Specific sections enable you to Understand Electrical and Electronic Principles, Active and Passive Components, Circuit Diagrams, Circuit Measurements, Radio, Computers, Valves and manufacturers' Data, etc.

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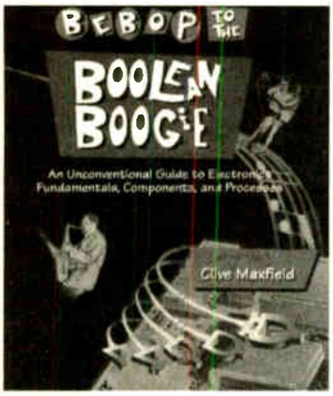

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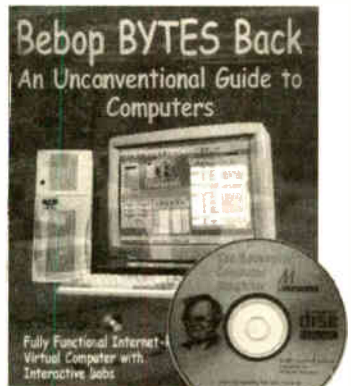

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Audio and Music

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(Second Edition) Ian Sinclair
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Along with the electric guitar, sections are also included relating to acoustic instruments. The function of specialised piezoelectric pickups is explained and there are detailed instructions on how to make your own contact and bridge transducers. The projects range from simple preamps and tone boosters, to complete active controls and equaliser units.
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Vivan Capel
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Ten practical enclosure designs with plans and comments are given in the last chapter, but by the time you've read that far you should be able to design your own!
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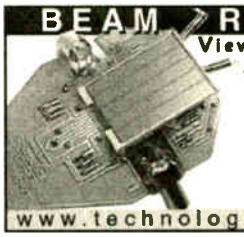

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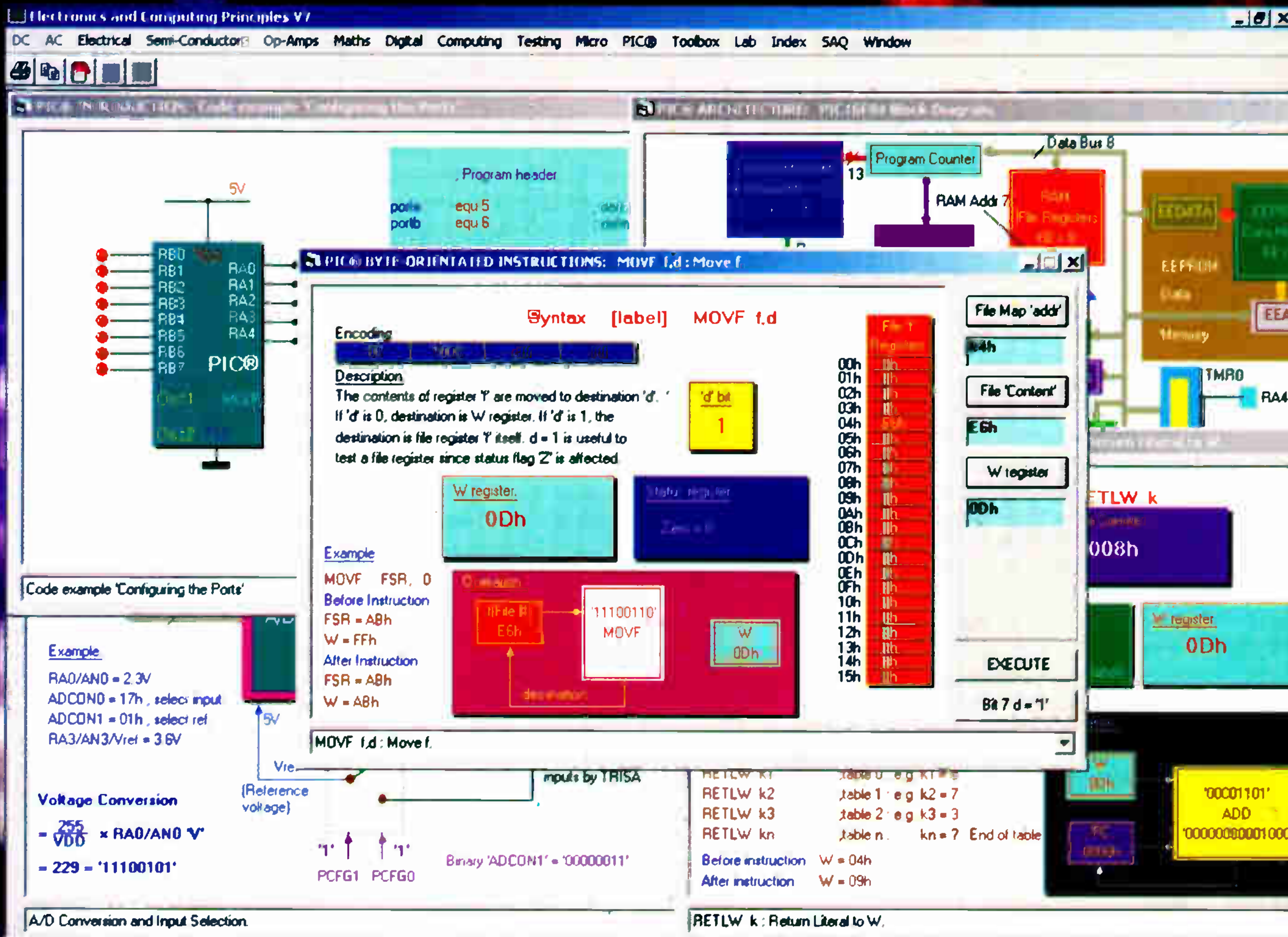

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