ETI
ELECTRONICS TODAY INTERNATIONAL

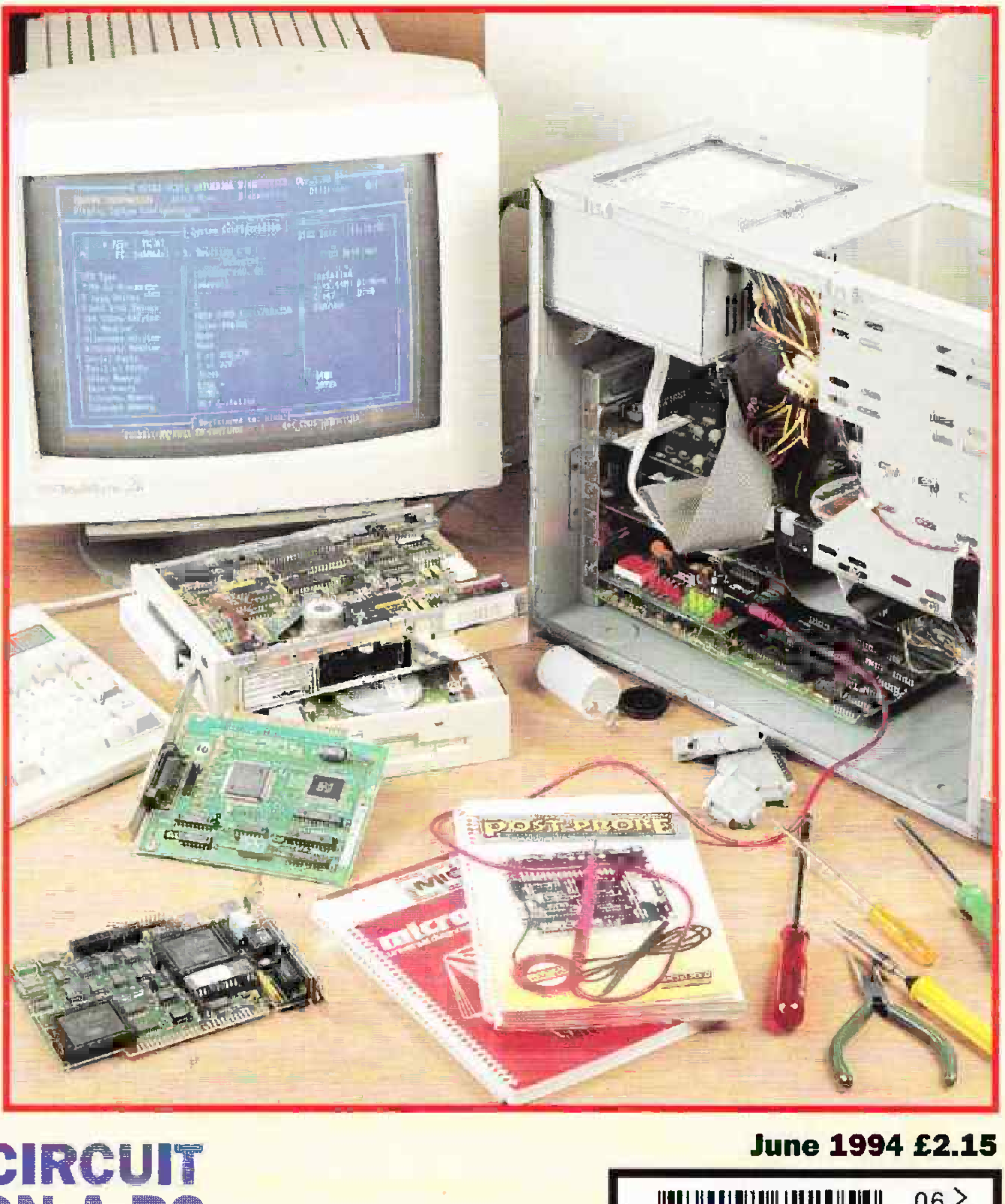
New Look Bumper Issue

OVER £300 OF PRIZES TO BE WON!

TOMORROW'S TECHNOLOGY TODAY

PC CLINIC

BUILDING, MAINTAINING, CHOOSING AND UPGRADING PCs



Construct a Midi bass pedal

Build a passive infra-red alarm

Sending data on a laser beam

Make an electronic cycle speedo

ELECTRONIC CIRCUIT SIMULATION ON A PC

AN INTRODUCTION TO MIDI

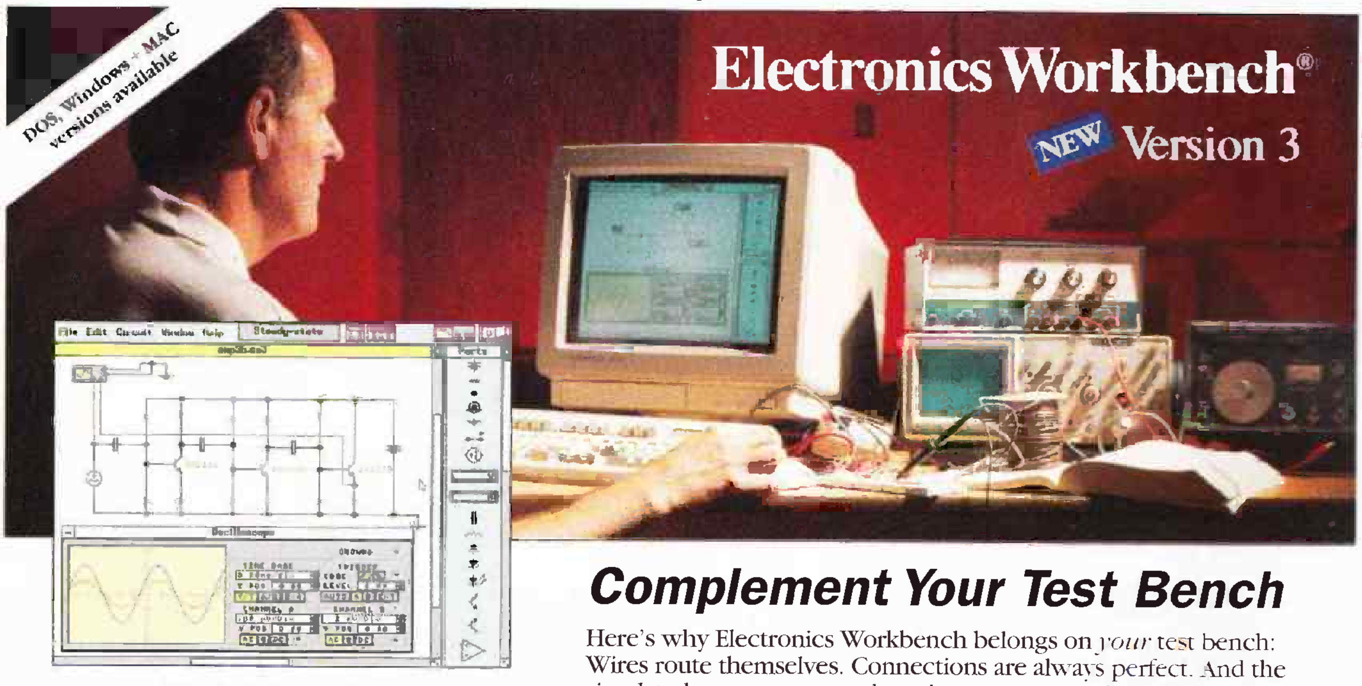
June 1994 £2.15

06

9 770142 722054

Argus SPECIALIST PUBLICATION BEST VALUE

Design and Verify Circuits. Fast.



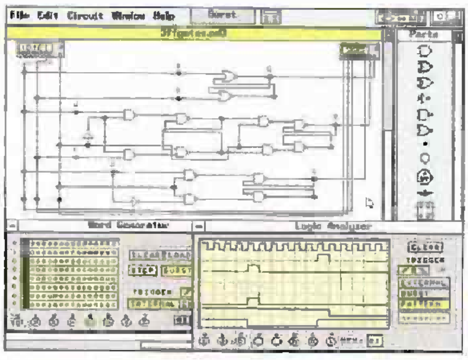
Complement Your Test Bench

Here's why Electronics Workbench belongs on *your* test bench: Wires route themselves. Connections are always perfect. And the simulated components and test instruments work just like the real thing. The instruments are indestructible and the parts bin holds an unlimited supply of each component. The result: thousands of electronics professionals and hobbyists save precious time and money. **Over 90% would recommend it to their friends and colleagues.** Electronics Workbench: the ideal, affordable tool to design and verify your analog and digital circuits before you breadboard.

And now the best is even better – Electronics Workbench Version 3.0 is here. It simulates more and bigger circuits, and sets the standard for ease of use. Guaranteed!

Analog Module includes:

- complete control over all component values
- ideal *and* real-world models for active components
- resistors, capacitors, inductors, transformers, relays, diodes, Zener diodes, LEDs, BJTs, opamps, bulbs, fuses, JFETs, and MOSFETs
- manual, time-delay, voltage-controlled and current-controlled switches
- independent, voltage-controlled and current-controlled sources
- multimeter
- function generator (1 Hz to 1 GHz)
- dual-trace oscilloscope (1 Hz to 1 GHz)
- Bode plotter (1 mHz to 10 GHz)
- SPICE simulation of transient and steady-state response

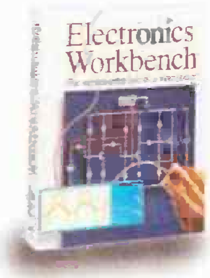


Digital Module includes:

- fast simulation of ideal components
- AND, OR, XOR, NOT, NAND and NOR gates
- RS, JK and D flip-flops
- LED probes, half-adders, switches and seven-segment displays
- word generator (16 eight-bit words)
- logic analyzer (eight-channel)
- logic converter (converts among gates, truth table and Boolean representations)

NEW Features in Version 3

- new components include JFETs, MOSFETs, voltage-controlled and current-controlled sources and manual, time-delay, voltage-controlled and current-controlled switches
- real-world models for opamps, BJTs, JFETs, MOSFETs and diodes – over 100 models available
- MS-DOS version now supports up to 16 MB of RAM for simulation of bigger circuits
- new Microsoft® Windows™ version available
- technical support now also available on CompuServe®



Just £199!

Electronics Workbench®

The electronics lab in a computer™

Call: (0203) 233216

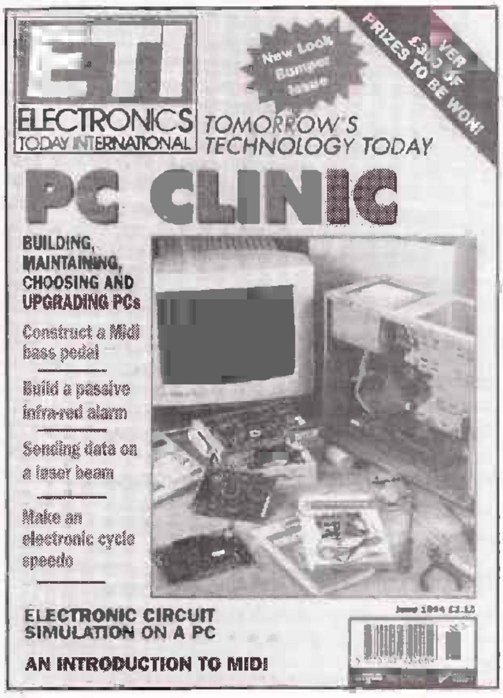
ROBINSON MARSHALL (EUROPE) LTD.
Nadella Building, Progress Close, Leofric Business Park,
Coventry CV3 2TF TEL: (0203) 233216 FAX: (0203) 233210

*30-day money-back guarantee

Shipping charges – UK £4.99. All prices are plus V.A.T.
All trademarks are the property of their respective owners.

INTERACTIVE

Contents



Volume 23 No.6

Features & Projects

Regulars

Competitions

In this issue of ETI, we have three great competitions for readers to enter.

Enter any one, or all three of them and test your luck and knowledge.

EXPRESS COMPONENTS

MAINS IONIZER KIT. Very useful kit that increases the flow of negative ions, helps clear cigarette smoke, dust, pollen etc. Helps reduce stress and respiratory problems. £15 kit, £20 built.

COMBINATION LOCK. Electronic 9 key combination lock suitable for alarms, cars, houses etc, easily programmable. Includes mains 2A relay o/p. 9v operation. £10 kit, £14 built.

VARIABLE POWER SUPPLY. Stabiized, short circuit protected. Gives 3-30v DC at 2.5A, ideal for workshop or laboratory. £14 kit, £18 built. 24VAC required.

LEAD ACID CHARGER. Two automatic charging rates (fast and slow), visual indication of battery state. Ideal for alarm systems, emergency lighting, battery projects etc. £12 kit, £16 built.

PHONE LINE RECORDER. Device that connects to the 'phone line and activates a cassette recorder when the handset is lifted. Ideal for recording 'phone conversations etc! £8 kit, £12 built.

ROBOT VOICE. Turns your voice into a robot voice! answer the phone with a different voice! £9 kit, £13 built.

PHONE BUG DETECTOR. This device will warn you if somebody is eavesdropping on your 'phone line. £6 kit £9 built.

PHONE BUG. Small bug powered by the telephone line. Only transmits when the phone is used. Popular surveillance product £8 kit, £12 built.

STROBE LIGHT. Bright strobe light with an adjustable frequency of 1-60hz. (a lot faster than conventional strobes!) £16 kit, £20 built.

4W FM TRANSMITTER 3 RF stages, audio preamp. 12-18vDC. Medium powered bug £20 kit, £28 built.

3 CHANNEL LIGHT CHASER. 3x 800w output, speed and direction controls, can be used with 12 led's (supplied) or TRIACS for mains lights (also supplied). 9-15v DC. £17 kit, £23 built.

25W FM TRANSMITTER. 4 stage, a preamp will be required. (Our preamp below is suitable) £79 built.(no kits)

SOUND EFFECTS GENERATOR. Produces any thing from bird chips to sirens! add sounds to all sorts of things £9 kit £13 built.

FM/AM SCANNER. Well not quite, you have to turn the knob yourself but you will hear things on this radio (even TV) that you would not hear on an ordinary radio! A receiver that covers 50-160MHZ both AM and FM. Built in 5w amplifier. £15 kit, £20 built.

CAR ALARM SYSTEM. Works on vibration and/or voltage drop from door etc being opened. Entry and exit delays plus adjustable alarm duration. Low cost protection! £12 kit, £16 built.

15W FM TRANSMITTER. 4 stage, high power bug. You will need a preamp for this (see our preamp below which is ok) £69 built (no kits).

1W FM TRANSMITTER. 2 stage including preamp and mic. Good general purpose bug. 8-30VDC. £12 kit, £16 built

50 I/C's for £1.50
Nice mix of chips at a bargain price!

CERAMIC CAPACITOR PACK
Good mixed pack of 100 capacitors for just £1.00

ELECTROLYTIC PACK 1
100 small mixed electrolytic capacitors just £1.00

ELECTROLYTIC PACK 2
50 larger electrolytic mixed capacitors

RESISTOR PACK NO 1
250 low wattage resistors, ideal for most projects etc. Just £1.00

RESISTOR PACK NO 2
Hi wattage pack, good selection of mixed wattages and values 50 in all, bargain price just £1.00

PRESET PACK
Nice selection of 25 mixed preset pots for just another £1!

RELAY PACK NO 1
6 mixed relays for £1, thats just 17p each.

CONNECTOR PACK
10 different connectors, again for £1

FUSE PACK NO 1
40 mixed 20mm fuses, ideal for repairs etc, or just to stock up the spares box! Just £1.00

FUSE PACK NO 2
30 mixed 1.25" fuses again ideal for spares etc. Just £1.00

WIRE PACK
25 Metres of insulated wire for just £1.00, good for projects etc.

SLEEVING PACK
100 assorted pieces of sleeving for connectors etc. Yours for just £1.00

DIODE PACK
100 assorted diodes for just £1.00

LED PACK
20 light emitting diodes for £1.00

TRANSISTOR PACK
50 mixed transistors, another bargain at £1.00

BUZZER PACK
10 things that make a noise for just £1.00!

POT PACK
10 pots for £1, (5 different types) a snip at £1.00

DISPLAYS
10 seven segment displays for £1.00

ORDER 10 PACKS OR MORE AND CHOOSE ONE FREE PACK!!

FREE COMPONENT CATALOGUE WITH EVERY ORDER!!

BULK PACKS

99p Post

KITS 'N MODULES

PREAMP MIXER. 3 channel input, independent level and tone controls. Ideal for use with the hi power FM transmitters. £15 kit, £19 built.

TREMBLER ALARM. Designed for bikes etc, adjustable sensitivity, preset alarm time, auto reset. Could be adapted for all sorts of "borrowable" things £12 kit, £16 built.

ULTRASONIC RADAR. A project that can be used as a movement detector in an enclosed space. Range about 10 metres, 12vDC. Good basis for car, shed, caravan alarm etc £14 kit, £19 built.

PHONE CALL RELAY. Very useful kit that incorporates a relay that operates when the phone rings. Can be used to operate more bells, signalling lights etc. Good for noisy enviroments or if you have your headphones on! £10 kit, £14 built.

PORTABLE ALARM SYSTEM. Small 9v alarm system based on a mercury switch. The alarm contitues to sound until disabled by the owner. Buzzer included. £11 kit £15 built.

800W MUSIC TO LIGHT EFFECT. Add rhythm to your music with this simple sound to light kit. £8 kit, £12 built.

MOSQUITO REPELLER. Modern way to keep the midges away! Runs for about a month on one 1.5v battery. Frequency is set to drive away mosquitos etc. £7 kit, £11 built.

3 CHANNEL SOUND TO LIGHT. Can be used anywhere as no connection is made to hi fi. Separate sensitivity controls for each channel, 1,200W powerhandling. Microphone included. £14 kit, £19 built.

MINI METAL DETECTOR. Detects pipes, wires etc up to 20cm deep. Useful before you drill those holes! £8 kit, £12 built.

0-5 MINUTE TIMER. Simple time switch adjustable from 0-5 mins, will switch 2A mains load. 12v op. Ideal for laboratory, photographic projects etc. £7 kit, £11 built.

7 WATT HI FI AMPLIFIER. Useful, powerful amplifier 20hz-15hz, 12-18vdc. Good for intercoms, audio systems, car etc. £7 kit £11 built.

INCAR SOUND TO LIGHT. Put some atmosphere in your car with this kit. Each channel has 6 led's that create a beautiful lighting effect! £10 kit, £14 built.

VOX SWITCH. This is a sound activated switch, ideal for use on transmitters, CB's, tape recorders etc. Adjustable sensitivity, built in delay. Mic input. £7 kit, £11 built.

LIQUID LEVEL DETECTOR. Useful item, can be used to detect fluid levels in watertanks, baths, ponds fishtanks etc. Could also be used as rain alarm with an easily constructed sensor. £5 kit, £9 built.

FM TRANSMITTER. Mini FM transmitter 2 transistor, comes with FET minature mic and is tuneable from 63 to 130MHZ. £7 kit, £11 built.

FUNCTION GENERATOR. Generates sinusoidal, saw tooth and square wavefoms from 20hz up to 20khz. Separate level controls for each waveform. 24vac. £15 kit, £20 built.

5 WATT SIREN. Powerful siren kit with an impressive 5 watts output. Ideal for alarms etc. £6 kit £10 built.

TELEPHONE AMPLIFIER. Very sensitive amplifier which using a 'phone pickup coil (supplied) will let you follow a telephone conversation without holding the handset to your ear! £11 kit £15 built.

SWITCH PACK
10 switches for just £1.00

12v FLOURESCENT. A useful kit that will enable you to light large flourescent tubes from your car battery etc. 9v mains transformer required. £8 kit, £12 built.

KNOB PACK
10 knobs for just £1.00

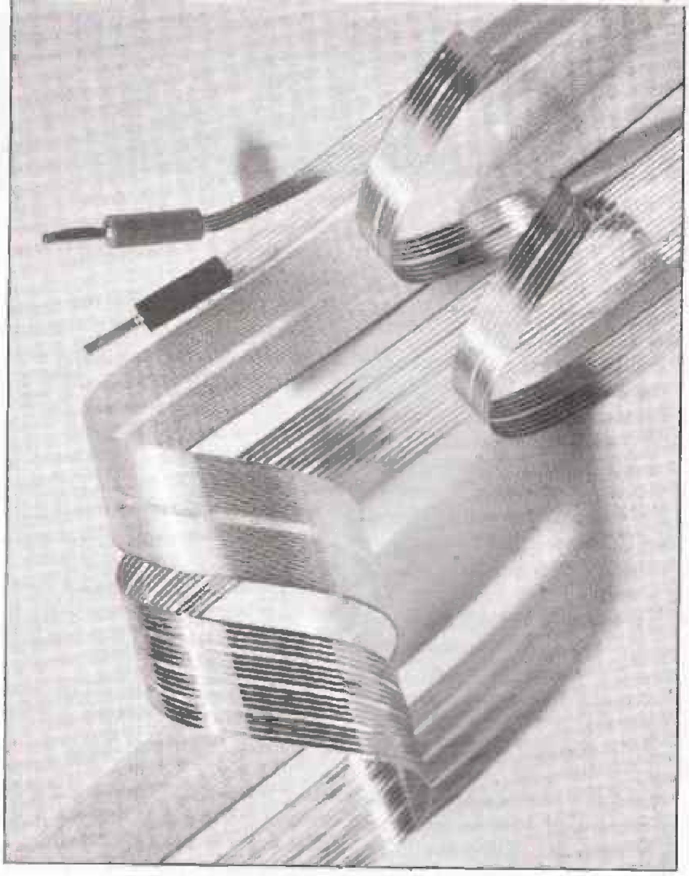
REMEMBER! YOUR FREE COPY OF OUR CUT PRICE COMPONENTS CATALOGUE SENT WITH EVERY ORDER!!!

How to place your order.........
By phone..........0273 771156
By FAX...........0273 206875
By Post...PO box 517 Hove Sussex BN3 5QZ

Payment by ACCESS, VISA, CHEQUE OR POSTAL ORDER.
Cheques and postal orders should be payable to Express Components.
ALL PRICES ARE SUBJECT TO 99p POST AND VAT. Some of our products may be unlicensable for use in the UK (particularly the FM transmitters.)

ETi News

Flatline speaker cable



The Chord Company of Salisbury is well known as a producer of high quality, no nonsense interconnection systems for use in home entertainment systems and hi-fi. It has now extended its range of products with a revolutionary flat cable called Flatline, which should prove very popular in a wide range of applications.

The cable was originally developed by NASA and is less than 1mm thick. It uses very high quality oxygen free copper strands surrounded in Teflon. This means that Flatline can be folded around corners, concealed under carpets, behind skirting board, or even under wallpaper.

Because of the high quality copper used, this is a 'low loss' cable which means that long runs do not compromise sound quality. It is available in three styles, Flatline Gold (£8.50 MT), Flatline Twin (£15.50 MT) and a silver stranded version called Blue Heaven (£58.50 MT)

For more information call the Chord Company on 0722 331674.

High temperature superconducting wire for motor

The first motor with rotating coils made from high temperature superconducting wire has been demonstrated by the Cleveland, Ohio based Reliance Electric Co. The alternating current motor, the superconducting coils of which rotate at 1800 rpm, puts out 5hp, a significant step beyond an earlier prototype that had stationary coils and an output power of 2hp. The 5hp motor has four racetrack shaped coils containing more than 670 metres of flexible copper oxide based wire that is superconducting at -196∞C (liquid nitrogen temperature).

The coils were supplied by American Superconducting Corp., Westborough, with support from the US Commerce Dept's Advanced Technology Programme. The 5hp motor is an engineering prototype for larger synchronous motors (1000 to 10,000hp) that may find use in industrial and electric utility applications.

Widespread use of such high temperature superconducting coils in large industrial motors, could potentially save large amounts of energy, because superconductors carry current with no losses due to resistance. Superconducting coils will also allow the use of smaller motors in industry.

Save Money with ETI and Bull Electrical Super Saver Card

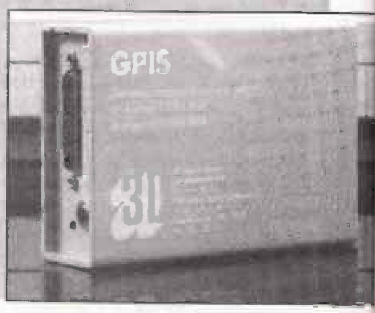
On the front cover of this issue of ETI you should find a special discount card which can be used to obtain a 10% discount on any items valued in total at £15 or more and purchased before 2nd of June 1994 from Bull Electrical of Hove, Sussex. See their ad on pages 4 and 5.

This card has a one time use only and to claim your discount, the card should be should be sent with your order. Please note that this saver card has no redeemable value and can not be used in conjunction with any other promotion by Bull Electrical. Neither can it be used to obtain a discount from ETI or any other company apart from Bull Electrical.

New general purpose interface system

From London based computer interface specialist 3D-Digital Design and Development Ltd, comes a new compact GPIS - General Purpose Interface System. This GPIS is designed for use in data acquisition and control and features a four channel, 16 bit ADC and a four channel, 12 bit DAC. Connection to the host computer is via the Printer Port.

The interactive menu driven software package, which is included with the unit, allows the user to perform a variety of tasks on both the input and output signals. These include sampling rate, logging rate, calibration, upper and lower limits and magnitude control (output) voltages.



The 3D GPIS is priced at £350 and more details can be obtained from 3D on 081 886 3668.

Desktop supercomputer

British company Parasys has launched a supercomputer capable of processing speeds in excess of 6400MIPs and 800MFLOPs peak performance, with upwards of 2Gb of RAM in a case that is little bigger than the average desktop PC and at a price which starts at just £17,400.

This is, in fact, a massively parallel architecture system based upon the INMOS Transputer and can have up to 32 T9000 processors, each with up to 64MB of EDC memory. Each of these Transputers has four high speed communications links which are connected to C104 switches in the backplane. The links run at 100Mbits per second in each direction and allow any processor to communicate directly with any other through the C104 switches.

The provision of multiple switches allows for multiple independent communications paths and gives the potential for redundancy in the network. Each network is inherently dead-lock free, ensuring maximum flexibility. A fifth card provides the interface to an external local area network, other Transputer systems or a SPARC host, or provides a Transputer based workstation environment for stand alone development.

For more information contact Parasys on 081 579 8683.

All silicon transistor gives 3V gain

The small US company, Nanodynamics Inc., has created an all silicon transistor in which a single electron can produce enough gain for 3V output at room temperature. At the same time, the company has designed a pocket sized X ray lithography system for the transistors that it says could be built for under $1 million.

According to its creator, the lithography system can squeeze billions of the company's so called nanotransistors on a chip with 0.1 micron design rules.

Raphael Tzu, who collaborated with Nobel Laureate Leo Esaki on the development of superlattice structures nearly 20 years ago, devised the transistor for Nanodynamics. Chia-Gee Wang, Nanodynamics' chief scientist, developed the X ray stepper. "The X-ray source by itself is worth pursuing. We have demonstrated a source that rivals synchrotron radiation in intensity and fits in a shirt pocket", Wang claimed.

Two other X-ray options are already being pursued for pushing design rules down to 0.1 micron. One uses large and expensive synchrotron radiation sources to produce hard X-rays, but synchrotrons are proving to be complex, power hungry and costly to develop and a production plant based on synchrotrons is projected to cost $2 billion.

Wang's alternative step and repeat process is intended for a cluster manufacturing approach and could operate below the 0.1 micron design rules. Rather than high-volume, linear manufacturing lines cranking out gigabit DRAMs, Wang envisages smaller production plants that could economically produce complex logic parts.

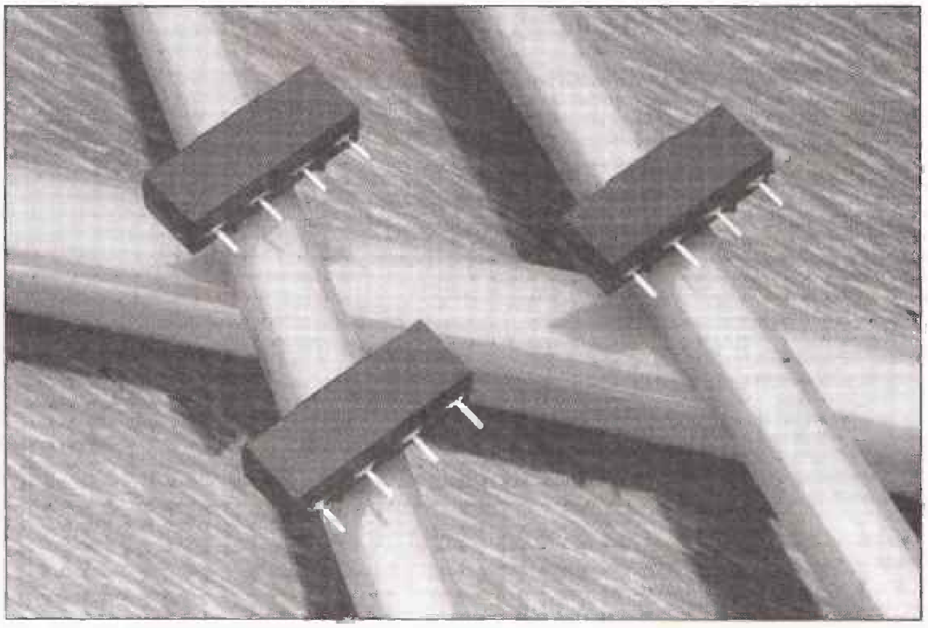
The nanotransistor itself, devised by Tzu at the University of North Carolina, is still in the research stage, although the basic effect has been demonstrated.

Tzu's latest work extends the quantum well structure to silicon materials, by building a new type of superlattice with silicon germanium and silicon dioxide layers. The fabrication breakthrough has been the ability to create a strained atomic layer of silicon dioxide molecules over a silicon germanium layer. While device researchers have discovered how to build quantum well devices in silicon germanium systems, the quantum confinement effect has been weak. Silicon dioxide forms a more effective barrier, which enhances quantum confinement in silicon.

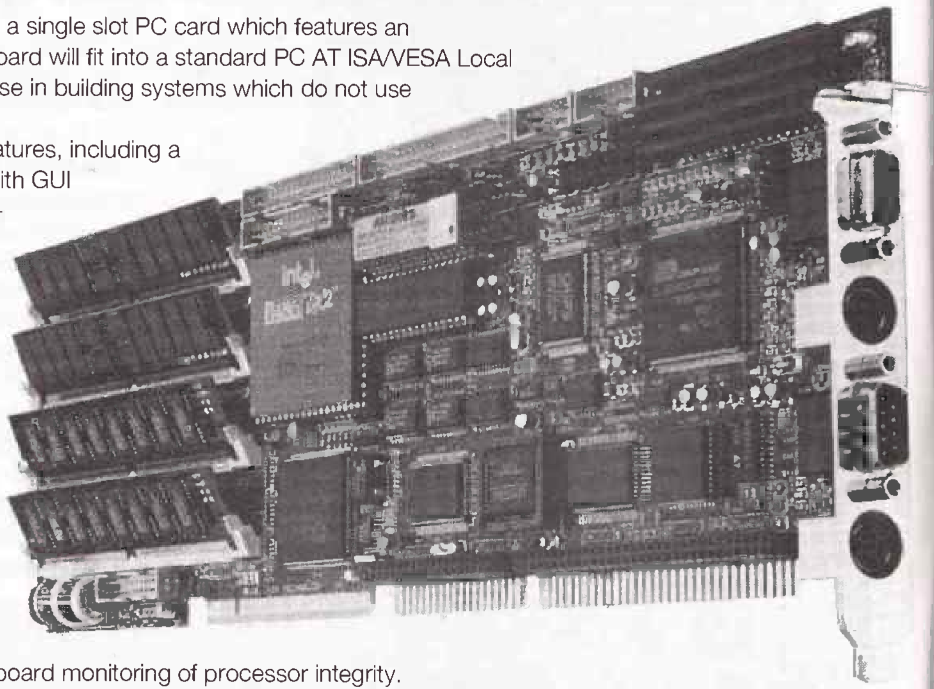
SIL relays from Astralux

A new line of SIL relays is being offered by Colchester based Astralux Dynamics. The relays offer high density in-line spacing, low profile for 0.5in board separation. Available in a standard 4-pin package, with normally open contact configuration, the relays feature high input/output isolation to all points, stable contact resistance and fast operate and release times. Maximum initial contact resistance is 150mohms, maximum switching is 100V DC, 0.5A, 10W, and the range offers coil voltages from 5 to 24V DC.

For more information contact Astralux Dynamics on 0206 302571.



Single slot processor card



Blue Chip Technology has just announced a single slot PC card which features an extremely high level of integration. The board will fit into a standard PC AT ISA/VESA Local Bus expansion slot and is designed for use in building systems which do not use a standard motherboard.

This board has a unique range of standard features, including a VESA local bus expansion slot, local bus video with GUI accelerator, on board solid state disk and peripheral support. Current processor options range from 486SX 25MHz to 486DX2 66MHz, plus a P24T Pentium version. Processor performance is enhanced by on-board memory to 64MB DRAM and 256KB cache. The GUI accelerator supports video resolutions up to 1280 x 1024 and comes with 1MB RAM, expandable to 2MB if required.

Other standard features include an AMI BIOS with embedded set-up utility, on board solid state disk up to 512KB SRAM and 1MB FLASH, 2 asynchronous 16550 serial ports with RS232 and RS485, 1 bi-directional parallel port, PS/2 mouse support, IDE and floppy controllers. A watchdog has also been included to provide on-board monitoring of processor integrity.

For more information contact Blue Chip Technology on 0244 520222.

Maplin device monitors time and temperature

New from Maplin is an attractive, compact thermometer and clock with an outdoor temperature probe. The device has a clear LCD display which can show the temperature in either Centigrade or Farenheit and the display alternates between time and temperature readings at three second intervals.

A small switch on the front of the unit selects either the indoor or outdoor temperature probe, which is attached to the module by 2m of white twin flex. Time settings and the C/F slide switch is on the back of the module.

The unit has a flip-out stand on the back for desk or table top use, or it can be wall mounted using the matching wall bracket (supplied). The unit is finished in light grey.

It uses a single G-13 type 1.55V battery and measures just 68 x 52 x 16mm. It costs just £9.95 and is available from any Maplin shop or by mail order. The Maplin sales office can be contacted by ringing 0702 554161.

Competition

Win a super Maplin digital thermometer and clock - we are giving away ten of them!
Answer the following three simple questions (the answers are all somewhere in this issue of ETI) and you could be the owner of one of these compact and useful little devices which are currently on sale in all Maplin shops, at £9.95 each.

1 What polymer is used to make nanowires?
a) poly (3-meythylthionyl)
b) poly (3-benzylthiophene)
c) poly.(3-methylthiophene)

2 What is the temperature of liquid nitrogen?
a) -212 C
b) -196 C
c) -193 C

3 What is the standard speed of the ISA bus?
a) 4MHz
b) 8MHz
c) 20MHz

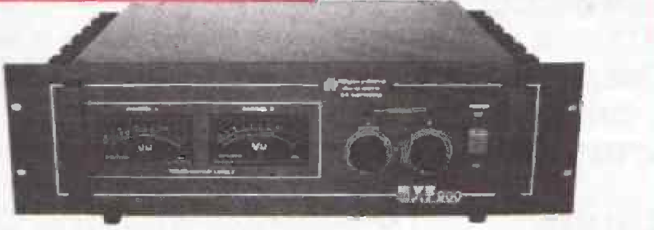
Write your answers clearly in block capitals on a postcard in the form of question number followed by your selection from the multiple choices. Don't forget to put your name and address on the postcard, also in block capitals.
All entries should be received by June 30th 1994 when a draw will be made from all replies with correct answers and the ten winners selected.
Entries should be addressed to Maplin Competition, ETI, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST.
THe competition is open to all UK residents other than employess or their families of ASP and Maplin. The prizes are as stated and theres is no cash alternative. The editor's decision is final and no correspondence can be entered into.

POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E. 60p STAMPED FOR CATALOGUE ★

OMP MOS-FET POWER AMPLIFIERS HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS



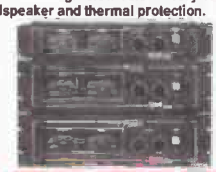
THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

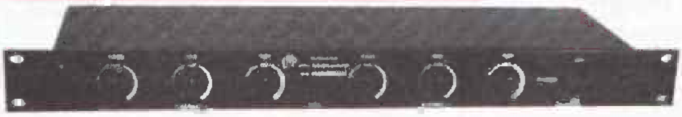


SIZES:- MXF200 W19"xH3½" (2U)xD11"
MXF400 W19"xH5¼" (3U)xD12"
MXF600 W19"xH5¼" (3U)xD13"
MXF900 W19"xH5¼" (3U)xD14¾"

PRICES:-MXF200 £175.00 MXF400 £233.85 MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

OMP XO3 STEREO 3-WAY ACTIVE CROSS-OVER

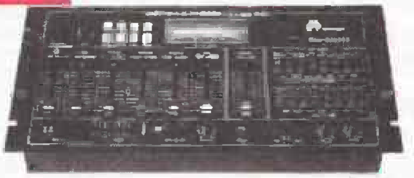


Advanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: bass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches on each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

Price £117.44 + £5.00 P&P

STEREO DISCO MIXER SDJ3400SE ★ ECHO & SOUND EFFECTS★

STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. **MANY OUTSTANDING FEATURES:-** including Echo with repeat & speed control, DJ Mic with talk-over switch, 6 Channels with individual faders plus cross fade, Cue Headphone Monitor. 8 Sound Effects. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.

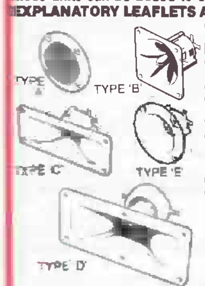


Price £144.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. **FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.

TYPE 'B' (KSN1005A) 3½" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.

TYPE 'C' (KSN1016A) 2"x5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.

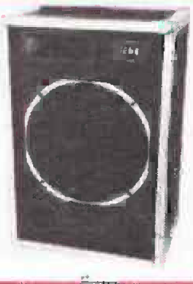
TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.

LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.

ibl FLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands.



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

ibl FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR
ibl FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

IN-CAR STEREO BOOSTER AMPS

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

PRICES: 150W £49.99 250W £99.99 400W £109.95 P&P £2.00 EACH

OMP MOS-FET POWER AMPLIFIER MODULES SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.

McKenzie and Fane Loudspeakers are also available.

EMINENCE:- INSTRUMENTS, P.A., DISCO, ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE

8" 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. PRICE £32.71 + £2.00 P&P

10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. PRICE £33.74 + £2.50 P&P

10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID.
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. PRICE £43.47 + £2.50 P&P

12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR.
RES.FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. PRICE £35.64 + £3.50 P&P

12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. PRICE £36.67 + £3.50 P&P

12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID.
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. PRICE £46.71 + £3.50 P&P

12" 300 WATT R.M.S ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC.
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. PRICE £70.19 + £3.50 P&P

15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR.
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £50.72 + £4.00 P&P

15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR.
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. PRICE £73.34 + £4.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8" 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P

10" 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P

10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P

12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P

6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P

8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P

10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

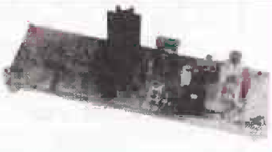


PHOTO: 3W FM TRANSMITTER

POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

BARCLAYCARD VISA

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243

VIEWDATA RETURNS £6 made by Tandata, includes 1200 75 modem, k/bd, RGB and comp o/p, printer port No PSU £6 MAG6P7
IBM PC CASE AND PSU Ideal base for building your own PC Ex equipment but OK £14 00 each REF: MAG14P2
SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor Superb value kit just £5 99 REF: MAG6P8
SOLID STATE RELAYS Will switch 25A mains Input 3 5-26v DC 57x43x21mm with terminal screws £3.99 REF MAG4P10
300DPI A4 DTP MONITOR Brand new, TTL/ECL inputs, 15" landscape, 1200x1664 pixel complete with circuit diag to help you interface with your projects JUST £24 99 REF MAG25P1
ULTRAMINI BUG MIC 6mmx3 5mm made by AKG, 5-12v electret condenser Cost £12 ea, Our? four for £9 99 REF MAG10P2
RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition Back anodised metal case £99 each REF MAG99P1
GX4000 GAMES MACHINES returns so ok for spares or repair £9 each (no games) REF MAG9P1
C64 COMPUTERS Returns, so ok for spares etc £9 ref MAG9P2
FUSELAGE LIGHTS 3 foot by 4" panel 1/8" thick with 3 panels that glow green when a voltage is applied Good for night lights, front panels, signs, disco etc 50-100v per strip £25 ref MAG25P2
ANSWER PHONES Returns with 2 faults, we give you the bits for 1 fault, you have to find the other yourself. BT Response 200's £18 ea REF MAG18P1, BT Response 400's £25 ea REF MAG25P3 Suitable power supply £5 REF MAG5P12
SWITCHED MODE PSU ex equip, 60w +5v @5A, -5v@ 5A, +12v@2A,-12v@ 5A 120/220v cased 245x88x55mm IEC input socket £6 99 REF MAG7P1
PLUG IN PSU 9V 200mA DC £2 99 each REF MAG3P9
PLUG IN ACORN PSU 19v AC 14w, £2 99 REF MAG3P10
POWER SUPPLY fully cased with mains and o/p leads 17v DC 900mA output Bargain price £5 99 ref MAG6P9
ACORN ARCHIMEDES PSU +5v @ 4 4A on/off sw uncased, selectable mains input, 145x100x45mm £7 REF MAG7P2
GEIGER COUNTER KIT Low cost professional twin tube, complete with PCB and components £29 REF MAG29P1
SINCLAIR C5 13" wheels complete with tube, tyre and cycle style bearing £6 ea REF MAG6P10
AA NICAD PACK encapsulated pack of 8 AA nicad batteries (tagged) ex equip, 55x32x32mm £3 a pack REF MAG3P11
13.8V 1.9A psu cased with leads Just £9 99 REF MAG10P3
360K 5.25 brand new half height floppy drives IBM compatible industry standard Just £6.99 REF MAG7P3
PPC MODEM CARDS These are high spec plug in cards made for the Amstrad laptop computers 2400 baud dial up unit complete with leads Clearance price is £5 REF: MAG5P1
INFRA RED REMOTE CONTROLLERS Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects Our clearance price is just £2 REF: MAG2
TOWERS INTERNATIONAL TRANSISTOR GUIDE. A very useful book for finding equivalent transistors, leadouts, specs etc £20 REF: MAG20P1
SINCLAIR C5 MOTORS We have a few left without gearboxes These are 12v DC 3,300 rpm 6"x4", 1/4" OP shaft £25 REF: MAG25
UNIVERSAL SPEED CONTROLLER KIT Designed by us for the above motor but suitable for any 12v motor up to 30A Complete with PCB etc. A heat sink may be required £17.00 REF: MAG17
VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op Price is £15 REF: MAG15 12v psu is £5 extra REF: MAG5P2
***FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels Reqs PP3 9v battery Tuneable to any FM receiver Price is £15 REF: MAG15P1
LOW COST WALKIE TALKIES Pair of battery operated units with a range of about 200' Ideal for garden use or as an educational toy Price is £8 a pair REF: MAG 8P1 2 x PP3 req'd
***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range of up to 2 kilometres in open country Units measure 22x52x155mm Complete with cases and earpieces 2xPP3 req'd, £30.00 pair REF: MAG30.
COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video 12v DC £8.00 REF: MAG8P2.
LQ3500 PRINTER ASSEMBLIES Made by Amstrad they are entire mechanical printer assemblies including printhead, stepper motors etc etc In fact everything bar the case and electronics, a good stripper! £5 REF: MAG5P3 or 2 for £8 REF: MAG8P3
SPEAKER WIRE Brown 2 core 100 foot hank £2 REF: MAG2P1
LED PACK of 100 standard red 5m leds £5 REF MAG5P4
JUG KETTLE ELEMENT good general purpose heating element (about 2kw) ideal for heating projects 2 for £3 REF: MAG3
UNIVERSAL PC POWER SUPPLY complete with flyleads, switch, fan etc Two types available 150w at £15 REF:MAG15P2 (23x23x23mm) and 200w at £20 REF: MAG20P3 (23x23x23mm)
***FM TRANSMITTER** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £26 REF: MAG26 Transmits to any FM radio
***FM BUG KIT** New design with PCB embedded coil for extra stability Works to any FM radio 9v battery req'd. £5 REF: MAG5P5
***FM BUG BUILT AND TESTED** superior design to kit Supplied to detective agencies 9v battery req'd £14 REF: MAG14
TALKING COINBOX STRIPPER originally made to retail at £79 each, these units are designed to convert and ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges However they can be adapted for their original use or used for something else?? Price is just £3 REF: MAG3P1
100 WATT MOSFET PAIR Same spec as 2SK343 and 2SJ413 (8A,140v,100w) 1 N channel, 1 P channel, £3 a pair REF: MAG3P2
VELCRO 1 metre length of each side 20mm wide (quick way of fixing for temporary jobs etc) £2 REF: MAG2P3
MAGNETIC AGITATORS Consisting of a cased mains motor with lead The motor has two magnets fixed to a rotor that spin round inside There are also 2 plastic covered magnets supplied Made for remotely stirring liquids! you may have a use? £3 each REF: MAG3P3

BULL'S BULLETIN BOARD

100MHZ DUAL TRACE OSCILLOSCOPES
JUST £259
RING FOR DETAILS

MASSIVE
WAREHOUSE CLEARANCE
FANTASTIC £20.00 REDUCTION

REFURBISHED PC BASE UNITS
COMPLETE WITH KEYBOARD

FROM ONLY **£29.00**

AMSTRAD 1512 BASE UNITS
GUARANTEED
PERFECT WORKING ORDER.

A LOW COST INTRODUCTION TO THE HOME COMPUTER MARKET.

AMSTRAD 1512SD
1512 BASE UNIT, 5.25" FLOPPY DRIVE AND KEYBOARD. ALL YOU NEED IS A MONITOR AND POWER SUPPLY. WAS £49.00
NOW ONLY **£29.00**
REF: MAG29

AMSTRAD 1512DD
1512 BASE UNIT AND KEYBOARD AND TWO 5.25" 360K DRIVES . ALL YOU NEED IS A MONITOR AND POWER SUPPLY WAS £59.00
NOW ONLY **£39.00**
REF: MAG39

SOLAR POWER PANELS
3FT X 1FT 10WATT GLASS PANELS
14.5v/700mA
NOW AVAILABLE BY MAIL ORDER
£33.95
(PLUS £2.00 SPECIAL PACKAGING CHARGE)

TOP QUALITY **AMORPHOUS SILICON CELLS** HAVE ALMOST A TIMELESS LIFESPAN WITH AN INFINITE NUMBER OF POSSIBLE APPLICATIONS, SOME OF WHICH MAY BE CAR BATTERY CHARGING, FOR USE ON BOATS OR CARAVANS, OR ANYWHERE A PORTABLE 12V SUPPLY IS REQUIRED. **REF: MAG34**

FREE SOFTWARE!
Brand new, UNUSED top quality *Famous brand* licensed software discs. Available in 5.25" DSDD or 5.25' HD only. You buy the disk and it comes with free BRAND NEW UNUSED SOFTWARE. We are actually selling you the floppy disc for your own **"MEGA CHEAP" storage facilities,** if you happen to get software that you want/need/like as well........ you get a "MEGA BARGAIN" too!
DSDD PKT10 £2.99 REF: MAG3P7 PKT100 £16.00 REF: MAG16

££££££WE BUY SURPLUS STOCK££££££££
TURN YOUR SURPLUS STOCK INTO CASH
IMMEDIATE SETTLEMENT WE WILL ALSO QUOTE FOR COMPLETE FACTORY CLEARANCE

1994 CATALOGUE.
PLEASE SEND 45P , A4 SIZED SAE FOR YOUR FREE COPY.
MINIMUM GOODS ORDER £5.00 TRADE ORDERS FROM GOVERNMENT, SCHOOLS, UNIVERSITIES, & LOCAL AUTHORITIES WELCOME. ALL GOODS SUPPLIED SUBJECT TO OUR CONDITIONS OF SALE AND UNLESS OTHERWISE STATED GUARANTEED FOR 30 DAYS RIGHTS RESERVED TO CHANGE PRICES & SPECIFICATIONS WITHOUT PRIOR NOTICE ORDERS SUBJECT TO STOCK. QUOTATIONS WILLINGLY GIVEN FOR QUANTITIES HIGHER THAN THOSE STATED

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL
250 PORTLAND ROAD HOVE SUSSEX BN3 5QT
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
TELEPHONE ORDERS WELCOME
TEL: 0273 203500
FAX: 0273 323077

TOP QUALITY SPEAKERS Made for HI FI televisions these are 10 watt 4R Jap made 4" round with large shielded magnets. Good quality general purpose speaker. £2 each REF: MAG2P4 or 4 for £6 REF: MAG6P2
TWEETERS 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 REF: MAG2P5 or 4 for £3 REF: MAG3P4
AT KEYBOARDS Made by Apricot these quality keyboards need just a small modification to run on any AT, they work perfectly but you will have to put up with 1 or 2 foreign keycaps! Price £6 REF: MAG6P3
XT KEYBOARDS Mixed types, some returns, some good, some foreign etc but all good for spares! Price is £2 each REF: MAG2P6 or 4 for £6 REF: MAG6P4
PC CASES Again mixed types so you take a chance next one off the pile £12 REF: MAG12 or two the same for £20 REF: MAG20P4
COMMODORE MICRODRIVE SYSTEM mini storage device for C64's 4 times faster than disc drives, 10 times faster than tapes Complete unit just £12 REF: MAG12P1
SCHOOL STRIPPERS We have quite a few of the above units which are 'returns' as they are quite comprehensive units they could be used for other projects etc Let us know how many you need at just 50p a unit (minimum 10).
HEADPHONES 15P These are ex Virgin Atlantic You can have 8 pairs for £2 REF: MAG2P8
PROXIMITY SENSORS These are small PCB's with what look like a source and sensor LED on one end and lots of components on the rest of the PCB. Complete with fly leads. Pack of 5 £3 REF: MAG: 3P5 or 20 for £8 REF: MAG8P4
SNOOPERS EAR? Original made to clip over the earpiece of telephone to amplify the sound-it also works quite well on the cable running along the wall! Price is £5 REF: MAG5P7
DOS PACKS Microsoft version 3 3 or higher complete with all manuals or price just £5 REF: MAG5P8 Worth it just for the very comprehensive manual! 5.25" only.
DOS PACK Microsoft version 5 Original software but no manuals hence only £3 REF: MAG3P6 5 25" only
FOREIGN DOS 3 3-German, French, italian etc £2 a pack with manual 5 25" only REF:MAG2P9
CTM644 COLOUR MONITOR Made to work with the CPC464 home computer Standard RGB input so will work with other machines Refurbished £59 00 REF:MAG59
PIR DETECTOR Made by famous UK alarm manufacturer these are hi spec, long range internal units 12v operation Slight marks on case and unboxed (although brand new) £8 REF: MAG8P5
WINDUP SOLAR POWERED RADIO AM/FM radio complete with hand charger and solar panel! £14 REF: MAG14P1
COMMODORE 64 TAPE DRIVES Customer returns at £4 REF: MAG4P9 Fully tested and working units are £12 REF: MAG12P5
COMPUTER TERMINALS complete with screen, keyboard and RS232 input/output Ex equipment Price is £27 REF: MAG27
MAINS CABLES These are 2 core standard black 2 metre mains cables fitted with a 13A plug on one end, cable the other. Ideal for projects, low cost manufacturing etc. Pack of 10 for £3 REF: MAG3P8 Pack of 100 £20 REF: MAG20P5
SURFACE MOUNT STRIPPER Originally made as some form of high frequency amplifier (main chip is a TSA5511T 1 3GHz synthasiser) but good stripper value, an excellent way to play with surface mount components £1.00 REF: MAG1P1.
MICROWAVE TIMER Electronic timer with relay output suitable to make enlarger timer etc £4 REF: MAG4P4
MOBILE CAR PHONE £5.99 Well almost! complete in car phone excluding the box of electronics normally hidden under seat Can be made to illuminate with 12v also has built in light sensor so display only illuminates when dark. Totally convincing! REF: MAG6P6
ALARM BEACONS Zenon strobe made to mount on an external bell box but could be used for caravans etc 12v operation Just connect up and it flashes regularly) £5 REF: MAG5P11
FIRE ALARM CONTROL PANEL High quality metal cased alarm panel 350x165x80mm With key Comes with electronics but no information sale price 7 99 REF: MAG8P6
SUPER SIZE HEATSINK Superb quality aluminium heatsink 365 x 183 x 61mm, 15 fins enable high heat dissipation No holes! sale price £5 99 REF: MAG6P11
REMOTE CONTROL PCB These are receiver boards for garage door opening systems You may have another use? £4 ea REF: MAG4P5
6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA Bargain price just £5 99 ea REF MAG6P12
FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1
LOPTX Line output transformers believed to be for hi res colour monitors but useful for getting high voltages from low ones! £2 each REF: MAG2P12 bumper pack of 10 for £12 REF: MAG12P3

SHOP OPEN 9-5.30 SIX DAYS A WEEK

PORTABLE RADIATION DETECTOR
£49.99
A Hand held personal Gamma and X Ray detector. This unit contains two Geiger Tubes, has a 4 digit LCD display with a Piezo speaker, giving an audio visual indication. The unit detects high energy electromagnetic quanta with an energy from 30K eV to over 1.2M eV and a measuring range of 5-9999 UR/h or 10-99990 Nr/h. Supplied complete with handbook.
REF: MAG50

Circuit simulation on PC

With a fast modern PC it is now possible to simulate the behaviour of any linear or digital circuit, an invaluable aid for anyone interested in electronics, from the student to the designer. In this article we take a look at how it is done

When we think of personal computers, we all too often tend to think of them as being used for word-processing, for data bases or computer aided design We tend to forget that a computer is a general purpose machine, which can be used to emulate the behaviour of any other machine or mathematically describable system. The system being modelled could range from a simple bouncing rubber ball to the global weather system, or even the circuit of the processor performing the emulation.

Let's looks at a simple system, such as a bouncing rubber ball, a system where the height of the ball from the ground can, given a knowledge of the nature of the ball and the ground on which it is bouncing, be calculated with considerable precision for any given time. For a computer to do this, it is simply a matter of repeating a mathematical calculation over a successive number of small time periods, with the result of each calculation being used as the input for the next calculation. The result is a linear sequence of position calculations plotted against time. It is a simple system, because there is only a need for one set of calculations per time period.

We can also use a computer to emulate the behaviour of a complex system, where a great many identical calculations are performed in any one time period. This could be a complex system, such as the combustion of fuel in an engine, or a model of the flow of heat generated by the components on a printed circuit board. In order to model such system, what the computer does is divide the system up into a large number of small cells. Thus the three dimensional space that forms the combustion chamber would be divided into a large number of small three dimensional spaces, the physical state of each being defined by a mathematical equation. Each small space has the same identical equation but with perhaps different input parameters to define initial temperature, closeness to chamber walls, etc.

In order to simulate the system, the computer will need to perform that calculation for all of those small spaces within the system. But these thousands of different calculations are all part of a large system and the result of the calculation for one small space will affect the future calculations for that space and also for all neighbouring spaces. In this way, a change in input variables, such as a change in temperature, in one part of the system will ripple through the system until it has affected every part.

It is this type of computer modelling of a complex dynamic system that has revolutionised areas as diverse as weather forecasting and designing supersonic aircraft. But as electronics engineers, we are primarily interested in using the computer to simulate a complex dynamic system where it is not possible to simply divide the system up into a large number of small but otherwise identical units. We want to be able to model a system where every unit is different and where the linkage between units is not necessarily a simple positional one.

This is not an easy computational task, but one which has become enormously important to the electronics industry. Indeed, it would be fair to say that without sophisticated computer simulation we would have very few of the electronics devices which are common-place today. Consider the Pentium processor found in the most powerful PCs. It is a huge chip onto which is crammed an enormously complex circuit with over 3,100,000 transistors, designed and built with the aid of highly sophisticated simulation software. Can you imaging someone trying to breadboard a design with that number of components?

Computer simulation of both digital and linear circuits lies at the very heart of modern electronics. Without it, engineers could not handle the complexity of today's designs.

From small beginnings

If we look at any electronic circuit then we discover that we can define it, in cybernetic terms, as being a 'black box' - a determinate system which exhibits a behaviour that can be expressed as a mathematical equation. Indeed, any circuit can be defined as a mathematical function, even one which produces a random output.

The problem with this approach is that the more complex the circuit, the more complex the mathematical equation. Furthermore, every different circuit will require its own specific mathematical equation to model its behaviour and any change to it will necessitate the creation of a new equation. These are all factors which make the use of a single equation to model a whole circuit somewhat impractical.

The solution is to break the circuit up into its constituent components and use relatively simple mathematical equations to model each component. The way that the components are wired up then determines the interaction between them and therefore the behaviour of the entire circuit. This approach makes it possible for the user to easily build, emulate and, if necessary, alter a computational model of any electronic circuit, using a collection of predefined component models, where each component model is a mathematical formula for that specific component.

If we look at the simplest forms of circuit we find that there are very few basic component types. In a passive linear circuit there are resistors, capacitors and inductors and the variables we are measuring consist of voltage and current with respect to time. We can define each of these three basic components as a formula that involves the voltage and current variables and their change with respect to time.

A simulated circuit thus consists of a number of such components joined together and the point where one component joins another is referred to as a 'node'. The circuit solution calculates the voltage at each node in the circuit and each branch joining two nodes will have a current flowing through it. Note that variables like frequency are simply a relationship between voltage change and time.

From these three basic component types we can build more complex components. Thus, a switch can be modelled as a simple circuit consisting of two resistors, an infinitely large 'off' resistance and a very low 'on' resistance. If we wanted to turn it into a relay, we would simply add an inductor to our 'relay' circuit to model the energising coil. Of course, before we actually use this, or any other, component model we have to ensure that the actual resistance, inductance and capacitance values used correspond to those specified by the manufacturer of the device.

This same approach is used to build models of active devices, such as transistors, diodes, operational amplifiers, MOSFETs, JFETs, BJTs, etc. However, in most commercial electronic circuit simulation software it is unnecessary for the user to build such models, since they use component models based upon industry standard SPICE algorithms. SPICE is an acronym for Simulation Program with Integrated Circuit Emphasis, a general purpose circuit simulation program developed at the University of California, Berkeley. Nearly all the current generation of linear circuit analysis programs are descended from SPICE.

What about digital circuits?

Digital circuit simulation is a lot simpler, since all we are interested in is logic states rather than voltages and current. This means that we can represent any component in a digital circuit as a simple truth table, rather than as a complex mathematical formula. However, in most other respects digital and linear circuit simulation is much the same.

There are just four fundamental types of component which can be used to build any digital circuit - AND gates, OR gates, Exclusive OR gates, and Inverters, or NOT gates. To this list we need to add buffers which ensure that pulses have the correct signal strength and pulse shape. In theory, one could build a computational model of any digital circuit, even a Pentium processor chip. In fact most, digital integrated circuits are actually built from these simple logic gates, a typical example of which is the field programmable logic arrays that are now so frequently used to replace discrete logic in many commercial products.

However, as with linear circuit simulation, the devices available to the user of a digital circuit simulation program are much more comprehensive than just a few gates. In a full blown simulation system, one will find libraries of nearly all the 74LS and 4000 series integrated circuit families, as well as some more complex ones such as memory chips, although I have yet to see a digital circuit simulation program which includes a model for any of the processor chips. These libraries of integrated circuits are in essence just truth tables, but in the more sophisticated programs they will also take account of propagation delays, thereby helping to ensure that timing for the design is correct

Practical computer simulation of electronic circuits

As I have already stated, there are a large number of commercial circuit simulation programs on the market today. By far the largest number of these run on the PC and compatibles. However, before dashing out and buying any one of these programs, it is worth remembering that they are all computationally very intensive and require a lot of semiconductor memory. The bigger and more complex the circuit, the worse the problem.

If you have a 286 with 640K of RAM you will be able to run quite a few of the simulation packages, but you will only be able to model small circuits with a half dozen or so components. In practice the minimum size machine for this sort of application is a 25MHz 386 with 1MB of RAM and an EGA display, better still is a 66MHz 486DX with SVGA and 8MB of RAM!

As far as the range of programs available, one cannot go far wrong with SPICE compatible packages. In this article we are including short reviews of four widely available packages, although we are not necessarily saying that these are the best. In many ways, the choice is very much a matter of personal preference and need.

Computer simulation as an educational tool

One of the most important benefits to be gained from using computer simulation of electronic circuits is as an educational tool. With a simulated circuit, it is possible to easily see how a particular design works and the student can see how voltages and waveforms change at each node and how changing component values will change these measurements. All a lot easier than breadboarding and without the risk of damaging expensive components (schools' component budgets are often as little as £2 per student, per term).

Of course the kind of simulation program used in an educational role will be different from that used in a more orthodox design capacity. For a start, it will need to have a highly graphical user interface which is easy to use and as intuitive as possible. It will also need to be highly integrated with full schematics layout incorporated as part of the simulation program. In addition it will need virtual instrumentation to enable the user to measure and view what is happening in the simulated circuit.

A typical example of this type of educationally oriented simulation software is Electronics Workbench. For more details on this product, see the accompanying review and if you would like a copy, why not enter our competition at the end of this article and win yourself a copy?

Computer simulation as a design tool

In the design environment, the great advantage of computerised circuit simulation is that it allows the circuit, or parts of it, to be tested prior to the breadboarding stage. This can substantially speed up the design process, since all the major design errors can be pinpointed at a much earlier stage. It is far easier and quicker to change a computer model than it is to change an actual circuit.

Many commercial computer simulation packages are now being produced as part of an integrated suite of design programs running from schematic layout through to PCB design. In many cases, it is possible to cut out the traditional breadboarding stage and move directly from the computer simulated design to a prototype PCB.

Of course, it must always be remembered that software simulation, particularly of linear circuits, requires certain compromises. The algorithms used to model a particular component may be very good, but they may not exactly model that component. This means that one always has to go through the hardware prototyping stage in order to verify that actual performance matches the performance predicted by the simulation.

Into the future

As I have already stated, the use of computers to simulate the behaviour of both digital and linear circuits is of enormous importance to the electronics industry of today. This type of software has enabled designers to tackle tasks of greater and greater complexity. The type of program we have looked at in this article is relatively simple, when compared to that employed by the designers of complex integrated circuits and it is probably true to say that the future of electronics depends to a large degree on the development of computerised design tools of ever greater sophistication.

Already, design and simulation programs are being written which incorporate intelligence. These types will automatically perform a lot of low level design tasks and allow the designer to define the function and behaviour of a circuit at a much higher level than is possible today. It is with tools like these that the next generations of electronic devices will be created.

For the electronics engineer, whether amateur or professional, the availability of low cost circuit simulation and analysis software, particularly where it is integrated with schematics capture and PCB design, brings with it a great boost in productivity. A design can now be completely tested and debugged in a matter of hours rather than days or weeks. Breadboarding can be virtually eliminated, as well as the need for expensive test equipment. By eliminating a lot of the tedious and frustrating aspects of circuit design, such software can free the designer to be more creative, surely a good thing!

Further reading...

For more information about linear circuit analysis with a computer, a good starting point is a recently published book by Ian Sinclair, entitled 'PC Assisted Linear Circuit Analysis and Drawing', published by Newnes, ISBN 0 7506 1662 8

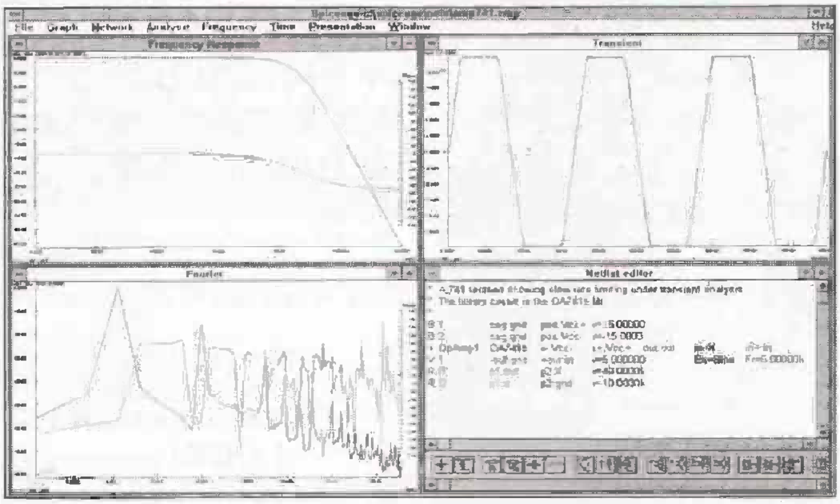
Electronics Workbench

This is a powerful and highly graphical software tool which allows the user to build and test simulated analogue and digital circuits with the aid of a range of virtual instruments. In fact, it is really two separate programs, one for digital circuits and one for linear circuits, both very easy to use and making full use of Windows, or a Windows type display. Circuits can easily be built using the mouse to obtain parts from a parts bin and then wire them up to other components, each component being assigned its own values.

The analogue module has a library of SPICE compatible models that includes resistors, capacitors, inductors, transformers, diodes, Zener diodes, LEDs, BJTs, bulbs, fuses, JFETs, MOSFETs and switches. The library has both ideal and real world models and both AC and DC voltage and current sources are available. There is also a function generator for square, triangular, and sinusoidal waves.

Linear circuits can make use of a number of virtual instruments (activated by clicking on an icon and then connecting up to the circuit using the mouse). These instruments include a multimeter, ammeter and voltmeter, a dual trace oscilloscope and a Bode plotter. Transient and steady state analyses can also be performed on a circuit.

The digital module allows the simulation of ideal logic and has a library of AND, OR,



SpiceAge

SpiceAge is a high power linear circuit simulation and analysis program which is available in versions which will run under Windows and under DOS. This is a full SPICE compatible program and comes with an extensive library of models including transistors, op-amps, thyristors, triacs, diodes, bridge rectifiers, transformers, logic gates and the ubiquitous 555 timer. Additional models can easily be built by the user and any SPICE compatible model can also be utilised.

The circuit which is to be simulated is defined as a netlist, which can be entered directly using the programs' flexible circuit text editor, or automatically from the GESSICA schematics editor which is available as an additional program. For larger circuits, input from GESSICA is preferable since circuit size is only limited by available RAM.

SpiceAge gives the user great flexibility with presentation. The probe control panel gives a choice of probe points and function, with the output from the probe points being set up like a multi-trace oscilloscope. But a scope with a difference since it also allows one to measure power, current, gain, phase angle, impedance and relative voltages with infinite CMR and input impedance. Furthermore, there are no triggering problems and one can easily capture single events.

For the simulation, any number of programmable voltage and/or current signal generators may be used. They may be programmed to emit step, impulse, triangular, sine or pulse trains. All waveform parameters, including offset, slew rate and duty cycle are adjustable. Up to 20 user defined input signals are also available, each defined by its own ASCII text file. The file contains the time and voltage vertices of the waveform, with SpiceAge doing any interpolation automatically. SpiceAge is able to write outputs to file in the same format as that used for the input, which means that it is possible to chain the output of one circuit to the input of another, if required.

A very wide range of different analyses can be performed on a circuit using SpiceAge, including frequency, DC, Transient and Fourier. In every case, graphs can be displayed on screen or output to a printer with a wide range of different co-ordinate and axes options.

SpiceAge requires a PC 286 or higher with the Windows version needing Windows 3.0 or higher in standard or 386 mode, a mouse is required and a maths co-processor is recommended. The program will require 700KB of disk space.

SpiceAge is a very sophisticated program and is available in a variety of different levels. Thus, level 1 is a restricted introductory system and is available at £85.11 plus VAT, the most sophisticated version is Level 15 which has all the SpiceAge functions plus a limited range of logic facilities and an additional library of TTL gates, and costs £695 plus VAT. There is a special addition to SpiceAge which allows the modelling of op-amps, priced at £30. There are other levels available in between these two and a demo program is available for £5.

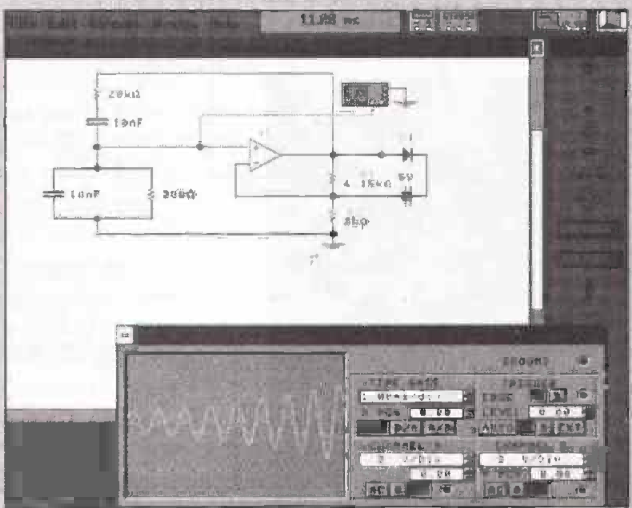
The schematics capture program GESSICA costs £195 and for all products from Those Engineers there are special educational discounts and multiple user licences.

SpiceAge is produced by Those Engineers Ltd, 31 Birkbeck road, Mill Hill, London NW7 4BP. Tel: 081 906 0155. Fax: 081 906 0969.

XOR, NOT, NAND, and NOR gates, plus RS, JK, and D flip-flops, half adder, seven segment displays and voltmeter. Input to the circuit can be provided by a programmable virtual word generator (16 eight bit words) and output can be displayed on a virtual eight channel logic analyser, capable of both hexadecimal and graphical display.

The digital module is also capable of performing logic conversion, gate, NAND gate, truth table and Boolean expression representations. It can also perform logic simplification using the Quine McCluskey method.

This is a fully integrated design and simulation tool for both digital and analogue circuits and, as such, is a great educational tool as well as a useful design aid for testing out the behaviour of small circuits.



This software is available in both MS-DOS, Windows and Macintosh versions. The DOS version requires a PC AT or true compatible, with 286 or greater, hard disk, 1MB RAM, Microsoft compatible mouse, EGA or VGA display adapter and DOS 3.0 or greater and it will support a maths co-processor if available. The Windows version requires similar minimum hardware specifications, DOS 5.0 or higher and Windows 3.0 or higher. The Macintosh version requires a Macintosh Plus or higher, 2MB RAM, system 6 or 7.

Electronics Workbench costs £199. The supplementary units - Electronics Workbench: 15 Circuits, costs £24.95 and Electronics Workbench: Practical Teaching Ideas costs £19.95

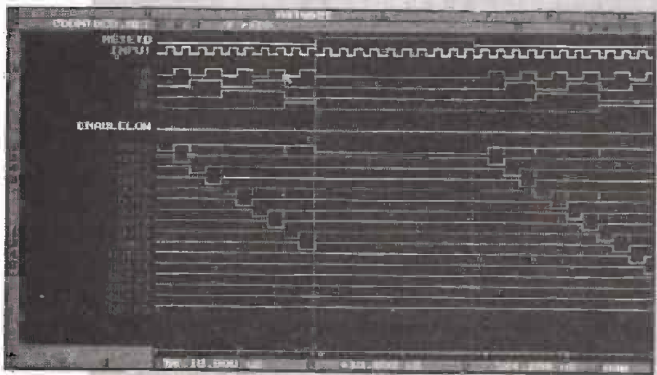
Available from Robinson Marshall (Europe), 17 Middle Entry, Tamworth, Staffordshire, England B79 7NJ. Tel: 0827 66212.

Pulsar

Pulsar, and the more sophisticated version Pulsar Professional, are advanced digital logic circuit simulation programs that completely eliminate many of the expensive and time consuming aspects of digital design. These programs allow the user to test his designs without soldering a single component and without the need for expensive test equipment. Indeed, it is even possible to skip the breadboarding stage altogether and go straight from design concept to PCB!

The programs incorporate fully programmable signal sources (you can have up to 1500 independent programmable pulse generators in your simulation), a printable logic analyser display with zoom in capability, which can catch glitches down to 1 picosecond, plus a whole range of adjustable component models.

Circuits are defined as a netlist, which can be entered directly using Pulsar's interactive netlist editor or created automatically by the schematics capture and PCB CAD program EASY-PC Professional. In order to perform the simulation, pulse generators need to be added to the input lines, these are easily created with Pulsar. Once the netlist and pulse generators have been created the circuit simulation can be run. The analyser shows the resultant waveforms at all labelled points within the



devices and can simulate a circuit at over 1000 gate states per second on a 12MHz 286. With Pulsar, a circuit can have a maximum complexity of 1500 gate equivalents and in Pulsar Professional over 10,000 gate equivalents. The maximum number of simulated events is over 40,000 gate state changes in Pulsar and 1,000,000 in Professional. The timing resolution is one picosecond in over 250 hours.

Pulsar runs on any PC from an 8088 upwards and uses just 640K DOS memory. Pulsar

circuit, thereby making it fairly easy to identify logic errors and glitches.

With Pulsar, it is possible to design and debug a digital circuit in a very short period and without the need for expensive test equipment, while because of the extensive library of components, the designer will not encounter delays due to components not being available.

Pulsar and Pulsar Professional include libraries for both 74LS and CMOS4000 series

Professional can simulate larger and more complex circuits and thus requires up to 16MB of memory and a 286 or later processor with EGA/VGA display, mouse, hard disk and DOS 3.1 or later.

Pulsar is priced at £98 and Pulsar Professional at £195, the Pulsar 74HC and 74HCT Libraries cost £48 each. They are available from Number One Systems Ltd., Harding Way, Somersham Road, St Ives, Cambs., PE17 4WR. Tel: 0480 461778.

Analyser III

Analyser III and the more sophisticated Analyser III Professional are advanced linear circuit analysis programs that are designed to eliminate many of the expensive time consuming aspects of circuit design. Both programs allow you to test your designs without soldering a single component and without the need for expensive test equipment.

The Analyser III family is ideal for analysis of Filters, Amplifiers, Crossover Networks, Wideband Amplifiers, Aerial matching networks, Radio and TV IF amplifiers, Chroma Filters, Linear ICs, etc.

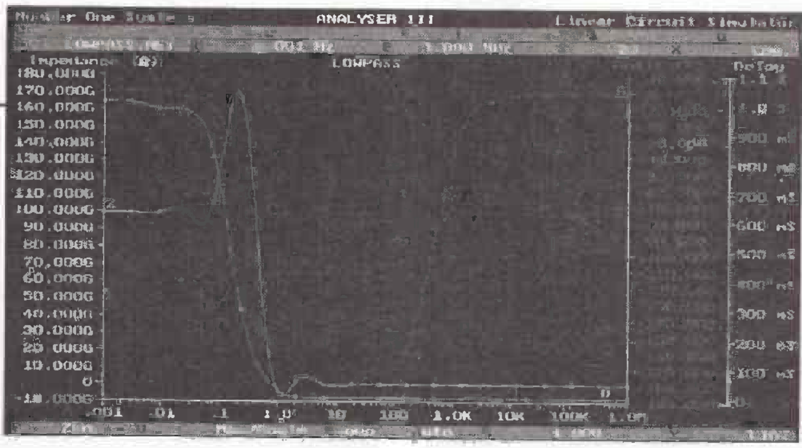
Analyser III actually out-performs any test equipment, since its frequency range extends from 0.001Hz to 10GHz. Analyser III's library contains models of over 500 different devices and an additional library is available. The devices in the library include bipolar transistors, FETs, operational amplifiers, resistors, capacitors, transformers, inductors, etc. New models of both active and passive devices can easily be added by the user.

Circuits are defined using a netlist, which can be entered directly using Analyser's interactive netlist editor or automatically from the schematics capture and PCB CAD package, EASY-PC Professional. With Analyser III, a circuit can have up to 2000 components and 130 nodes, with the Professional version these figures go up to 10,000 components and 750 nodes.

Analysis is at over 50 nodes per second on a 20MHz 386SX and the result can be plotted out to screen or printer in a variety of different graph forms. The graphs are generated in frequency response format, showing calculated points and a smooth high resolution curve drawn through them. Alternatively, a tabular listing of 100 points is available if required. The frequency axis can be linear or logarithmic and the displayed response can be shown either linearly or in dB. Impedance results may optionally be plotted in Smith chart form using an additional program called Z-Match II.

Analyser III runs on any PC from an 8088 upwards and uses just 640K DOS memory. Analyser III Professional can simulate larger and more complex circuits and thus requires 2MB of memory and a 286 or later processor, with EGA/VGA display, mouse, hard disk and DOS 3.0 or later.

Analyser III is priced at £98 and Analyser III Professional at £195, the Analyser III Library costs £48, Z-Match II costs £195. They are available from Number One Systems Ltd., Harding Way, Somersham Road, St Ives, Cambs., PE17 4WR. Tel: 0480 461778.



Win over £240 worth of Electronics Workbench software to run on your PC

All you have to do is answer the following questions and you will find the answer to all of them somewhere in this copy of ETI.

1 What is the analogue circuit simulation standard known as?

a) ANSIM
b) SPICE
c) ACSS

2 How many PCs have been sold around the world?

a) 14 million
b) 76 million
c) 120 million
d) 212 million

3 What is the table of interconnections in a circuit simulation program known as?

a) Complist
b) Connectlist
c) Netlist

4 What are a PC's self test codes known as?

a) POST
b) STEST
c) ERRORVAL
d) STC

To enter, put your answers on a post card in the form of question number followed by your selection from the multiple choice answers, please make sure that all answers and your name and address are printed as clearly as possible, preferably in block capitals. All entries should be received by June 30th 1994, when the winner will be drawn at random from all the correct entries.

Competition entries should be addressed to: Electronics Workbench Competition, ETI Argus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST.

The competition is open to all UK residents other than employees and their families of ASP and Electronics Workbench. The prizes are as stated, there is no cash alternative. The editor's decision is final and no correspondence can be entered into.

www.americanradiohistory.com

At last, a fully functional upgradeabl PCB CAD system to suit any budget. Substantial trade-in discounts are available against other "professional PCB design packages ...

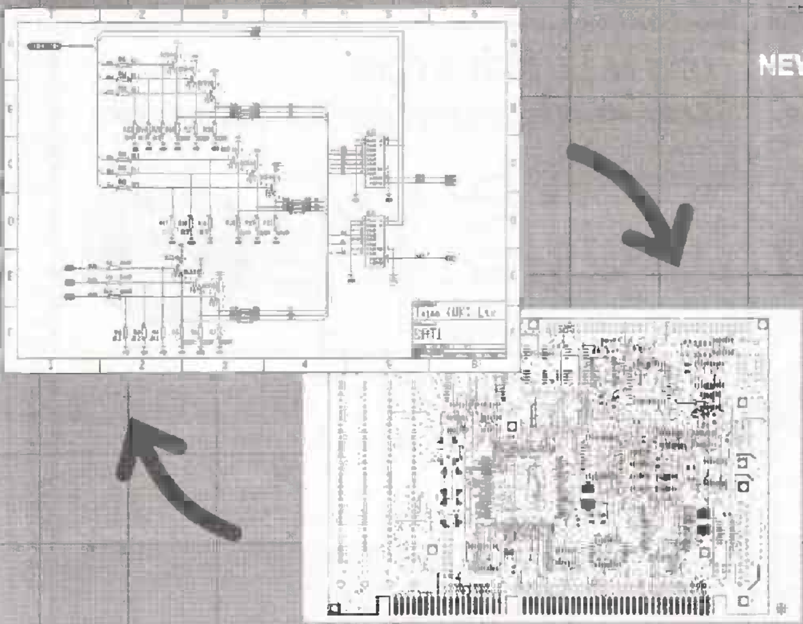
... call now for details

BoardCapture

Schematic Capture Design Tool **£395**

- Direct netlist link to BoardMaker2
- Forward annotation with part values
- Full undo/redo facility (50 operations)
- Single-sheet, multi-paged and hierarchical designs
- Smooth scrolling
- Intelligent wires (automatic junctions)

- Dynamic connectivity information
- Automatic on-line annotation
- Integrated on-the-fly library editor
- Context sensitive editing
- Extensive component-based power control
- Back annotation from BoardMaker2



BoardMaker

BoardMaker1 - Entry level **£9**

- PCB and schematic drafting
- Easy and intuitive to use
- Surface mount and metric support
- 90, 45 and curved track corners
- Ground plane fill
- Copper highlight and clearance checking

BoardMaker2 - Advanced level **£29**

- All the features of BoardMaker1 +
- Full netlist support - BoardCapture, OrCad, Schema, Tango, CadStar and others
- Full Design Rule Checking both mechanical and electrical
- Top down modification from the schematic
- Component renumber with back annotation
- Report generator - Database ASCII, BOM
- NEW Thermal power plane support with full DRC

BoardRouter

Gridless re-entrant autorouter **£20**

- Simultaneous multi-layer routing
- SMD and analogue support
- Full interrupt, resume, pan and zoom while routing

Output drivers - Included as standard

- Printers - 9 & 24 pin Dot matrix, HPLaserjet and PostScript
- Penplotters - HP, Graphtec & Houston
- Photoplotters - All Gerber 3X00 and 4X00
- Excellon NC Drill and Annotated drill drawings (BM2)

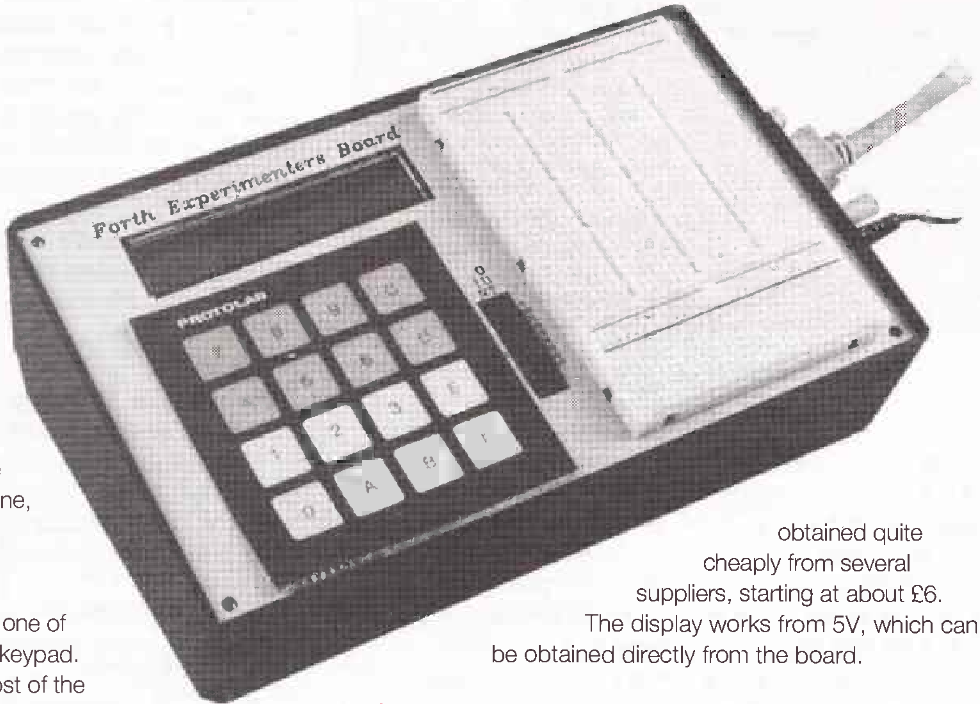
Call, write or fax for more information
or a full evaluation kit
Tsien (UK) Limited
Aylesby House
Wenny Road, Chatteris
Cambridge
PE16 6UT
Tel (0354) 695959
Fax (0354) 695957

tsien

PROJECT

The *Experimenter's* Computer – Keypad and Display

In Part 3 of this project, Jim Spence shows how to construct and program a versatile display and keypad interface for the FORTH experimenters board



Most applications require some form of input and output. One of the most useful forms of output device is the LCD display and these are now available at a very reasonable cost. Although they have their own built in microprocessor, they are still not particularly easy to drive. They come in various forms, 16 x 1 line, 20 x 2 line, etc. I have used several types from several sources and they all work in exactly the same way.

This article describes how to use one of these displays and also a 16 button keypad. There is very little to construct as most of the work is carried out by software, but to save on Output lines, a decoder has been used to multiplex the keypad.

LCD Display

The display chosen as an example is a 20 x 2 line LCD display, but most of the LCD displays you can buy work in a similar way. They are capable of displaying all the ASCII character set and have their own microprocessors built in. They are, in fact, designed to interface almost directly to most 8 bit microprocessors, although, in this case, we will not be interfacing directly but via an output port. They can be obtained quite cheaply from several suppliers, starting at about £6. The display works from 5V, which can be obtained directly from the board.

LCD Drive Voltage

A voltage of between about 3.7V and 4.7V is needed to drive the LCD. The voltage affects the contrast and viewing angle, and the best solution is to use a potentiometer between ground and vdd.

It was found in practice, however, that a 1K resistor between Vo and Vdd proved adequate in most cases.

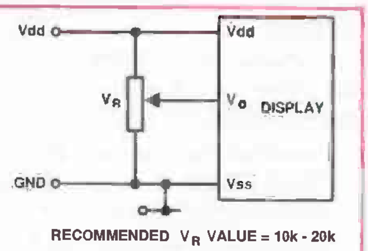


Figure 1. Resistor divider derived LCD supply voltage

Connections

The positions of connections to the module may vary.

Figure 2 shows the pin connections and Table 1 shows the function of each connection.

Table 1. Pin Functions

Symbol	I/O	Function
VSS	–	Module ground – provides supply and logic signal reference.
Vdd	Input	+5V power supply for controller and driver circuits.
Vo	Input	LCD drive voltage – adjusts contrast and viewing angle.
RS	Input	Register select signal 0 = instruction register (write) busy flag/address counter (read) 1 = data register (read/write)
R/W	Input	Data direction control 0 = write to display module 1 = read from display module
E	Input	Operation "enable" – activates the read or write function.
DBO-DB3	I/O	Lower four bits of the tri-state bi- directional data bus. Data is read and written using these lines, only if using the 8-bit data transfer mode.
DB4-DB7	I/O	Upper four bits of the tri-state bi-directional data bus. These lines are used both in 8-bit and 4-bit data transfer modes.

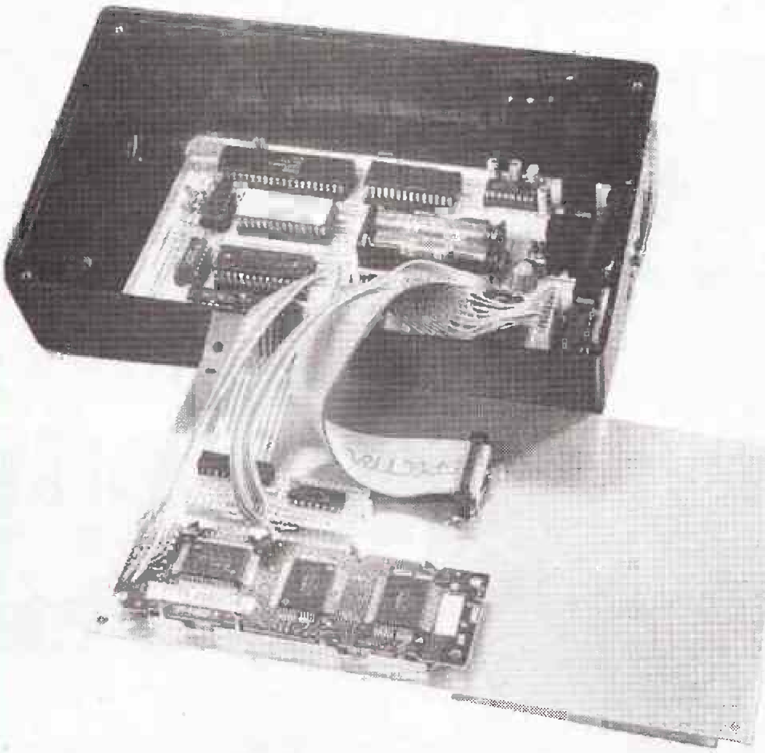
In addition to the character display, there is also an internal RAM which can be programmed to form your own unique characters. This RAM can be either read or written to.

In order to save on output lines, this system will use the 4 bit mode of operation and will not read from the display. This means that lines DB0-DB3 will not be used and that the R/W line can be permanently tied to ground. We now only need 4 data lines, RS & E, which is six lines in total leaving 2 spare to drive the keypad.

Circuit

The complete circuit diagram in shown in Figure 2, which also shows the connection to the experimenter's board. The reason for using IC1 is to minimise on the use of output lines. This leaves an 8 bit input and an 8 bit output port free.

The 20 x 2 line display has the connections as shown in the diagram. This is looking from the front of the display. Output port 0 is used to control the display and the keypad and the bottom half of input port 4 is used for the keypad input.



Construction

Construction is very straight forward. There is no real need for a PCB as the IC and the four resistors can be mounted on a piece of Veroboard. If you use the Protolab keypad then the connector can also be mounted on this Veroboard.

The whole unit was mounted in a sloping front box with the RS232 and power connectors protruding through holes made in the side. There is room on the front for the display, keypad and a bread board, while the two spare ports are taken to the front panel via an IDE connector socket. This acts as a mini bread board and power is also available here, providing not too much is taken.

The FORTH board is held in place by the RS232 socket and small spacers attached to the bottom of the board keep it level. Figure 4 shows the front plate cutting details.

Driving the Display

The display will either accept commands or characters. This is controlled by the RS line which is connected to our D5. When low the display will expect commands, when high it will expect data. The E line (our D4) acts as a kind of clock. To write data or an instruction, this line (normally high) must be taken low and back to high again.

To further complicate matters, an instruction or data consists of two writes, one for the high nibble and one for the low nibble. Some of the instruction set is shown in Table 2.

The full code for driving the display is shown in Box 1 and is split for convenience into five sections as follows.

Section 1

```
Display module driver 20 x 2 lines, 4 bit mode

Set up and utilities
hex
0 constant dport       \ port used for display
variable emode \ display entry mode
variable cds   \ Cursor and display shift
```

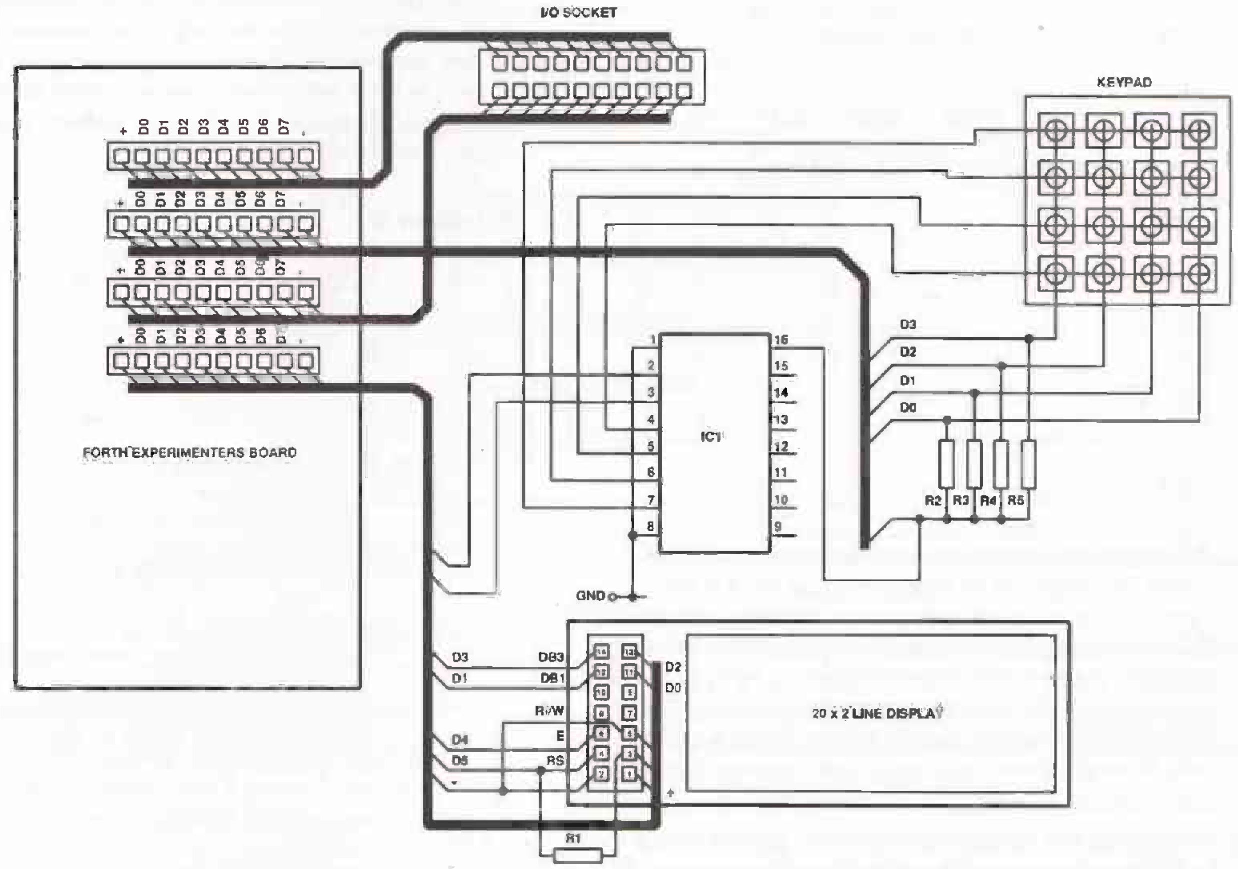


Figure 2. Display and keypad circuit diagram

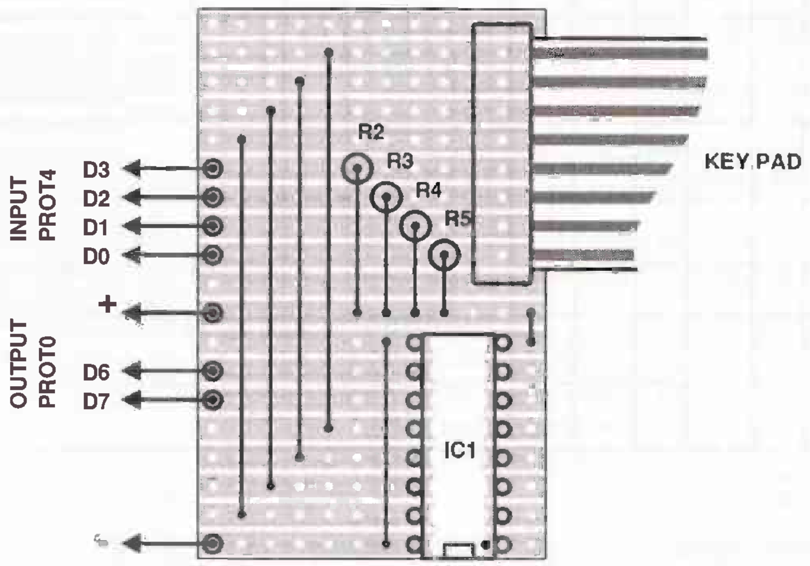


Figure 3. V eroboard layout for keypad circuit.

```
variable cpos  \ current display address
variable linex \ line indicator
variable pvalue \ current value of o/p port

6 emode !       \ initial values
10 cds   !

create lbuff 14 allot \ line 1 buffer 20 char

\ This gives including call and return a 1 ms
  delay
: del1
    19 0 do loop
    ;

\ This gives about 3ms delay including call
and
  return
: del3
    3 0 do del1 loop
    ;
```

This defines the variable constants and also two delay utilities. The delays are necessary because some of the commands to the display can take up to 10ms to complete. There is a status word generated on the display which can be read in order to determine if the display is ready to accept a command or letter. In this application, there is no means by which we can read the display and so a suitable delay must be introduced. In practice this method was found to be quite satisfactory.

There are two variables, EMODE and CDS which must be initialised (have something put in them) before being used. The initialise word (later) uses these to set up the type of display and how it will work according to the 'cursor display and shift' and the 'function set' commands.

PVALUE works with the word DIP and is important in this application: Bits 0 to 5 of the output port are used for the display, and bits 6 and 7 are used for the keypad. For this reason we must write values to this port while still retaining the value of the data on lines 6 and 7. PVALUE stores the value of the port so this can be achieved.

Section 2

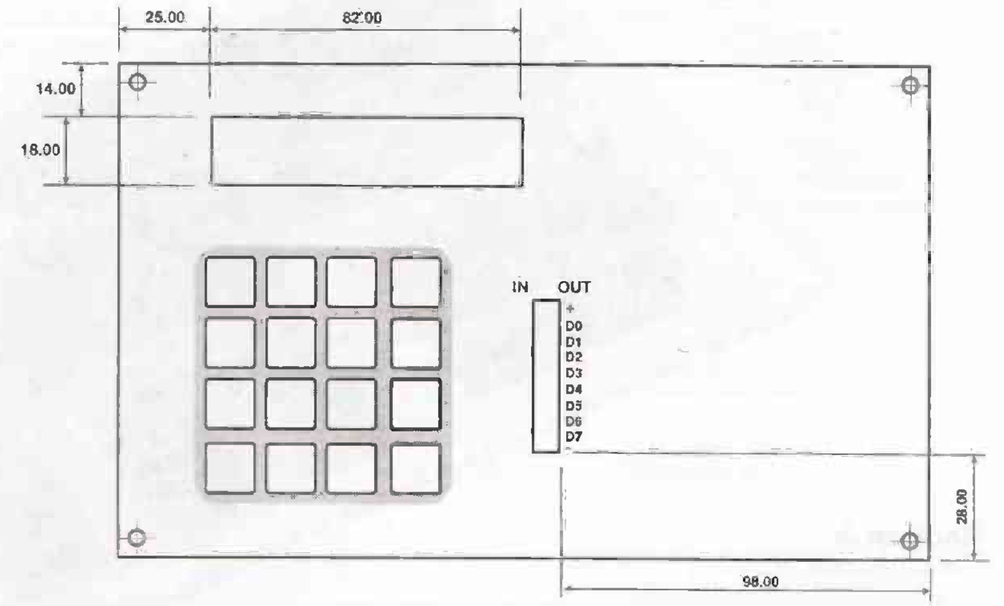
```
\ Raw data writes to relavant ports
\ Sends byte b to port specified by dport but only
to
\ bits 0 to 5, leaves 6 and 7 alone
: dip       (b —) \ Display o/p port
    3f and         \ mask bits 6 & 7
    pvalue c@      \ get copy of actual port
    contents
    c0 and         \ mask bits 6 & 7
    or             \ combine
    dup            \ 2 values to be written
    dport p!       \ o/p to port
    pvalue c!      \ store in variable
    ;
\ Write a 4 bit instruction to the display port
: inst4          ( b — ) \ Only lower nibble is
                          sent
    dup dup      \ copy because 2 writes are
                   needed
    10 or  dip   \ write with E high
    0f and dip   \ bring E low, this writes
    10 or  dip   \ leave E high for next write
    ;

\ Write a 4bit data nibble to the display port
```

TABLE 2

Instruction	Code										Description
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position.
Entry mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies whether or not to shift the display. Performed during data read and write
Display ON/OFF control	0	0	0	0	0	0	1	D	C	B	Sets the display ON/OFF, Cursor, and blink.
Cursor and display shift	0	0	0	0	0	1	S/C	RL	*	*	Moves the cursor and shifts the display
Function set	0	0	0	0	1	DL	N	F	*	*	Sets the data length, number of display lines and character length.
Set the DDRAM address	0	0	1			Add					Sets the Display data ram address
Write data to display	1	0			WriteData						

I/D = 1:Increment (+1)
I/D = 0: Decrement (-1)
S = 1: Accompanies display shift.
S/C = 1 :Display shift — S/C = 0: Cursor move
R/L = 1:shift to the right.
R/L = 0: Shift to the left.
DL = 1: 8 bits — DL = 0: 4 bits
N = 1:2 lines — N = 0: 1 line.
F = 1:5 x 10 dots — F = 0: 5 x 7 dots
BF = 1:Internally operating
BF = 0:Can accept instruction

Figure 4. Front panel cutting instructions




```
: dat4          ( b — ) \ Only lower nibble is sent
    dup dup     \ copy because 2 writes are needed
    30 or  dip  \ write with E high
    0f and dip  \ bring E low, this writes
    30 or  dip  \ leave E high for next write
    ;

\ Instructions and data are made up of two 4 bit
  writes
\ high nibble first and then low. This sends byte b
: inst          ( b — )
    dup         \ copy stack
    10 /        \ divide by 16 to get top nibble
    inst4       \ send to instructions
    0f and      \ mask off high nibble
    inst4       \ send to instructions
    ;

\ Instructions and data are made up of two 4 bit
  writes
\ high nibble first and then low. This sends byte b
: dat           ( b — )
    dup         \ copy stack
    10 /        \ divide by 16 to get top nibble
    dat4        \ send to instructions
    0f and      \ mask off high nibble
    dat4        \ send to instructions
    ;
```

This is where the basic writing to the display is carried out. To write to the display (ignoring 4 bit mode for the moment) we need to place the required data on the port, take the E line low (D4) and then bring it high again. Take a look at INST4 in detail

Box 2

```
1)\Write a 4 bit instruction to the display port
2): inst4 ( b — )\ Only lower nibble is sent
3)dup dup\ copy because 2 writes are needed
4)10 or  dip\ write with E high
5)0f and dip \ bring E low, this writes
6)10 or  dip \ leave E high for next write
7);
```

Line numbers have been added for the purposes of explanation only.

1) It is always a good idea to give a title and any necessary comments to the word before it is defined, this will act as a short reminder as to what the word does.

2) The ':' (colon) and space defines the word INST4 and the (b —) is a stack diagram. Because the stack is of such importance to FORTH words it is always a good idea to document this. It is carried out in the following way:

The brackets are alternative comments in FORTH, i.e. anything surrounded by brackets will be ignored, and by convention we use the bracketed comment for the stack diagram. The diagram consists of three parts read from the left hand side. The far left is items on the stack before the word executes, the '—' is the word itself and the right of the '—' is the stack after the word executes. In this case, the b indicates that there should be a byte on the stack before the word executes and, after the word has executed, there will be nothing left on the stack. As an example, the word '+' (plus) would have the following stack diagram - (n1 n2 — n3). A description of this would be that the word + takes two numbers from the stack, n1 & n2 adds them together and leaves the result n3 on the stack.

3) The word DUP (duplicate) copies the top item on the stack. As this is executed twice the stack will containn 3 bytes of identical data after this line.

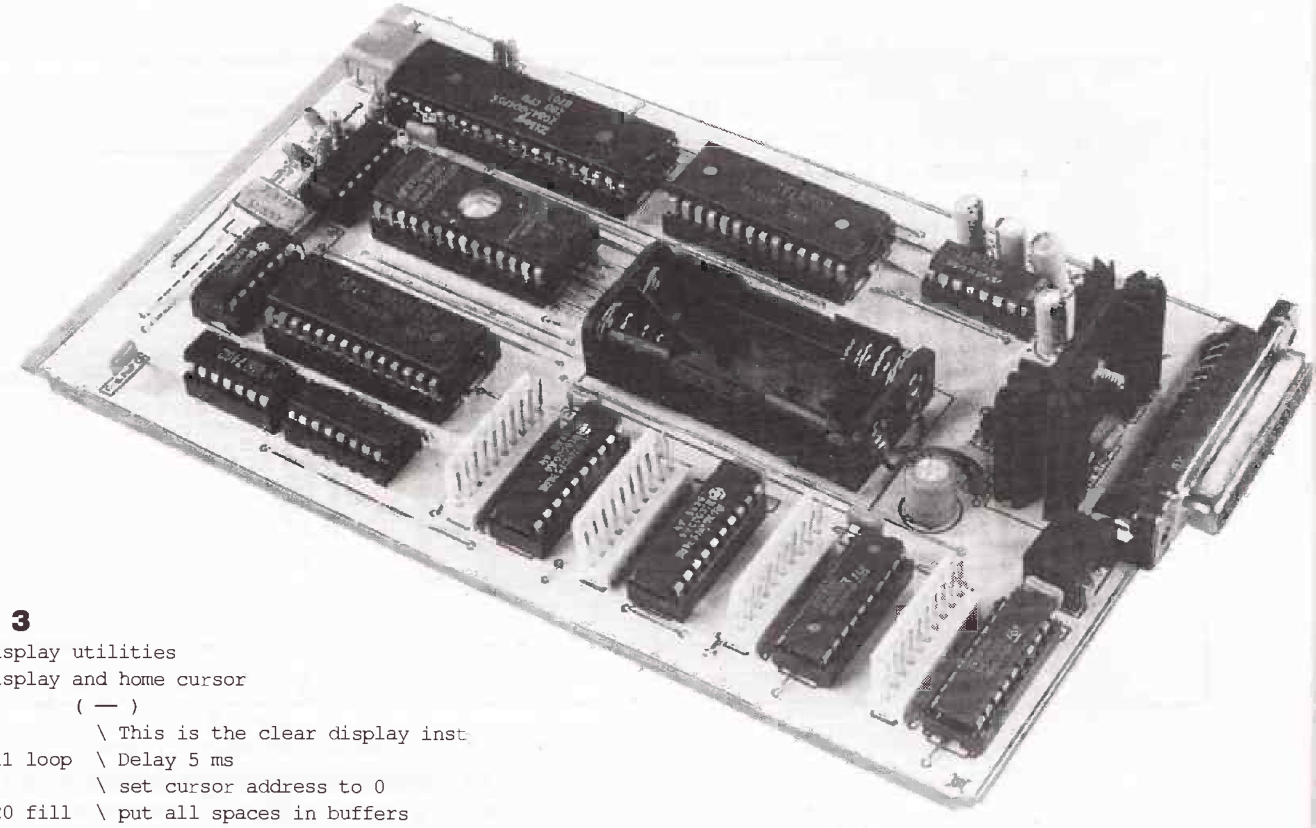
4) This line simply puts (via DIP) the byte onto the output port, making sure bit D4 is high. The byte is or'd with 10hex before being written.

5) E is now taken low with the same data on the port. This effectively writes the byte to the display.

6) Puts E back to the high state.

7) All words are defined between ':' and ';'. This line holds the terminating semicolon.

DAT4 is the same as INST4 except it writes data because the RS line is held high when writing The display will accept 4 bit nibbles instead of 8 bit bytes. The high nibble must be sent followed by the low nibble. This is the job of words INST, for instruction, and DAT, for data. Notice that to get the low nibble the byte is divided by 16 (10 hex).



Section 3

```
\ Basic display utilities
\ Clear display and home cursor
: clear          ( — )
01 inst           \ This is the clear display inst
5 0 do dell loop  \ Delay 5 ms
0 cpos !          \ set cursor address to 0
lbuff 14 20 fill  \ put all spaces in buffers
linex off         \ current line 1
;


\ Initialise the display after a reset
: init       ( — )
 f 0 do dell loop \ delay for 15ms at start
 3 inst4 del3     \ repeat 3 times
 3 inst4 del3
 3 inst4 del3
 2 inst4 del3     \funotion set for 4 bit interface
 2c inst del3 \function set: 4bit, 2 line, 5x10 dots
 0e inst del3     \ display on, cursor on, uline
 01 inst del3     \ clear display
 cds    @
    inst del3     \ cursor display & shift
    emode @
    inst del3     \ entry mode
    0 cpos !      \ set cursor address to 0
    clear
    ;

\ Sets the ddram address to that specified by b
: setadds        ( b — )
    80 or              \ set up address instruction
    inst               \ send it

    ;

\Go to xy, like setadds but with respect to the line
\ we are on
: gxy            ( xy — )
    linex @
    if
    40 + setadds \ 64 decimal is next line
    else
    setadds
    endif
    ;

\ Corsor to start of line 1 or 2
: line1          ( — )
    0 setadds
    0 cpos !      \ reset cursor position
    linex off     \ indicate current line
    ;

: line2          ( — )
    40 setadds      \ deciaml 64
    0 cpos !        \ reset cursor position
    linex on        \ indicate current line
    ;
```

The most important word of this section is INIT. This word initialises the display and sets it to operate in 4 bit mode. The '3 inst4 del3' statements set the display into the 8 bit mode. This is the default reset condition of the display at switch on. Don't forget that we are writing to the top nibble of the display. Referring to table two, writing 3 to the top nibble is the same as function set with DL high, which is the 8 bit mode. After '2 inst4' is executed, the instructions can go through the word INST which takes care of converting the byte into two nibble instructions.

The other words either clear the display or put the cursor at a specific position along the display. You may notice that the addressing for the display is rather awkward, in that the first line goes from address 0 to 19 but the second line goes from 64 to 83. This is because the chips driving the display are used in several formats, from single line by 80 characters to 1 line by 16 and various combinations between. If you use a different display format, 2 line by 16 for example, then these addresses will need changing.

Section 4

```
\ Higher level display functions
\ Display carrage return, moves display line up one
\ and puts cursor on bottom line
: dcr            ( — )
    01 inst              \ clear display inst
    5 0 do dell loop     \ Delay 5 ms
    lbuff 14 bounds      \ display all buffer on
                           top line
    do
    i c@ dat
    20 i c!                 \ and clear buffer
    loop
    line2                 \ start on second line
    ;

\ Primary back space function
```

```
: (bs)              ( -- )
    -1 cpos +!              \ decrement cursor
    cpos @ gxy              \ move display cursor
    20 dat                  \ print space
    cpos @ gxy              \ move it back again
20 cpos @ lbuff + c!    \ put space in buffer
    ;
    \ Display back space, this also takes care of back
spacing
\ from the bottom line to the top line
: dbs               ( -- )
    linex @
    if              \ this is line 2
    cpos @          \ see if bs takes it to line 1
    0=              \ 0 is first position
    if
    line1           \ move to line 1
    14 setadds      \ end of line 1 + 1
    14 cpos !       \ cursor to end + 1
    (bs)            \ do back space stuff
    else
    (bs)            \ simply back space
    endif
    else
    (bs)
    endif
    ;

\Writes b to display stores it in the buffer and increments
\ caracter pointer
: dat-store       ( b -- )
    dup dat               \ display
    cpos @ lbuff + c!     \ store in buffer
    1 cpos +!             \ increment buffer
    ;

\ Writes b to display and takes care of back spaces and
CR
: dat1            ( b -- )
    case
    0d of dcr endof      \ carrage return
    0a of     endof      \ same as cr
    08 of dbs endof
    dat-store
    1 endcase
    ;

\ places b as an ascii character to display, takes care
of special
\ characters and scroling. Equivalent to FORTH word EMIT
: demit           ( b -- )
    cpos @              \ check line not full
    13 >                \ 20 line display
    if
        dcr
        dat1            \ display character
        else
        dat1
        endif
        ;

\ Equivalent to the Forth word TYPE except this word
\ out puts to the display device.
: dtype           ( addr n -- )
    bounds
    ?do                 \ only do if there are some
                          characters
    i c@ demit          \ get character at address and
send
    loop
    ;

\ Equivalent to the forth word (.") except this word
  o/p to
\ the display because it uses DTYPE
: (d")
    r> count 2dup + >r dtype
    ;
  \ Equivalent to the forth word ." except this word
  o/p to
\ the display
    : d"                        ( console input )
    22                        \ place ASCII " on stack
    state @                   \ can be used within words
                                or directly
    if
    compile (d")              \ compile address of (d")
    word                      \ fetch text string up to "
    c@                        \ get length of text string
    1+ allot                  \ move dictionary pointer
                                ready for next word
    else
    word                      \ get the text
    count dtype               \ display it
    endif
    ;
    immediate                 \ must be immediate
```

Most of this section may be omitted if simply writing characters to the display is required. Some words look complicated because they take care of special characters such as back space. If a back space occurs at the beginning of the second line, then it needs to know this so the cursor may move to the end of the first line.

The last three words of the section DTYPE, (D") and D" are straight equivalents to the FORTH words TYPE and .". Just a word about TYPE here. FORTH stores strings as counted strings, that is the length of the string is the first byte. For example, the string FRED would be stored as 04, 46, 52, 45, 44, the 04 being the count byte. TYPE will print out to the console the number of characters, n, at a specified address, adds. DTYPE will do the same but to the display rather than the console.

Section 5

```
\ Useful words
\ 1 space to display
: dspace
    d" "
    ;
\ n spaces to display
: dspaces        ( n -- )
    0 ?do
    dspace
    loop
    ;
\ Equivalent to the Forth . (dot) to print numbers
\ to the display
: di.
    s>d
    swap over
    dabs
    <# #s sign #>
    dtype
    ;
;end
```

These are simply useful words which make the display easier to work with.

Next Month...
We will look at the code for the keyboard

PARTS LIST

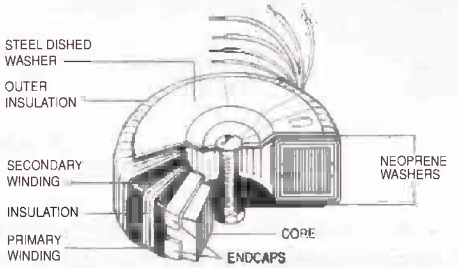
IC1	74ls139
R1	1k
R2-R5	10k
1	Liquid Crystal Display 20 x 2 lines (Greenweld)
1	Protolab 16 way keypad
4	10 way connectors
1	Breadboard type AD-01 (Maplin)
1	2 x 10 dil IDC socket
1	Sloping front case, desk console, size 215 x 130 x 78/47 (Maplin M1006)

TRANSFORMERS *from*

JAYTEE

UK Distributor for Standard Toroidal Transformers

- 107 types available from stock
- Sizes from 15VA to 625VA
- Dual 120v primaries allowing 110/120v or 220/240v operation



TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT
15VA £10.68	03010	6+6	1.25
	03011	9+9	0.83
	03012	12+12	0.63
	03013	15+15	0.50
	03014	18+18	0.42
	03015	22+22	0.34
	03016	25+25	0.30
	03017	30+30	0.25
30VA £12.21	13010	6+6	2.50
	13011	9+9	1.66
	13012	12+12	1.25
	13013	15+15	1.00
	13014	18+18	0.83
	13015	22+22	0.68
	13016	25+25	0.60
	13017	30+30	0.50
50VA £13.84	23010	6+6	4.16
	23011	9+9	2.77
	23012	12+12	2.08
	23013	15+15	1.66
	23014	18+18	1.38
	23015	22+22	1.13
	23016	25+25	1.00
	23017	30+30	0.83
	23028	110	0.45
	23029	220	0.22
	23030	240	0.20
80VA £15.43	33010	6+6	6.66
	33011	9+9	4.44
	33012	12+12	3.33
	33013	15+15	2.66
	33014	18+18	2.22
	33015	22+22	1.81
	33016	25+25	1.60
	33017	30+30	1.33
	33028	110	0.72
	33029	220	0.36
	33030	240	0.33
120VA £16.45	43010	6+6	10.00
	43011	9+9	6.66
	43012	12+12	5.00
	43013	15+15	4.00
	43014	18+18	3.33
	43015	22+22	2.72
	43016	25+25	2.40
	43017	30+30	2.00
	43018	35+35	1.71
	43027	20+20	3.00
	43028	110	1.09
	43029	220	0.54
	43030	240	0.50
160VA £19.21	53011	9+9	8.89
	53012	12+12	6.66
	53013	15+15	5.33
	53014	18+18	4.44
	53015	22+22	3.63
	53016	25+25	3.20
	53017	30+30	2.66
	53018	35+35	2.28
	53026	40+40	2.00
	53028	110	1.45
	53029	220	0.72
	53030	240	0.66

TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT
225VA £21.04	63012	12+12	9.38
	63013	15+15	7.50
	63014	18+18	6.25
	63015	22+22	5.11
	63016	25+25	4.50
	63017	30+30	3.75
	63018	35+35	3.21
	63026	40+40	2.81
	63025	45+45	2.50
	63033	50+50	2.25
	63028	110	2.04
	63029	220	1.02
	63030	240	0.93
300VA £22.94	73013	15+15	10.00
	73014	18+18	8.33
	73015	22+22	6.82
	73016	25+25	6.00
	73017	30+30	5.00
	73018	35+35	4.28
	73026	40+40	3.75
	73025	45+45	3.33
	73033	50+50	3.00
	73028	110	2.72
	73029	220	1.36
	73030	240	1.25
500VA £29.57	83016	25+25	10.00
	83017	30+30	8.33
	83018	35+35	7.14
	83026	40+40	6.25
	83025	45+45	5.55
	83033	50+50	5.00
	83042	55+55	4.54
	83028	110	4.54
	83029	220	2.27
	83030	240	2.08
625VA £32.64	93017	30+30	10.41
	93018	35+35	8.92
	93026	40+40	7.81
	93025	45+45	6.94
	93033	50+50	6.25
	93042	55+55	5.68
	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

13.8V DC POWER SUPPLY TRANSFORMERS

8C267	500VA	18+18V	£32.64
9T845	675VA	16.1V	£38.06

Prices include VAT and carriage

Quantity prices available on request

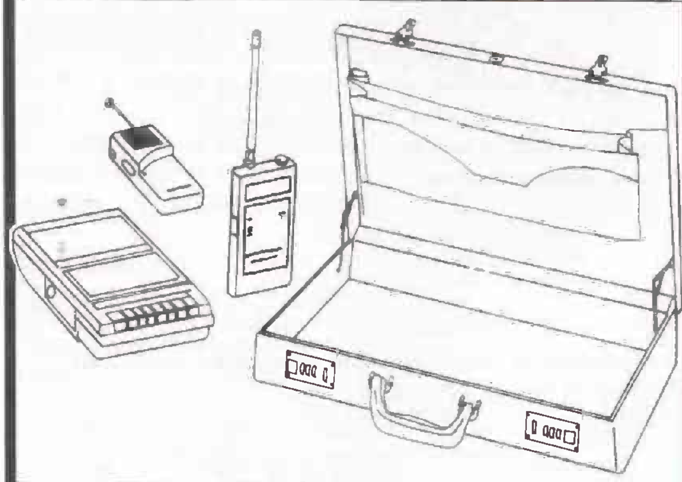
Write, phone or fax for free Data Pack

Jaytee Electronic Services

Unit 171/172, John Wilson Business Park,
Whitstable, Kent CT5 3RB. U.K.
Tel: (0227) 265333 Fax: (0227) 265331

SURVEILLANCE

A SMALL SAMPLE OF OUR RANGE	KIT	MODULE	PROF. FINISHED
ROOM TRANSMITTER RT1 An extremely sensitive miniature transmitter with long battery life. Dimensions: 20 x 20mm	9.95	13.75	18.00
MAINS TRANSMITTER MT4 Can be connected inside any equipment that is mains powered Dimensions 35 x 20mm	19.75	31.50	45.00
TELEPHONE TRANSMITTER TTS Small enough to conceal within a telephone. Will transmit both sides of a conversation (series connection) Dimensions: 10 x 20mm	12.75	17.50	25.00
TELEPHONE SOCKET TRANSMITTER TSTS Replace your telephone socket with this one within which a transmitter has been concealed	14.74	---	29.00
ROOM AND TELEPHONE TRANSMITTER RTT Operates as a room transmitter, then switches to telephone transmitter mode during telephone calls Dimensions: 30 x 25mm	31.50	45.50	65.00
AUTOMATIC TELEPHONE RECORDER SWITCH TRS2 Record telephone conversations with this interface unit and your own tape recorder. Dimensions: 36 x 50mm	16.90	25.90	39.00
AUTOMATIC TELEPHONE RECORDER ATR1 Adapt the tape recorder included to record telephone calls automatically.	34.95	---	59.00
TELEPHONE TAP ALERT TTA1 Visual warning of any invasions of privacy on your telephone line. Dimensions: 38 x 52mm	21.95	31.50	45.00
RF DETECTOR RFD1 Highly sensitive hand-held detector. Range between 10Mhz and 600Mhz. Silent operation. Dimensions: 70 x 50mm	42.75	69.00	95.00
CAMERA DETECTOR CD8 Detects hidden video cameras (even miniature CCD models) Dimensions: 63 x 38mm	69.00	89.00	125.00
RECORDING BRIEFCASE RBC1 Completely discreet recordings at a value for money price.	---	---	145.00
SHOTGUN MICROPHONE AMPLIFIER SMA Ideal for surveillance. The amplifier will pick up sounds from a long distance.	24.95	36.00	45.00
SIGNALLING TRANSMITTER SIGT Sends a continual audio pulse. Can be integrated into alarm, tracking or warning systems. Dimensions: 20 x 50mm	21.95	34.89	45.00
TELEPHONE AMPLIFIER TA5 Connected directly to the telephone, this unit will amplify both sides of a telephone call. Dimensions: 25 x 52mm	10.95	16.95	19.95
PROFESSIONAL SOUND TO LIGHT UNIT SK72 Custom built for disco or home use. Audio signal divided into bass, mid and treble bands, with internal microphone and spotlight option. Dimensions 210 x 45mm	21.95	32.49	44.95
MICRO METAL DETECTOR MMD Detect the presence of ferrous and various non-ferrous metals. Useful for all those DIY jobs. Dimensions: 40 x 25mm	9.95	16.95	---



Please add £2.00 P & P to all orders and 17.5% VAT on all U.K. orders

For full catalogue please send two 1st class stamps or 2 IRC'S

172 Caledonian Road London N1 0SG
Dept ET
CANAL BRIDGE AUDIO
071-837 4423

ESR ELECTRONIC COMPONENTS

Station Road, Cullercoats,
Tyne & Wear NE30 4PQ
Tel. 091 251 4363 Fax. 091 252 2296

74LS Series

74LS00	£0.22
74LS01	£0.14
74LS02	£0.14
74LS03	£0.14
74LS04	£0.14
74LS05	£0.14
74LS08	£0.14
74LS09	£0.14
74LS10	£0.14
74LS107	£0.23
74LS109	£0.21
74LS11	£0.17
74LS112	£0.21
74LS113	£0.21
74LS114	£0.21
74LS12	£0.14
74LS122	£0.31
74LS123	£0.31
74LS125	£0.21
74LS126	£0.21
74LS13	£0.14
74LS132	£0.21
74LS133	£0.18
74LS136	£0.16
74LS138	£0.24
74LS139	£0.25
74LS14	£0.25
74LS145	£0.56
74LS147	£1.26
74LS148	£0.70
74LS15	£0.14
74LS151	£0.25
74LS153	£0.25
74LS154	£0.70
74LS155	£0.25
74LS156	£0.36
74LS157	£0.25
74LS158	£0.25
74LS160	£0.32
74LS161	£0.32
74LS162	£0.32
74LS163	£0.32
74LS164	£0.26
74LS165	£0.48
74LS170	£0.30
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.25
74LS191	£0.24
74LS192	£0.42
74LS193	£0.24
74LS195	£0.24
74LS196	£0.24
74LS197	£0.24
74LS20	£0.16
74LS21	£0.14
74LS22	£0.14
74LS221	£0.40
74LS240	£0.32
74LS241	£0.32
74LS242	£0.32
74LS243	£0.32
74LS244	£0.32
74LS245	£0.36
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS26	£0.14
74LS266	£0.14
74LS27	£0.14
74LS273	£0.32
74LS279	£0.25
74LS30	£0.14
74LS32	£0.14
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS37	£0.14
74LS373	£0.32
74LS374	£0.32
74LS375	£0.34
74LS377	£0.32
74LS378	£0.62
74LS38	£0.19
74LS390	£0.25
74LS393	£0.24
74LS395	£0.26
74LS399	£0.62
74LS40	£0.14
74LS42	£0.25
74LS47	£0.72
74LS51	£0.14
74LS670	£0.69
74LS73	£0.17
74LS74	£0.25
74LS75	£0.19
74LS76	£0.25
74LS83	£0.31
74LS85	£0.35
74LS86	£0.20
74LS90	£0.23
74LS92	£0.35
74LS93	£0.25

4000 Series

4000	£0.17
4001	£0.21
4002	£0.17
4006	£0.40
4007	£0.28
4008	£0.31
4009	£0.19
4010	£0.23
4011	£0.26
4012	£0.16
4013	£0.21
4014	£0.30
4015	£0.31
4016	£0.18
4017	£0.27
4018	£0.27
4019	£0.19
4020	£0.31
4021	£0.31
4022	£0.32
4023	£0.16
4024	£0.21
4025	£0.15
4026	£0.59
4027	£0.18
4028	£0.22
4029	£0.36
4030	£0.17
4031	£0.70
4033	£0.56
4034	£1.24
4035	£0.31
4040	£0.29
4041	£0.31
4042	£0.22
4043	£0.28
4044	£0.35
4046	£0.31
4047	£0.25
4048	£0.31
4049	£0.20
4050	£0.20
4051	£0.36
4052	£0.25
4053	£0.25
4054	£0.56
4055	£0.34
4060	£0.48
4063	£0.29
4066	£0.18
4067	£1.91
4068	£0.16
4069	£0.20
4070	£0.17
4071	£0.20
4072	£0.17
4073	£0.17
4075	£0.17
4076	£0.30
4077	£0.17
4081	£0.14
4082	£0.21
4085	£0.28
4086	£0.26
4089	£0.55
4093	£0.18
4094	£0.31
4095	£0.56
4097	£1.20
4098	£0.48
4099	£0.38
4502	£0.38
4503	£0.40
4508	£0.90
4510	£0.26
4511	£0.32
4512	£0.32
4514	£0.77
4515	£0.98
4516	£0.31
4518	£0.27
4520	£0.26
4521	£0.62
4526	£0.40
4527	£0.40
4528	£0.40
4529	£0.44
4532	£0.32
4534	£2.48
4536	£1.00
4538	£0.37
4541	£0.33
4543	£0.46
4555	£0.34
4556	£0.34
4560	£1.18
4566	£1.96
4572	£0.25
4584	£0.24
4585	£0.32
4724	£0.70
40106	£0.31
40109	£0.50
40163	£0.46
40174	£0.34
40175	£0.36
40193	£0.60

TRANSISTORS

2N1613	£0.31	BC186	£0.33	BD534	£0.47
2N1711	£0.26	BC204C	£0.72	BD535	£0.48
2N1893	£0.29	BC206B	£0.72	BD536	£0.65
2N2218A	£0.28	BC207C	£0.72	BD646	£0.52
2N2219A	£0.25	BC208	£0.72	BD648	£0.52
2N2222A	£0.18	BC209A	£0.72	BD650	£0.53
2N2646	£0.80	BC212	£0.08	BD707	£0.42
2N2904A	£0.25	BC212L	£0.08	BD807	£0.80
2N2905A	£0.23	BC212LB	£0.08	BDX32	£1.78
2N2907	£0.20	BC213	£0.08	BDX33C	£0.49
2N2926	£0.16	BC213LC	£0.08	BDX34C	£0.50
2N3053	£0.27	BC214	£0.08	BDX53C	£0.47
2N3054	£0.90	BC214L	£0.08	BDX54C	£0.50
2N3055	£0.62	BC237B	£0.09	BF180	£0.31
2N3440	£0.50	BC238C	£0.09	BF182	£0.31
2N3702	£0.09	BC239C	£0.10	BF185	£0.31
2N3703	£0.10	BC251	£0.13	BF194	£0.19
2N3704	£0.10	BC252	£0.13	BF195	£0.19
2N3705	£0.10	BC261B	£0.24	BF244	£0.35
2N3706	£0.10	BC262B	£0.24	BF257	£0.33
2N3771	£1.44	BC267B	£0.30	BF259	£0.33
2N3772	£1.51	BC307	£0.10	BF337	£0.36
2N3773	£1.79	BC308	£0.10	BF355	£0.38
2N3819	£0.40	BC327	£0.10	BF423	£0.13
2N3820	£0.66	BC328	£0.10	BF451	£0.19
2N3904	£0.10	BC337	£0.10	BF459	£0.29
2N3905	£0.10	BC338	£0.10	BF469	£0.36
2N3906	£0.10	BC414C	£0.13	BFX29	£0.29
2N4036	£0.31	BC441	£0.40	BFX84	£0.31
2N5296	£0.57	BC461	£0.40	BFX85	£0.32
2N5321	£0.57	BC463	£0.29	BFY50	£0.29
2N6107	£0.60	BC478	£0.32	BFY51	£0.26
AC126	£0.30	BC479	£0.32	BFY52	£0.28
AC127	£0.30	BC490	£0.24	BS107	£0.21
AC128	£0.28	BC516	£0.22	BS170	£0.21
AC187	£0.45	BC517	£0.20	BSW66	£1.35
AC188	£0.37	BC527	£0.20	BU126	£1.70
ACY17	£3.84	BC528	£0.20	BU205	£1.82
AD149	£1.67	BC537	£0.20	BU208A	£1.73
AD161	£0.92	BC546C	£0.09	BU326A	£1.80
AD162	£0.92	BC547C	£0.09	BU500	£2.32
BC107	£0.14	BC548C	£0.08	BU508A	£1.76
BC107B	£0.15	BC549C	£0.10	BU526	£2.24
BC108	£0.13	BC550C	£0.10	BU806	£1.36
BC108A	£0.14	BC556A	£0.08	BUX84	£0.78
BC108C	£0.16	BC557C	£0.08	IRF540	£1.60
BC109	£0.17	BC558C	£0.08	IRF740	£1.63
BC109C	£0.17	BC559C	£0.08	MJ11015	£2.11
BC114	£0.41	BC560B	£0.09	MJ11016	£2.11
BC115	£0.41	BC637	£0.21	MJ2501	£1.60
BC116	£0.41	BC638	£0.21	MJ3001	£1.52
BC118	£0.41	BC639	£0.21	MJE340	£0.40
BC132	£0.36	BC640	£0.21	MJE350	£0.42
BC134	£0.36	BCY70	£0.21	MPSA13	£0.12
BC135	£0.36	BCY71	£0.20	MPSA42	£0.17
BC140	£0.25	BCY72	£0.20	MRF475	£7.26
BC141	£0.27	BD135	£0.20	TIP121	£0.35
BC142	£0.31	BD136	£0.21	TIP122	£0.37
BC143	£0.34	BD137	£0.22	TIP125	£0.37
BC149	£0.21	BD138	£0.22	TIP127	£0.40
BC154	£0.36	BD139	£0.23	TIP132	£0.46
BC157	£0.12	BD140	£0.24	TIP137	£0.46
BC159	£0.12	BD150C	£0.82	TIP142	£1.08
BC160	£0.28	BD165	£0.42	TIP147	£1.12
BC170	£0.16	BD166	£0.35	TIP2955	£0.63
BC170B	£0.16	BD187	£0.39	TIP29C	£0.31
BC171	£0.11	BD201	£0.40	TIP3055	£0.63
BC171B	£0.16	BD202	£0.40	TIP30C	£0.31
BC172	£0.13	BD203	£0.40	TIP31C	£0.34
BC172B	£0.13	BD204	£0.40	TIP32C	£0.32
BC177	£0.18	BD222	£0.40	TIP33C	£0.72
BC178	£0.18	BD225	£0.42	TIP41A	£0.36
BC179	£0.17	BD232	£0.38	TIP42C	£0.38
BC182	£0.08	BD237	£0.32	TIP47	£0.46
BC182L	£0.08	BD238	£0.32	TIP48	£0.62
BC182LB	£0.08	BD240B	£0.37	TIP50	£0.53
BC183	£0.08	BD243B	£0.50	VN10KM	£0.44
BC183L	£0.08	BD244A	£0.53	VN66AF	£1.50
BC183LB	£0.08	BD246	£1.06	ZTX300	£0.16
BC184	£0.08	BD441	£0.41	ZTX500	£0.16
BC184L	£0.08	BD442	£0.41		

LINEAR ICs

CA311E	£0.28
CA324	£0.35
CA555	£0.22
CA741CE	£0.28
CA747CE	£0.39
CA3046	£0.37
CA3080	£0.72
CA3130	£0.98
CA3130E	£0.98
CA3140	£0.56
CA3240	£1.22
ICL7621	£1.70
ICM7555	£0.43
ICM7556	£0.96
LM301A	£0.25
LM348N	£0.31
LF351N	£0.36
LF353	£0.41
LM358N	£0.27
LM377	£2.57
LM380N	£1.12
LM381	£2.70
LM386	£0.48
LM387	£1.60
LM392N	£0.79
LM393N	£0.28
LM748CN	£0.31
LM1458	£0.26
LM3900	£0.72
LM3914	£2.70
LM3915	£2.70
MC3340	£1.60
MC4558	£0.36
NE531	£1.56
NE556N	£0.36
NE567N	£0.47
NE5532	£0.80
NE5534	£0.66
TBA120S	£0.90
TBA810S	£0.68
TBA820M	£0.39
TDA2002	£1.04
TDA2030	£1.36
TL061	£0.35
TL062	£0.42
TL064	£0.46
TL071CP	£0.32
TL072CP	£0.34
TL074CN	£0.48
TL081	£0.33
TL082CP	£0.34
TL084	£0.63
TL084CN	£0.46
UA733	£0.64
ULN2003	£0.52
ULN2004	£0.48
ZN414Z	£1.16
ZN425E	£4.68
ZN426E	£2.61
ZN427E	£8.82
ZN428E	£6.12
ZN435E	£5.31
ZN448E	£7.92

EPROMS & RAMS

2716	£4.46
2732	£4.84
27128-20	£3.69
2764-25	£3.00
27C64-25	£2.17
21728-20	£3.16
27C128-20	£3.31
27256-20	£3.99
27C256-20	£3.57
27C512	£3.56
27C010	£8.98
6116-10	£1.53
6264-10	£3.06
62256-10	£5.36
4164-15	£1.78
41256-10	£2.80
511000-8	£5.61
514256-8	£5.61

ENAMELLED COPPER WIRE

All 2oz Reels

14 SWG	£0.63
16 SWG	£0.67
18 SWG	£0.67
20 SWG	£0.72
22 SWG	£0.76
24 SWG	£0.80
26 SWG	£0.89
28 SWG	£0.91
30 SWG	£0.93
32 SWG	£0.93
34 SWG	£0.99
36 SWG	£1.04
38 SWG	£1.10
40 SWG	£1.22

TRIACS

Z0105DA	£0.42
TIC206D	£0.65
TIC226D	£0.73
BTA08-600B	£0.84
TIC236D	£0.96
DIAC	£0.20

VOLTAGE REGULATORS

78L05	£0.24
78L12	£0.24
78L15	£0.24
79L05	£0.28
79L12	£0.28
79L15	£0.28
7805	£0.44
7812	£0.28
7815	£0.28
7905	£0.38
7912	£0.38
7915	£0.38
LM317T	£0.56
LM723	£0.29
L200CV	£1.16
LM323K	£2.70
LM338K	£5.52

OPTO DEVICES

5mm Red LED	£0.09
5mm Green LED	£0.10
5mm Yellow LED	£0.10
5mm Orange LED	£0.10
3mm Red LED	£0.08
3mm Green LED	£0.12
3mm Yellow LED	£0.13
3mm Orange LED	£0.13
5mm Flashing Red	£0.50
5mm Flashing Green	£0.54
5mm Bi Colour	£0.36
5mm Tri Colour	£0.48
5mm Plastic Bezel	£0.04
3mm Plastic Bezel	£0.05
0.3" 7 Segment Display Red common anode	£1.14
common cathode	£1.14

THYRISTORS

PO102AA	£0.30
TIC106D	£0.40
TIC116D	£0.66
TIC126D	£0.77

BRIDGE RECTIFIERS

W005 1.5A 50V	£0.19
WO2 1.5A 200V	£0.20
BR32 3A 200V	£0.36
BR62 6A 200V	£0.64
1004 10A 400V	£1.39

HARDWARE

T2 Box 75 x 56 x 25mm	£0.82
T3 Box 75 x 51 x 25mm	£0.82
T4 Box 111 x 57 x 22mm	£0.98
MB1 Box 79 x 61 x 40mm	£1.44
MB2 Box 100 x 76 x 41mm	£1.56
MB3 Box 118 x 98 x 45mm	£1.82
MB5 Box 150 x 100 x 60mm	£2.50

DIL SOCKETS

8 Pin	£0.07
14 Pin	£0.11
16 Pin	£0.15
18 Pin	£0.15
20 Pin	£0.16
24 Pin	£0.19
28 Pin	£0.22
40 Pin	£0.25

ELECTROLYTIC RADIAL CAPACITORS

µF	16V	25V	63V	100V	450V
0.47	–	–	£0.05	£0.07	–
1.0	–	–	£0.05	£0.06	£0.15
2.2	–	–	£0.05	£0.06	£0.18
4.7	–	–	£0.05	£0.08	[illegible]
10	£0.05	£0.05	£0.06	£0.08	£0.48
22	£0.05	£0.05	£0.09	–	–
47	£0.06	£0.06	£0.11	–	–
100	£0.06	£0.09	£0.11	–	–
220	£0.09	£0.12	£0.31	–	–
470	£0.15	£0.19	£0.57	–	–
1000	£0.22	£0.29	–	–	–
2200	£0.37	£0.57	–	–	–
4700	–	£1.11	–	–	–

ELECTROLYTIC AXIAL CAPACITORS

µF	16V	25V	63V	100V	450V
0.47	–	–	–	£0.15	–
1.0	–	–	£0.10	£0.10	£0.19
2.2	–	–	£0.10	£0.10	£0.22
4.7	–	£0.09	£0.10	£0.10	£0.34
10	–	£0.12	£0.12	£0.12	–
22	–	£0.09	£0.13	£0.17	–
47	£0.10	£0.11	£0.16	£0.20	–
100	£0.10	£0.13	£0.21	–	–
220	£0.13	£0.18	£0.42	–	–
470	£0.21	£0.24	£0.69	–	–
1000	£0.33	£0.40	£1.05	–	–
2200	£0.52	£0.64	–	–	–
4700	£0.90	–	–	–	–

SOLDERING IRONS

Antex Soldering Irons

M 12 Watt	£8.18
C 15Watt	£8.18
G 18Watt	£8.41
CS 17Watt	£8.31
XS 25Watt	£8.41
ST4 Stand	£2.97
35Watt Gas Iron	£11.58
'Gascat' Gas Iron	£15.26
Low Cost 15 Watt Iron	£3.93
Desolder Pump	£3.00
Antistatic Pump	£4.25
22SWG 0.5Kg Solder	£7.40
18SWG 0.5Kg Solder	£6.60
1mm 3 yds Solder	£0.62
Desolder Braid	£0.87

RF CONNECTORS

BNC Solder Plug 50R	£0.93
BNC Solder Plug 75R	£0.96
BNC Crimp Plug 50R	£0.68
BNC Crimp Plug 75R	£0.68
BNC Solder Skt	£1.08
BNC Chassis Skt	£0.80
PL259 5.2mm	£0.68
PL259 11mm	£0.62
RND UHF socket	£0.68
SQR UHF socket	£0.45
F Plug RG58	£0.30
F Plug RG6	£0.27
N Plug RG8	£1.60
N Socket RG8	£1.40
BNC Crimp Pliers	£17.44

PCB EQUIPMENT

UV EXPOSURE UNIT	£67.38
PLASTIC DEVELOPING TRAY	£1.35
PHOTO RESIST AEROSOL SPRAY (100ml)	£3.90
FERRIC CHLORIDE CRYSTALS (0.5Kg)	£2.45
ETCH RESIST PEN	£0.72
PCB POLISHING BLOCK	£1.84

STRIPBOARD 0.1 PITCH

64mm x 25mm	£0.27
64mm x 95mm	£0.90
64mm x 431mm	£3.22
95mm x 127mm	£1.50
95mm x 95mm	£1.10
95mm x 431mm	£4.80
119mm x 454mm	£6.20

BREADBOARD

81mm x 60mm	£3.30
175mm x 42mm	£3.74
175mm x 67mm	£5.56
203mm x 75mm includes mounting plate & posts	£7.36

COPPER BOARD (G Fibre)

100mm x 160mm	£0.90
110mm x 220mm	£1.34

PHOTO RESIST BOARD (G. Fibre)

3" x 4"	£0.86
4" x 6"	£1.62
4" x 8"	£2.09
6" x 6"	£2.41

PHOTO RESIST BOARD (Paper)

3" x 4"	£0.67
4" x 6"	£1.24
4" x 8"	£1.58
8" x 10"	£4.63

CAPACITORS

Ceramic Mini Disc 100 & 63V
1.0pF to 100nF
1pF-1nF £0.06, 1n2-2n7 £0.07,
3n3-4n7 £0.12,
10n & 12n £0.07
Polystyrene 160V 5% 47pF to 10nF
47p-2n2 £0.09, 2n7-10n £0.12

D CONNECTORS

	Plug	Socket
9 Pin	£0.29	£0.30
15 Pin	£0.39	£0.39
15 Pin H.D.	£0.81	£0.90
23 Pin	£0.40	£0.49
25 Pin	£0.48	£0.50
9 Way plastic cover		£0.30
15 Way plastic cover		£0.33
23 Way plastic cover		£0.36
25 Way plastic cover		£0.36

SWITCHES

3amp 250v 6.4mm ϕ mounting

SPST Toggle	£0.58
SPDT Toggle	£0.60
SPDT CO Tog	£0.64
DPDT Toggle	£0.68
DPDT CO Toggle	£0.76
DPDT CO Toggle (biased)	£1.20
DPDT CO Toggle (biased 1 way)	£1.20
DPDT mini slide	£0.15
Rotary Wafer 1P-12W, 2P-6W, 3P 4W, 4P 3W	£0.78
Key Switch SPST	£2.70
Push to make	£0.25
Push to break	£0.28
Latching Push Sqr	£0.63
PCB Tact 6 x 6mm	£0.25

RESISTORS

0.25W 5% CF E12 Series	£0.60/100
0.5W 5% CF E12 Series	£0.95/100
0.25W 1% MF E24 Series	£1.72/100
POTS Log or Lin 470R – 1MO 25mm dia 0.25in shaft	£0.42
PRESETS Enclosed Horz or Vert 100R – 1MO 0.15W	£0.15
PRESETS Skeleton Horz or Vert 100R – 1MO 0.1W	£0.11

★ PLEASE STATE VALUE REQUIRED ★

COMPUTER ACCESSORIES

Leads	
RS232 Lead Male 25 to Female 9	£3.99
Null Modem Lead Female 25-Female 25	£2.99
PC Link Lead Female 9 to Female 9	£2.99
PC Link Lead Female 9 & 25-Female 9 & 25	£4.50
Parallel Printer Lead 2m	£5.40
RS232 Lead (all pins) Male – Male	£3.75
RS232 Lead (all pins) Female – Male	£3.80
Centronics 36 Way Lead Male – Male	£4.78
Gender Changers	
9 Way D Mini Female to Female	£1.81
9 Way D Mini Male to Male	£1.95
25 Way D Mini Female to Female	£2.48
25 Way D Mini Male to Male	£2.48
9 Way D Female to Female	£2.33
9 Way D Male to Male	£2.48
25 Way D Female to Female	£2.71
25 Way D Male to Male	£2.71
Adaptors	
9 Way Male to 25 Way Female	£2.71
9 Way Female to 25 Way Male	£2.71
25 Way Male to 9 Way Female	£2.71
25 Way D Male to 36 Way Centronic	£3.88
25 Way Null Modem Female – Female	£3.02
25 Way Null Modem Male to Female	£3.02
25 Way Null Modem Male to Male	£3.02
RS232 Surge Protector Male – Female	£6.32
RS232 Jumper Box Male to Female	£3.02
RS232 Tester (7 LEDs) Male – Female	£6.59
Data Switch Boxes	
Serial Switch box – 2 Way A/B	£9.20
Serial Switch box – 3 Way A/B/C	£13.16
Serial Switch box – 4 Way A/B/C/D	£15.15
Serial Switch box – Cross over	£19.69
Parallel box – 2 Way A/B	£11.84
Parallel box – 3 Way A/B/C	£17.11
Parallel box – 4 Way A/B/C/D	£18.43
Parallel box – Cross over	£20.42
Disks – 3.5" DSDD Disks Pack of 10	£4.56
3.5" DSDD Disks Pack of 50	£17.95
3.5" DSHD Disks Pack of 10	£6.45
3.5" DSHD Disks Pack of 50	£28.48
3.5" x 50 Disk Storage Box	£4.26
3.5" x 100 Disk Storage Box	£5.45

DIODES

Zener Diodes 2V7–33V	
BZY88400Mw	£0.08
BZX85 1.3W	£0.14
1N4001	£0.06
1N4002	£0.07
1N4003	£0.07
1N4004	£0.07
1N4005	£0.07
1N4006	£0.08
1N4007	£0.08
1N5400	£0.09
1N5401	£0.09
1N5402	£0.09
1N5404	£0.11
1N5406	£0.11
1N5407	£0.14
1N5408	£0.15
1N914	£0.06
1N916	£0.06
1N4148	£0.05
BY133	£0.13
OA47	£0.28
OA90	£0.07
OA91	£0.10
OA202	£0.27
BA157	£0.10
BA158	£0.10
BA159	£0.10
1N4149	£0.06
OA200	£0.10

ORDERING INFORMATION

All prices exclude VAT
Please add £1.25 carriage to all orders and VAT (17.5%)
No minimum order charge.
Please send payment with your order.
PO/Cheques made payable to
ESR Electronic Components
Access & Visa cards accepted
Offical orders from schools & colleges welcome.

CALL IN – OPEN: MON-FRI 8.30-5.00 SAT 10.00-5.00

PROJECT

Send Your Data By *Laser Beam*

In this fascinating project, Ken Gill shows how to link two computers and transfer data between them using no wires or cables, just a beam of infra-red light.

Imagine the problem faced by a business which has premises on either side of a busy road. On each side of the road, they have a PC but to use them efficiently, they need to be able to transfer data between them. So what is the solution?

They could send someone across the road ten times a day with the floppy disk. Not the best idea, it is after all a very busy road. Alternatively they could use modems and the telephone network to link the two computers and transfer the data. A neat solution but also one which could run up serious phone bills.

Of course one could take a do-it-yourself approach and string a cable across the road between the two buildings. But council road traffic departments take a rather dim view of anyone stringing pieces of cable across a road. So not worth trying unless you are BT or one of the electricity companies.

The solution is, of course, a line of sight optical link. No cables, no modems, no repeated crossing of the road with a floppy disk, just send the data down a beam of light!

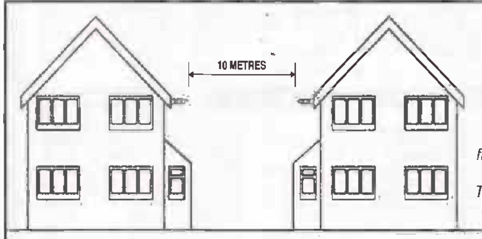
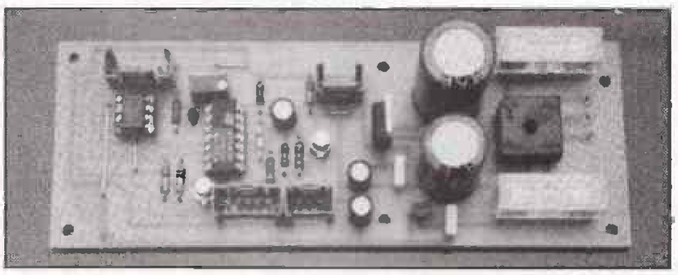


Figure 1 showing overall idea of system. Range of models should not be greater than 10m. There should be no obstacles in the beam's way to cause reflections from one transmitter back to the adjacent receiver. This will cause an echo to occur and slow down the data transfer.

An Overview

A simple alternative to a wire or fibre optic link from one piece of equipment to another over a short distance can be very useful if it overcomes the problems associated with both running a cable between the two pieces of equipment and protecting the cables from outside interference. In the above example we have the case of running a serial data link from one building to another over ten metres a part. If the cabling is run inside the building, then the



Main PCB, signal processor and power supply

problem of cable protection has to be addressed, more so if the cable is to be run along the outside of a building and is exposed to all weathers.

The system described here uses a similar principle to the one already used in the remote controllers, found with a number of domestic televisions and video recorders. With such systems, the remote control device is used to send special control codes to the television or video, which will then perform the relevant function. Press a specific button on the hand held controller and the channel will be changed or the sound volume lowered.

This project uses an infra-red beam to send data continuously to and from either end of the system at the same time, i.e. full duplex. It thus provides a simple secure data link between two buildings with the minimum of installation. In terms of cost, this is a very economic way of sending data. To perform the same linkage using twin fibre optic cables would require cable totalling some forty metres in length. If we were to utilise polymer cables, then the component cost is very similar to the design described in this article, but what must be considered is the actual cost of cabling. Protecting such a cable, if surface mounted to a building, or indeed laid under ground is a problem and the alternative of having a cable strung above head height may be unsightly or impractical. Using copper cables to convey the same information over the same installation again runs into problems of running and protecting these delicate cables.

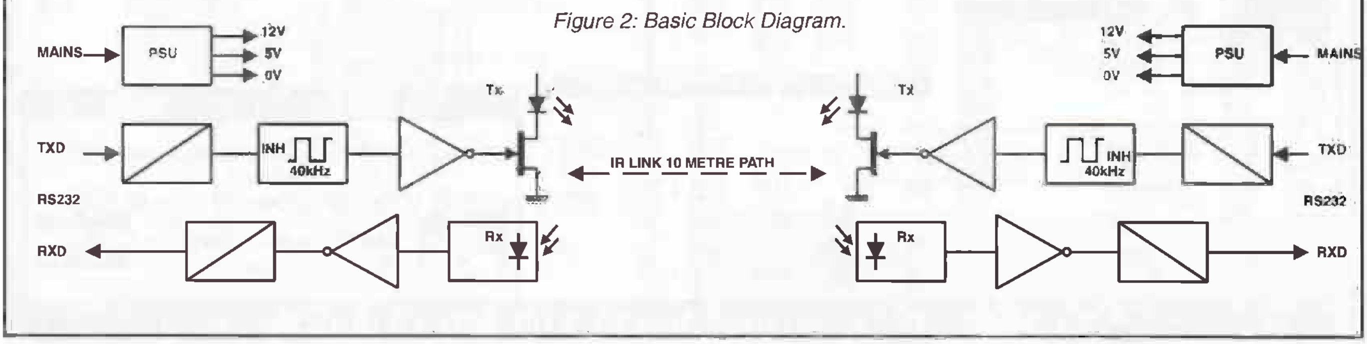


Figure 2: Basic Block Diagram.

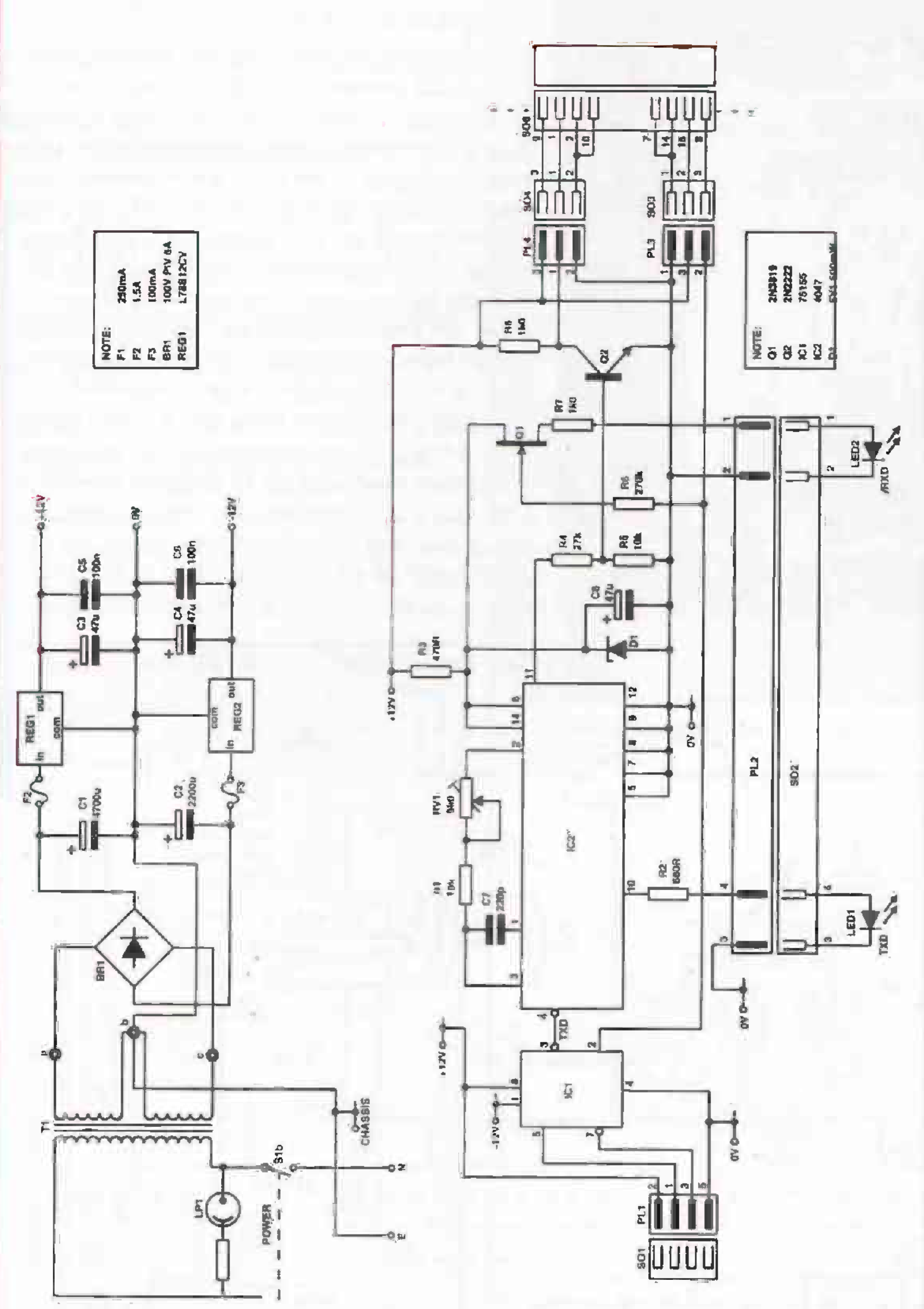


Figure 4: Circuit diagram of power supply and interface circuitry

Cost

The cost of such a system is comparable with a conventional fibre optic system, when considering the cost of fibre optic cables over, in this example, a twenty metre run with forty metres of cable (one cable for transmit and one for the receive data path). The data rate, on the other hand, would without doubt be much higher through such a cable. The cost of protecting the fibre optic cable through a run in the ground would prove a problem and perhaps the most cost effective means of running a data cable would be the use of a copper cable. Here, the problems with such a long cable run will have its effect on the ultimate speed of the cable, necessitating perhaps the use of RS485 to cover this distance at higher speeds. The cost again has to be born to protect the cable.

The Mechanical Side

There is one set of equipment at each end the system. This comprises of a mains power supply and associated circuitry, and two remote heads, one head for the IR transmitter and optics, the second enclosing the IR receiver circuitry and optics. This makes for easy construction of the optical system, utilising mainly 1.5in plastic waste pipe and fittings to fabricate water tight enclosures which need to withstand the variations in weather. Additional metalwork is needed to make the supports for the optical assemblies, which is minimal. The power supplies and signal processing circuitry, including the serial equipment interface, are housed within a separate enclosure, making a total of three parts at each end of the system. Each end has to be duplicated, doubling the equipment, work and cost.

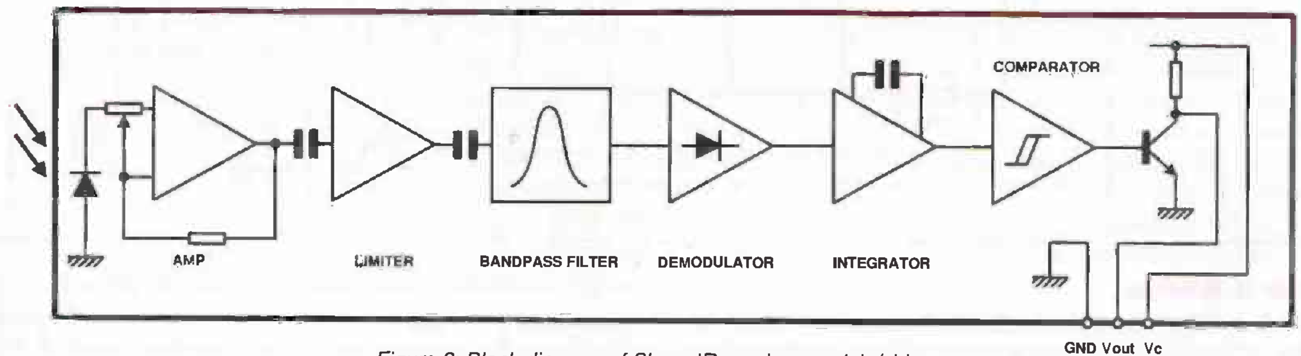
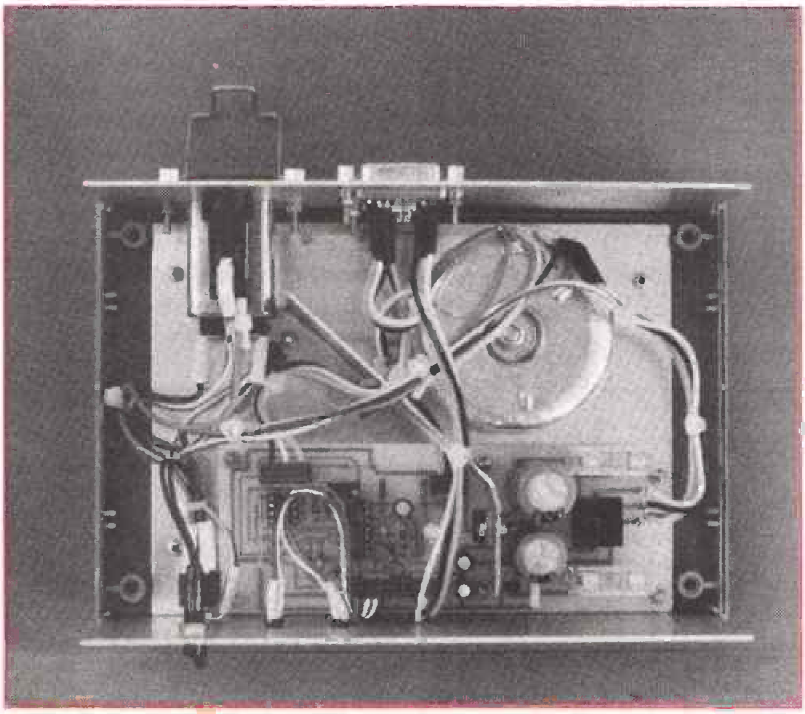


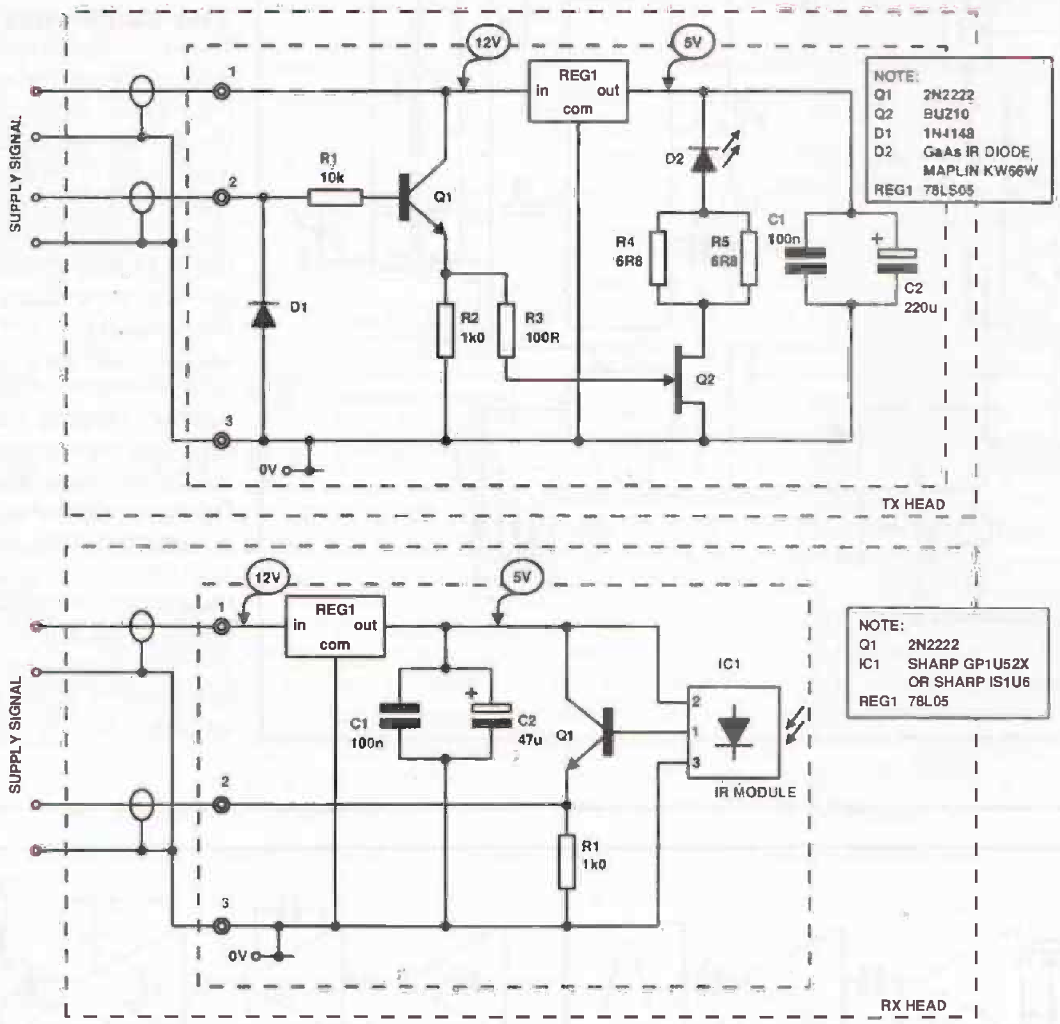
Figure 3: Block diagram of Sharp IR receiver module/chip



others. In this system, the simpler approach has been undertaken. The AM system has been adopted, which is adequate for the distance which this serial link is to cover.

Considering the circuit diagram, we will look at the transmit path first. The RS232C serial data comes to the modem via the 9 pin D-type connector, through the transmit path to pin 5 of IC1. This is then inverted and passed on to IC2 pin 4 which is a gated astable oscillator running at 38 to 40kHz, the actual frequency being set by adjusting RV1. The running frequency of this oscillator is dependent on the IR receiving devices used in the system, but more about that later. The output from the astable is fed to a driver transistor TR2 which sends the data down a cable to the remote head, which houses the transmitting IR LED and driver circuitry. TR2 converts the TTL logic levels to 12V logic levels. The square wave, when enabled at pin 11 of IC2, is at a TTL level. This is accomplished with TR2 and gives a higher drive level to the remote transmitter head, which would be a 12V. The IR LED is pulsed at a current of just under 1A through the FET TR2 (TX

Figure 5: Circuit diagram of transmit and receiver heads



How it Works

Most IR systems use some form of modulated carrier (950nm) which is controlled to a degree, either switched on and off in the case of AM systems, or frequency modulated (FM) in head) and current limiting resistors R4 and R5. Within the remote transmit head assembly, provisions are made to provide the transmitter assembly with it's own regulated supply in the head. It was thought best to isolate the supplies to each remote

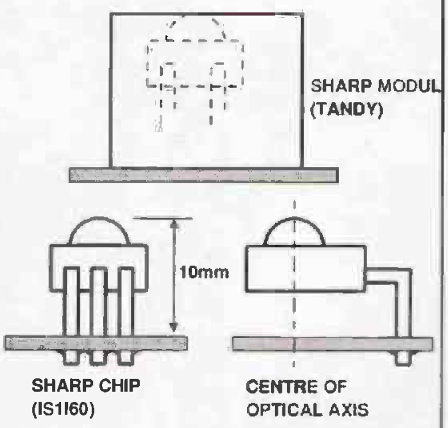


Figure 6: Mounting details of IR receivers

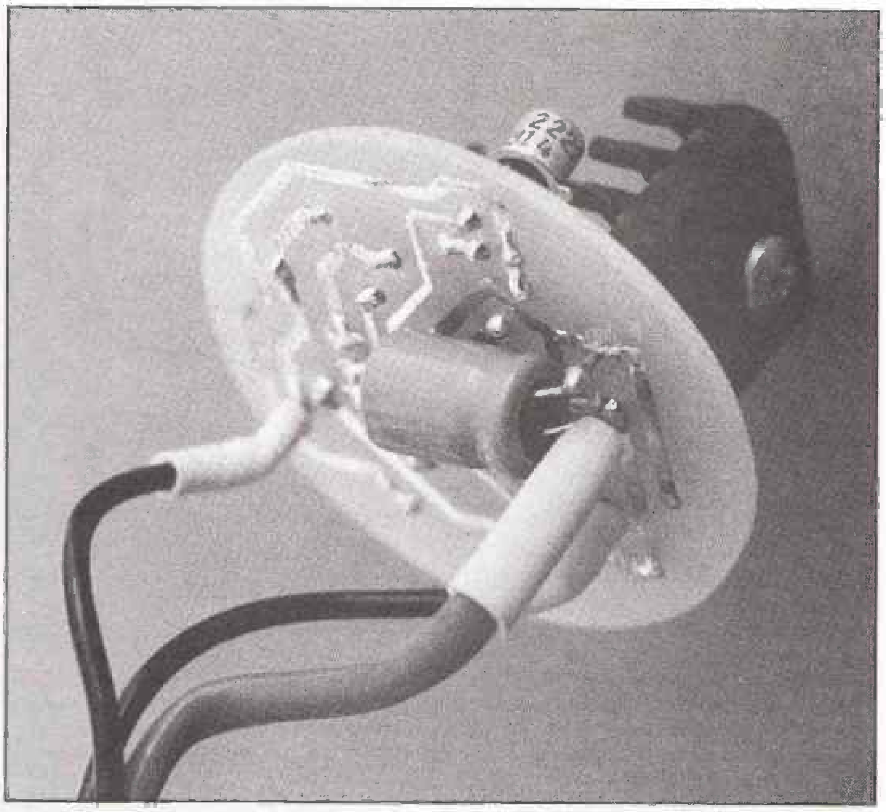
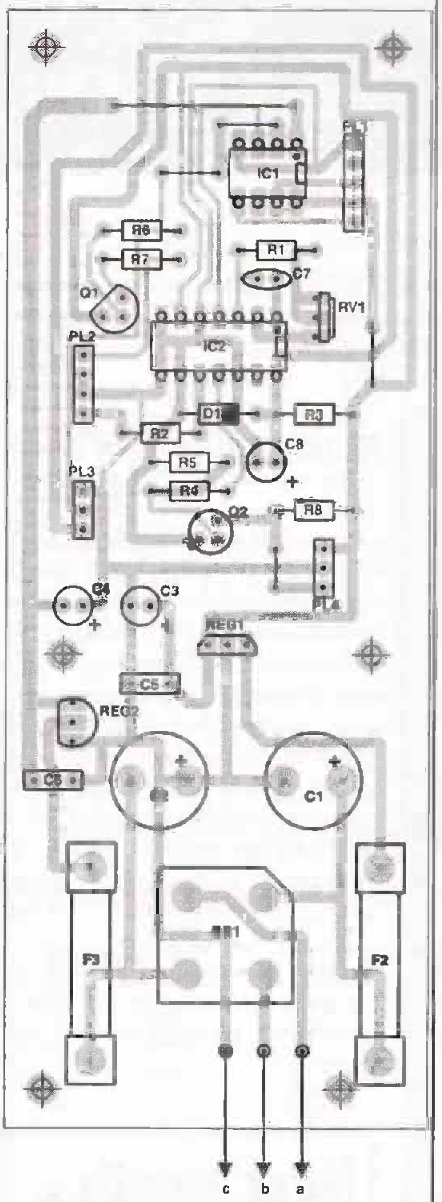


Figure 7: Component placements



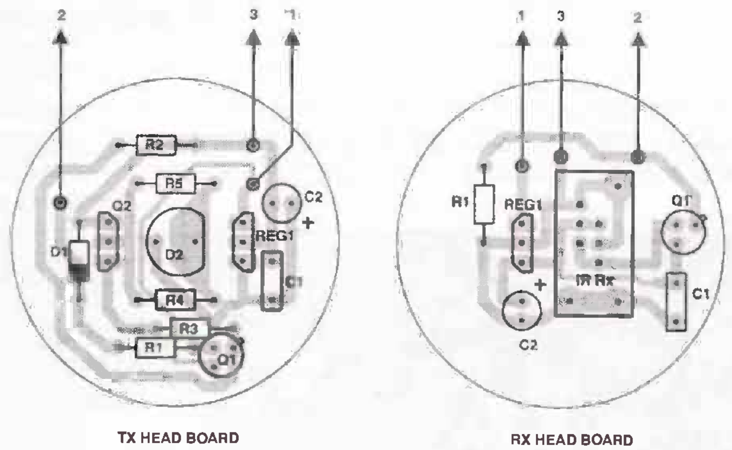
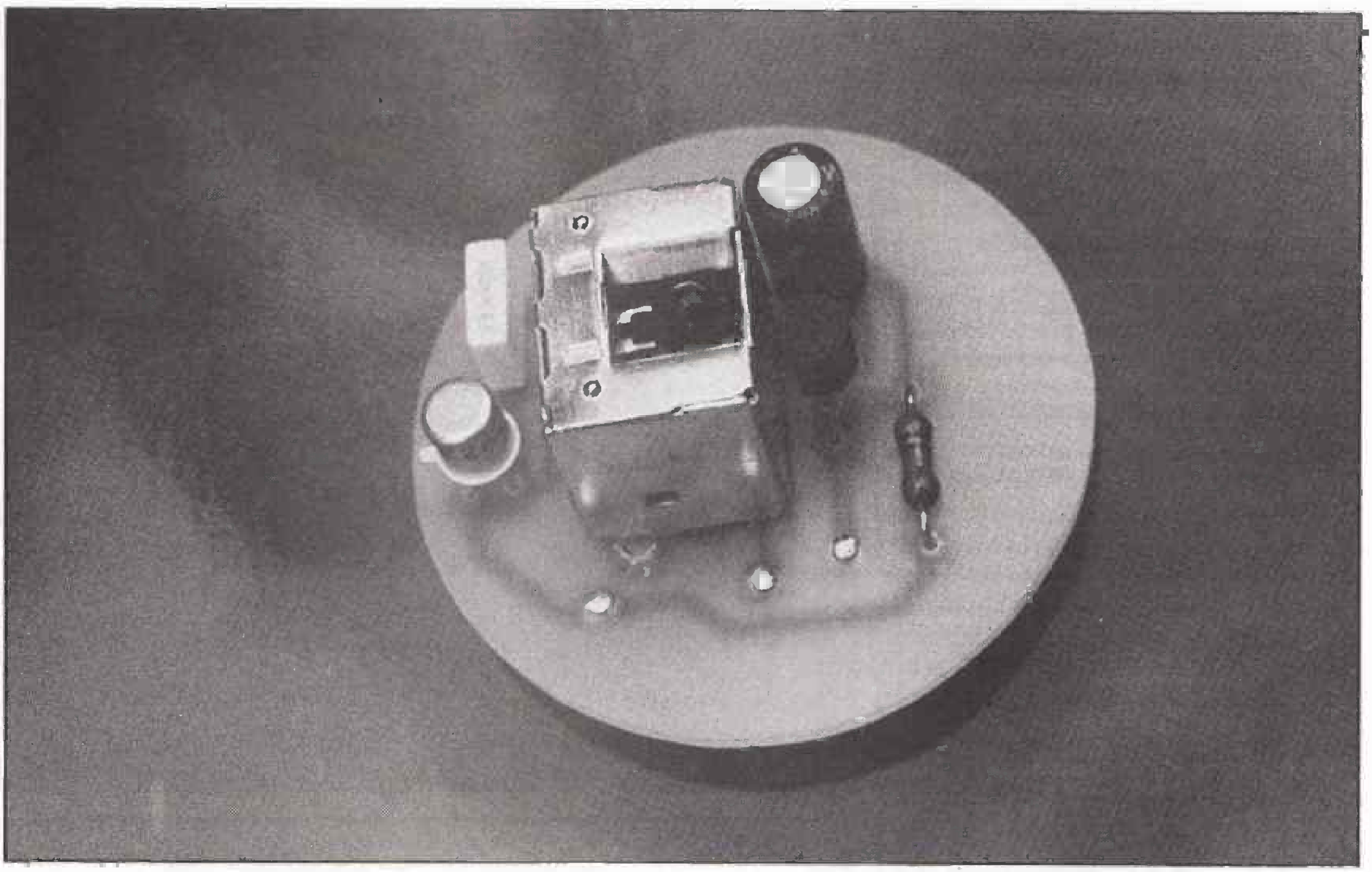


Figure 8: Component placements, C2 of Tx head is placed on trackside of board

head, albeit the transmit head or the receive head. The component dissipating any appreciable power is adequately heat sinked, with the 5V regulator in the transmit head.

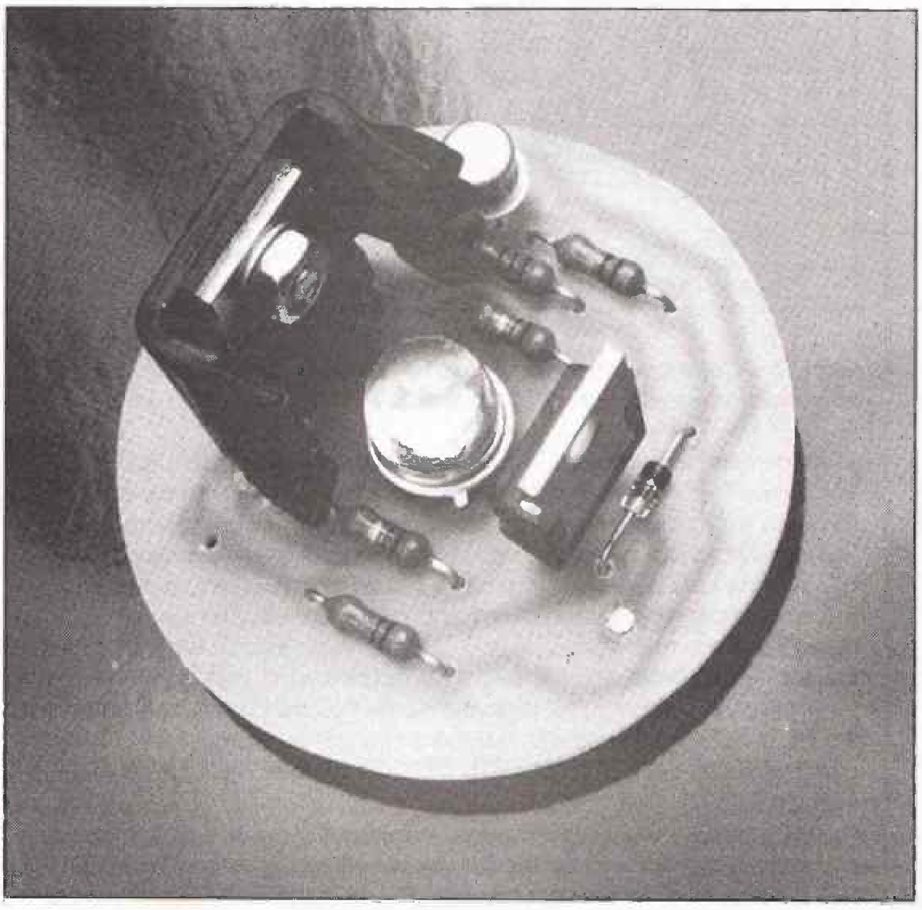
The receive head is housed in a similar enclosure to the one used in the transmitter. The circuitry within the head is powered and regulated on the receive PCB with an individual 5V regulator, in order to isolate the receiver's power supply. The received signal is picked up by the IR module (or chip) and processed in that device where the IR receiver is a complete system in it's own right, i.e. amplifier, limiter, band pass filter, demodulator, comparator and driver. The output from the device is in the form of an inverted pulse, i.e. TTL, which then passes on to an emitter follower TR1 (RX head). This then sends the received signal, inverted, to IC1 pin 2 down the cable connecting the head and the main control circuitry, which then drives the TTL to RS 232C converter (IC1) and on to the connected equipment. In the prototypes case, this is a number of TNC's (Terminal Node Controllers, used for packet radio).

TR1 is an LED driver which indicates the presence of received data and is connected to the received data line from the remote receiver head. TR1 is a junction FET and is a source follower that drives the RXD LED, LED2, the gate impedance of



Sharp I.R. module mounted on Rx P.C. B.

which is high, so it does not appreciably load the output from the IR receiver. LED2 will illuminate when there is no activity from the IR receiver module. It could be regarded as a NOT RXD (NOT Received Data) indicator. If power were to fail at the IR receiver, then the LED would extinguish, indicating a fault with the RX head. Transmitted Data (TXD) is indicated by LED1 which is driven from the Q output of IC2, pin 10.



IR Remote Control Receiver

In the receiver head, provisions have been made to cater for one of two IR receivers. The prototype was developed around the Sharp GP1U52X IR module, which runs at 40kHz and is currently available from Tandy. The alternative is the IS1U60, also manufactured by Sharp and available from RS Components, stock no 577-897. This runs at 38kHz. The difference in operating frequency of the two components is accounted for at each end of the IR link, where the frequency adjustment of the sub-carrier frequency of 38 or 40kHz is provided with RV1. Therefore, the IR modules can be bought from either one of two suppliers, but it would be wise to use the same type IR receiver modules at both ends of the system and not mix types.

Next month...

We look at construction set up and use.

PARTS LIST

Power Supply and Interface Circuitry

Resistors

R1	18K (all resistors are 0.6W metal film)
R2	680R
R3	470R
R4	27K
R5	10K
R6	270K
R7	1K0
R8	1K0

Capacitors

C1	4700µF 35v radial elect
C2	2200µF 35v radial elect
C3	47µF 25v radial elect
C4	47µF 25v radial elect
C5	100nF 63v metalised polyester
C6	100nF 63v metalised polyester
C7	220pF 100v monolithic ceramic
C8	47µF 25v radial elect

Diode

D1 5v1 500mW zener diode, BZY88C/5V1

Rectifier

BR1 100V PIV 6A bridge rectifier

Transistors

TR1	2N3819
TR2	2N2222

Regulators

REG1	L78S12CV 12V 2.5A TO220 regulator
REG2	79L12 -12V 100mA TO92 regulator

Semiconductors

IC1	SN75155
IC2	CD4047

Transformer

T1 12V, 12V secondary 30VA toroidal transformer, 240V primary

Miscellaneous Components

Neon mains indicator, DPDT mains switch, 250mA 20mm fuse and panel holder, 1.5A and 100mA 20mm fuses and printed circuit board mounting holders. Molex PCB plugs and sockets. 9 and 15 way D-type plugs and sockets and covers. Enclosure, wire, solder tags, mains filter optional. LEDs. PCB. Terminal pins (1.00mm)

COMPONENT LISTING (ELECTRONIC)

Remote Heads (TX head)

Resistors

R1	10K
R2	1K0
R3	100R
R4	6R8
R5	6R8

Capacitors

C1 100nF 63v metalised polyester
C2 220µF 16v radial elect. (mounted on rear of board, see photo)

Diodes

D1 1N4148
D2 GaAs IR photo emitting diode, Maplin stock number KW66W

Transistors

TR1	2N2222
TR2	BUZ10

Regulators

REG1 78LS05 5V 2.5A regulator

Miscellaneous Components

Terminal pins (1.0mm), connecting cable (twin individually screened cable, Maplin stock number XS26D used in prototype). Cable glands. PCB

COMPONENT LISTING

Remote Heads (RX head)

Resistor

R1 1K0

Capacitors

C1	100nF 63v metalised polyester
C2	47µF 25v radial elect

Transistor

TR1 2N2222

Regulator

REG1 78L05, 5V 100mA TO92 regulator

Semiconductor

IC1 SHARP GP1U52X IR receiver module (40kHz), available from Tandy, or SHARP IS1U60 (38kHz) available from RS Components, stock number 577-897

Miscellaneous Components

Terminal pins (1.0mm), connecting cable (twin individually screened cable, Maplin stock number XS26D used in prototype). Cable glands. PCB

MECHANICAL PARTS

Optical Assemblies
3ft 1.5in PVC waste pipe
PVC glue for waste pipe
4 reducers, 1.5in to 1.25in
4 blanking plugs 1.25in
8 couplers 1.5 to 1.5in
4 blanking plugs 1.5in
4 cable glands
Silicon rubber sealing compound or Evostik
Lens, Maplin stock number FA95D
8 1.5in pipe clamps.
Metal sheet to fabricate head assembly

New from Argus Books!

SCANNERS 3 –

Putting scanners into practice a new edition **by Peter Rouse.**

This is the 4th revised and completely updated edition of Scanners. This new edition has seen the largest ever number of changes and additions to the point of being a virtual rewrite, and contains everything you need to know to put your scanner to better use.

There is vastly more information than ever on frequency listing, particularly those by coastal stations, airfields and the emergency services. Also included for the 1st time is a section on HF (short wave) bands. Together with actual frequency listings for these services, full British bandplans from 25 to 2000MHZ are given, including cordless and cellular telephones, private mobile radio, amateur radio, repeaters, beacons, satalites, (amateur, military, communication, navigation and weather. Including *COSMOS* and *NASA Space Shuttle Frequencies).*

Fully illustrated throughout, including a comprehensive section featuring the actual scanners currently available.

This book includes all the information you need to put your Scanners into practice.

❒ Scanners 3 – Putting Scanners into Practice.
ISBN 1 85486 1066 9 £9.95
p&p + 10% minimum £1. U.K. only. Overseas + 20%.
Telephone orders 0679 66905.

I enclose my remittance of .... Please make cheque payable to Bailey Distribution and send to the address below Please charge my Mastercard/Visa

Expiry Date: .... Signature ....

Name ....

Address ....

.... Post code ....

Complete details and return to Bailey Distribution Ltd, Units 1a/1b Learoyd Road, Mountfield Road Estate, New Romney, Kent. TN28 8XU. Please ensure that all cheques are made payable to Bailey Distribution.

BUILD YOUR OWN PC

Using our low cost component parts or we can assemble for you for only £25

386 MOTHERBOARDS
386SX-33MHz £72
386DX-40MHz .... 128k Cache £99

486 MOTHERBOARDS With VESA Local Bus
2 Slots & Pentium P24T Socket.

486SX-25MHz	256k Cache	£159
486DX-33MHz	256k Cache	£279
486DX-40MHz	256k Cache	£299
486DX2-50MHz	256k Cache	£290
486DX-50MHz	256k Cache	£369
486DX2-66MHz	256k Cache	£399
486DX-33MHzEISA	256k Cache	£399
486DX-40MHz EISA	256k Cache	£420
486DX2-50MHz EISA	256k Cache	£425
486DX-50MHz EISA	256k Cache	£480
486DX2-66MHz EISA	256k Cache	£520

HARD DISK DRIVES

130MB	IDE 16ms	£150
170MB	IDE 15ms	£159
213MB	IDE 15ms	£179
250MB	IDE 12ms	£189
330MB	IDE 12ms	£229
420MB	IDE 12ms	£360
540MB	IDE 12ms	£430
1GB	SCSI-2 9ms	£699
2G4B	SCSI-2 10ms	£980
Hard Disk Mounting Brackets		£5

FLOPPY DISK DRIVES
3½" 1.44Mb Floppy Disk Drive £33
3½" 1.44Mb Floppy with 5¼" Frame £36
5¼" 1.2Mb Floppy Disk Drive £35

MONITOR
14" Mono VGA £89
14" SVGA Colour (Interlaced) (0.28mm) £175
14" SVGA Colour (Non Interlaced)(0.28mm) .. £199
17" High Resolution (0.28mm) £640

MEMORY
256K x 9 Simm 70ns £13
1M x 9 Simm 70ns £36
4M x 9 Simm 70ns £125

DISPLAY CARDS
Oak 16-Bit SVGA Card 256k £25
Oak 16-Bit SVGA Card 512k £30
Oak 16-Bit SVGA Card 1MB £49
VESA Local Bus SVGA 1MB £70
VESA Local Bus SVGA 2MB £99
VESA Local Bus S3 Windows Accel 1MB £110
VESA Local Bus S3 Windows Accel 2MB £140

KEYBOARDS
102 Key Standard £22
102 Key Deluxe £27

ADD-ON CARDS
I/O Card 2S/1P/1G £12
IDE Card 2HD/2FD with Cables £12
IDE I/O Card 2HD/2FD/2S/1P/1G with cables .. £16
VL-Bus IDE I/O card as above £29
VL-Bus IDE Caching controller 4HD/2FD £129
VL-Bus SCSI-2 IDE I/O card £125
SCSI-2 card with software £89
Future Domain SCSI with cables £45
Future Domain SCSI 2S/1P/1G with cables .. £59
16-bit Ethernet card (NE2100 compatible) £59

OTHER ITEMS
Microsoft Compatible Mouse £12
Deluxe Desktop Case (200W PSU) £55
Mini Tower Case (200W PSU) £59
Tower Case (250W PSU) £89
MS-DOS 6.2 .... £39
Windows 3.1 .... £35

CD ROM DRIVES
Mitsumi CD-ROM Drive with Interface card £129
Panasonic CR-562B Double speed CD-ROM £165
Toshiba XM3401 D Speed SCSI CD-ROM £295

Eurocom International Ltd
Telephone (035 388) 325

The Old School, Prickwillow, Ely, Cambridgeshire, CB7 4UN.

Call for free catalogue or send cheque with order. Carriage £12.00 per order. All prices exclude VAT please add at current rate to total order.

PC Clinic

In the first article in a new series on repairing, maintaining, and upgrading PCs, Nick Hampshire takes an initial look under the cover.

It is just fifteen years since the first IBM PCs started to appear on desktops across the world and few could have realised that it was the beginning of a revolution. Today, there are an estimated 120 million PCs in use around the world, over 8 million of them in the UK alone.

All this represents an enormous world-wide investment in PC hardware and software. If one adds the cost of the PC to that of the various peripherals used, and the software packages run on it, then we are probably looking at a world-wide capital investment of around £600 thousand million. In the UK alone we are probably looking at an investment of £40 billion.

This is an enormous amount and one which, in terms of magnitude, is in the top ten product categories. It is not surprising, therefore, that software and hardware upgradeability is such an important factor in this industry. A state of the art Pentium system can still run the same software as the very first PC and you can still connect it to the same peripherals, the same printers and plug in the same adapter cards.

There is now a considerable market in upgrade components and spare parts. Users are starting to realise that you do not need to throw away the whole system in order to upgrade it. Adding more memory, a better video display, larger disk drives, even a new processor, is not difficult and can be lot cheaper than buying a whole new system.

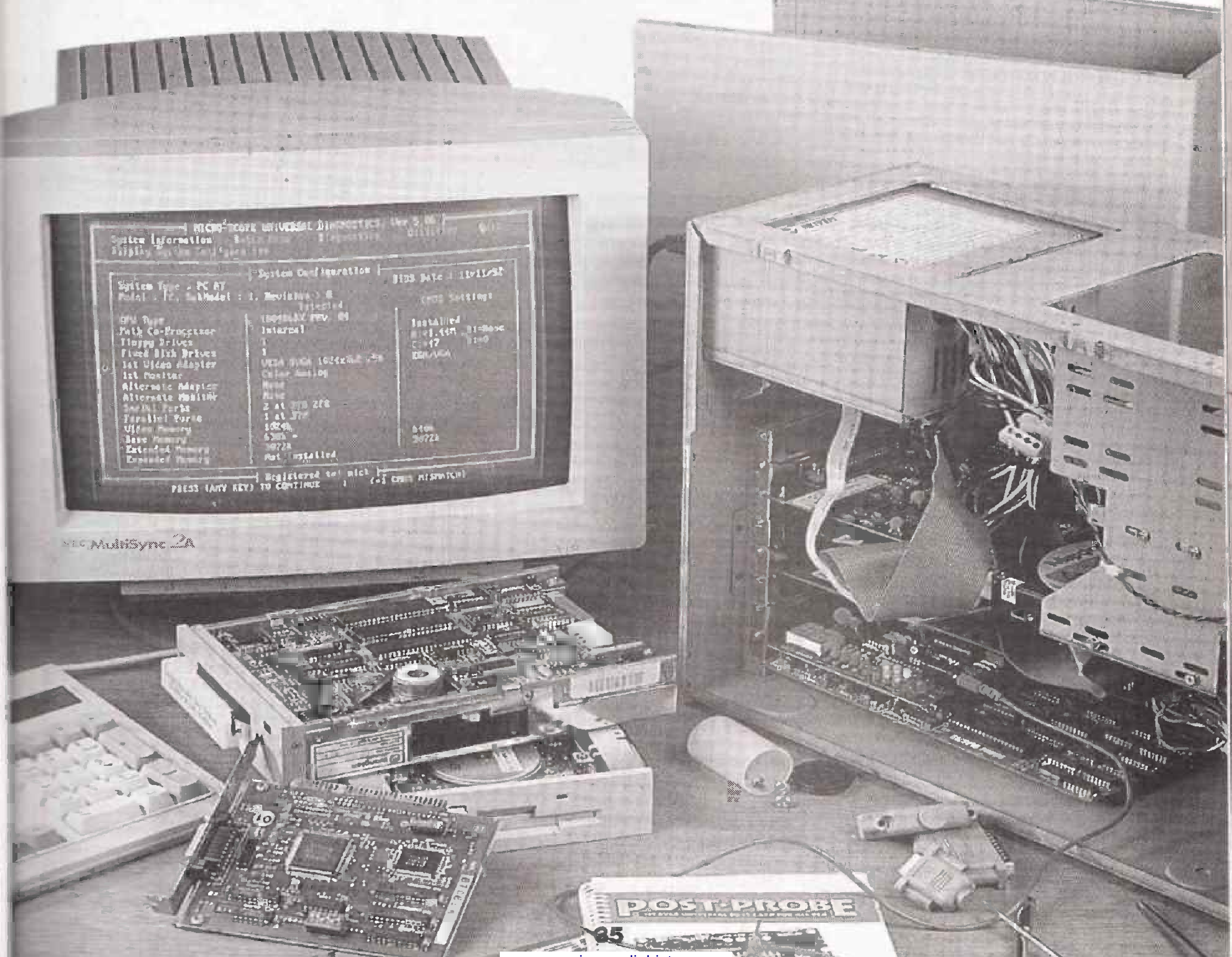
As a result of the continuing use of old systems and the increasing demand for upgrading such machines, it is hardly surprising that there has also been, in the last couple of years, an explosion in the demand for people capable of servicing and maintaining PCs. Indeed, the US Government has estimated that over 250,000 new jobs will be created by the end of the decade in servicing, upgrading, and maintaining PCs. That is a lot of jobs, and if one takes the same proportion of new jobs in relation to the number of installed PCs in the US, and apply it to the UK, then we should be looking at between 40 and 50,000 new jobs in this country.

So, if you are a PC owner or user (and according to our reader surveys over 90% of ETI readers are) it can be well worthwhile learning how to repair, trouble-shoot, maintain and upgrade PCs. With such a shortage of skilled people, most of us will have to resort to doing it ourselves, hence the reason for this series of articles in ETI. Of course, these articles may just persuade some readers to decide to take it up professionally!

The series will provide readers with a sound introduction to the PC's hardware which will, in conjunction with other ETI projects, enable you to repair faulty systems, salvage old machines, build and design plug in boards, upgrade systems, build your own specification system using commercially available boards and cases and generally understand and find your way around the hardware of a PC.

The way that the series has been designed means that it should appeal to everyone. Readers with little prior knowledge of electronics and computing will find plenty of interest and those with a good grounding in these subjects will find that the information given opens up new areas for experimentation.

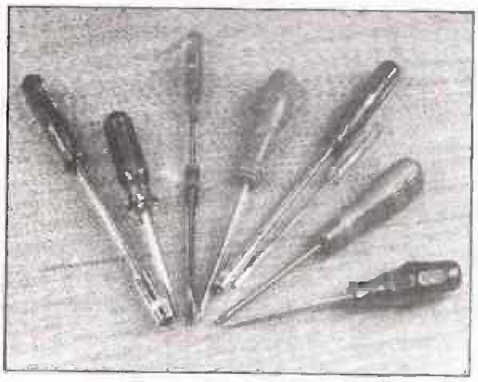
➤



PC Toolkit

Before attempting to do any work on a PC, a limited range of tools should be at hand. The number of tools required to perform basic upgrading tasks is not extensive, but should not be skimped upon. Most of us at some time or another have improvised with tools, used a knife blade instead of a screwdriver, or a flat blade screwdriver to undo a Pozidrive screw, or a pair of pliers instead of a nut driver. Invariably, one damages the screw and if the improvised tool slips one can damage oneself, or worse still with electronic equipment, damage a PC board.

Resist the temptation to improvise, the basic toolkit will cost less than £20 and can be used for other purposes as well as fiddling around inside PCs. One important point to note when choosing your toolkit is that all tools must be non-magnetic. This obviously precludes using some of the combination toolkits, since these often have a magnetic bit clutch. The reason for this is, of course, that there are many components within a PC which can be damaged by exposure to a magnetic field.



Screwdrivers and Nutdrivers

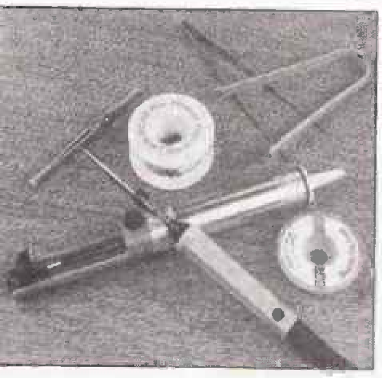
Screwdrivers are one of the most important components of the basic toolkit and the range should include a small and medium Philips screwdriver and a small and medium flat blade screwdriver, while a useful addition is a medium flat blade screwdriver with a spring clutch, that will hold a screw onto the blade so that it can be easily inserted into a difficult location. These basic screwdrivers will undo most of the screws used in most systems, but if you are dealing with a Compaq, or Apple system, you will need a special sort of screwdriver called a Torx driver. Without such a driver you will not be able to get into such systems and you will also find Torx screws used on components which are not meant to be user serviceable, such as power supplies and disk drives. Two sizes of Torx driver will be needed, a T10 and a T15.

You will also meet a range of screws with six sided heads, such as the ones used to secure the case, or adapter cards. In most cases, these are also slotted for Philips or flat blade screwdrivers, but sometimes they are not and in such situations a nut driver is an invaluable aid. You will need a 1/4in driver to remove the case screws and a 3/16in driver to remove the adapter card screws.

Gripping and Retrieving

The basic toolkit should also include a chip extractor and a chip inserter. Both are particularly useful for adding and removing memory chips, such as those used on memory expansion boards and can prevent a lot of problems with bent IC pins. If IC pins do become bent, then a small pair of needlenose pliers can be used to straighten them out.

You will also find a pair of tweezers useful for retrieving small parts and removing jumper blocks. When screws and other components become lost deep in the interior of the system, such as under the motherboard, then a small flexible claw type parts grabber can save you having to completely disassemble the system. To prevent screws and other small components getting lost, a small plastic container with a snap on lid, such as 35mm film container, is an invaluable component of the toolkit. Though not an essential part of the basic toolkit a pair of wire cutters can be very useful, as is a wire stripper.



Soldering and Unsoldering

When repairing systems there will be many occasions where it will be necessary to replace a component which is soldered into one of the boards, or to repair a broken wire. You will need to be able to both solder and unsolder. For soldering a low wattage soldering iron is essential, nothing more than about 25W, since higher wattage irons generate too much heat and can thus damage both the component being soldered and the board. To reduce the possibility of heat damage, it is a good idea to use a clip-on heatsink which will absorb excess heat before it reaches the component.

For unsoldering, there are two commonly used techniques which are designed to remove the unwanted solder that links the component to the board. The cheapest solution is to use a desoldering braid (a woven tape of flux impregnated with very thin copper wire, into which the solder melted by the soldering iron is drawn using capillary action). The other solution is to use a solder sucker, which uses a form of air pump to suck away the molten solder, but which ever technique is used, be very careful not to apply too much heat and damage the board.

Dirt, Dust and Overheating

Dirt and dust constitute an ever present enemy for electronic equipment of all kinds, but a particular hazard for computer equipment. Open up any machine which has been in use for a few years and you will find it full of the stuff. It is important to keep a machine relatively clean, since dust and dirt could easily damage components such as disk drives. A combination of dirt and oxidation can also cause problems with connectors of all sorts, leading to malfunction of the entire system or of certain components.

Cleaning a system is therefore one of the first tasks in any repair/maintenance procedure. A small paintbrush is a first line of attack. However, there are a lot of very inaccessible places on a PC and an excellent way of removing dust from such places is to use a can of compressed air, often to be found in photography shops under the name Spraydust.

For cleaning contacts and PCB edge connectors, a good tip is to rub a soft pencil eraser over the contact (make sure it is the soft type and not one of the rather abrasive ink erasers). This will help get rid of any thin film of oxidation that may be causing problems, then clean off the residue using isopropyl alcohol on a lint free cloth. Isopropyl alcohol can be obtained from a chemist and will dry off without leaving any moisture.

On the subject of chemicals there is one further product which may prove very useful in tracking down an intermittent fault, caused by a chip, or any other component, getting too hot. This is a can of spray freezer - a small quantity squirted onto the suspect device will cool it down and, if the fault disappears for a while, then obviously you have a heat related problem with that component.

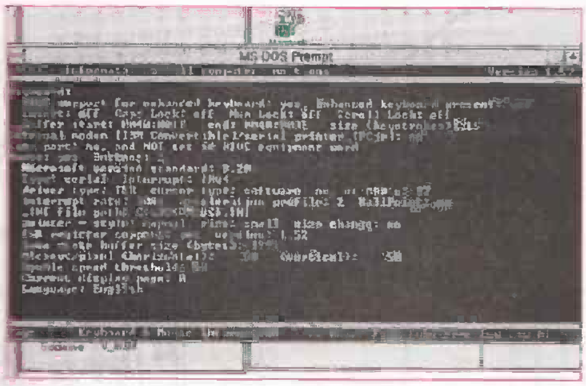
WARNING - some of these chemicals are highly flammable and should not be used in confined spaces or near naked flames. Always read and obey the instructions on the container!

What is in your system?

Simply looking at a PC from the outside it can be very difficult, if not impossible, to determine the machine's hardware configuration. Even taking the cover off and looking at the boards will not necessarily tell you everything about the machine.

Fortunately, the design of a PC means that the system knows all about itself, how much memory it has, how many and what type of disk drives, which video adapter card, how much cache memory, which processor and co-processor - if any, the interrupt allocations and a lot, lot more. All that is needed, therefore, is a special program which, when run in the system, will analyse it and, if required, produce a print-out of that analysis.

There are quite a few programs of this sort on the market today, either as commercial products, as shareware, or as public domain software and a typical example is a program called InfoPlus.



This was written by Andrew Rossmann, who released Version 1.56 into the public domain on December 30th 1992. Copies are available from ETI at a minimal cost - see the box at the bottom of this page.

All one has to do is load and run InfoPlus from the DOS prompt and then let the program do the rest. It takes just a few seconds for the program to analyse the system on which it is running and obtain information about all its hardware components, over twenty pages of information in total. The pages output by InfoPlus are as follows:

1	System and ROM identification	11	Environment variables
2	CPU identification	12	Device drivers
3	RAM identification	13	DOS drive information
4	Memory block listing	14	BIOS drive information
5	Video display type	15	Partition table listing
6	Video data	16	Boot and DOS drive parameters
7	Keyboard and mouse information	17	CMOS data
8	Serial, parallel, and sound ports	18	TSRs and drivers
9	DOS information	19	Alternate multiplex
10	Multiplex programmes	20	Memory managers

As can be seen, InfoPlus gives the user a pretty impressive collection of information about the system he or she is using, which can make an excellent starting point for solving a wide range of hardware related problems, ranging from IRQ conflicts, to checking memory usage.

By simply typing InfoPlus at the DOS prompt you will be able to display all the above information on the screen, one page at a time, but the program can also be more selective thanks to the use of a range of switches, which are as follows:

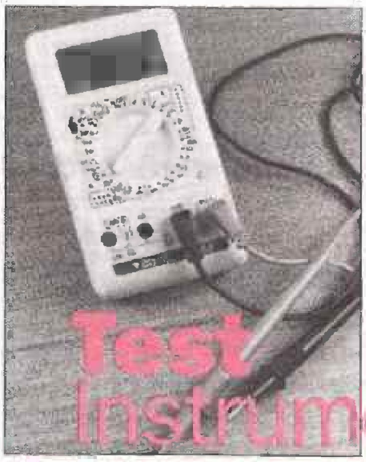
AP	autoprints all screens and asks for set-up	F	leaves 16550 FIFOs enabled
AP:filename	autoprints to a file or device	H	displays the help screen
B	writes to screen using BIOS	M	uses monochrome colours
C	uses normal colours	NP	specifies not to read partition table
D	writes directly to screen memory	NV	specifies not to perform VGA chipset detection

Programs like InfoPlus are a valuable tool in fault diagnosis and in upgrading unknown systems. It is well worthwhile obtaining a copy.

Disk offer

ETI can supply copies of InfoPlus version 1.56 to readers who require them. This is a public domain program so we are simply making a small charge, £6 inclusive of P&P, to cover the cost of the disk and the various handling charges. To get your copy, simply send a cheque or postal order for £6 made out to ASP, to: Reader Services, ASP, Boundary Way, Hemel Hempstead, Herts HP2 7ST. Please make sure that you quote order reference number E9406 D.

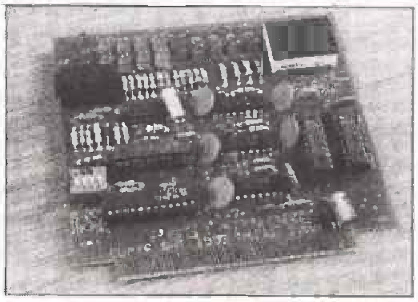
Test Instruments



Besides a range of hand tools, a few pieces of test equipment can prove very useful in tracking down faults. A good quality digital voltmeter is an excellent investment and a suitable one can be obtained for between £30 and £50. It should be capable of measuring AC/DC voltages and currents as well as resistance. Such a meter can be used to check the power supply on the main boards, as well as the state of various bus lines (though for this purpose a simple logic probe is the best solution and we will be including a design for one in the next issue of ETI).

Checking the power supply is well worth while, and should be the first thing which is done when attempting to repair any faulty system. Probably 80% of all system failures are power supply related and we will be looking at the power supply voltages and cables in the next article in this series.

A much more serious piece of test equipment for the PC repairer, and only really worth investing in if you are going to repair a lot of machines, is a fully featured Power On Self Test diagnostic card and its associated software. Such a POST diagnostic card will simply plug into an ISA adapter card expansion slot. It is capable of examining every part of the system and precisely locating faulty components even though the system may have no functioning keyboard, display, or I/O ports.



So long as the processor and BIOS ROM is functioning, then this card will read the power-up self test codes generated when the PC is first switched on. These codes will identify any faulty parts of the circuitry and thus narrow down the search area. The card also includes voltmeter circuitry to check the state of the power supply lines and main processor control lines. It also has a built in logic probe to make fault finding easier.

A typical example of such a card is that produced by Micro 2000. This card and the associated software form a very powerful diagnostic tool and we will be showing in some detail how it can be used, in future articles in this series.

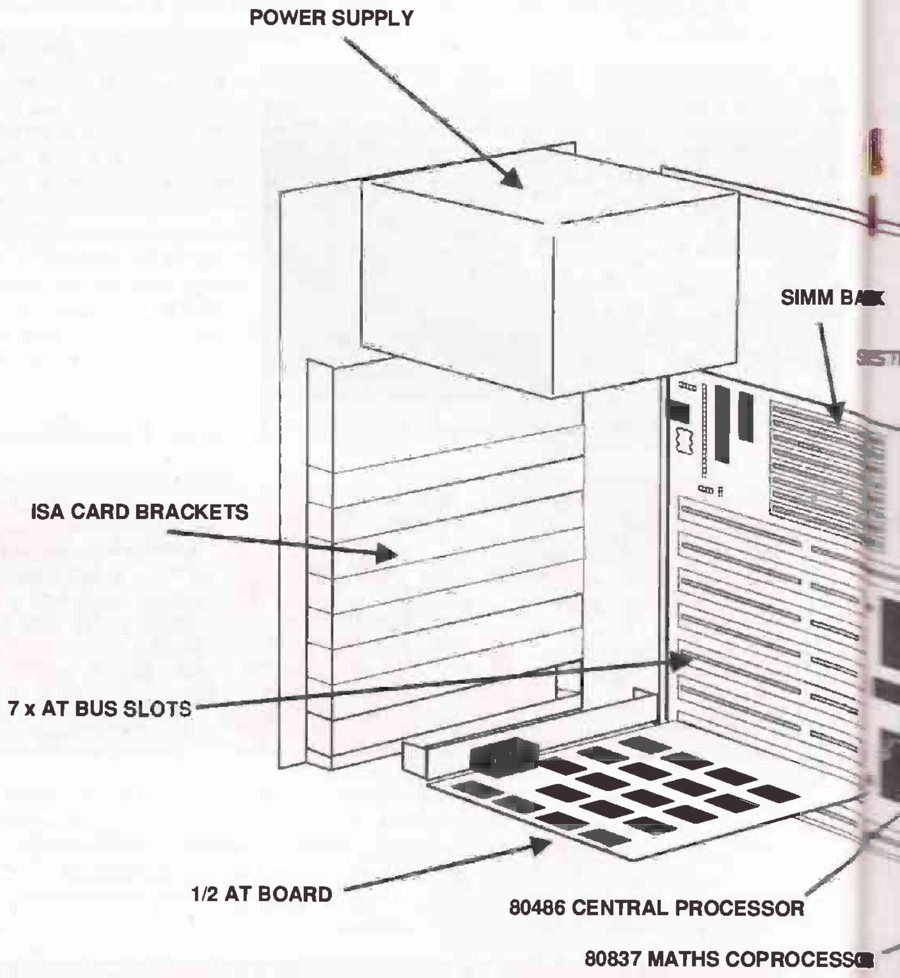
If you would like more information about this diagnostic system, then contact Micro 2000 Europe, P.O.Box 2000, Letchworth, Herts. SG6 1UT. Tel: 0462 483483.

Before one starts to do anything to the hardware of a PC, it is a good idea to know what one is looking at and where all the major components are located. This exploded view of a fairly standard 486 PC should help readers find their way around their own system.

Motherboard

A standard AT motherboard, such as those found in most modern PCs, measures 8.5in by 13in. There is also a mini AT motherboard measuring 8.5 x 9in and an oversized AT at 12 x 14in, neither of which are widely used. Having a standard size motherboard means that one can upgrade motherboards without having to get a new case and power supply which, for upgraders, is a very useful piece of standardisation.

The layout of components on a motherboard is also fairly standard. This is because the standard case design dictates that the eight expansion slots are located at the rear left hand side of the board, where the openings for the expansion card rear panels are positioned. The power connectors are on the right hand side of the board, next to the power supply. Main system memory, today in the form of plug-in SIMMs, is usually located on the right hand side of the board. Connectors to the reset switch, speaker, power LED and keylock, turbo switch, and turbo LED are all located along the front of the board, while the keyboard connector is at the rear right hand corner, next to the hole in the case punched out for it.



Expansion Slots

On a standard AT motherboard there are 8 ISA expansion slots, of which six are full 16 bit versions and two are 8 bit versions. However, on modern motherboards designed for 486 processors, expect to find additional local bus connectors on at least two of the expansion slots. On high powered systems, look for one or two 32 bit EISA expansion sockets, which are much deeper than the standard ISA socket.

Memory

On the older PCs, system memory consisted of an array of memory chips soldered into, or socket mounted onto, the motherboard. There could be anywhere between 512KB and 1Mb of such memory. On this type of system, expanding memory above 1Mb invariably meant using a plug in memory card that fitted into one of the ISA expansion sockets.

On more modern systems, the motherboard is usually designed to take up to 16Mb of memory, but most systems will only be sold with 2 or 4Mb of RAM and it will be up to the user to upgrade as desired. Upgrading the amount of memory on such systems is made easier by having memory chips mounted on small plug in printed circuit boards called SIMMs. Each SIMM usually contains 1M x 9 bits of memory. Memory is 9 bits wide rather than the expected 8 bits, in order to allow error checking using bit 9.

GU

Hard Disk Drive

The technological advances in hard disk drive design has been almost as rapid as the developments in processor technology. The physical size of drives has decreased, their data capacity has increased enormously, and their access times have also increased. On old AT systems, 20 or 40Mb hard disks were standard, on today's 486 based systems, drives of 210 or 340Mb are increasingly common.

Other Data Storage Devices

There are a whole range of different data storage devices which can be fitted into a standard drive bay on a PC. A CD-ROM drive is an increasingly common choice, with the popularity of multimedia software. Tape streamers are another popular choice, where regularly backing-up of data is important. Another increasingly common option, which is also used for data backup and as a supplement to the hard disk, is a magneto-optical disk drive.

Inside a PC's Pro

Processor and Co-Processor

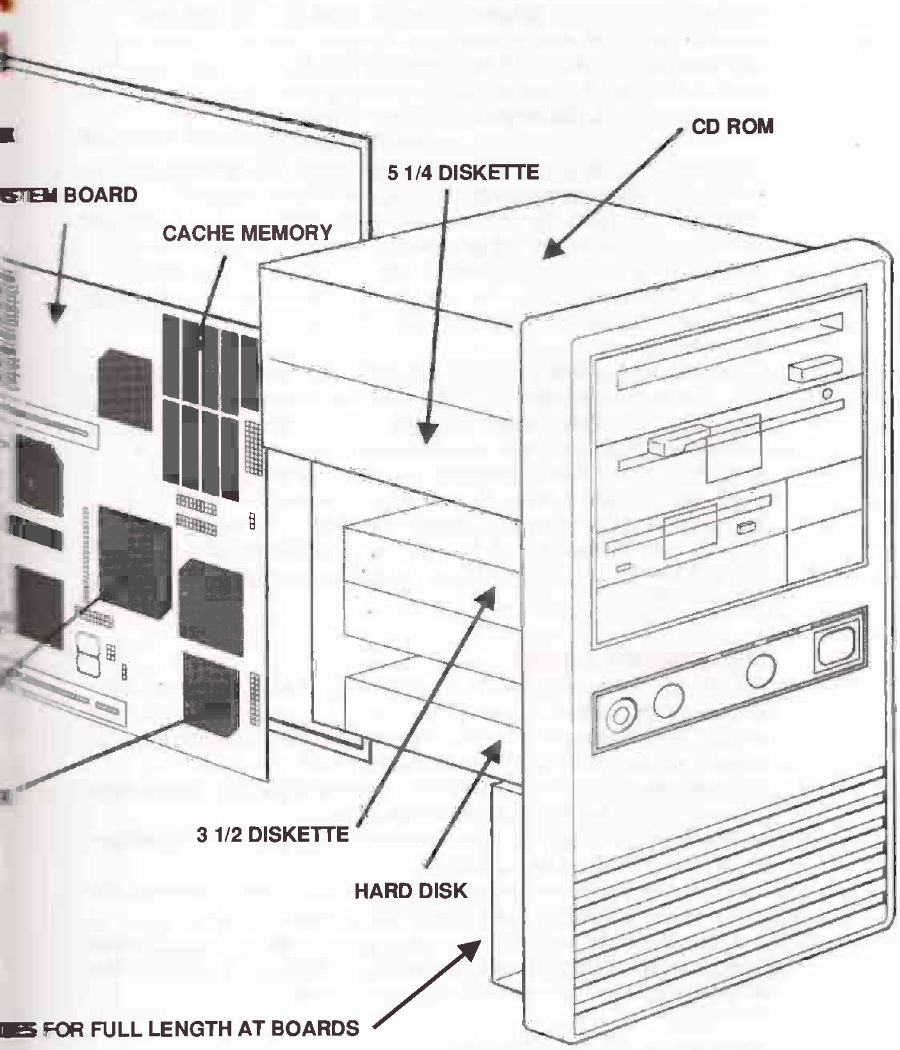
The processor is fairly easily identifiable - it is large and square, with the newest generation of chips having as many as 238 pins. With so many transistors packed onto such a small piece of silicon it is not surprising that processor chips use a lot of power and run very hot, about 85∞C in fact. This heat production means that processor chips are often fitted with large heatsinks or even equipped with a small fan that blows air over the chip to cool it down. Overheating of the processor chip is a common cause of processor failure and can easily occur if the fan is not working properly, if the case is left open, or if the system is used in a very hot environment. In such cases, the addition of a thermal warning device is a good idea and we will be showing how to build such a device in a couple of months' time.

Most AT systems, from the 286 onwards, have had provision for adding a maths co-processor chip in order to improve processing speed in maths intensive operations. On most of the more powerful modern systems, such as the 486DX2, the co-processor is actually built into the processor chip, but there is an additional spare socket on such systems for upgrading the processor, by adding either a clock doubler chip or over-drive chip. More about these next month.

Adapter Cards

Most systems usually have several different adapter cards. There will probably be a video controller card, which is used to generate the video display for output on the CRT monitor. Then there will probably be a disk controller card which is used to control the hard and floppy disk drives. Then, of course, there will be an I/O card which will provide parallel and RS232 serial communications ports for attaching to printers, modems, etc.

In the next couple of months we will be running a project in ETI to show you how to build and design your own adapter cards and this will be followed by a couple of super adapter card designs, including a very high speed analogue to digital converter that can be used as the basis for a range of data acquisition and virtual instrumentation projects.



Power Supply

In most modern PCs, the power supply is a sealed unit with a power rating of 200W. The power input plug and the on/off switch are usually, though not always, part of the sealed unit. The power supply output is fully regulated and consists of four voltages:

+5V at a current of 20A
-5V at a current of 0.5A
+12V at a current of 8A
-12V at a current of 0.5A

These power supplies are now mass produced and it is really not worth trying to repair a faulty one, it is far better and far safer to simply replace it with a new one.

Case

The case used in this diagram is a standard mini-tower designed to stand vertically, an orientation which has the advantage that it takes up only a small amount of desk top space. Slightly larger versions of this type of case are the midi-tower and the tower. The difference in these is the height of the unit and the number of bays it has in which disk drives can be located. So a mini will probably have four bays, of which one is hidden (this means that a mini-tower based system could have two floppy disk drives, a CD-ROM drive, and an internal hard disk drive). A full tower system, on the other hand may, have as many as nine bays, of which four are hidden. This larger case is the type commonly used for server systems which will have a lot of attached disk drives.

Probably the most common type of case is not the tower system but the desktop. This has the same disk drive capacity as a mini-tower and is about the same size, except that it is laid horizontally instead of vertically. It takes up more desk top space, but usually has the CRT display mounted on top of it.

Getting into a case is not that difficult, usually involving undoing between four and six hex headed bolts with a 1/4in nut driver. The bolts are located at the rear of the case and attach the outer cover to the main rear casing onto which the adapter card end plates are attached. This outer casing usually clips under the front plate, or is integral with it.

cessor Box

The ISA a

REAR OF PC

NON-COMPONENT SIDE			COMPONENT SIDE
GROUND	B1	A1	I/O CHANNEL CHECK
RESET	B2	A2	D7
+5V	B3	A3	D6
(IRQ9 ON AT) IRQ2	B4	A4	D5
-5V	B5	A5	D4
DRQ2	B6	A6	D3
-12V	B7	A7	D2
(OWS ON AT) RESERVED	B8	A8	D1
+12V	B9	A9	D0
GROUND	B10	A10	I/O CHANNEL READY
(SMEMW ON AT) MEMW	B11	A11	AEN
(SMEMR ON AT) MEMR	B12	A12	SA19
IOW	B13	A13	SA18
IOR	B14	A14	SA17
DACK3	B15	A15	SA16
DRQ3	B16	A16	SA15
DACK1	B17	A17	SA14
DRQ1	B18	A18	SA13
(REFRESH ON AT) DACK0	B19	A19	SA12
CLK	B20	A20	SA11
IRQ7	B21	A21	SA10
IRQ6	B22	A22	SA9
IRQ5	B23	A23	SA8
IRQ4	B24	A24	SA7
IRQ3	B25	A25	SA6
DACK2	B26	A26	SA5
T/C	B27	A27	SA4
BALE	B28	A28	SA3
+5V	B29	A29	SA2
OSC	B30	A30	SA1
GROUND	B31	A31	SA0

THIS CONNECTOR ON AT ONLY

MEM CS16	D1	C1	SBHE
I/O CS16	D2	C2	LA23
IRQ10	D3	C3	LA22
IRQ11	D4	C4	LA21
IRQ12	D5	C5	SLA0
IRQ13	D6	C6	LA19
IRQ14	D7	C7	LA18
DACK0	D8	C8	LA17
DRQ0	D9	C9	MEMR
DACK5	D10	C10	MEMW
DRQ5	D11	C11	D8
DACK6	D12	C12	D9
DRQ6	D13	C13	D10
DACK7	D14	C14	D11
DRQ7	D15	C15	D12
+5V	D16	C16	D13
MASTER	D17	C17	D14
GROUND	D18	C18	D15

The designers of the PC realised that users would want to be able to customise the hardware in their systems, to add specialist I/O circuitry to connect the PC to equipment not considered by the original system designers. To make it possible to do this, they added an expansion bus to the PC motherboard so that additional circuitry could be easily plugged in.

On a standard PC you will find eight of these expansion slots, each with 31 connections on the front of the card and 31 more on the back, a total of 62 contacts. These are 0.1in apart are sued to carry all the necessary address, data and control lines, plus the various supply voltages which are needed to permit the main processor system to be extended with additional circuitry, ranging from a simple I/O port to a multi-processor system.

This 62 line bus is found on all generations of PC. However, in the history of the development of the PC it was soon realised that this bus had severe limitations when trying to use it with new generations of processor. It could only support 8 bit wide data transfer and memory addressing was limited to 1Mb.

The limitations were overcome in the AT by expanding the original ISA bus by adding another 36 lines to form the 16 bit Industry Standard Architecture, or ISA, bus. If you look inside any AT system you will find that between four and six of the expansion slots have this bus extension socket. With the EISA bus, data can be transferred in 16 bit wide format and up to 16Mb of memory can be directly addressed.

With the development of processors capable of handling 32 bit wide data transfers, even the AT bus proved a limitation. The problem was solved with the development of the Extended Industry Standard Architecture, or EISA, bus. This uses a deeper connector than normal and has the extra bus connectors stacked one above the other, so that the actual connector size is no different to that of a 16-bit ISA bus but has twice as many connections. Its use is limited to very high power systems and even then only one or two slots out of the eight will be capable of taking EISA cards.

In the last couple of years, motherboards have been appearing with two or three EISA expansion slots having yet another expansion socket, making a total of three sockets per card. This is to handle something known as a 'local bus' that is used to transfer data between adapter cards and the motherboard at very high speed (currently a massive 132Mbits per second, although soon to be upgraded to 264Mbits per second) thereby freeing the bottleneck which has so limited processing speed. There are two sorts of 'local bus' in use at the moment, the VESA bus and the PCI bus. We will be looking at these in greater detail in future issues of ETI.

Expansion Cards

The diagram to the rightt shows the dimensions of a full size PC expansion card, however, most adapter cards do not need such a large area of printed circuit board and therefore the most commonly used cards are so called 'half cards'. The normal dimensions for such a 'half card' are shown by the dotted line. Note that the card in this diagram has the edge connectors for a full 96 line AT slot - if the extension connectors are not required then the block of edge connectors towards the front of the PC will be unnecessary.

Since the distance between each expansion slot on the motherboard is just 0.8in, the actual board with its mounted components cannot be any thicker than this. Indeed, to allow air to be blown across the board and thus prevent hot spots from occurring, the maximum thickness of a card including board and components should not exceed 0.5in.

The Bus Connections

As can be seen from the two diagrams accompanying the text on this page the ISA bus edge connector has a total of 62 contacts, 31 on each side of the board. The extension which forms the EISA bus has an extra 36 connections, 18 on each side of the board. Together they form the standard connection between the PC motherboard and an adapter card, although not all adapter cards will use the EISA extension.

The following is a description of the function of each of the 98 lines which make up the complete EISA bus. In the function description, 'I' signifies that the line is an input to the motherboard, 'O' that it is an output from the motherboard, 'I/O' that it is both an input and an output to and from the motherboard and, finally, '*' indicates signals which, during normal processor operations, are outputs but may become inputs during a DMA cycle. All signals which are an active low are preceded by a minus sign, all others are active high. Each line, whether input or output, is designed such that the equivalent of two LS TTL loads per expansion slot may be placed upon them.

Power supplies:

+5V	current 20A	The power used by any single expansion slot should not exceed 45W and total power consumption should not exceed the power supply's rating. All power supply lines are fully regulated and the current rating is for a standard 200W power supply.
-5V	current 0.5A	
+12V	current 8 A	
-12V	current 0.5A	

Address Bus and Associated Signals

SA0-SA19 * — The main address bus, SA0 being the least significant bit. These signals are gated when BALE is high and latched on the falling edge of BALE. These address lines allow addressing up to the 1Mb limit.

LA17-LA23 * — To fully decode memory up to the 16Mb limit, these additional address lines on the bus extension are required. These lines are only valid during BALE high as they are not latched on the falling edge and, consequently, they will have to be latched on board by any designs using them.

AEN O — Address enable. Differentiates between SA0-19 and LA17-23 being driven by the processor and being driven by a DMA device. Only when a DMA controller has control of the address bus will this signal be asserted. AEN should therefore be included in all decodes of the address bus.

BALE O — Address latch enable. This is used on the system board to latch address bits SA0-SA19. To a device on the I/O channel, this signal may be used to detect the start of a processor or DMA cycle.

SBHE * — On the extension bus, this is the bus high enable line and it is use to indicate that the data transfer is to take place on bits SD8-15, in addition to the transfer on bits SD0-SD7 which is common on all cycles. In other words, the use of a full 16 bit data bus.

Data Bus

SD0-SD15 I/O — Data lines 0 to 15. Line 0 is the least significant. SBHE is used to indicate that the top half of the data bus is in use.

Interrupts

IRQ2,3,4,5,6,7,9,10,11,12,14,15 I — Interrupt request lines. In order of decreasing priority they are: 9,10,11,12,14,15,2,3,4,5,6,7 (note that on old PC systems only IRQ lines 2-7 were used and that IRQ2 is not used on AT systems). There is no hardware interrupt acknowledge signal, but since the 8259A interrupt controllers are used in edge triggered mode, there are no critical timing limitations. It is normal practice to keep the signal high and the pulse low to generate an interrupt.

-I/O CH CK I — I/O channel check. This signal indicates a memory parity eror to the system board. NMI is asserted as a result of this signal being active.

Direct Memory Access

DRQ0,1,2,3,5,6,7 I — DMA request lines (lines 1-3 only on the old PC). DRQ 0 has the highest priority and DRQ 7 the lowest. On the original PC, DRQ 0 was used exclusively for memory refresh and was therefore generated on the motherboard. On the AT this refresh function was performed by circuitry independent of DMA thus allowing DRQ0 to be made available. It should be noted that, to confuse matters, some manufacturers label DRQ0 as DRQ4. An active level on a DRQ line must be maintained until the corresponding -DACK signal is asserted.

-DACK0,1,2,3,5,6,7 O — DMA acknowledge. Although DRQ0 is not a bussed signal on the old PC, since it is dedicated to memory refresh and therefore generated by the mother board, the acknowledge signal is present on the I/O channel to indicate a refresh cycle. As with DRQ, some manufacturers refer to -DACK0 as -DACK4.

-Refresh O — On the AT, this line replaces the -DACK0 line on the PC and is used to signal memory refresh.

T/C O — Terminal count. Indicates that a DMA channel has reached terminal count. It is a pulsed signal.

-Master I — Found on AT systems only. This line is used in conjunction with a DMA request line to take control of the bus. A processor of DMA controller on the I/O channel asserts a DMA request in cascade mode and receives a DMA acknowledge. -Master may then be asserted causing the address, data and control lines to go tri-state. The device must then wait one clock period before driving the address and data bus and two cycles before doing a read or write. This signal must not remain asserted for more than 15µs or system memory could be lost due to lack of refresh.

Control Signals

-SMEMR (-MEMR on the PC) * — Memory read. Note the different name on the AT, System Memory Read, as -MEMR also exists on the AT. This signal instructs the memory device to put data onto the data bus. On the AT, this signal is only active if the read is from memory within the first 1Mb. Use of this signal on the AT obviates the need to decode address bits LA17-LA23 when working within the first Mb of memory address space.

-MEMR O — AT only. Memory read. It should be noted that this is not the same as -MEMR on the PC. It is similar to -SMEMR but is active for all read operations. This signal will only be used for access to memory outside the first Mb of memory address space.

-SMEMW (-MEMW on the PC) * — Memory write. Again a different name on the AT: System Memory Write. Note that -MEMW also exists on the AT. This signal instructs the memory device to store data from the data bus. Only active on ATs if the write is to memory within the first Mb of memory address space. Use of this signal on the AT obviates the need to decode address bits LA17-LA23 when working in the first Mb.

-MEMW O — AT only. Memory write. Not the same as -MEMW on the PC. Similar to SMEMW but active for all write operations and only used for access to memory outside the first Mb.

-IOR * — I/O Read. Instructs the I/O device to read data from the data bus.

-IOW * — I/O Write. Instructs the I/O device to write data to the data bus.

Reset Drv O — Reset Drive. Generated during power-up. Used to initialise devices in the I/O channel.

-MEM CS16 I — AT only. Memory 16 chip select. This signal informs the motherboard that memory transfer is 16 bits wide. Failure to assert this signal (as will be the case with PC boards) will result in the 16 bits being transferred as two 8 bit wide operations.

-I/O CS16 I — AT only. I/O 16 chip select. This signal informs the motherboard that the I/O transfer is 16 bits wide. Failure to assert this signal (as will be the case with PC boards) will result in the 16 bits being transferred as two 8 bit wide operations.

Wait states

I/O CH RDY I — I/O channel ready. Should be pulled low to indicate 'not ready' by slow devices requiring additional wait states to be inserted. It should be driven on detecting a valid address and a read or write signal and should be held for an integral number of clock cycles. There is no harm in using this signal to insert wait states already generated by the motherboard (or more usefully to increase the number of wait states).

OWS I — AT only. Zero wait state. Causes the automatic wait state generation of the motherboard (if present - see text on wait states) to be over-ridden. To complete a 16 bit memory cycle without wait states, this signal is derived from an address decode and either the read or write signal. To reduce the wait states on an 8 bit memory cycle to 2, this signal should be made active one system clock after the read or write command. OWS should be driven with an open collector capable of sinking 20mA.

Oscillators

CLK O — The system clock. The frequency depends upon the system. True PC clones have a frequency of 4.77MHz. The original ATs were 6MHz and many of the current generations of systems have clock rates of 33MHz and upwards. This signal has a 50% duty cycle. On the 286 processor, the input frequency is double the actual processor internal working frequency, the CLK signal is still the processor frequency (although actually in antiphase for reasons of compatibility with the PC). On more recent systems with a DX2 chip, the internal working frequency of the processor is twice that of the clock, thus a 486DX2-66 machine will have a processor running at 66MHz and a system clock running at 33MHz.We will be looking at clock speeds in much greater depth in the next issue of ETI.

OSC O — Oscillator. A high speed clock with a frequency of 14.31818MHz. The frequency of this signal does not depend upon the processor clock speed and is not synchronous with it.

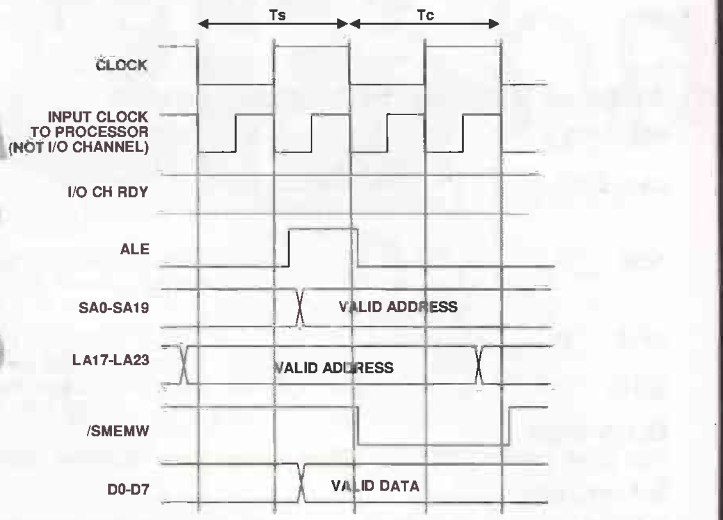
➤

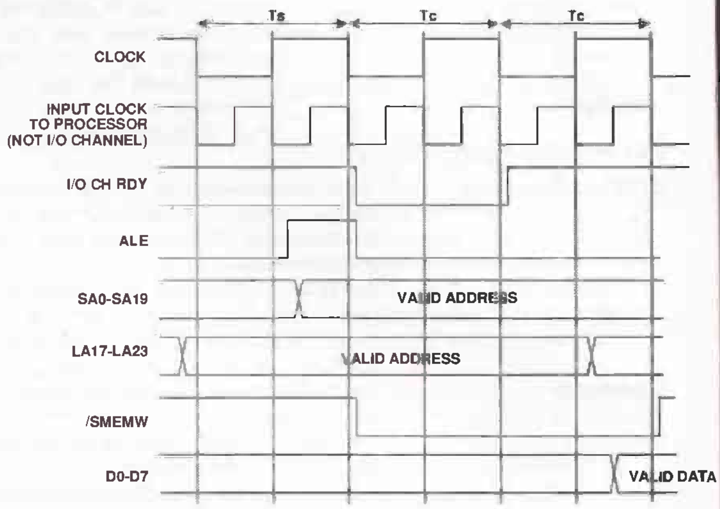
The ISA bus timing diagrams

Whether one is repairing a system or designing an adapter card one, of the most important considerations is to look at how changes in the state of the various expansion bus lines relate to each other with respect to time. To do this, we need to look at a timing diagram for the most important lines. These are shown in the two boxes on this page, the ones at the top are for the old PC and underneath it are the ones for the AT. These timing diagrams are valid for all ISA and EISA machines.

It should be stressed, however, that these timing diagrams are only approximate, for accurate timing diagrams consult the appropriate Intel data book, although there will be differences between the data book waveforms and those actually observed. This is because the PC buffers most of the signals with the result that a few extra nanoseconds propagation delay will have to be added. But the most important difference lies in the address bus timing. This is because the system has to demultiplex the address from the data and later the address on the PC and latch the address lines on the AT, both time consuming operations.

The diagrams included on this page should be sufficient for most purposes, since they give a clear indication of what happens on the various bus lines during a read or write operation. The timing is of course all synchronised by the system clock, although with high speed processors, data transfer on the ISA bus may not be able to take place at clock speed. There are several reasons for this, the most important of which is that the standard ISA bus is only designed to have a maximum data transfer rate of 8MHz on any one line, although some manufacturers have pushed this up to 12 or even 16MHz. With the EISA bus, the same constraints apply but, because data is being transferred as 32-bit wide chunks, the effective data transfer rate is doubled.

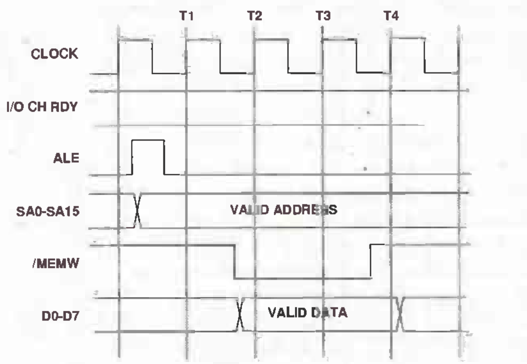


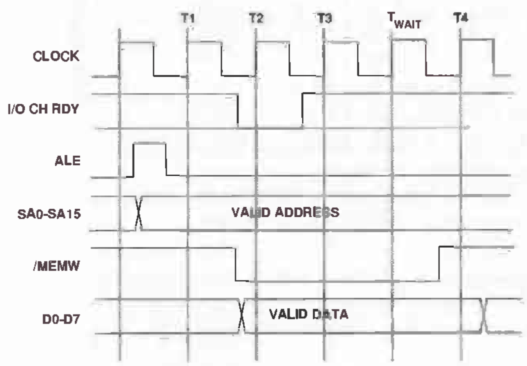


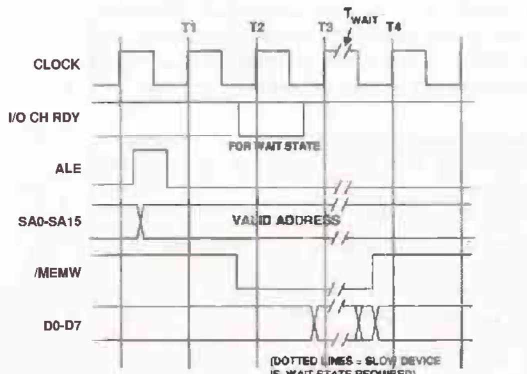
Wait States

Another factor which can slow down a fast processor is the fact that memory chips and I/O circuitry are often too slow for the processor. The processor will need to use one or more wait states to slow things down whenever it is attempting to access any slow device. With modern very fast processors this can be a serious problem and prevent the processor achieving its maximum potential throughput. It is a problem which has led to the development of such techniques as primary and secondary memory caching (more about caching hardware in a future issue of ETI)

A wait state is simply the addition of one or more processor cycles into a standard read or write cycle, thereby lengthening the access time to the memory chip or I/O circuitry. Most of the circuitry used in a modern PC is sufficiently fast that it can operate at 15 to 20MHz without any need for wait states. This is thanks to the enormous improvement in overall speed of most ICs. With the original PC operating at 4.77MHz and the first ATs at 6MHz the memory chips available at the time were so slow that they often needed one wait state. Indeed the original AT circuitry automatically inserts a wait state into all memory cycles. This was abandoned in more recent versions of the AT in favour of a link selectable automatic wait state generator, which can be set according to the available memory speed.







(DOTTED LINES = SLOW DEVICE IE. WAIT STATE REQUIRED)

An understanding of wait states is particularly important when designing any adapter card, particularly an I/O card. On the original PC, one wait state was automatically added to all I/O cycles (this is the reason why some adapter cards which did include fast I/O devices and which were speed critical, were memory mapped rather than interfaced to the conventional I/O map. This is an important consideration when dealing with some of the older adapter cards).

Since adapter cards will generally be expected to run on all systems, the generation of wait states is good way of ensuring this flexibility of use. This can be done by including link selectable wait state circuitry in the adapter card. This will not be necessary in applications where speed is not critical and where a couple of wait states can always be added.

The circuit diagram at the bottom of this page shows a link selectable wait state circuit, suitable for use on adapter cards (this circuit comes from IBM's Technical Reference Manual). It simply counts the clock cycles in order to generate between 0 and 8 wait states, sufficient for most applications and most processors. Determining how many wait states will be needed will depend on the processor and the access time of the circuitry. If the access time is longer than the time during which the processor address and data lines are valid, then wait states will be needed, the number of wait states depending on how much longer.

Next Month

In the next issue of ETI we will be continuing this series by taking our first real look under the cover at the motherboard and power supply. We will also be taking a close look at the processor, with special emphasis on the PC's memory maps, Interrupts, and direct memory access.

CVC Chelmer Valve Company

for audio valves

Audio valves with famous brand names of yesteryear such as MULLARD, MOV, GEC,RCA etc, are in very limited supply and their scarcity also makes them very expensive.

We at Chelmer Valve Company however provide high quality alternatives to these old makes. We have over 30 years experience in the supply of electronic valves of all types and during this time have established close ties with factories and sources worldwide.

For high fidelity use we further process valves from these souces using our specially developed facilities. After rigorous testing - including noise, hum, microphony, post burn-in selection and matching as needed - we offer this product as CVC PREMIUM valves.

A selection of the more popular types are listed below.

Price list & order form for CVC PREMIUM Audio Valves

	UNIT PRICE	QTY.	TOTAL PRICE
PRE-AMP VALVES			
ECC81/12AT7	5.00		
ECC82/12AU7	4.00		
ECC83/12AX7	5.00		
ECC85	4.00		
ECC88	5.00		
EF86	4.00		
E81CC(GOLD PIN)	6.00		
E82CC " "	6.00		
E83CC " "	6.00		
E88CC " "	7.00		
E80F	9.00		
E83F	5.50		
6SL7GT	4.00		
6SN7GT	4.20		
6922	5.00		
POWER VALVES			
2A3 (4 PIN)	14.00		
2A3 (OCTAL)	14.00		
211	22.00		
300B	50.50		
811A	9.50		
845	29.90		
EL34/6CA7	7.50		
EL84/6BQ5	4.00		
EL84/7189A	5.10		
KT66	9.20		
KT77	12.00		
KT88	12.50		
KT88 (GOLD Q)	18.50		
6L6GC	6.50		
6L6WGC/5881	8.00		
6V6GT	5.00		
6146B	10.20		
6336A	38.00		
6550A	11.00		
6550A-S	13.50		
7581A	11.00		
TOTAL CARRIED FORWARD			

	UNIT PRICE	QTY.	TOTAL PRICE
CARRIED FORWARD			
RECTIFIERS			
GZ32	4.50		
GZ34/5AR4	5.00		
5U4G	5.00		
5Y3GT	3.20		
5Z4GT	3.50		
SOCKETS			
B9A (PCB)	1.60		
B9A (CHASSIS)	1.60		
OCTAL (CHASSIS)	1.75		
4 PIN (UX4)	3.00		
4 PIN (FOR 211)	11.00		
MATCHING CHARGES*			
POST & PACKING (UK)			3.00
TOTAL EXC. VAT			
VAT @17 1/2% (UK & EEC)			
TOTAL TO PAY			£

***MATCHING, if required; state valve types & if PAIRS, QUADS or OCTETS - Allow £1.00 per valve for this service.**

Make CHEQUES payable to 'CHELMER VALVE COMPANY or pay by ACCESS/MASTER CARD/VISA, give details:

Signature .... Expiry ....

Name ....

Address ....

....

....

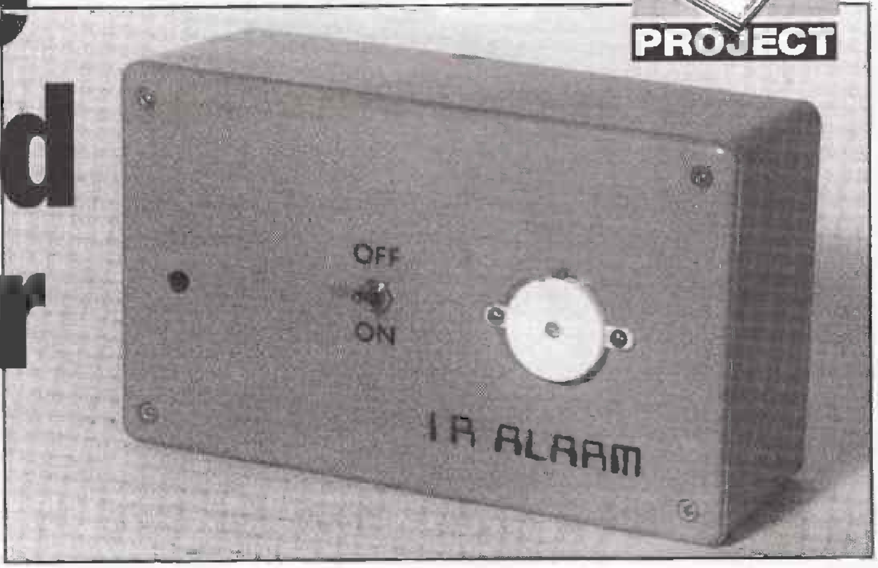
.... Post Code ....

Valve amplifiers sound better still with CVC PREMIUM valves!

130 New London Road, Chelmsford, Essex CM2 0RG, England. Telephone 0245 355296/265865 or FAX. 0245 490064.

PROJECT

Passive Infra-red Intruder Alarm



Get the better of burglars with this portable alarm unit from Robert Penfold

This intruder alarm is a self contained unit, which is intended for use where the cost of a comprehensive alarm system is not justified. It can also be used as a back-up alarm to an extensive burglar alarm system. As it is small and self-contained, this unit could also be useful as a burglar deterrent for use in a boat or caravan.

It operates using the passive infra-red detection system. In other words, it detects the body heat of anyone who passes in front of the sensor. The unit 'looks' down a narrow corridor and has a maximum range of about 3 metres. It does not require any special lenses, or any form of optical system. It has a built-in delay circuit which enables the user to get clear after switch-on without triggering the alarm, but once the unit is triggered, it immediately produces a warbling alarm signal. The unit is battery powered and, with a standby current consumption of only about 500 µA, each set of HP7 size batteries provides the equivalent to about one year of continuous operation.

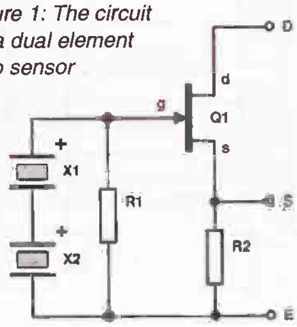
Heat Of The Moment

Passive infra-red alarms are based on special pyrosensors, which detect long wavelength infra red radiation. Normal infra-red opto-electronic devices operate at wavelengths of about 850 to 950nm, which is only slightly beyond the visible red wavelengths. Body heat is at much longer wavelengths and pyrosensors have optimum sensitivity at wavelengths from about 1 to 20µm (1000 to 20000nm).

Practical pyrosensors normally have two ceramic sensing elements connected in series, but out of phase. The sensing elements are not a form of photodiode or transistor, butare much more like Piezo-electric devices which form the basis of crystal microphones and pick-ups. They consist of a slice of a natural crystal or a synthetic ceramic material which has a metal electrode on each face. Twisting the device results in a small electrical charge being produced across the electrodes. Twisting in the opposite direction produces a charge of the opposite polarity. Pyrosensors are physically similar, but it is heat on one side of the device that results in an electrical charge being produced across the electrodes.

Pyrosensors invariably have a built-in JFET source follower buffer stage (Figure 1). R2 is the source load resistor, which is not always an integral part of the sensor. R1 is the gate bias resistor, and this has a very high resistance which gives the amplifier a correspondingly high input impedance at low frequencies. X1 and X2 are the anti-phase pyro sensing elements. It might seem that the sensor would fail to work due to the anti-phase connection of the sensing elements. On the face of it, any output voltage produced by one element will be cancelled out by an equal and opposite voltage from the other sensor!

Figure 1: The circuit for a dual element pyro sensor



To a large extent, this cancelling does occur, but only with changes in the background infra-red level. This is the main point of using dual sensing elements. The sensor as a whole is largely immune to variations in the background infra-red level, which helps to avoid false alarms. It has to be borne in mind that passive infra-red alarms are movement detectors. It is someone moving across the unit's field of view, and the change in the infra-red level that this produces, which is detected by the sensor.

With a dual element sensor, one element receives the increased infra-red first, giving a change in output voltage from the sensor. Then the other element receives the infra-red signal and cancels out the original signal. Next, the infra-red moves past the first element, giving an output voltage due to the infra-red still received by the second element. This voltage has the opposite polarity to the original change in output potential. Finally, the infra-red moves away from the second element, and the output voltage returns to its normal standby level. Someone moving across the sensor's field of view therefore produces a double output pulse, with the pulses having opposite polarities. Compared to a single element, this gives double the peak-to-peak output level.

The frequency response of a pyrosensor is, to say the least, a bit limited. The high frequency response is limited by the thermal inertia of the sensing elements, which are made from very thin pieces of ceramic material in order to minimise this problem. The low frequency end of the response is governed by R1, which leaks away the charges produced by the sensing elements. This gives a typical frequency response which extends from about 0.5Hz to 2Hz! In practice, this extremely limited frequency response is quite adequate, because someone activating the sensor will produce changes that give strong output signals within this band.

System Operation

Figure 1 shows the block diagram for the passive infra-red alarm. The changes in output voltage from the sensor will be generally be no more than a few millivolts peak to peak. A large amount of amplification is therefore needed in order to bring the signal up to a level that can reliably operate the subsequent stages of the circuit. In this case, two high gain amplifiers provide about 80dB of gain. A low pass filter severely restricts the high frequency response of the circuit, which helps to give a better signal to noise ratio. The loss of high frequency response is of no significance due to the very restricted bandwidth of the pyrosensor.

The output of the second amplifier stage directly drives a level detector circuit. Under standby conditions, the output potential from the amplifier is too high to activate the level detector. However, when the unit is activated, the output voltage from the amplifier will go below the detection threshold of the level detector on negative signal peaks. The level detector then activates a latch, which in turn switches on the alarm generator. The latch ensures that the alarm continues to sound, even when the intruder has moved out of the sensor's field of view. A form of warbling alarm sound is produced by the alarm generator which consists of a low frequency oscillator (l.f.o.) modulating a voltage controlled oscillator (v.c.o.).

There is a slight problem with any unit of this type in that it tends to trigger at switch-on as the coupling capacitors take up their initial charges. Also, it is likely that the person who switches the unit on will trigger it as they move away. Both problems are overcome by having a delay circuit which holds the latch in the reset state for several seconds after the unit has been switched on.

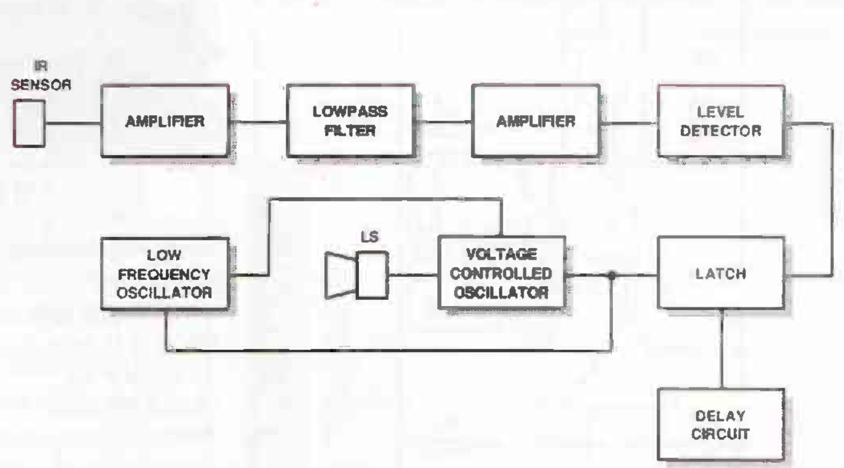
The circuit could also include a delay circuit to prevent the alarm from sounding as soon as the unit is triggered. This would enable someone entering the premises legitimately to switch off the unit before the alarm sounded. With a small self-contained alarm of this type it is probably better not to include this delay, but to instead deter intruders as soon as possible. The false alarm each time the unit is switched off will not disturb the neighbours, but it will serve as a check that the unit is functioning correctly and that the battery is still serviceable. The unit could also be equipped with a timer that would automatically switch off the alarm generator after a few minutes of operation. Again, a small unit of this type is not going to annoy the neighbours and an automatic muting circuit is not really necessary.

Circuit Operation

Refer to Figure 3 for the full circuit diagram. IC1 is the dual element pyrosensor and R1 is its discreet source load resistor. Both stages of the high gain amplifier are simple common emitter amplifiers. As the circuit must operate for long periods of time from ordinary 'dry' batteries, it is essential that the overall current consumption is kept quite low. For this reason, TR1 and TR2 are operated at collector currents of only about 100 to 150μA. C4 provides the low pass filtering. The values of C2 and C3 are quite high relative to the input impedances of the two amplifiers, but this is necessary in order to give a suitably extended low frequency response.

IC2 is an operational amplifier which is used here as a voltage comparator. R7 and R8 set the non-inverting input at a little under one third of the supply voltage. The inverting input is driven direct from the output of TR2 and the bias voltage here is typically a little over half the supply voltage. Consequently, the output of IC2 is low under standby conditions. When the unit is activated, the voltage at TR2's collector will fall below the reference level on negative signal peaks, resulting in the output of IC2 pulsing high. IC2 is a low current operational amplifier which has a current consumption of only about 150μA.

Figure 2. The passive I.R. alarm block diagram



The first pulse from IC2 sets the flip/flip formed from two of the NOR gates in IC3. The other two gates are unused, but their inputs are connected to the positive supply rail so that they are not left vulnerable to static charges. C5 and R9 provide a long reset pulse to the flip/flop at switch-on. This pulse lasts about 10 seconds, and provides the unit with its exit delay feature. D1 aids rapid discharging of C5 at switch-off, so that a proper delay is provided when it is switched on again.

The not Q output of the flip/flop (IC3 pin 3) controls the inhibit inputs of the l.f.o. and v.c.o. stages. The not Q output is normally high and it therefore inhibits both oscillators under standby conditions. It goes low when the unit is activated and switches on both oscillators. The v.c.o. is the oscillator section of a 4046BE micro-power phase locked loop (IC4). One of the phase comparators is used as an inverter which gives anti-phase outputs to drive LS1. This gives a high peak to peak voltage swing across LS1, which is a ceramic resonator. A ceramic resonator gives a high sound level from the limited drive current available from the standard CMOS outputs of IC4. An ordinary moving coil loudspeaker cannot be used with this circuit. Even high impedance types require far higher drive currents than IC4 can provide.

IC5 is used as the basis of the l.f.o., and this is another 4046BE. In this case the v.c.o. is the only section of the device that is utilised. R12 and R15 provide a fixed bias voltage to the control input of the v.c.o. With the specified values for timing components R13 and C8, this gives an output frequency of about 4Hz.

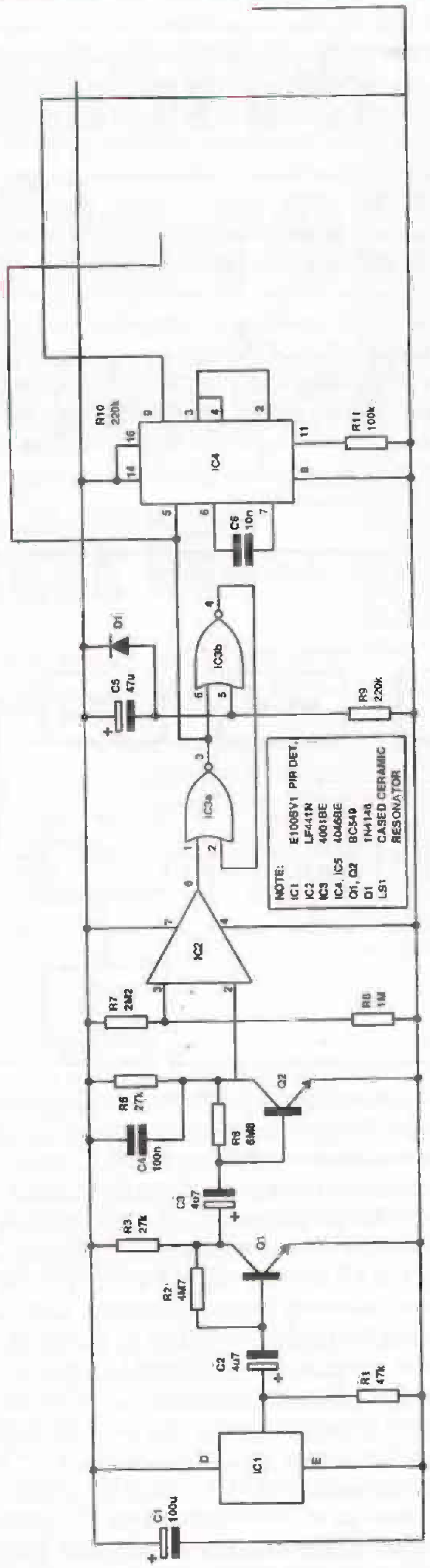


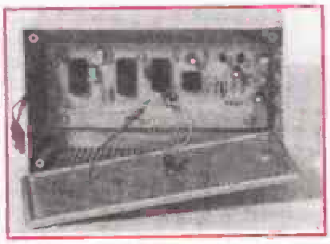
Figure 3: The passive infra-red alarm circuit.

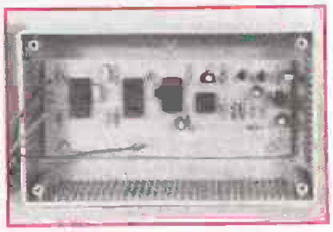
The output of IC5 drives the control input of IC4 via the potential divider formed by R10 and R14. Although the output signal from IC5 is a squarewave, C9 provides filtering that gives a roughly triangular modulation signal. The v.c.o. is therefore swept smoothly over a range of frequencies rather than simply being switched between two frequencies. A swept tone generally gives a more effective output from a ceramic resonator than a simple two tone signal. The specified values should give a piercing alarm sound, but if desired the value of R11 can be selected to give optimum results.

IC3 to IC5 are CMOS integrated circuits which have insignificant current consumptions under standby conditions. The overall current consumption of the circuit is about 500µA under standby conditions and only increases by about 2mA or so when the alarm sounds.

Construction

Figure 4 shows the component overlay for the printed circuit board. IC3, IC4 and IC5 are CMOS integrated circuits which require the usual anti-static handling precautions. In particular, use holders for these devices and do not fit them into their holders until the board and wiring have been completed. IC1 and IC2 contain JFETs rather than MOSFETs and therefore do not require anti-static handling precautions, but it is still a good idea to use a holder for IC2.



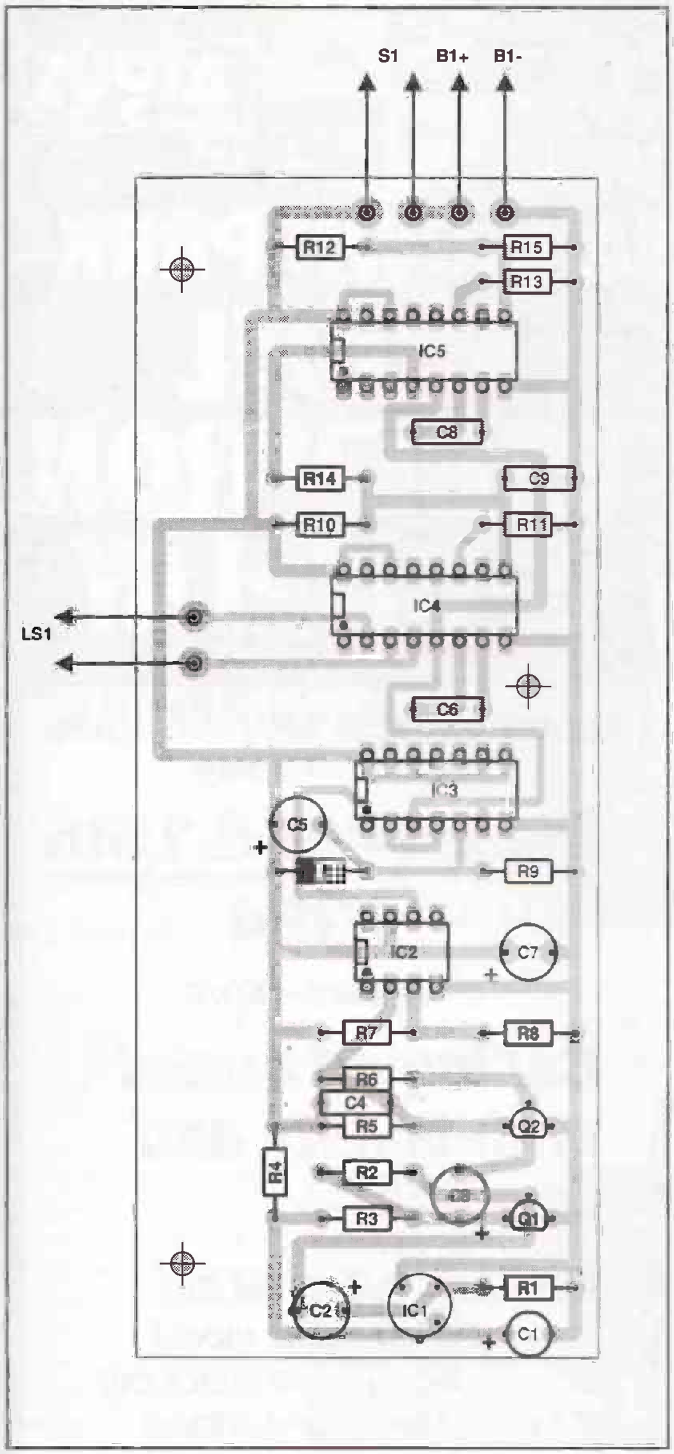


In order to fit into the component layout properly, the non-electrolytic capacitors must be printed circuit mounting types, having 7.5mm (0.3in) lead spacing. Fit single-sided solder pins at the six points where connections to off-board components will be made.

The unit will fit into practically any medium size plastic or diecast aluminium box. In the interest of good security, it might seem to be best to use a tough diecast aluminium box and a key-switch for S1. In practice, the unit will always be easily silenced if the intruder is determined to do so, because the ceramic resonator is vulnerable to physical attack. With a unit of this type you are relying on the intruder being unnerved by the alarm going off and beating a hasty retreat. Trying to make the alarm bullet proof is probably not worthwhile! Therefore, an inexpensive case is adequate and S1 can be a miniature toggle switch, slider switch, or whatever.

The printed circuit board is mounted on the rear panel of the case, using 6BA or metric M3 fixings. S1 and LS1 are mounted on the front panel. LS1 can be mounted on the rear surface of the front panel, but it will then be necessary to make a large mounting hole, in addition to the two smaller mounting holes. It is easier to fix it onto the front surface of the panel, because it is then only necessary to make the two small mounting holes, plus another small hole to permit the lead out wires to pass through to the inside of the case. Most ceramic resonators require two 8BA or metric M2 fixing screws (plus nuts), which must be purchased separately.

A hole must be drilled in the front panel, directly in front of IC1. This permits infra-red radiation to pass through to IC1 and also narrows IC1's angle of view. Without this narrowing of its response angle, the unit will have relatively low sensitivity. This is simply because someone moving in front of IC1 will tend to produce signals at extremely low frequencies which the unit cannot handle efficiently. A narrower angle ensures that someone moving in front of the sensor produces signals at frequencies where the circuit offers good sensitivity. This increases the range from approximately 1m to about 3m. A hole having a diameter of about 5 to 10mm seems to give good results.



The performance of a passive infra-red system can be massively boosted by the addition of a suitable lens but, unfortunately, lenses for this application seem to be unobtainable these days. Note that lenses sold for use with infra-red LEDs, etc., do not work well with pyrosensors and long wavelength infra-red signals. These lenses are not designed for use at long wavelengths and, in most cases, they are almost totally opaque to long wavelength infra-red radiation. For a simple self-contained unit of this type, a range of about 3m should be perfectly adequate and a lens is not really necessary.

If a piece of 'window' material is fixed behind the hole in the front panel it must be made from something that is reasonably transparent to long wavelength radiation. Material that is transparent to visible light is not necessarily transparent to long wavelength infra-red (and vice versa). A little experimentation might be needed in order to find a suitable material, or the window can simply be omitted.

To complete the unit, the battery clip, on/off switch and ceramic resonator are connected to the printed circuit board. The resonator might have one red lead and one black one, but these simply indicate the phasing. The resonator can be connected either way round.

In Use

The alarm generator might operate briefly when the unit is switched on, but it should not latch in the on state. Passing in front of the unit after the hold-off period has expired should trigger the alarm and it should continue to operate until the unit is switched off. If the alarm tends to trigger itself after the hold-off period, try making R6 higher in value.

When positioning the unit for normal use, bear in mind that it is most sensitive to some passing across its field of view. It is least sensitive to someone moving straight towards or away from the sensor. Also, bear in mind that the unit should be positioned horizontally and not on end. If it is used vertically the orientation of the twin sensing elements will not be correct and the maximum operating range will be significantly reduced. It is not a good idea to aim the unit towards a radiator or other heat source and it is probably best to have the unit partially concealed behind some books, ornaments, etc.

PARTS LIST

Resistors (0.25 watt 5% carbon film)

R1	47k
R2, R12	4M7
R3, R5	27k
R4	10k
R6	6M8
R7, R15	2M2
R8	1M
R9, R10	220k
R11, R13	100k
R14	390k

Capacitors

C1	100µ 10v radial elect
C2, C3	4µ7 50v radial elect
C4	100n polyester
C5	47µ 10v radial elect
C6	10n polyester
C7	10µ 25v radial elect
C8	470n polyester
C9	220n polyester

Semiconductors

IC1	E100SV1 P.I.R detector
IC2	LF441N
IC3	4001BE
IC4	4046BE
IC5	4046BE
TR1	BC549
TR2	BC549
D1	1N4148

Miscellaneous

LS1	cased ceramic resonator
B1	6 x HP7 size cells in holder
S1	s.p.s.t mini toggle switch (see text)

Case about 150 x 90 x 50mm, printed circuit board, battery clip (PP3 type), 8 pin d.i.l. IC holder, 14 pin d.i.l. IC holder, 16 pin d.i.l. IC holder (2 off), wire, solder, etc.

AN **Argus** SPECIALIST EXHIBITION

ELMBRIDGE MODEL CLUB AND ARGUS EXHIBITIONS

Don't miss the 19TH

SANDOWN PARK MODEL EXHIBITION & DISPLAY

Sandown Exhibition Centre
Esher, Surrey.

May 14th & 15th 1994

9.30am – 6pm

Calling all model enthusiasts and families..

Come one. Come all!
Watch the incredible model aircraft displays and check out the model car racing, model railway displays and novelties on the boat pool.
Wander around the numerous trade stands. There's something for everyone at ***Sandown...***

A first for Sandown!

TWO WORLD CHAMPIONS

display their skills...

Hanno Prettner
World Aerobatic Champion

AND

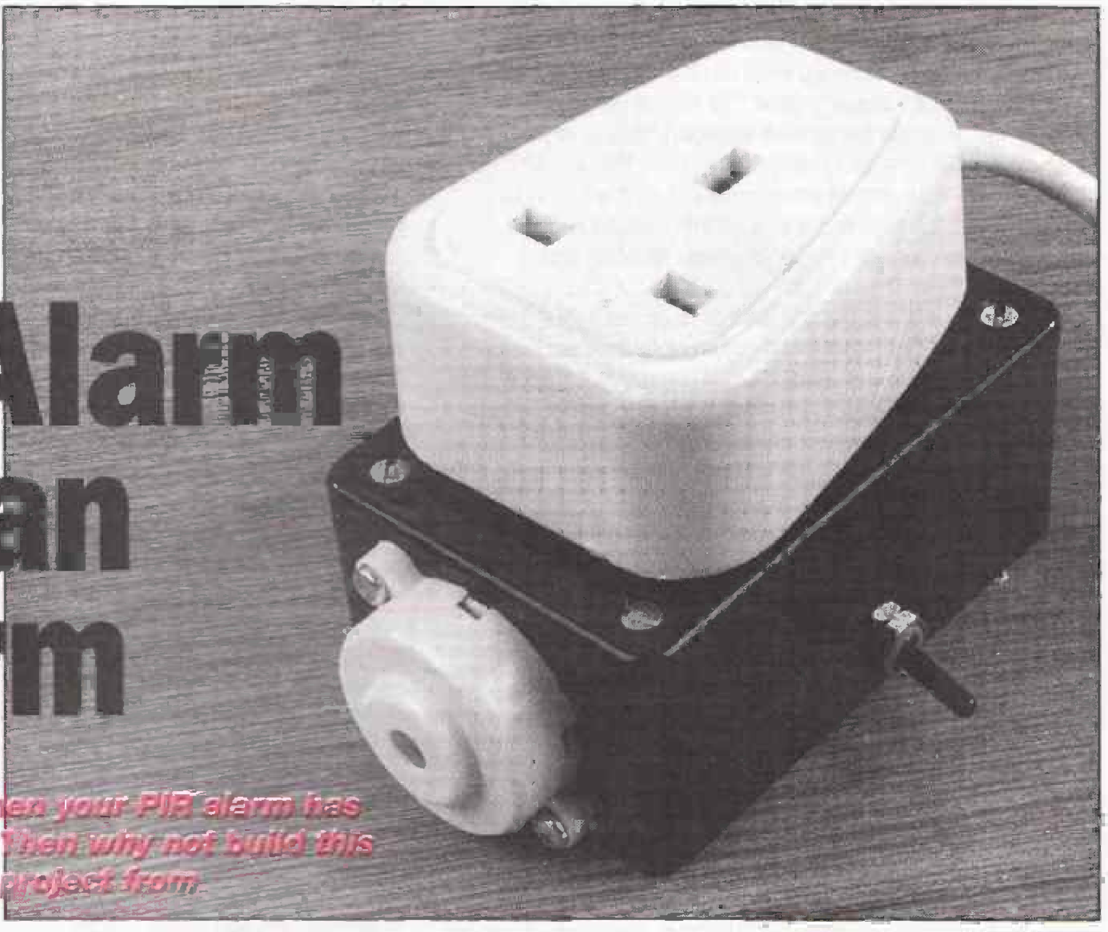
Curtis Youngblood
World Champion F3C Helicopters
(Sponsored by Northern Helicopters Ltd.)

- ***Radio control equipment*** ● ***Aircraft***
- ***Car and marine engines*** ● ***Helicopters***
- ***IC and electric cars*** ● ***Boats and yachts***
- ***Railway layouts and engineering products.***

Further details and advance tickets available from: Argus Specialist Exhibitions
Argus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST. Tel: 0442 66551.

PROJECT

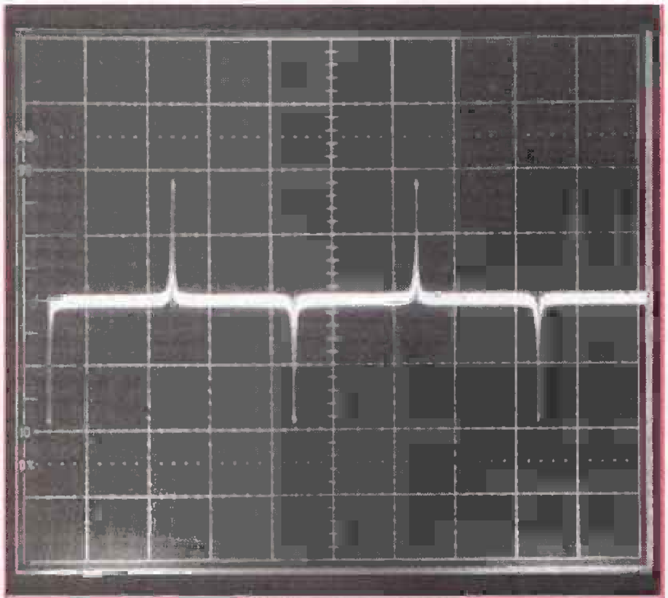
An Alarm for an Alarm



Want to know when your PIR alarm has been triggered? Then why not build this interesting little project from Ben Sullivan

I recently installed a PIR(Passive Infra-Red) operated floodlight at the rear of his house, in response to a spate of local burglaries. The unit is installed at one side of the house behind the laundry room, which is separated from the lounge by the kitchen and hall. Consequently (apart from spending the evening sitting in the laundry room) there is no way of knowing whether the 500W tungsten halogen floodlight has been activated or not. This would be handy to know, not only in case of prowlers, but also to check if the alarm is triggered by animals, such as our large moggy or the occasional fox which we have seen in the garden.

One could, of course, wire a mains operated bell in parallel with the lamp, but this means bringing extra leads out through the weatherseal grommet on the outdoor unit, which might leave it unsealed and in any case would be a modification which would void the warranty. Hence the little alarm, activated by the PIR floodlight, which forms the subject of this article was developed.



The current transformer's secondary voltage due to the 2A flowing in the primary, consists of alternate positive and negative spikes

Design considerations

To simplify installation, the unit was designed as a short extension lead, which could be connected between the PIR security light's plug and the ring-main outlet into which it had previously been connected. The unit needs to sense that current (about 2A, given the 500W rating of the bulb) is being drawn from the mains. For safety's sake, this should be accomplished without any direct connection between the mains wiring and the rest of the unit.

This 'galvanic isolation' could be accomplished using an opto coupler, but that would need an auxiliary supply derived from the mains to operate the opto-coupler's internal LED, so another method was sought. The obvious solution was a current transformer, and this was the method chosen.

However, it had to fit the transformer actually within a 13A ring-main type socket (as indicated on the circuit diagram, Figure 1) so that the primary winding could be formed by the neutral conductor of the mains lead itself. This necessitated an unorthodox design of current transformer.

In a conventional current transformer, a resistive secondary load (forming the meter circuit and called the 'burden') is transformed down to an exceedingly small resistive load in series with the main circuit. The transformer has sufficient primary inductance for its reactance to be large, compared to the transformed burden impedance. The measurement circuit is thus insensitive to frequency. This type of current transformer, which may be designed to measure a current of hundreds or even thousands of amps, is designed to work in the 'constant current' domain, which is entirely the opposite of the usual 'constant voltage' regime that we are so used to in everyday life. Whereas the safe off-load condition for an ordinary transformer is with the secondary open circuit, the safe off-load condition for a large current transformer is with the secondary short circuited. The full rated primary current would cause a dangerously high voltage to appear across an open circuit secondary.

A second type of current transformer operates into an open circuit secondary (or at least into a high resistance load) and therefore is designed with a much lower primary inductance. This type of current transformer is inherently frequency sensitive, the secondary voltage being proportional to the product of the number of primary turns and the number of secondary turns, and to the frequency.

The transformer used in this project is a variant of this second type. The difference is that the core is inadequate for handling the peak magnetising force provided by the primary current, so the core is driven heavily into saturation on each half cycle of the current. Thus, the flux approximates a squarewave and the secondary voltage, being proportional to the rate of change of flux, consists of alternate positive and negative going spikes, as shown on previous page.

How it works.

When the lamp in the PIR floodlight is lit, the positive spikes of voltage out of the secondary of the current transformer turn on NPN transistor TR1, which discharges C1 and turns on PNP transistor TR2. The time constant C1R2 is so long that C1 cannot recharge significantly between positive spikes, which occur every 20ms. TR2 applies the battery voltage (assuming ON/OFF switch S1 is closed, of course) to the rest of the circuitry.

The rest of the circuit consists of an astable multivibrator formed from a CD4069 hex inverter, driving a Piezo electric sounder. With the component values shown, the 'beep' rate is about three beeps every ten seconds. For a faster, possibly more urgent sounding rate, C2 may be reduced to 47n or even less. When the current drawn by the 500W floodlight ceases, TR1 remains cut off, C1 charges back up to 9V, TR2 turns off and silence reigns once more.

Construction

IMPORTANT NOTE: This project involves the wiring of mains plugs and sockets. Readers are advised that, if they are not 100% competent in handling this, they should on no account undertake this task, or at the very least, should have their handiwork checked by a qualified person.

The unit was constructed in a black plastic project box (see parts list) to the lid of which the 13A socket SK1 was bolted. The current transformer T1 was mounted inside SK1. T1 is wound on a ferrite ring core with an Al value of 4000nH/turn. However, the exact value of Al is academic, in this application it is only the saturation flux density which is important.

The secondary consists of 36 turns of very fine enamelled copper wire, leaving most of the aperture free for the primary. This consists of four passes through the core of the neutral conductor of the three-core mains lead. The core will easily accommodate these, if a mains lead rated at not more than 3A is used. The ring core is plastic coated and thus completely free of sharp edges, so there is no danger of the insulation of either winding being penetrated.

The ends of the secondary winding were passed through a hole in the socket and lid and connected to two solder pins on the circuit board, which itself was mounted on the inside of the lid, on the tails of two of the three screws with which the socket was attached.

It is strongly recommended that IC1 be mounted in a 14 pin IC socket, rather than directly onto the circuit board. On completion of the circuit board, inspect all joints with an eyeglass and, if using copper strip board, look out especially for shorts between strips or due to incompletely cleared holes.

The ON/OFF switch S1 was mounted on the side of the box and the Piezo-sounder was mounted on one end, on the outside naturally. A scrap of strip board was inserted into one position of the box's internal guides, forming a battery compartment to retain the PP3 battery firmly in place. Take care when assembling the finished unit to avoid trapping any of the leads as the lid is fitted to the box.

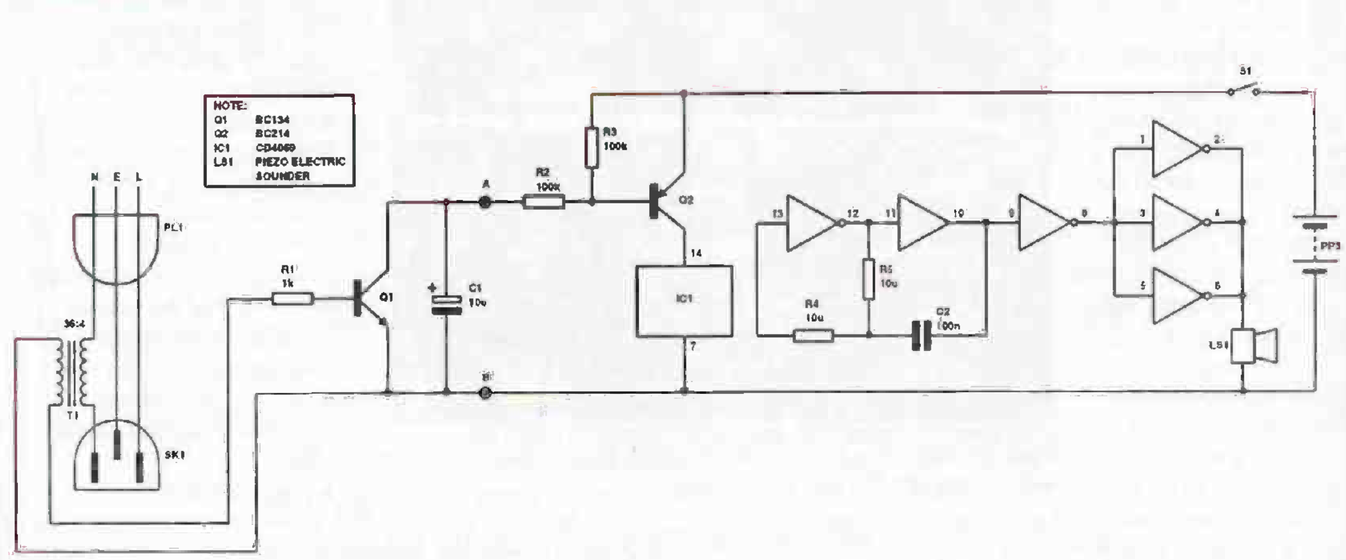
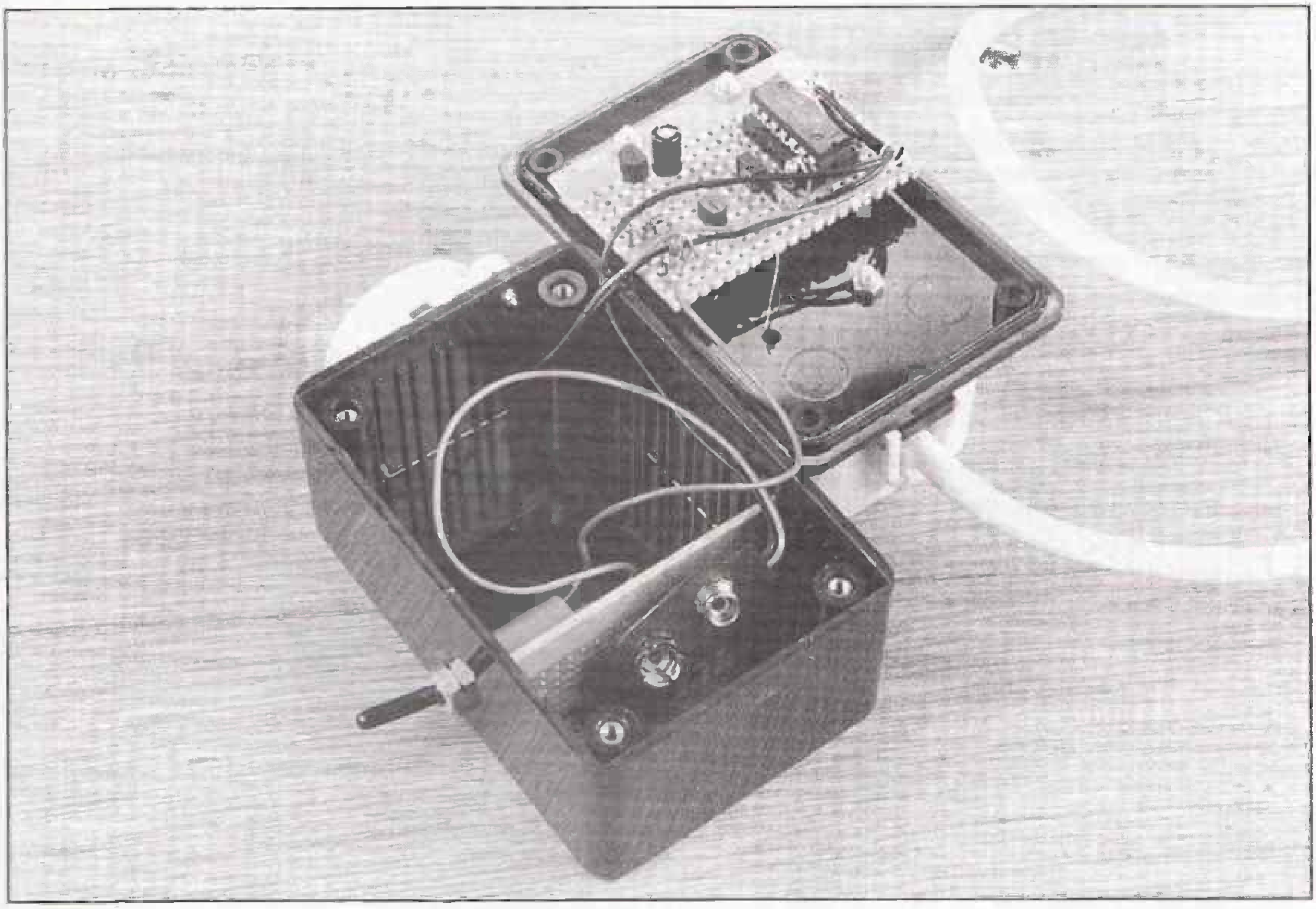


Figure 1. The circuit diagram of the PIR Activated Alarm



Testing

There are no setting up adjustments, so if the unit has been assembled correctly, it should work first time. However, resist the temptation to try it out without the covers fitted to either SK1 or PL1. The greater part of the circuitry can be tested before ever connecting the unit to the mains.

With the battery fitted and S1 ON, short points A and B - the sounder should commence to beep. Remove the short, and within a second or so the sound should cease - if not, suspect excessive leakage in C1.

A good component is essential here, its leakage will then be a microamp or less, far too little to turn on TR2. Barring wrong wiring, the only other possibility would be a faulty TR1.

Use

The unit is simply inserted between the PIR unit's mains plug and the socket into which it was previously plugged. When the floodlight comes on, the unit will immediately commence to sound. The sound is fairly penetrating, without being too alarming and will probably be heard from another room even with the door shut, unless the TV is too loud.

If it is felt that the unit would not be heard, it may be constructed in two separate parts. The circuitry to the right of the points A, B can be constructed in a separate box and the the rest as described above. Thin bell wire can be used for the run between the two units, with the wire permanently connected at one end, but, for convenience, via (say) a 3.5mm jack plug and socket at the other. The arrangement using separate units is completely safe, thanks to the isolation between the mains circuitry and the rest, provided by the current transformer.

Note that if a heavy load such as a washing machine is supplied from an adjacent socket, when it switches the alarm may emit a slight hiccup, but it will only sound normally when the PIR unit's floodlight comes on.

PARTS LIST

Resistors

R1	1K
R2	100K
R3	100K
R4	10M
R5	10M

Capacitors

C1	10µF
C2	100nF

Semiconductors

TR1	BC184
TR2	BC214
IC1	CD4069

Sundry

13A plug fitted with 3A fuse
13A socket
3A 3 core mains lead
Small 'BIMBOX' (Electrovalue stock no. 2001)
Battery connector lead
Battery PP3
Siemens ferrite ring core B64290-K38X38, (Electrovalue stock no. 2903838K)
Piezo electronic sounder (Electrovalue stock no. DMP27S)
Single pole ON/OFF switch
14 pin IC socket
Solder pins, as required

MIDI Explained

In the first part of a new series, Robert Penfold takes a close look at the MIDI musical instrument interface.

The MIDI (Musical Instrument Digital Interface) has been in existence for well over ten years now. To start with, it was not exactly an overnight success, but it did eventually gain widespread acceptance. MIDI is now an everyday part of electronic music making and a comprehensive MIDI implementation is mandatory for any electronic instrument intended for serious music making. At least a basic understanding of MIDI is virtually essential for anyone wishing to exploit modern electronic musical instruments and there is a definite advantage in having an in-depth knowledge of the subject.

In this series of articles, MIDI will be considered in some detail. Subjects to be covered include basic MIDI interface hardware, the MIDI messages and their coding, connecting everything up and practical aspects of using MIDI. We will also be examining the ways in which a MIDI system can be linked up with, and controlled by, a personal computer, and taking a look at a PC to MIDI interface.

No previous knowledge of MIDI is presumed, but it is assumed that you are reasonably familiar with modern electronic musical instruments. Obviously at least a basic understanding of electronics is needed in order to understand the material that deals with the hardware side of MIDI interfacing.

Swapping Notes

MIDI is simply a means of passing digital information from one musical instrument to another, or between any two pieces of equipment in an electronic music system. Probably in most cases a MIDI system is composed of a computer running sequencer software, plus one or more instruments. MIDI is also used with other items of hardware, such as audio mixers and lighting control units.

It was clear to the MIDI designers that they needed to produce a system which was rigidly standardised so that the incompatibility problems which afflicted previous musical instrument interfaces would not be repeated. On the other hand, MIDI also had to be versatile enough to cope with rapid developments in the electronic music business. With hindsight, they would no doubt have done some things differently, but the system they devised was sufficiently versatile to stand the test of time.

The basic hardware for a MIDI interface is just an asynchronous serial link operating at 31250 baud. The interfacing hardware is actually very similar to a computer RS232C port, but opto-isolators are used at all inputs to minimise problems with 'hum' loops. The opto-isolated inputs also help to prevent digital noise from finding its way into audio signal paths. The opto-isolation does not guarantee that 'hum' loops, etc., will not occur, but it does at least ensure that MIDI will not be the cause of any problems of this general type.

Standardising the hardware is easy enough, but the software side of things is more awkward. Previous musical instrument interfaces only provided a means of playing notes on a slave instrument and in many cases did not even provide any control over the dynamics of each note.

MIDI had to be able to cope with increasingly sophisticated instruments, having numerous features that could usefully be controlled via a master controller of some kind. MIDI enables notes to be switched on and off, but it also gives full control over the dynamics of each note, multi-channel polyphonic operation, pitch bending, and a whole range of facilities that are way beyond the old gate/CV interfaces. The coding of most MIDI messages is rigidly standardised so that, within reason, it is possible to connect together any two MIDI devices and get them to work together as a system.

However, there are some general purpose messages that offer a degree of flexibility. Using these requires rather more care on the part of the user, since their effect (if any) will vary somewhat from one MIDI device to another. There is also a special category of MIDI message which enables manufacturers to implement any special features which can not be handled by the normal message types. This system includes a safeguard which ensures that devices ignore messages that they can not respond to properly.

Quick Bytes

With a serial interface, the bytes of data are sent one bit at a time until all eight bits have been transmitted. With an asynchronous system, there are only two connecting wires, the signal and earth leads, there is no third lead to provide some form of synchronisation signal. Obviously some form of synchronisation is essential if the receiving circuit is going to decode the incoming signals correctly. This problem is partially overcome by having the transmitting circuit send the data at a standard rate. If the receiving circuit samples the signal line at the same rate it will not miss bits, or read the same one twice. MIDI is transmitted at a rate of 31250 baud, which is substantially quicker than the highest standard rate used for normal RS232C interfaces.

A serial system such as MIDI also relies on synchronisation signals being sent with each byte of data. MIDI uses the popular word format of one start bit, one stop bit and no parity bit. In other words, an extra bit is always added ahead of each set of eight bits. This simply indicates to the receiving device that a byte is about to be sent, and that after the appropriate delay it must start detecting the logic level on the signal line. The stop bit is not really a synchronisation signal and its purpose is simply to place a small gap between each byte so that the receiving circuit has time to deal with one byte before it has to start decoding the next one. Parity bits are used in a simple method of error checking, but this system is not implemented in MIDI.

Choked Up

The timing diagram of Figure 1 helps to explain the way in which a MIDI interface transfers data. It is the convention that the least significant bit (bit 0) is transmitted first and the most significant bit (bit 7) is sent last. Although MIDI is quite fast by serial interface standards, it has to be borne in mind that it is slow by general electronic and computing standards. Data is sent at a rate of 31250 bits per second, but including the start and stop bit it requires ten bits for each complete byte of data. Furthermore, most MIDI messages consist of a group of two or three bytes. For example, it takes a three byte message to switch on a note and another three note message to switch it off again.

With 30 bits per message this equates to a time of just under one millisecond. This is usually quite fast enough, but at times of high MIDI activity it can be inadequate. Controlling some functions via MIDI requires numerous messages to be sent in rapid succession. It is when using a profusion of these messages that problems with MIDI 'choke' are likely to occur.

The effect of MIDI choke on the reproduced music is unpredictable. It is unlikely that the system will crash or simply grind to a halt, but the timing of notes may well suffer. It is even possible that notes will be omitted, or left switched on. Many sequencers now include a facility that combats MIDI choke by filtering out the messages of lesser importance at times of high MIDI activity. This generally means that something like pitch bending will be less smooth than it might otherwise have been, but no notes will be omitted, left switched on, or significantly delayed.

A much higher data transfer rate could be achieved using some form of parallel interface, but there are practical difficulties with a parallel interface in this application. One of these is simply that relatively thick and expensive connecting cables would be needed. A more serious limitation is that

Figure 1. MIDI uses one start bit, 8 data bits, one stop bit and no parity.

parallel data links tend to have relatively short maximum operating distances. A parallel printer port for example, should not be used with a cable more than 2m long.

Serial interfaces provide much greater operating ranges but, due to the relatively high baud rate and low operating current, MIDI is only guaranteed to operate reliably over a maximum range 15m. However, this should be more than adequate for most purposes. In practice it would probably be possible to obtain good reliability over significantly greater ranges, provided very high quality cables are used.

RS232C serial interfaces have additional connecting wires which are used to provide handshaking. In other words, they are used to control the flow of data from one device to another so that the sending device does not provide data at such a high rate that the receiving device can not cope. MIDI does not use any handshake lines, and MIDI hardware must be designed to cope with a continuous stream of data.

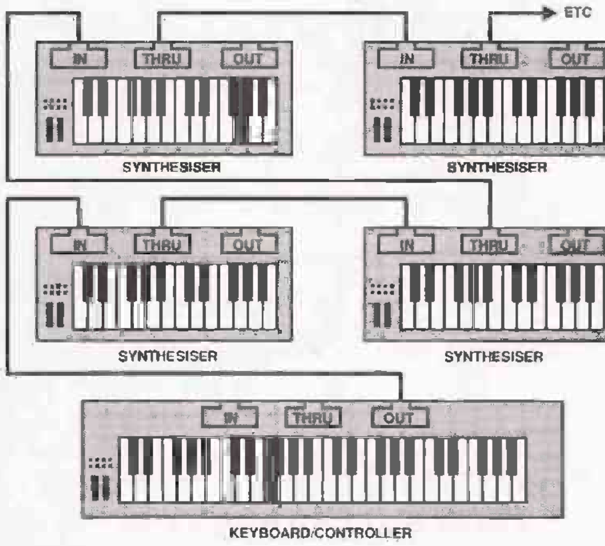


Figure 2. A system which uses the chain method of connection.

Software handshaking is sometimes used with MIDI when large amounts of data must be 'dumped' from one unit to another. With this type of handshaking 'on' and 'off' codes sent via the normal signal lines are used to control the flow of data. However, this is a special case and is not the way in which MIDI normally functions.

Right Connections

These days, virtually all MIDI equipment has a full set of three MIDI sockets. It is not actually a requirement of the MIDI specification that all three sockets should be present and I suppose that, with some pieces of MIDI hardware, only one or two of the sockets are relevant. The three types of MIDI port are the IN, OUT and THRU varieties. As one would expect, a device transmits data on its OUT socket, and receives data on its IN socket. The THRU port is an output type and it simply provides an output signal that is an exact replica of the signal received at the IN socket.

In its most basic form, a MIDI system consists of a master unit controlling a slave unit, with a single connecting cable.

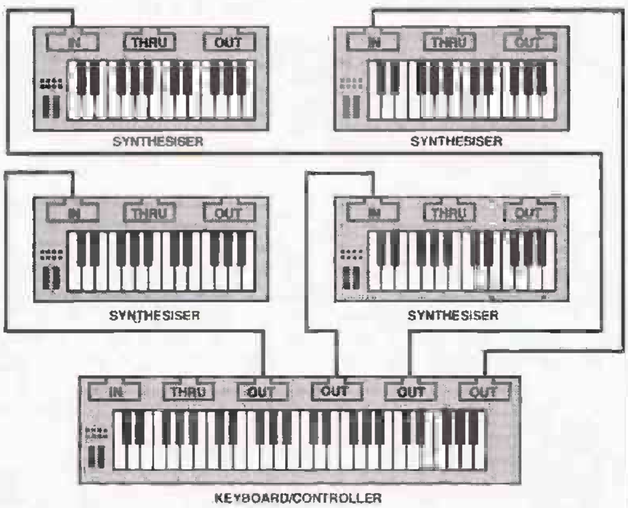


Figure 3. The star method of connecting the slave units to the controller.

Competition

Win a copy of Robert Penfold's new book

'Electronic Music and MIDI Projects'.

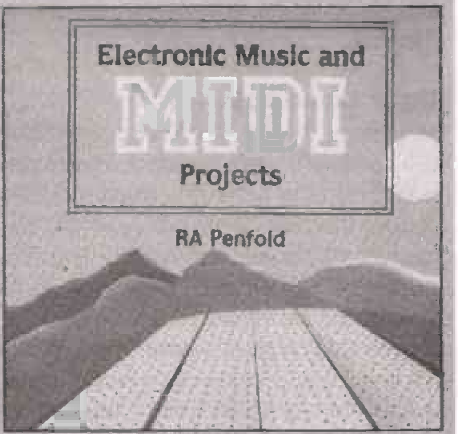
Just answer the following simple questions:

1. What does MIDI stand for?
   a) Melody instrument digital interface
   b) Musical instrument digital interface
   c) Musical instrument device instructions
2. At what speed does the MIDI asynchronous serial interface operate?
   a) 31200baud
   b) 32500baud
   c) 31250baud
3. How many bits in each MIDI data byte?
   a) 11
   b) 10
   c) 12
4. How many pins in a MIDI cable?
   a) 5
   b) 7
   c) 9

Write your answers, which can all be found somewhere in this issue of ETI, on a postcard in the form of question number followed by choice, as well as your full name, address and post code. Please write clearly in block capitals. All answers must be received by June 30th 1994 when a draw will be made for a total of six winners from all the correct answers received on or before that date.

Send your entries to MIDI Book Competition, ETI, Argus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST.

The competition is not open to the employees or their families of ASP or PC Publishing. The prizes are as stated, there is no cash alternative. The editor's decision is final and no correspondence can be entered into.



Book Review

Electronic Music and MIDI Projects
by Robert Penfold

This book, by one of the country's leading writers on electronics (and a regular ETI contributor), is a great source of circuits and ideas for the budget conscious electronic music enthusiast and could literally save you thousands of pounds.

The book has been written from the standpoint of a reader who has a minimal knowledge of electronics, although it will be equally of interest to more experienced and knowledgeable readers. The author takes the reader through all the different types of component used in the various projects, as well as explaining the basic assembly techniques. All the projects use commonly available components and are assembled using stripboard and a minimal range of tools. The author does not attempt to explain MIDI systems, which is dealt with by many other books and, of course, this new series of ETI articles. What he does include are seventeen useful MIDI projects. Each project is described in detail with circuit diagrams, component listings, strip board layout and detailed information on assembly and testing.

The projects include a MIDI tester, THRU Box, MIDI patch bay, Stereo mixer, MIDI controlled switcher, Program change pedal, Analogue echo unit, Electronic swell pedal and many more.

If you are interested in electronic music then this book is a very useful addition to your bookshelves and could save you its cost many times over.

ISBN 187 0755 24 4
Price £9.95
Published by PC Publishing,
4 Brook Street,
Tonbridge,
Kent. TN9 2PJ

Most practical MIDI systems actually consist of a master unit controlling several slave units. This easiest way of driving several slave devices from a single controller is to use the 'chain' method of connection. This utilises THRU sockets to carry the signal from the master unit from one slave device to the next. Figure 2 shows this basic scheme of things.

There are a couple of potential problems with the chain method of connection. One is simply that not every unit that has an IN socket has a THRU output as well. If only one slave unit lacks a THRU socket there is no problem and it is just a matter of placing that unit at the end of the chain. If two or more of the slave units lack a THRU socket it is impossible to wire up the system using the chain method. In the early days of MIDI, it was by no means uncommon for the THRU socket to be absent and even relatively recently it was not included on some keyboard instruments. Fortunately, all the MIDI devices manufactured in the last few years seem to be equipped with a full complement of MIDI ports.

The second possible problem with the chain system is that the signal passes through an opto-isolator and a switching transistor on each journey from an IN socket to a THRU output. The switching transistor is unlikely to degrade the signal to a significant extent, but opto-isolators are rather slow by normal electronic standards. In fact, standard opto-isolators cannot successfully handle a MIDI signal. MIDI requires the use of high speed opto-isolators that are around one hundred times faster than inexpensive types such as the TIL111.

Even using high speed opto-isolators there is some smearing of the signal as it passes through the system. With the chain method of connection the signal passes through several opto-isolators and there is a risk of significant smearing by the time the signal reaches the final unit in the chain. This smearing alters the timing of the signal and the timing is all-important to correct serial to parallel conversion at the slave units. This problem has become known as MIDI 'delay', and it could cause one or more units in the system to behave erratically. In practice, there should be no problem with MIDI delay, even with a dozen or more units chained together, provided that everything in the system uses opto-isolators which are up to the standard dictated by the MIDI specification.

MIDI delay is sometimes described as being a significant delay through the system, causing units at the end of the chain to noticeably lag behind those near the beginning. This is quite definitely a myth and the delay through a chain of even a hundred MIDI devices should be less than a millisecond. The problem of MIDI delay is one that tends to be exaggerated and the likelihood of problems with the chain system is minimal. If some units in a chain system do not operate reliably, it is much more likely that the problem is due to a faulty lead than that the system is suffering a bad case of MIDI delay.

Seeing Stars

There is an alternative to the chain system in the form of the 'star' system. With the star method of connection, each unit in the system is driven from a separate output on the master unit. This basic scheme of things is outlined in Figure 3. In practice it is not usually possible to implement the star system without some additional hardware, because it is unlikely that the master unit will have more than one or two MIDI OUT sockets. All that is needed is a THRU box, which is a simple and inexpensive device which provides several THRU outputs from a single input signal. It is just a matter of connecting the OUT socket of the master unit to the IN socket of the THRU

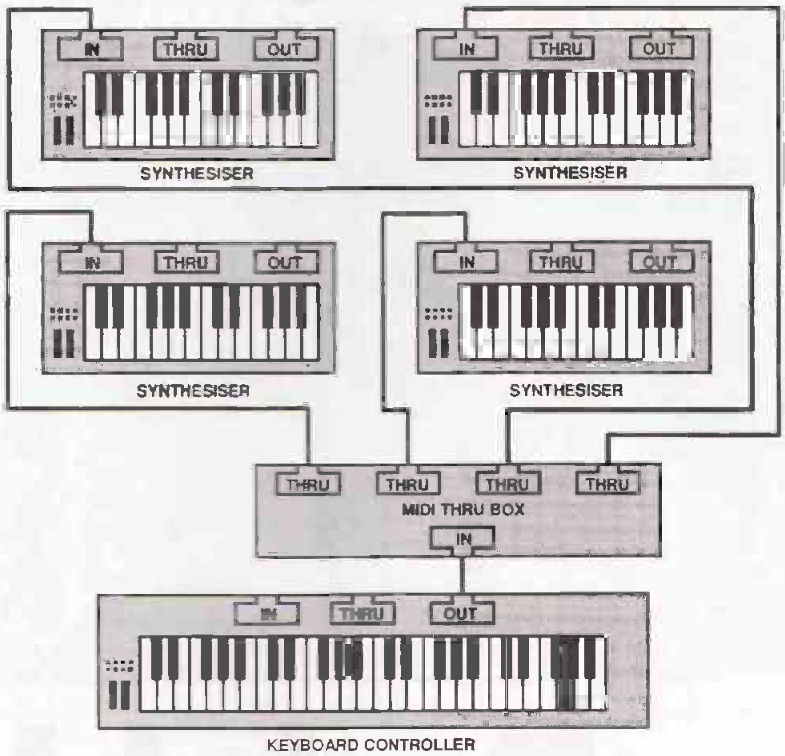


Figure 4. Using a THRU box to facilitate the star method of connection.

box and then driving each slave device from a different output of the THRU box. Figure 4 shows the connections for a star system which incorporates a THRU box.

Deciding whether to use the chain or star method of connection is an easy choice. Unless it is not possible to use the chain system for some reason, or the chain system has been tried and is giving problems, it is unlikely that there will be any advantage in using the star system. In fact, the star method is likely to be the more costly and difficult to implement.

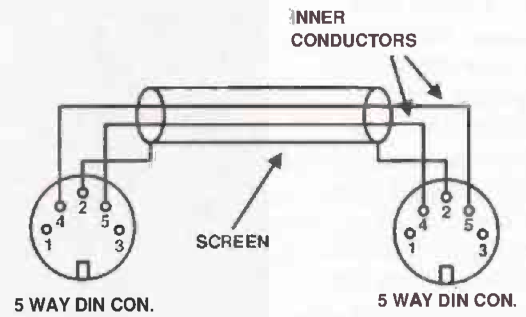
Cables

The standard connector for MIDI ports is the 5 way 180 degree DIN type (also known as a 5 way type A DIN connector). The cable is a twin screened type which provides a 'straight' coupling between pins 2, 4, and 5. Pin 2 connects to the screen, with pins 4 and 5 carrying the signal. Figure 5 shows the method of interconnection used. In reality, many ready-made MIDI cables seem to provide connections between all five pins. This is not actually within the MIDI specification, but it should not result in any difficulties. Pins 2 and 3 are always left unconnected internally on MIDI units and any external connections to them are therefore superfluous.

Pin 2 is also left unconnected on MIDI input. This is to maintain the isolation at each input. Pin 2 is connected to ground on MIDI outputs and this helps to minimise the radiation of electrical noise by properly earthing the connecting cable's screen.

The MIDI specification allows XLR connectors to be used instead of the normal DIN type. This is only permitted if the equipment manufacturer also makes available suitable DIN to XLR adaptors. XLR connectors are very high quality components, intended for use in top quality professional equipment. In practice they seem to be little used in MIDI equipment.

Figure 5. A MIDI lead only provides connections between three pins of the five way sockets.



Next Month....

Robert Penfold will be looking at the mysteries of MIDI coding.

Bass Pedal Unit

Tom Scarff gets down to bassics with this MIDI pedal unit

Nowadays, MIDI devices come in all shapes and forms and MIDI controllers range from standard keyboards to various trigger devices.

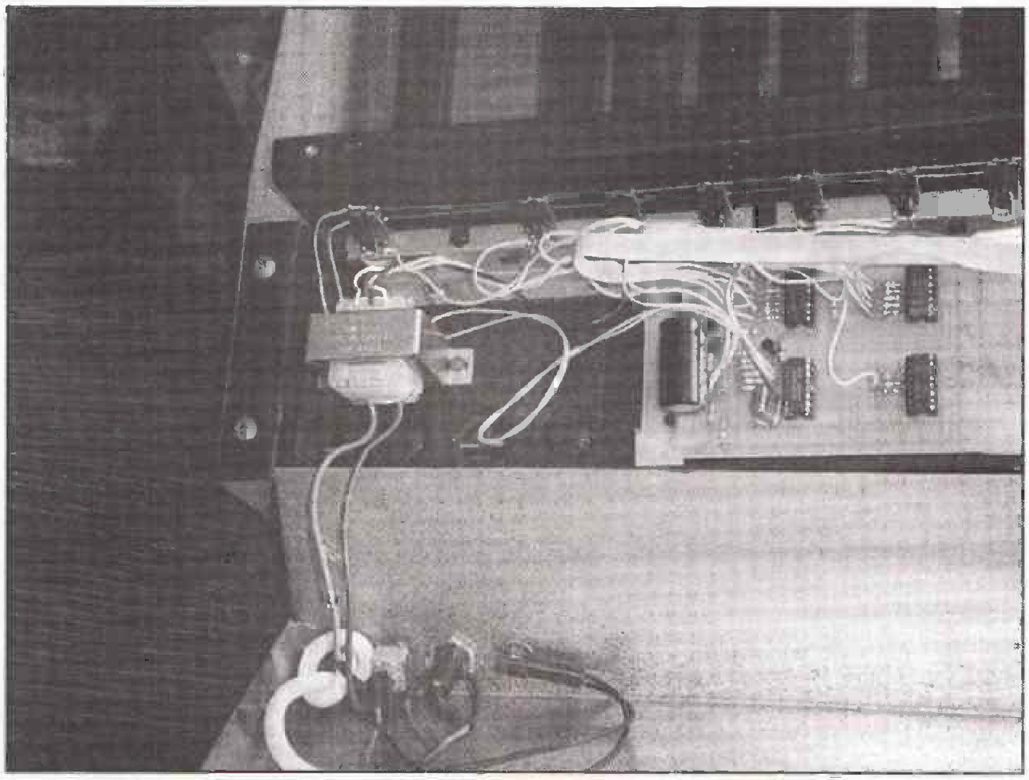
While most MIDI triggers are controlled by hand, some people like to use their feet as well, allowing a guitarist or keyboard player to add bass or trigger drums or other MIDI sources, while simultaneously playing their instrument by hand.

A number of MIDI bass pedals have appeared on the market in the last few years but their price is in the hundreds of pounds range, so I decided to design and build my own bass pedal unit.

Circuit Description

The circuit is designed around the MIDI keyboard controller type E510 and Figure 2 shows its internal structure. The switch scanning frequency and the timing of the serial MIDI data are derived from an internal oscillator that operates with an external 4 MHz quartz crystal, connected to pins 14 and 15.

The complete circuit diagram of the bass pedal unit is shown in Figure 1 consisting of the MIDI controller IC4, MIDI out driver transistors Q1, Q2 and Q3, the address decoders IC1, IC2 and



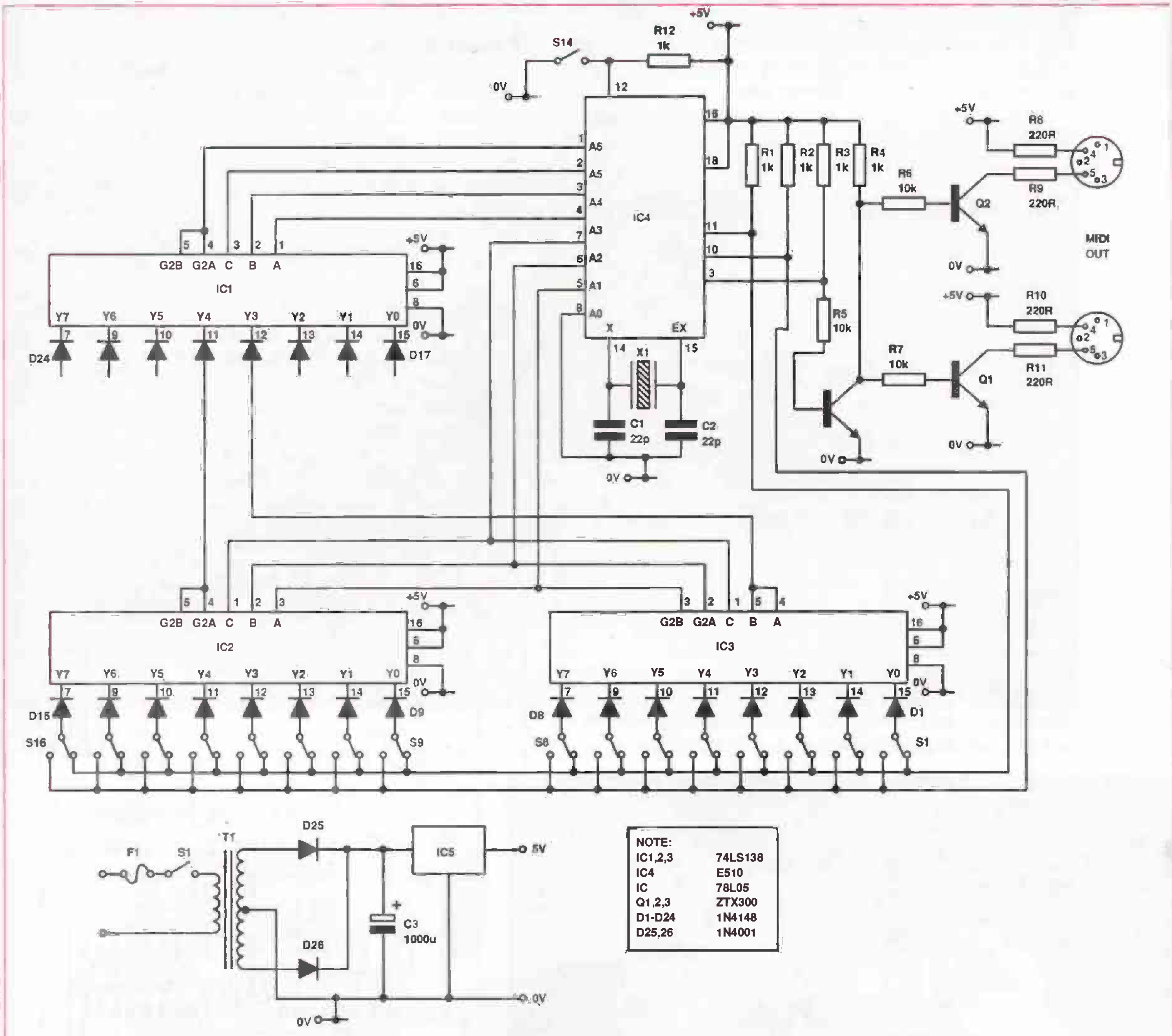


Fig. 1 Circuit diagram of the Midi Bass Pedal Unit

IC3, and the power supply plus regulator IC5.

The address bus consisting of 7 lines, A0 to A6, allows the E510 to scan up to 128 individual switches. However, even though the bass pedal unit only requires one octave to be scanned, the other addresses should be fully decoded to prevent incorrect or spurious operation.

While the switches are being scanned, the logic levels at BS and BE, pins 10 and 11 respectively, are monitored internally by the E510 to detect the operation and velocity of any switch being pressed. The time taken for the switch to operate is measured internally by the E510 and generates an appropriate velocity byte relative to how hard the key was pressed. With a clock frequency of 4MHz, the resolution is 256µs for the timing of the velocity byte.

Input BE is connected to the rest contacts of the switches, while BS is connected to the normally open contacts of the changeover switches. The centre pole of a switch addressed by the E510 is made logic low via the decoder/demultiplexer ICs and during scanning, when the centre pole is connected to the rest contact, the BE line is logic low. When the pole is switched to the normally open contact then BS goes logic low. In between the two contacts, both BE and BS are logic high via the pull-up resistors R1 and R2.

The serial output from pin 9 is internally set up to operate at the correct MIDI baud rate of 31.25kHz and is made TTL compatible by using the pull-up resistor R3. The MIDI output is then buffered and inverted by transistor Q1, before being fed to the two MIDI outputs via transistors Q2 and Q3. These two outputs allow the bass pedal unit to trigger two MIDI devices simultaneously even if they do not have a MIDI thru' socket.

The E510 can operate on MIDI channels 1 or 2, depending on the logic level on CO (pin 12) provided by switch SW14. If CO is at logical 0, the E510 transmits on channel 1, if at logical 1, it transmits on channel 2. The TST input is held high during normal operation.

Octave Selection

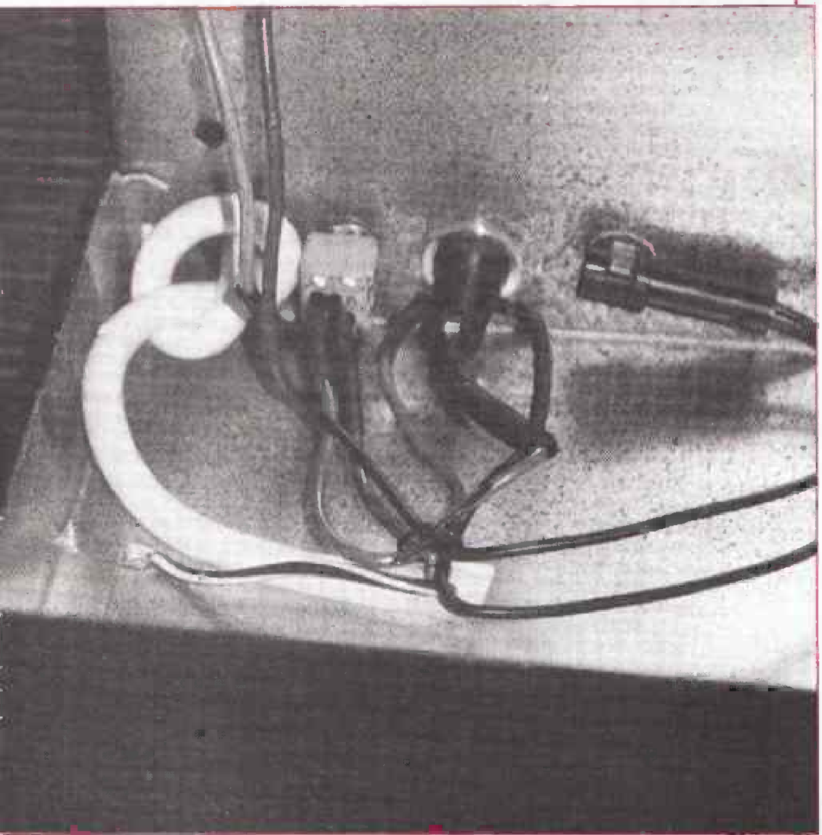
The octave that is selected depends on the connections of the outputs from IC1 to the gate enable inputs G2A, B, of IC2 and IC3. This allows selection of the particular octave to be triggered within a synthesiser module, as bass notes can sound better at different octaves on different machines. The various link options available are shown in Table 1.

TABLE 1 Links for MIDI Octave Output

Links from IC1 to G2A and B

IC3	IC2	MIDI Notes	Octave	Connect
Y0	Y1	0 to 16		
Y1	Y2	8 to 24	C0 to C1	D4-D16 to S1-S13
Y2	Y3	16 to 32		
Y3	Y4	24 to 40	C1 to C2	D1-D13 to S1-S13
Y4	Y5	32 to 48	C2 to C3	D4-D16 to S1-S13
Y5	Y6	40 to 56		
Y6	Y7	48 to 64	C3 to C4	D1-D13 to S1-S13

Table 1 shows how various octaves can be selected, depending on the links from IC1. Note that, although the two 3 to 8 decoders provide 16 outputs, only 13 are required for any



particular octave, so that for the octave C1 to C2 to be selected, Y3 and Y4 from IC1 must be connected to the gate enables of IC3 and IC2 respectively and their outputs from D1 to D13 are connected to S1 to S13 respectively.

Power Supply

The power supply uses a standard centre tapped 6V-0V-6V transformer, T1, whose output is rectified by D25 and D26, smoothed by C3 and regulated by IC5, to provide 5V at up to 100mA, although the circuit only draws around 30mA.

Mechanical Construction

The metalwork consists of 1mm aluminium which is bent through 90 degrees twice, to form an inverted 'U' shape. The two end brackets are connected to it, via self tapping screws, to form the main cover over the bass pedal switches and enclose the PCB and transformer. The MIDI out socket(s), on/off switch, fuse and neon indicator are mounted in a suitable position on the rear of the enclosure.

Details of the enclosure are shown in Figure 4 and the dimensions are designed to match the pedal unit available from Maplin. Holes need to be drilled in the enclosure, to match the bass pedal unit and, using self-tapping screws, the two units are joined together. The woodwork is nailed and glued together to form a suitable base to support the pedal unit and details are shown in Figure 4.

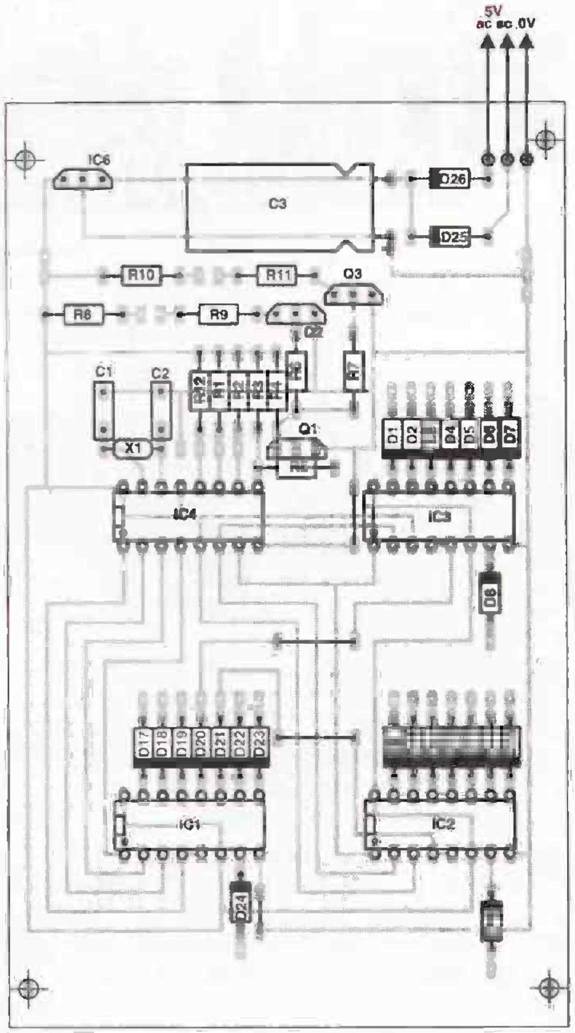
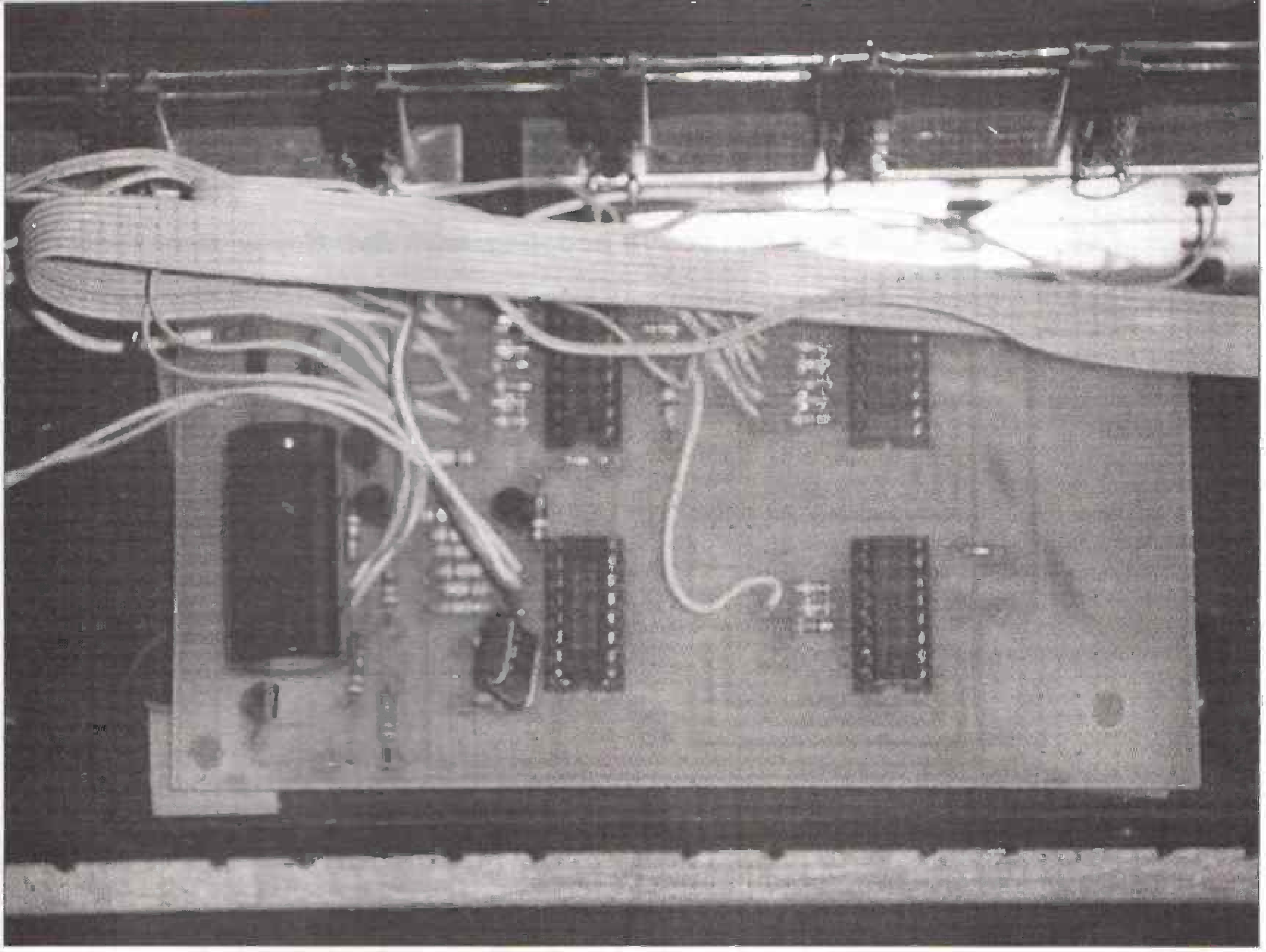


Fig. 2 Component overlay for midi bass:



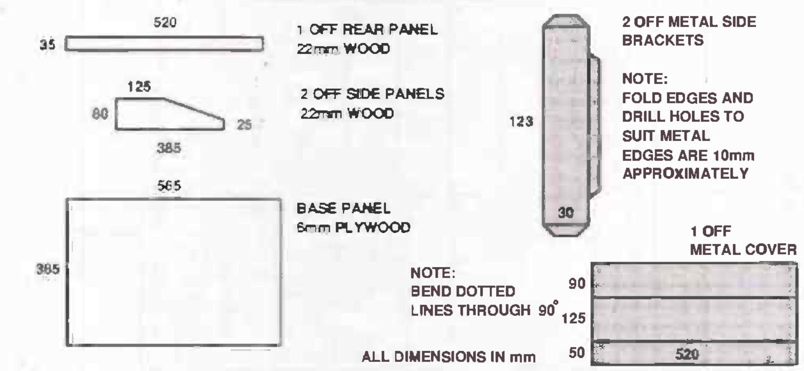


Fig. 3 Metalwork for bass pedal unit.

Electrical Construction

The PCB can be mounted on the bass pedal unit via self-tapping screws, through support pillars, or via adhesive PCB mounting pillars and then wired to the pedal change over switches, MIDI out sockets, channel 1 or 2 toggle switch and 6V-0V-6V transformer secondary. Care should be taken with the mains supply so that no mains connections on the fuse, on/off switch or transformer primary are left exposed and the earth lead should be connected to the metal chassis.

Operation

Actually playing the unit takes a little practise and I found that, by raising my ankle on a piece of wood in front of the pedals, the unit was easier to operate. The bass octave that sounds best depends on the MIDI device being operated, while the unit can also be used to trigger drum machines, but the drum patch may need to be set up internally to trigger the required drum sounds.

PARTS LIST

Resistors

R1, 2, 3, 4, 12	1k
R5, 6, 7	10k
R8, 9, 10, 11	220

Capacitors

C1, 2	22pF
C3	1000µF

Semiconductors

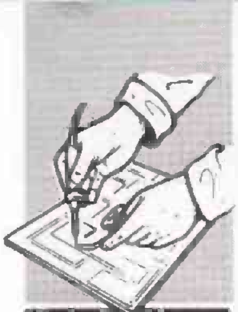
IC1, 2, 3	74LS138
IC4	E510
IC5	78L05
D1 to D24	IN4148
D25, 26	IN4001

Miscellaneous

Transformer 6V-0-6V; Fuse; DPDT switch; SPST switch; 5-Pin DIN (180); 16-pin IC holders (4 OFF).

Buylines

The foot-pedal is available from Maplin (order code XB18U) as is IC4 E510 (order code KU41U). The other components are available from many sources.



PROJECT

Cyclometer

Find out how fast you're pedaling, with Bob Noyes' Cyclometer

How many times have you heard children boasting to their family and friends that they "were doing 60" down such and such a hill, when in fact 16 miles per hour would be nearer reality? Children, on the whole, do not have a sense of speed - hardly surprising really when many adults don't seem to be able to relate to 30 mph in a built up area either. Anyway, I decided to build a bike speedo for my two boys so that they could see how fast they really were going. Simple, I thought - until the practicalities started to dawn.

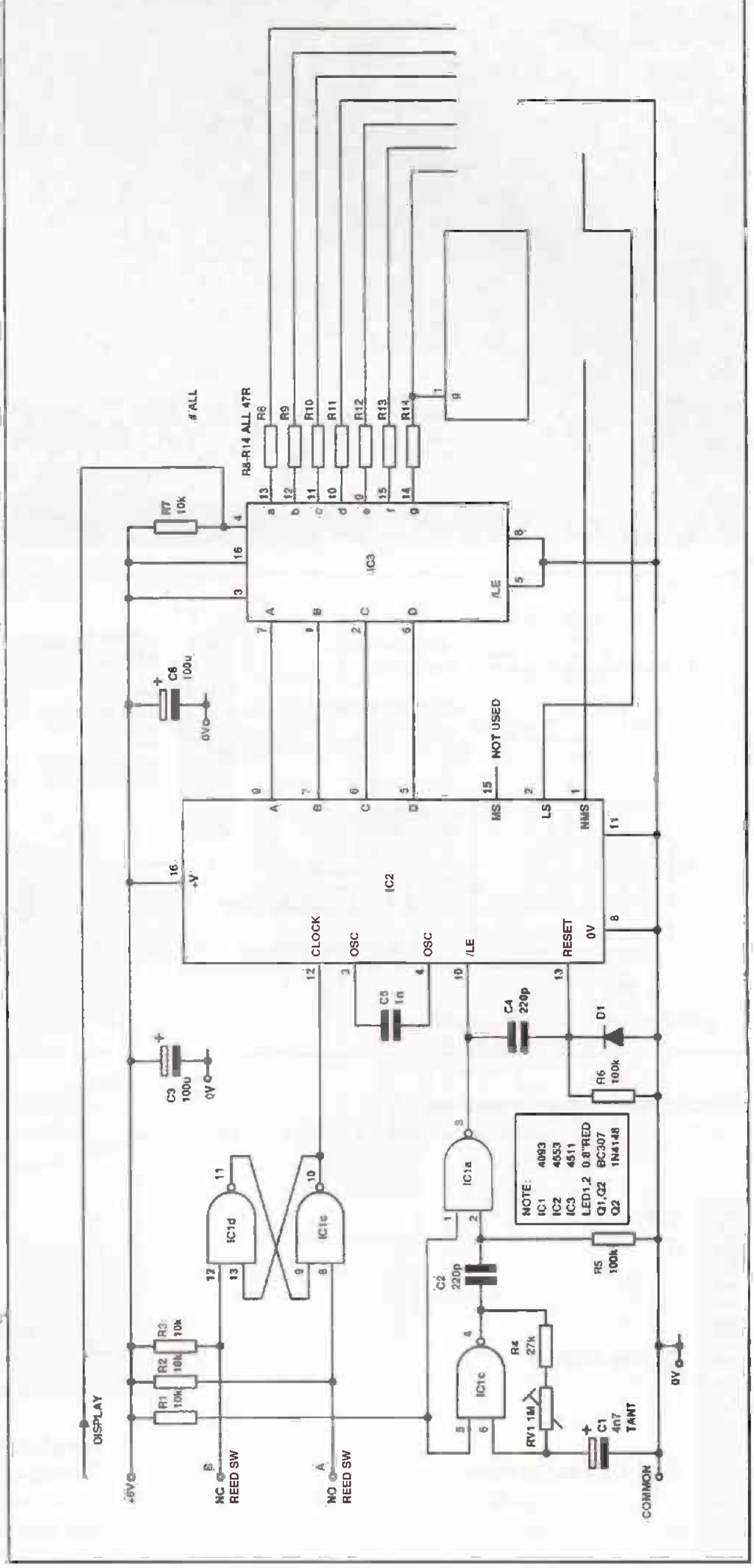
1. It had to be damn near bomb proof to survive my lads, so a strong moulded box would be required - Chobham armour was deemed too heavy.

2. The display or method of showing the speed presented a problem. Moving coil meters are not designed to be treated in the same way as most children treat their bikes, so they were ruled out. This also kissed goodbye to the '555' mono that was going to be the heart of the electronics.

A liquid crystal display was considered, as it is great at conserving energy because of its almost negligible power consumption, but on further inspection, the sheet of glass on the front of the display ruled it out on safety grounds. So that only left LEDs as a practical display medium, but to run the LEDs continuously would require a lot of power, so some means of battery conservation was needed - yet another problem. A very small, low power display could have been used but the difficulty of reading it while riding could distract the rider long enough to cause an accident, so this avenue was out too.

The course chosen was this. When the cyclometer is in use, the display or LEDs would normally be blank and when a reading is required, a button is pressed, the display giving an instantaneous read out. The display blanks again when the button is released, thus conserving power. The button can be mounted on the cyclometer or on the handle bars of the bike, near to the hand grips. Because the speedo isn't required most of the time, this is no hardship. To give some idea of the LEDs' power consumption, for a display of 08 mph, 13 of the 14 segments of the two digits will be illuminated. At, say, 20mA per segment, the consumption is 13 x 20 = 260mA and even the lowest display consumption, 11 mph would require 80mA. Reducing the current in the display reduces the brilliance, which may cause the rider to take longer to read it in sunny conditions - this in turn could increase the risk of an accident, so economies in LED power consumption can be ruled out. As well as the display, the control and counting electronics

Figure 1: Cyclometer circuit.



require power, but by using modern CMOS ICs, this can be kept to a minimum and is quite small compared with the display's requirements.

3. Because of the heavy current demands, well in excess of 1/4 of an amp, the good old PP3 9V battery is of no use. The higher current PP9 is too large as well as too expensive, so AA batteries are the ones to use. If normal AA non-rechargeable batteries are used, four are needed to produce 6V. If however rechargeable cells are used - and this is recommended - five are needed as their nominal voltage is only 1.2V.

Increasing the voltage by adding more batteries does not improve anything because an LED segment has a fixed voltage drop, independent of current (well, almost), so increasing the voltage only increases the power dissipated in the dropping resistors, R8 - R14, and reduces the efficiency of the unit.

If rechargeable batteries are used and they are the solder tag type rather than the plug in type, no battery holders are required as these tend to corrode at the terminals when exposed to damp conditions - which may well be the case in the life of a child's bike. There also needn't be a cover to come off and get lost.

4. The choice of detectors to detect the speed is a challenging problem in itself. An optical detector could be used but these require power supply to the transmitter LED all the time the cyclometer is on, so this is ruled out. If a bike has a dynamo generator for the lighting system this could be used as a kind of tacho, but most bikes do not have them fitted as standard and if they are fitted as an extra, they often slip on the wheel which would cause an accuracy problem, as well as being relatively expensive. So in the end, a reed switch activated by magnets has been chosen. There are several advantages of this method of detection:

a) There is no drive current needed, only digital levels being switched.

b) If more than one pulse per wheel revolution is required, another magnet can be added or several can be fitted at little expense.

c) Reed switches and magnets are quite cheap and readily available.

There is, however, one disadvantage in using reed switches and that is that they are prone to switch bounce when used in a counting circuit. One contact can produce a count of up to ten pulses, so a debounce circuit has been added between the reed switch and the counter.

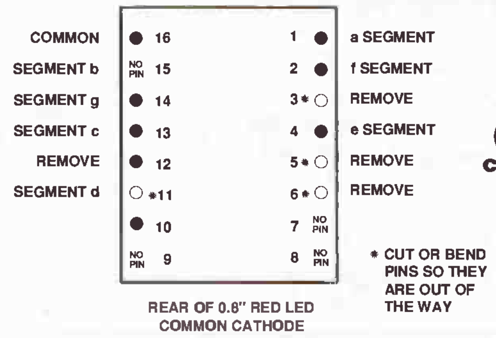


Figure 3: Rear of 0.8" red LED (common catmode).

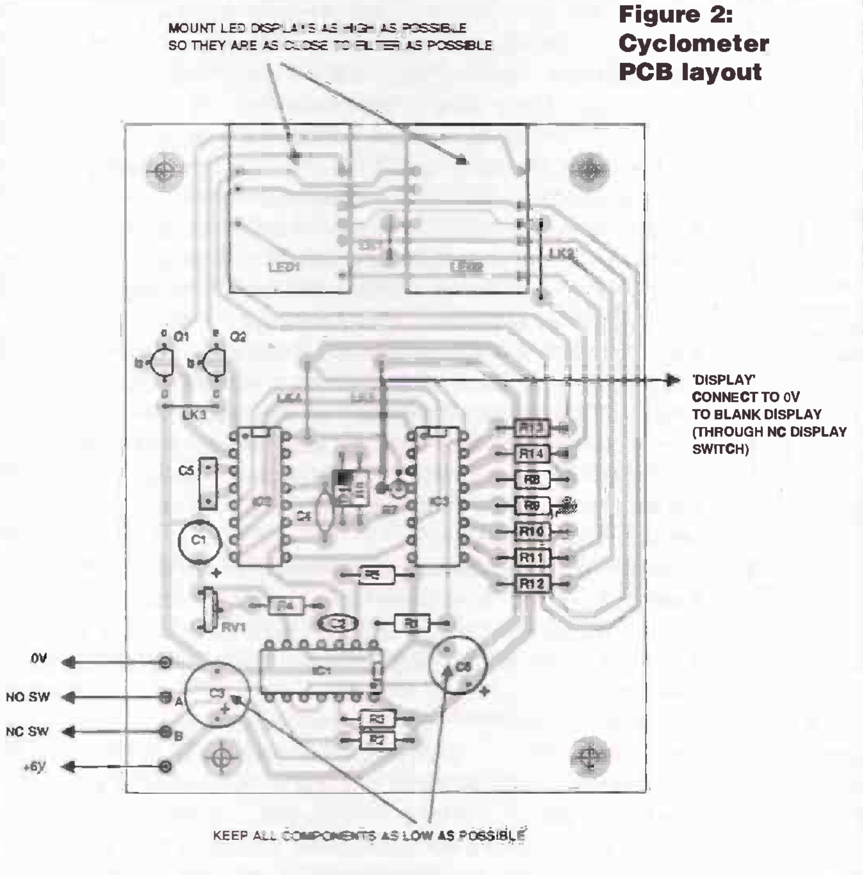


Figure 2: Cyclometer PCB layout

Background

Speed is defined as the rate at which distance is covered, in our case keeping to the British imperial standard of miles per hour. There are 63,360 inches in 1 mile and in my case both boys' bikes have a 26in nominal wheel, but when measured it was actually nearer 25.2in. The circumference of a circle, or a wheel, is 2Pr so 2 x 3.142 x 12.6 (radius = 1/2 diameter) = 79.2in wheel circumference. Number of revolutions per mile therefore is 63,360/79.2 = 800 revs/mile.

In order to keep the circuit simple, we do not want to use complicated and expensive electronic techniques to alter the number of pulses to a set 1 second time period, it is far easier to alter the timing period to set the calibration.

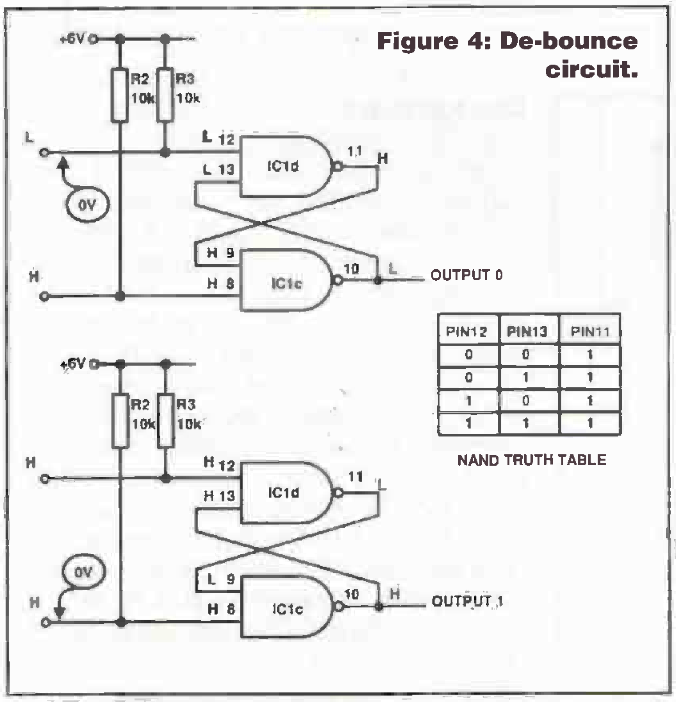
To read 20 on the cyclometer display at 20 mph, the counter must read 20 pulses in the time period. At 20 mph, one mile takes 3 minutes so the number of revs/minute = 800 revs/mile divided by 3 = 266.66 revs/minute. Divide this by 60 to get 4.4 seconds. This means that the counter for 4.4 seconds should read 20 (the number of revolutions) in order to give a direct reading in mph. Although this would work, it assumes that you keep a steady speed for 4.4 seconds to give an accurate read out. This is a long period of time and if two magnets were used instead of one, two pulses would be received per wheel revolution, so the time period could be halved, but if three magnets were used, three pulses per rev would reduce the time period to 1.46 seconds. This is a far more practical timing period as the display can re-time the speed count approximately every 1/1/2 seconds. The three magnets should be placed as symmetrically as possible, i.e. 120 degrees apart, so the gaps between pulses are equal. This calculation is based on a 26in nominal wheel which actually measures 25.2in.

Smaller wheels turn faster for the same speed than larger ones but their circumference is smaller too. For an 18in diameter wheel, assuming it to be actually 18in, the circumference is still 2Pr = 2 x 3.142 x 9 = 56.5in. Revs per mile is 56.5/63,360 = 1121.4. Again at 20 mph and for a reading of 20 on the cyclometer, it takes 3 minutes to travel 1 mile so revs/minute = 1121.4 divided by 3 = 373.8 revs/minute. To convert to revs/seconds divide 373.8 by 60 giving you 6.23 seconds. This is too long a time period, so by increasing the number of magnets to four, this timing period can be reduced to 1/4 = 6.23 divided by 4 = 1.55 seconds. Again the magnets should be mounted symmetrically, i.e. 90 degrees apart.

The same principle is used to calculate the time of count for any size wheel. The ideal time period of count is around 1.5 seconds in order to get a sensible and practical display. Too fast and the display appears to be constantly changing and is hard to read, too slow and the accuracy drops off as the speed is averaged out over a longer time.

How It Works

The sensor, or pick up, is a one pole, two way reed switch. As



PIN12	PIN13	PIN11
0	0	1
0	1	1
1	0	1
1	1	1

Figure 4: De-bounce circuit.

the wheel revolves, the magnets which are tie wrapped to the spokes activate the switch while they pass it. The reed switch is securely fitted to the forks of the front wheel.

The common of the switch (with no magnetic field present) makes contact with terminal B, but when a magnetic field is present (the magnet on the spoke passing the switch) the common breaks contact with B and makes contact with A. However, these contacts have a nasty knack of bouncing when directly connected to a counter, creating an error - one touch of the contacts can produce a count of up to ten. To prevent this error, they are connected to a debounce circuit, which takes the form of two cross coupled NAND gates, connected up as a latch. This requires a transition of the low (the common on the reed switch) from B to A and back to B again, to produce a pulse on the output. It does not matter how many times the common makes and breaks with A (the bounce effect), so long as it does not touch B and again, when the common makes with B it can bounce several times, so long as it doesn't touch A in between. This type of debounce circuit is used in many critical pulse count applications.

Now the clean pulses are generated at IC1 pin 10. The leading

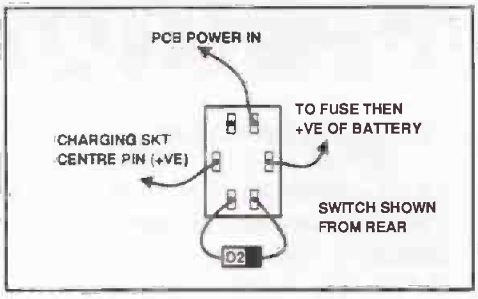


Figure 5: Power switch connections.

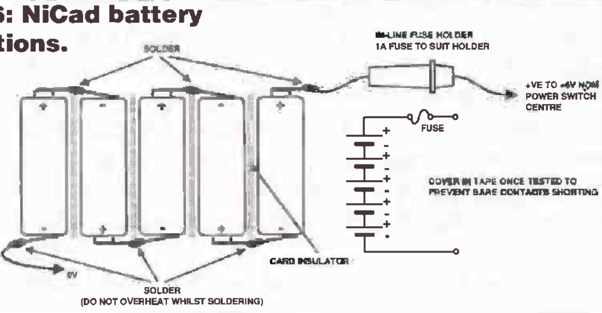
edge of the pulse is generated on the first touch of the common on A and the trailing edge generated on the first touch of the common back on B. These clean pulses are fed directly into the counter IC2 pin 12. IC2 is actually a three decade counter - hundreds, tens and units - but we are only using the two least significant decades, or tens and units. It is still far easier to use this chip, rather than two conventional counter ICs like 4029s, or even a two decade counter like 4518. The great advantage of the CMOS 4553 is that the output is 'multiplexed', which means it only requires one seven segment decoder IC, the 4511. Multiplexing basically means time sharing (not a dirty word in electronics).

Normally, two decades of a BCD counter require eight data output lines - 1, 2, 4, 8 for the units and 1, 2, 4, 8 for the tens. These are then taken as two groups of four, or two seven segment decoder ICs. In the case of the 4553, only one set of data outputs are required. These contain the information for all three decades. This is done by multiplexing - 1, 2, 4, 8 outputs pin 9, 7, 6, 5 respectively, first give the information applicable to one decade for a fraction of a second. This is accompanied by a decade drive signal which, via a transistor, turns on the appropriate display. The information on the BCD outputs is changed to the next decade and the decade drive signal, originally turned on, turns off and the next display is turned on, again via an external transistor. Finally, the third set of information for the third decade is outputted on the data lines and the second decade drive signal removed, the third being energised again via a transistor. This continuously repeats itself very quickly. All three decades appear to be on at the same time, because the human eye reacts much more slowly than the multiplexing speed. In our case we are not using the third decade but the principle of operation remains the same.

The 4553 is responsible for synchronising the turning on of the decade at the correct time, as well as outputting the data. This, with the three decade capacity and such features as 'disable' and 'latch enable', makes this a very useful IC, albeit a little more expensive than the average CMOS IC.

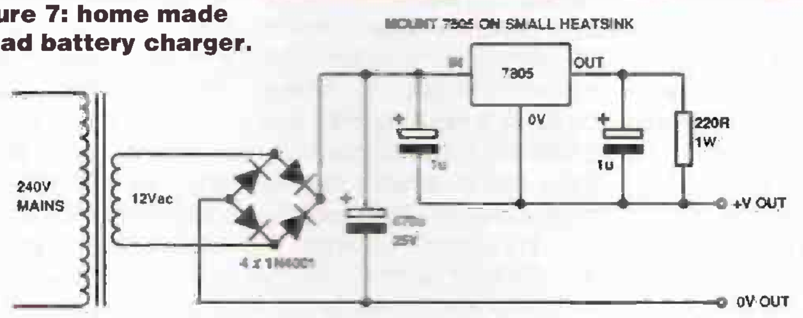
Because only one 4511 seven segment decoder is used to control two decades, its 'latch enable' cannot be used as this would freeze its output and both tens and units would show the same frozen number. This is of no consequence because the 4553 has its own latch enable pin 10. This is normally held high by IC1 pin 3 holding the output of the last count cycle, but at the

Figure 6: NiCad battery connections.



end of the present count cycle it has a very narrow 20µS pulse applied. This low pulse transfers the count at the end of the count cycle into the latch or memory, enabling the counter side of the IC to be reset via C4, R6, D1 and count the next number of pulses in the count cycle time period which, via the calibration, is the speed in mph. This cycle of count, latch, reset is repeated over and over again. The counting is never seen - only the result of the previous count cycle, stored as a number in the latch and displayed when the 'display' button is pressed.

Figure 7: home made NiCad battery charger.



In order to blank the display to conserve power, the 'blanking input' to the 4511 pin 4 is held low (0V) by means of normally closed contacts on a 'display' button. When the button is pressed, BI is pulled high by R7, enabling the 4511 to output its information to the LED display. This form of control, rather than pulling down BI with a resistor and switching a high with normally open contacts, was chosen so the battery positive need not be brought out of the box and possibly short to the bike's frame. A fuse is incorporated on the positive of the battery supply, because when using rechargeable batteries, very large currents are available owing to their extremely low internal resistance.

The LEDs used are 0.8in, quite large in LED terms. This is in order for the display to be read as quickly as possible, so as to distract the rider as little as possible. In order to get the greatest contrast from the display in all lighting conditions, a red filter is used. This blots out anything in the background and only shows the illuminated segments. The red filter, when mounted inside the box, produces a pocket which could trap water when left out in the rain, so the filter is bolted onto the inside of the front panel using neat instrument headed plated 3mm bolts. Care must be taken not to mount the bolts too close to the edge of the filter or over-tighten them as the filter has a nasty tendency to crack or chip, and the overlap of the filter with the front panel should be glued, using a glue that doesn't eat away the plastic. The 'power switch' used is chosen because a rubber cover can be obtained for it to keep out dampness - this is very important as contacts switching power are very prone to corrosion when exposed to dampness, due to electrolysis. The 'display' button is of the normally closed contact type - here the switch is not a waterproof type but as it only switches a logic level this is not too important. However, a waterproof one can be used if desired, but must be of the normally closed contact type.

The rechargeable batteries are soldered together as per diagram (make sure you use the solder tag type). Great care should be taken that the heat applied during soldering is not allowed to reduce the insulation around them, as their cases are the negative contact and each one is 1.2V different from the next one. To help with this, small cardboard strips are placed between the batteries. The batteries should not be charged until they are soldered, so if a short was to occur, any damage is limited. The five batteries should be fully checked and charged as a block. It is recommended that a charger is bought, because it is going to be used hundreds of times during the life of the speedo. Buying also ensures safety, as the charger is a mains unit and strict safety precautions should be taken. A diagram is given of a suitable charger, but no constructional details are given.

The charger should be capable of charging the batteries as a block and normally comes with a 2.1mm plug. If the output is switchable, as many are these days, the selection should be 4-6 cells as against 6-8. The output of the charger will need to be tested with regard to polarity. There seems to be no standard - some are wired with the positive in the centre, others wired with the negative in the centre and some are switched. I have used the positive in the centre, so some of you may need to have the plug either altered or changed to suit. Always alter the plug 2.1mm (charger type), do not take the charger apart. Do not use the rapid 1 hour type chargers, which can cause the batteries to heat up and come loose in their pack. No harm will come to the charger or the batteries if the polarity is incorrect, because of the protection diode D2, but incorrect polarity will not charge the batteries.

Once the batteries have been charged and the output checked to be 6V or above, they can be taped together - again great care being taken that they are not allowed to short to one another or to anything else. When the PCB is built and about to be tested, it is recommended that a bench power supply current, limited to 500mA is used, as some of the tracks on the board are quite thin and in the event of a fault could burn up if large currents are available. The Cyclometer should be fully tested on the bench using the power supply before the rechargeables are connected.

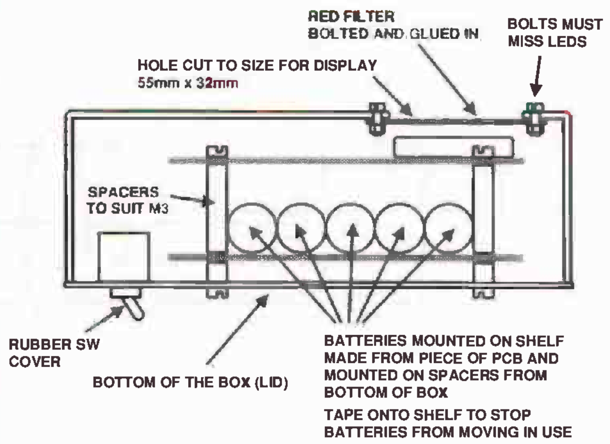


Figure 8: Cyclometer assembly.

When on the bench, the reed switch sensor can be replaced by a one pole two way press switch (break before make). This enables a reading to be obtained on the bench without trying to get the bike in the workshop. Pressing and releasing the switch will generate pulses, which are counted in the same way as the pulses from the reed switch. They do not appear on the display as the switch is pressed because of the 'latch enable' but should appear at the end of the count cycle as a number. VR1 can be set accurately if a scope is available, by monitoring pulses on pin 3 as calculated earlier. If a scope is not available, a logic probe set to 'pulse' rather than normal can be used - although not as accurate, the adjustment is made to VR1 to produce a bleep at the intervals calculated earlier.

Because the Cyclometer, when fitted, may well get left out in the rain, the box it's mounted in should at least be shower proof. To this end, the lid of the box is mounted underneath and the conventional bottom of the box is used as the top. This means that if the junction of the lid and the box leaks slightly, the circuit board is held well above any dampness and if any wet does get in it cannot fill the box up. The PCB and battery support board are mounted on suitable pillars, off the base of the box as in the diagram.

Another consideration is the increasing problem of theft from bikes. Although the Cyclometer is useless without the sensor and magnets, this does not seem to stop the light fingered from taking anything not securely fastened down. So, two thin aluminium brackets have been made to hold the Cyclometer to the handlebars, tape being used to prevent the brackets from scratching them. These two brackets are securely bolted to the bottom of the Cyclometer box and to get inside the Cyclometer or to remove it, the four bolts securing the lid must be undone. These, when supplied, are 4 slot headed 3mm counter sunk bolts. Two of these are replaced with cross headed 3mm bolts so it now requires two screwdrivers to remove it. This should discourage most from trying to steal it.

The cable to the sensor (reed switch) should be screened stereo cable, with the screen going to the common on the reed switch, as well as being used as the earthing point where the OV is connected to the chassis of the bike frame. This should help prevent stray pick up from radio signals and the like from affecting the accuracy during use. The cable should enter the case at the bottom, near the lowest point. To prevent seepage of dampness, the cable can be sealed with glue from a glue gun. The case of the reed switch is normally glass, but this is so small there is no safety problem in the case of an accident. The contacts of the reed switch are individually sleeved to prevent them from shorting, as the contacts A and B are very close together. Do not try and bend the leads out of the reed switch, as they will cause the glass to break. Solder a wire to the lead sleeve and bend the wire, not the lead out of the switch. The whole assembly, reed switch and sleeved wires are encased in a heat shrink sleeve, to help protect the switch as well as add strength to the whole assembly. The top of the heatshrink sleeve is glued together, again to prevent rain from getting into the switch. Great care should be taken that the brakes of the bike are not interfered with or fouled in any way by the wiring or mounting of the reed switch assembly. As every bike is different, no specific instructions can be given, but the diagram shows how my sensor is mounted and may be useful for other types of bike. As well as upsetting the brakes, the other danger is causing the front wheel to jam. To prevent this, the magnets are short bar types held firmly on to the spokes by two tie wraps, plus a dab of glue from a glue gun over the tie wrap to prevent it coming loose.

The magnets are mounted on the spokes, next to the rim of the wheel. The reason for this is that when the wheel revolves there is a centrifugal force which tries to throw the magnets outward from the centre towards the rim. If the magnets are already touching the rim, they cannot travel any further. Also, at the rim the spokes are all in the centre giving the most room between them and the forks of the frame. This gives more clearance and a greater safety margin. The magnets should be tried out with the sensor before fitting, to get some idea of their reliable range acting on the reed

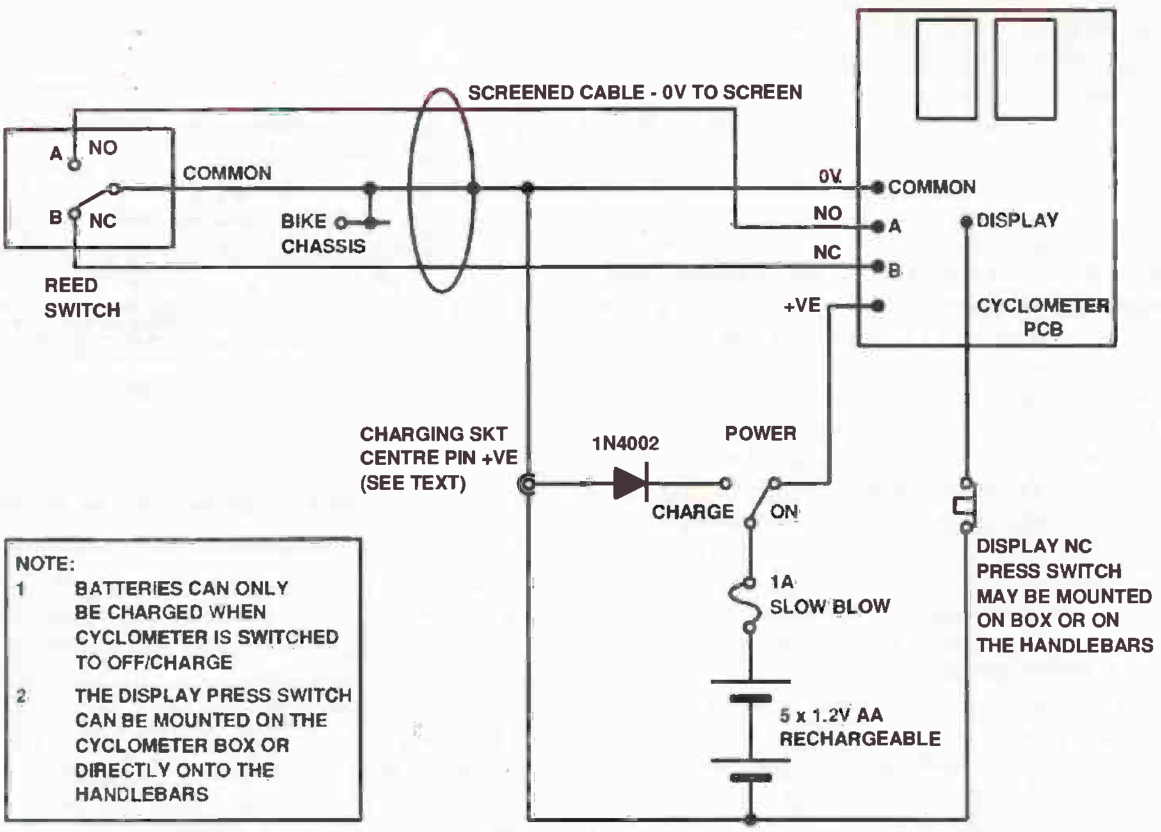


Figure 9: Cyclometer inter connections.

switch.

If any youngsters are fitting these magnets, a responsible adult should check the installation before the bike is taken on the road. Before anyone takes it on the road, the bike should be turned upside down. The front wheel can then be spun, slowly at first then gradually increasing the speed, to check that everything is clear and working. Remember the cyclometer must be switched on and the display button must be pressed in order to illuminate the display.

So far, the calibration has only been done theoretically by calculation and VR1 adjusted to the resultant figure. This can be checked against a car's speedo. For safety reasons, this should be done somewhere where the bike can be paced alongside the car, never follow the bike in a car in case the rider comes off.

Although not as accurate, another check would be to time a known distance at as constant a speed as possible, for instance, at 15 mph on the Cyclometer, you should take four minutes to travel one mile. The further the distance the less the error, assuming the speed is kept constant - easier said than done. This method can be employed well away from cars, although the distance can be measured by a car or motorbike beforehand. Adjustment can then be made to VR1 to improve the accuracy. Decreasing the resistance shortens the time period and hence reduces the reading, increasing the resistance of VR1 increases the time period and hence the reading.

In my case, my kids have complained that since the Cyclometer has been fitted, their bikes don't go as fast as they used to - they can't do 60 mph any more!

Figure 10: Reed switch assembly.

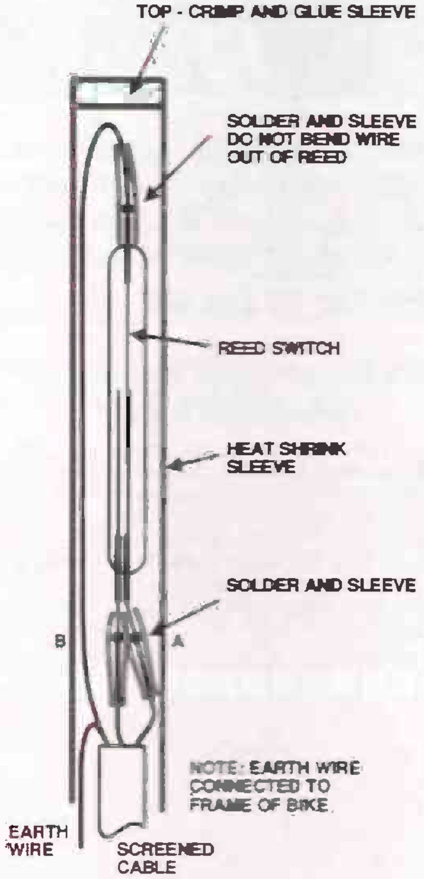
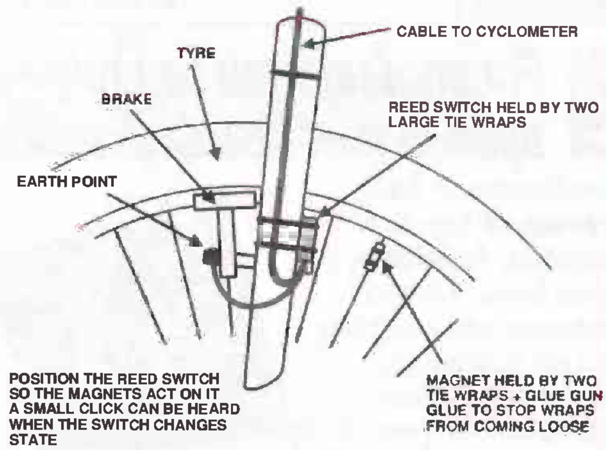


Figure 11: Reed switch and mounting.



PARTS LIST

RESISTORS

R1, R2, R3, R7	10K
R4	27K
R5, R6	100K
R8, 9, 10, 11, 12, 13, 14	47n

CAPACITORS

C1	4µ7	TANT 16V
C2	220pF	DISC 16V
C3	100µF	RADIAL 16V MIN
C4	220pF	DISC 16V
C5	100µF	RADIAL 16V MIN

TRANSISTORS

TR1, TR2	BC307 or BC178

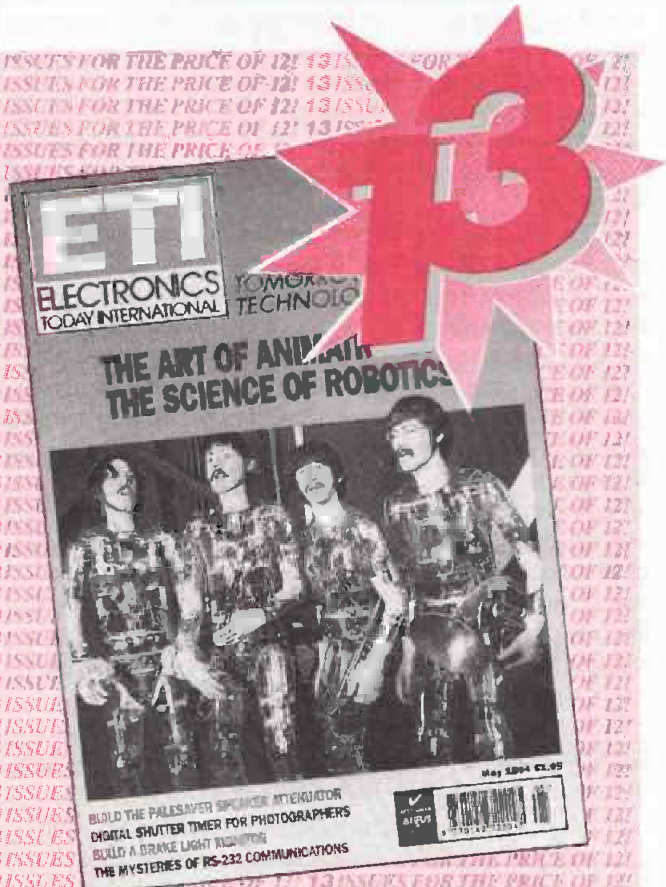
DIODES

D1	IN4148
D2	IN4002
IC1	CMOS 4093
IC2	CMOS 4553
IC3	CMOS 4511
VR1	1 MEG POT

MISCELLANEOUS

2 x 0.8in common cathode LED displays, Electromail 588-960 1 x box, Maplin LH61R
1 x 2.1mm charger socket, Maplin FT96E
1 x power switch, two pole, 2 way, Maplin FH04E
1 x press switch N/C contacts
5 x AA solder tag recharge batteries, Electromail 591-051
1 x reed switch, one pole, 2 way, Maplin FX69A
Magnets (see text for quantity), Maplin FX72P Screen stereo cable
Tie wraps
Spacers to suit
Scrap PCB for battery shelf
Aluminium for brackets
Cover for switch, Maplin JR79L

Summer SUBSCRIPTION OFFER



13 issues for the price of 12!

That's right, this summer saver offer means you can guarantee every issue of your favourite magazine will be delivered to your home for the next 13 MONTHS and you only pay for 12 issues.

So what are your waiting for?
Subscribe today!

Subscribe – 13 issues for the price of 12!

Yes! I would like to subscribe to ***ETI magazine*** for 1 year. (12 Issues) + **1** ***FREE*** Please commence my subscription from the .... issue.
(If renew/extending, please quote subscription number........................)

Electronics Today International One Year Subscription Rate
UK £25.80 Europe & Eire £32 70
Sterling Overseas £33 90 US Dollars Overseas $56

I enclose a cheque/M.O. for £ .... made payable to ASP or debit my Access/Visa:

Signature.. Expiry ....

Name..

Address...

.... Post Code ....

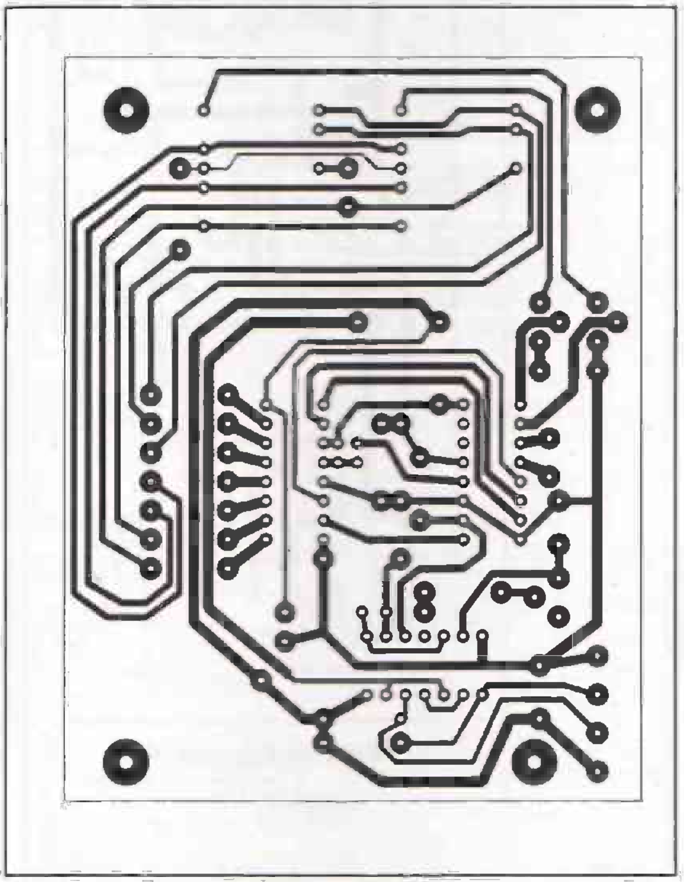
Home Telephone no ....

Please post this coupon to: Argus Subscription Dept, Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS.

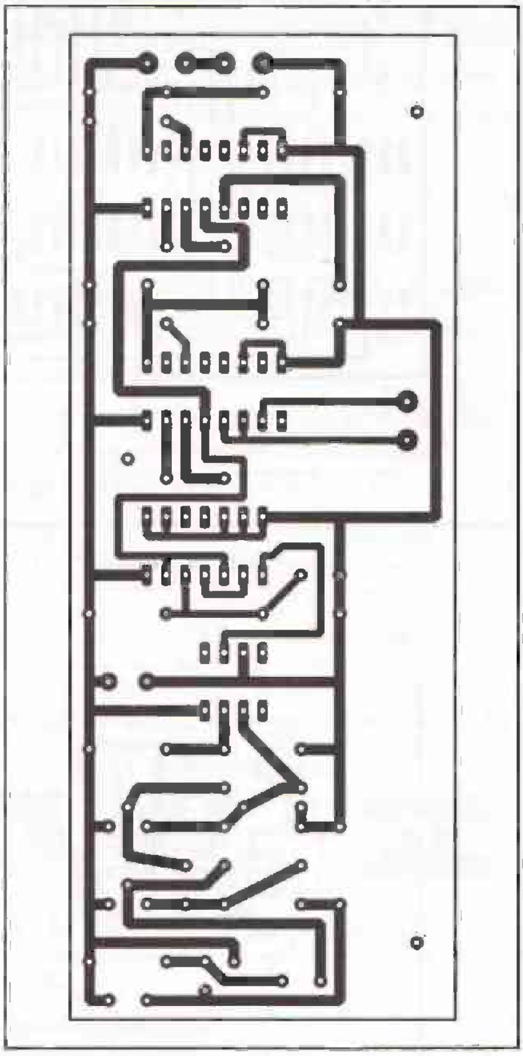
If you've got a credit card it's faster by phone! *Call us on 0737 768611.*

☐ *Please tick if you do not wish to receive information about offers and services from other companies. Offer closes 1/7/94* ET01

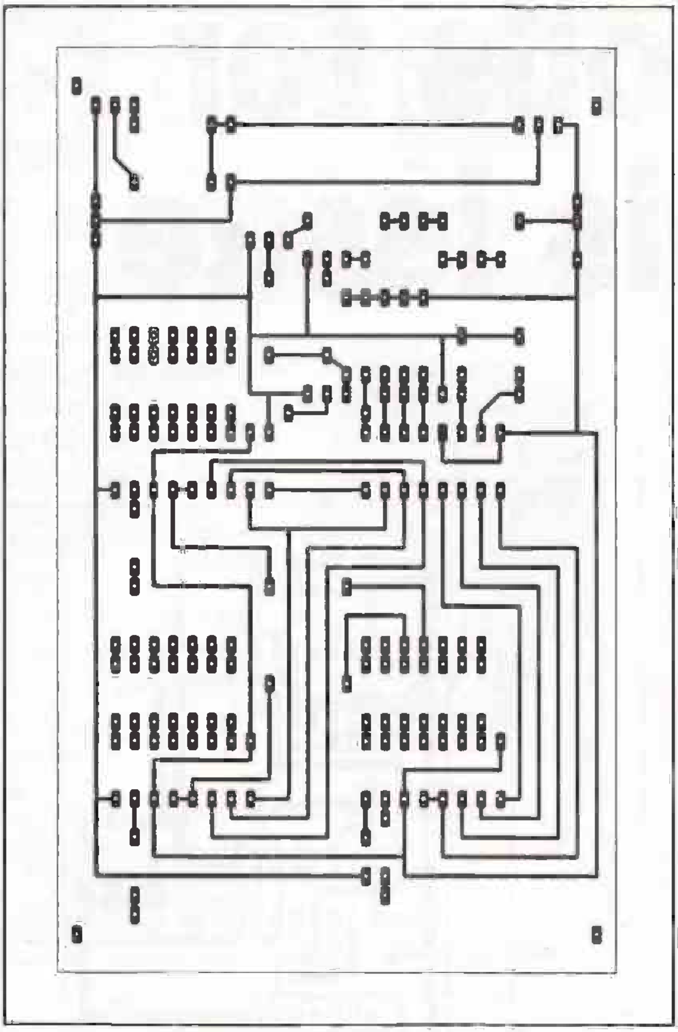
Foils for this issue



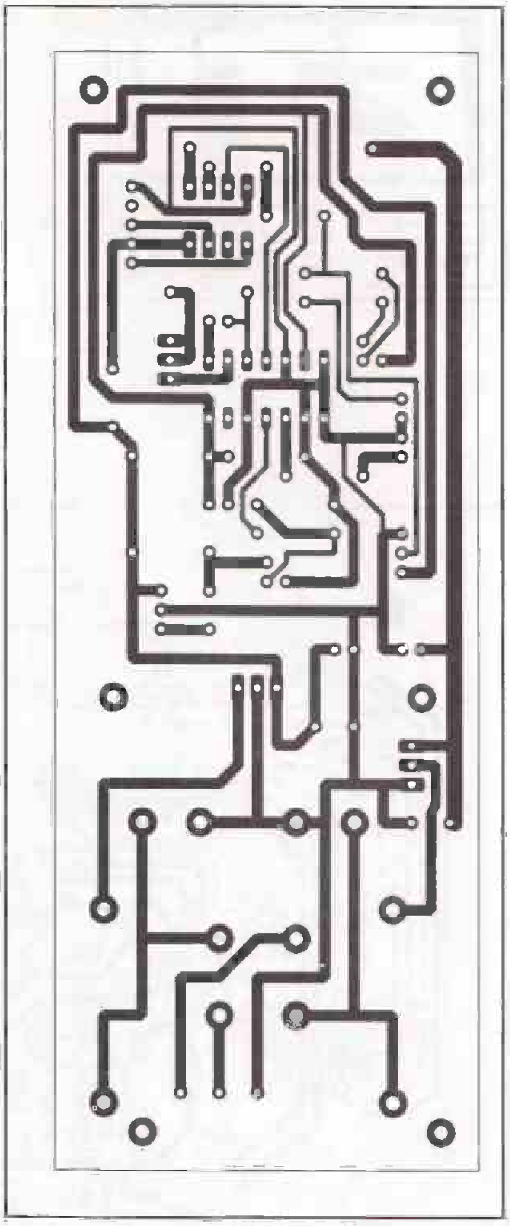
Cyclometer



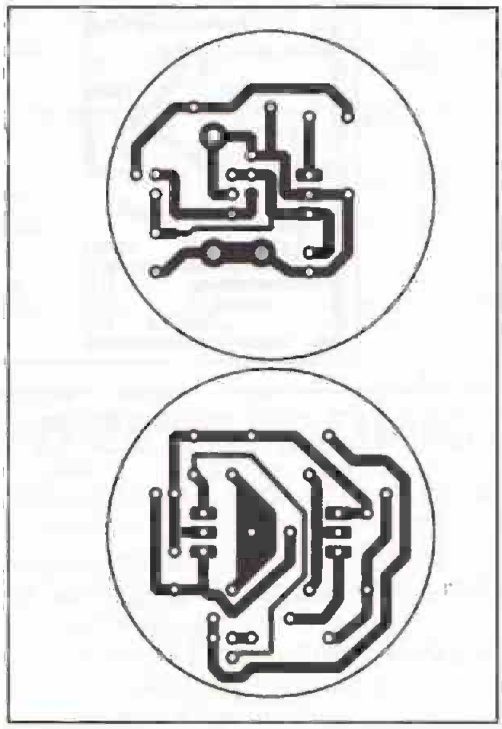
PIR Intruder Alarm



Mini Bass Pedal



Data by Laserbeam



Data by Laserbeam

ETI Classified

James Gale
0442 66551

Send your requirements to:
ETI Classified Department, ASP, Argus House,
Boundary Way, Hemel Hempstead, HP2 7ST

Lineage: 65p per word (+ VAT) (minimum 15 words)
Semi display: (minimum 2.5cms)
£8.70 + VAT per single column centimetre

VISA
Access

Ring for information on series bookings/discounts.
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

FOR SALE

FOR DETAILS OF HOW TO ADVERTISE CALL JAMES ON 0442 66551

SOFTWARE

PC TECHNICAL SHAREWARE

Would you like to see the best range of low cost technical and scientifice public domain & shareware for IBM PC in the UK?
HUGE RANGE includes:- PACKET, FAX, RX/TX control, PCB design, Circuit and ANTENNA analysis, QSO logging, CAD ELECTRONIC & MECH engineering, SCIENTIFIC, MATHS & STATS, MEDICAL, PROGRAMMING, SOURCE CODE, DATA, EDUCATIONAL, WINDOWS, BUSINESS and lots more
Write, phone or fax today for your free 124 page printed catalogue

The Public Domain Software Library
Winscombe House, Beacon Road, Crowborough, Sussex TN6 1UL
Tel 0892 663298, Fax 0892 667473

ASP Approved Vendor

CALL JAMES ON 0442 66551 TO ADVERTISE

PLANS

ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teslas, surveillance devices, pyrotechnics and computer graphics tablet. 150 projects. For catalogue. SAE to Plancentre Publications, Unit 7, Old Wharf Industrial Estate, Dymock Road, Ledbury, Herefordshire, HR8 2HS.

COMPONENTS

EPROM, PLDs + Microcontrollers copied or programmed. we supply devices/convert discrete logic to PLDs. PO Box 1561 Bath 0225 444467

ETI

TO PROMOTE YOUR BUSINESS IN ETI CLASSIFIED CALL 0442 66551

PROTECT *and* TREASURE

Top quality binders

your collection of ***Electronics Today International magazines.*** Keep up to 12 issues of your favourite magazines in pristine condition in our smart, sturdy binders.

Order your binder and post this today!

PLEASE COMPLETE IN BLOCK CAPITALS

Please supply..................binders at only £6.95 each, including p&p (UK only; Overseas please add £1.50)

I enclose my cheque/P.O. for £..........made payable to ASP or please debit my Access/Visa

Signature...............................Expiry............Today's Date..........

Name...

Address..

....Post Code..............................

Post this coupon and payment to:
ASP, ETI Binders Offers, Argus House, Boundary Way, Hemel Hempstead, Herts, HP2 7ST. Or if you've got a credit card, it's faster by phone 0442 66551
You may receive further information about offers and services which may be of interest to you. Allow 28 days for delivery.

ETI

ELECTRONICS TODAY INTERNATIONAL, CLASSIFIED ADVERTISEMENT DEPARTMENT, ARGUS HOUSE, BOUNDARY WAY, HEMEL HEMPSTEAD HP2 7ST

Rates: Lineage 65p per word + VAT minimum 15 words.
Semi-display £8.70 per single column cm plus VAT. No reimbursements for cancellations.
All ads must be pre-paid.

Name...

Address..

.... Daytime Tel. No: ....

Signature .... Date ....

PLEASE DEBIT MY ACCESS/BARCLAYCARD No.

Expiry Date ....

FOR SALE   COMPONENTS   PLANS   OTHER – PLEASE STATE

FOR SALE

DELCIA
THE TRANSMITTER PEOPLE

4 WATT PPO FM BROADCAST (Built) TRANSMITTER: with Low Pass Filter

Modulation .... 75KHz Wide Band
Range .... up to 4.2 miles
Supply .... 10-16 Volts AC/DC
Current 250mA
Audio Input .... 100mV (ADJ)
Frequency Range .... 88-108MHz FM
Stability .... +/- 20KHz
Size .... W. 70mm, D. 90mm, H. 50mm.
MANY USER CONTROLS ...... Price: £23.50

7 WATT PPO FM BROADCAST (Built) TRANSMITTER: Higher Watt Version of above Transmitter 7 miles range .... **Price: £52.50**

KIT: 3 WATT TRANSMITTER 80-108MHz
Coil Tank Controlled up to 3 miles range.
Supply 12V dc at 0.5 amps .... **Price: £12.50**

ALL PRICES INCLUDE VAT
PLEASE ADD £1 P&P PAYMENT WITH ORDERS TO:
DELCIA ELECTRONICS,
14 ST. MERYL PARK, GLEN ROAD,
BELFAST, BT11 8FY.
Tel: (0232) 611995 **24 Hour Turn Around**
Please send 2 x 1st class stamps for our catalogue

COMPONENT'S - COMPONENT'S - COMPONENT'S

★ WIDE RANGE ALWAYS IN STOCK
★ SURPLUS COMPONENT'S ALWAYS IN STOCK
★ SPEAKERS BY SOUND LAB AND R.C.L.
★ SOUND LAB IN-CAR BOOSTERS
★ LARGE RANGE OF ACCESSORIES IN STOCK
★ LARGE RANGE OF CONNECTORS IN STOCK
★ FM - TRANSMITTER - ROOM OR TELEPHONE
★ THERE IS LOTS LOTS MORE IN STOCK

Please give us a call on our
HOTLINE 0533 - 515944
ELEY ELECTRONICS LTD
100-104 BEATRICE ROAD
LEICESTER LE3 9FF

VISA OR ACCESS

OPEN MON-SAT 10-5pm

Falcon DIY SPEAKERS

Send for our FREE price list PL22:
All we ask for is a large S.A.E.
36p stamp or $2 bill U.S. overseass
(Europe - 3 International reply coupons)
SYSTEM DESIGNS (Total Kits):
Focal, KEF Constructor, Seas, etc.
DRIVE UNITS FOCAL, KEF, Audax, Coles, Peerless, Seas, Siare, Elac Metal Dome, Scanpeak, etc.
Also Group/Disco Units
CROSSOVER NETWORKS -
Active & Passive Components,
Accessories, Polypropylene Caps,
AUDIO AMATEUR PUBLICATIONS
BACK ISSUES:
Speaker Builder, Audio Amateur & Glass Audio, L/S Cookbook + books
Full details from
FALCON ELECTRONICS
(Dept E.T.I.) Tabor House, Mulbarton, Norfolk NR14 8JT (0508) 78272
(Proprietors: Falcon Acoustics Ltd.)

SWC SCIENTIFIC WIRE COMPANY

ENAMELLED COPPER WIRE
TINNED WIRE SILVER
PLATED COPPER WIRE
SOLDER EUREKA WIRE
NICKEL CHROME WIRE.
BRASS WIRE LI TZ WIRE
BIFILAR WIRE MANGANIN
WIRE TEFZEL WIRE NICKEL
SAE BRINGS LIST 18 RAVEN RD LONDON E18 1HW
FAX 081 559 1114

FARNELL STABLISED P.S.U. 30V-1 Amp. Sig Gen. IC's, components, weller iron. Heathkit digital trainer. Cambridge Learning Adventures in courses. Dozens of books all new. Hobbyist must sell. Tel: 0443 423761.

SURPLUS COMPONENTS WANTED

☆ COMPLETE CLEARANCE
☆ BEST PRICES PAID
☆ PCB BOARDS POPULATED

CONTACT
D.T.S. SERVICES
Tel: (0602) 208955
or Fax: (0602) 484530

NEWMARKET TRANSFORMERS LTD

Mail Order Transformer Specialists
Toroidal and Laminated Transformers, 3VA to 1kVA.
Fast delivery. Competitive prices. Quality guaranteed
Phone: Michael Dornan on 0638 662989 for Immediate Quote

COMPELEC

1994 BARGAIN LIST
THE ELECTRONIC ESSENTIAL MILLIONS OF COMPONENTS AT UNBEATABLE PRICES.
FOR A FREE COPY PHONE, FAX OR WRITE
(TRADE ONLY)
COMPELEC,
14 CONSTABLE ROAD, ST IVES,
HUNTINGDON, CAMBS. PE17 6EQ
0480 300819
WE ALSO PURCHASE ALL TYPES OF ELECTRONIC COMPONENTS, LISTS TO ABOVE ADDRESS.

LEN COOKE ENTERPRISES

For the best value in Used Electronic Test Instruments

We buy, sell and repair Oscilloscopes, Signal Generators, Frequency Counters, Spectrum Analysers, Power Meters, Logic Testers etc
Spare Parts available for most Tektronix Scopes
Tel/Fax: 081 864 5551
Mobile: 0831 630820
Mail Order Address: **179 Northolt Road, Harrow, Middx. HA2 0LY.**
We engineer what we buy, we support what we sell.

FAX YOUR ADVERT ON 0442 66998

COURSES

Start training now with the specialists for the following courses. Send for our brochure — without obligation or Telephone us on 0626 779398 ETI 3/94

Name ______________________

☐ **Telecomms Tech C&G 2710**
☐ **Radio Amateur Licence C&G**
☐ **Micro-processor**
☐ **Introduction to Television**

Radio & Telecommunications Correspondence School
12 Moor View Drive, Teignmouth, Devon TQ14 9UN

KITS

NEW VHF MICROTRANSMITTER KIT tuneable 70-115MHz, 500 metre range, sensitive electret microphone, high quality PCB, SPECIAL OFFER complete kit ONLY £5.95 assembled and ready to use £9.95 inclusive P&P. 3 Watt FM transmitter kit £15.95. Credit card orders Telephone: 021 486 3092, Fax: 021 411 2355. Cheques/PO's to: C.E.C.(Dept ETI), 515a Bristol Road, Birmingham, B29 6AU. Send 2 x 1st Class stamps for details of these and other kits.

HEATHKIT U.K. Spares and service centre / educational products distributor. Cedar Electronics, 12 Isbourne Way, Winchcombe, Cheltenham, GL5 5NS Tel: (0242) 602402.

SURVEILLANCE KITS

MRT1 MICRO TRANSMITTER, 25mm x 20mm including sensitive mic., tuneable 80-115MHz 500M range. Kit £4.95 Assembled £8.95

MTT1 TELEPHONE TRANSMITTER 35mm x 10mm, powered from line, discreetly transmits all conversations 500M range, 80-120MHz. Kit £6.95 Assembled £11.95

All prices include p&p. Send 2x2nd class stamps for catalogue. Cheques/P.O.s payable to:
EXCELL PRODUCTS (Dept ETI)
Unit 14, Sunningdale,
Bishop's Stortford, Herts CM23 2PA

TO ADVERTISE IN ETI CLASSIFIED CALL 0442 66551

Open Forum

My feelings about the future of technology, and electronics in particular, in this country have changed over the last few days. In the past, I had always had a gut feeling that the next generation of engineers would be able to continue the tradition for innovation that has for so long been something which we in Britain could be proud of. Now, I know that that gut feeling was not only correct but understated.

This change was brought about by talking to the finalists at the recent Young Electronics Designer Award.

If these young people, their ages ranging from 13 to 23, are at all representative of the next generation of engineers, then both they and the people of this country in general, could be in for an exciting future. Rarely have I encountered a group of people who were so enthusiastic, and knowledgeable about their chosen subject.

It went further than just knowing about electronics, these were designers and innovators in the best sense. They had all developed products to meet specific needs, they had thought carefully about how their creations would be used, the people who would use them and the markets they would sell to. They had thought about the questions raised by production and had optimised their designs for cheap and easy manufacture.

These are all attitudes which we need to foster if high technology industry in the UK is to survive and prosper. There is little doubt that we have had extraordinary success in developing new ideas, indeed the number of new ideas that were initially conceived in this country during the last fifty years is enormous and equalled only by the US.

The trouble is that we have, by and large, failed to turn ideas into commercial products. We have been beaten commercially by the undoubted skill of Japanese or German production engineers, who seem able to see a new device as a commercial product, as well as a great idea. These engineers can see a product from the point of view of the customer and tailor it to suit their needs. They can see a product from the point of view of costs and profit, then design it to be produced as cheaply as possible.

If we are to beat the Japanese and Germans, and I firmly believe we in this country can, then we need to go even further. We need to produce engineers who combine the traditional creativity of British engineers with the commercial orientation of our competitors. Such a combination would be unbeatable and if the young people I met last week were at all representative, then we may have a new generation of engineers with just that winning combination.

Another encouraging aspect highlighted by the group of finalists was the fact that about one third of them were girls. I have always considered it to be wrong that both electronics and computing are such solidly male dominated activities. In theory, they are subjects which should be equally as attractive to girls as they are to boys.

Of course, we all know the source of the problem lies in tradition within the educational system and within society in general. Engineering was not something done by girls. Come to that, given the rather negative attitude to engineering in this country, engineering was not considered a proper occupation for 'nice people' of either sex.

Far better to be a secretary, a civil servant, a bank manager, or an estate agent! The 'nice people' in society considered these clean, socially acceptable jobs, unlike engineers who had dirt under their finger nails and talked about 'boring' things.

That is the real problem, the reason why there are so few girls in engineering and why engineering has such a low social status. We have allowed ourselves to be given a sense of inferiority by a lot of ignorant, snobbish people and what is worse, we have allowed the future of this country to be dictated by such people.

It is time that we as engineers regained our self respect, it is time that we made the rest of society realise that without us they would have nothing. Every material comfort that society values so much was made possible by the work of engineers.

Next Month...

We continue our series on repairing, maintaining and upgrading PCs and Ken Gill will be concluding his article on sending data on a laser beam, showing how to set up the system. Jim Spence will conclude the Experimenter's computer keypad and display with a look at the software needed to implement the keypad, while we will also be continuing our series on MIDI musical instruments.

For computer users, Robert Penfold will show how to build a RS232 break out box for solving all those difficult cable configuration problems. Terry Balbyrnie will show how to build a handy little light meter for video cameras, and Bob Noyes has an interesting project to stop your children spending all their time playing computer games. In addition, we will be starting a new series of simple projects for the beginner with a logic probe designed by Robert Penfold.

The main feature next month will be looking at smart cards, what they are, how they work and whether they will replace the cash in your pocket.

ETI
ELECTRONICS TODAY INTERNATIONAL

EDITORIAL
Editor ***Nick Hampshire***
Sub Editor ***Jim Bluck***

CREATIVE
Art Editor ***Peter Kirby***
Technical Illustration ***John Puczynski***
Photography ***Manny Cefai***

ADVERTISEMENT SALES
Display Sales
Tony Hill
Advertisement Copy Control
Marie Quilter
Classified Sales
James Gale

MANAGEMENT
Managing Director
Terry Pattisson
Circulation & Promotions Manager
Debra Stupple
Production Manager
Tony Dowdeswell
Group Editor
Stuart Cooke
Group Advertisement Manager
Claire Jenkinson

ABC AUDIT BUREAU OF CIRCULATIONS CONSUMER PRESS

ISSN 0142-7229

ETI is normally published on the first Friday in the month preceding the cover date.

Subscription rates -UK £25.80 Europe & Eire £32.70 Sterling Overseas £33.90 US Dollars Overseas $56.00

Published by Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Telephone (0442) 66551. Subscriptions by Argus Subscription Services, ETI, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Telephone (0737) 768611.
US subscriptions by Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA90505 USA. For Visa/Mastercard orders in USA - Telephone (310) 375 6258 Fax (310) 375 0548. Pacific Time: 9am-9pm Weekdays. 10am-6pm Weekends. Typesetting and origination by Ebony, Liskeard, Cornwall. Printed by Wiltshire Ltd Bristol.

AN ARGUS SPECIALIST PUBLICATION

**Argus House, Boundary Way,
Hemel Hempstead HP2 7ST
Telephone (0442) 66551
Fax (0442) 66998**