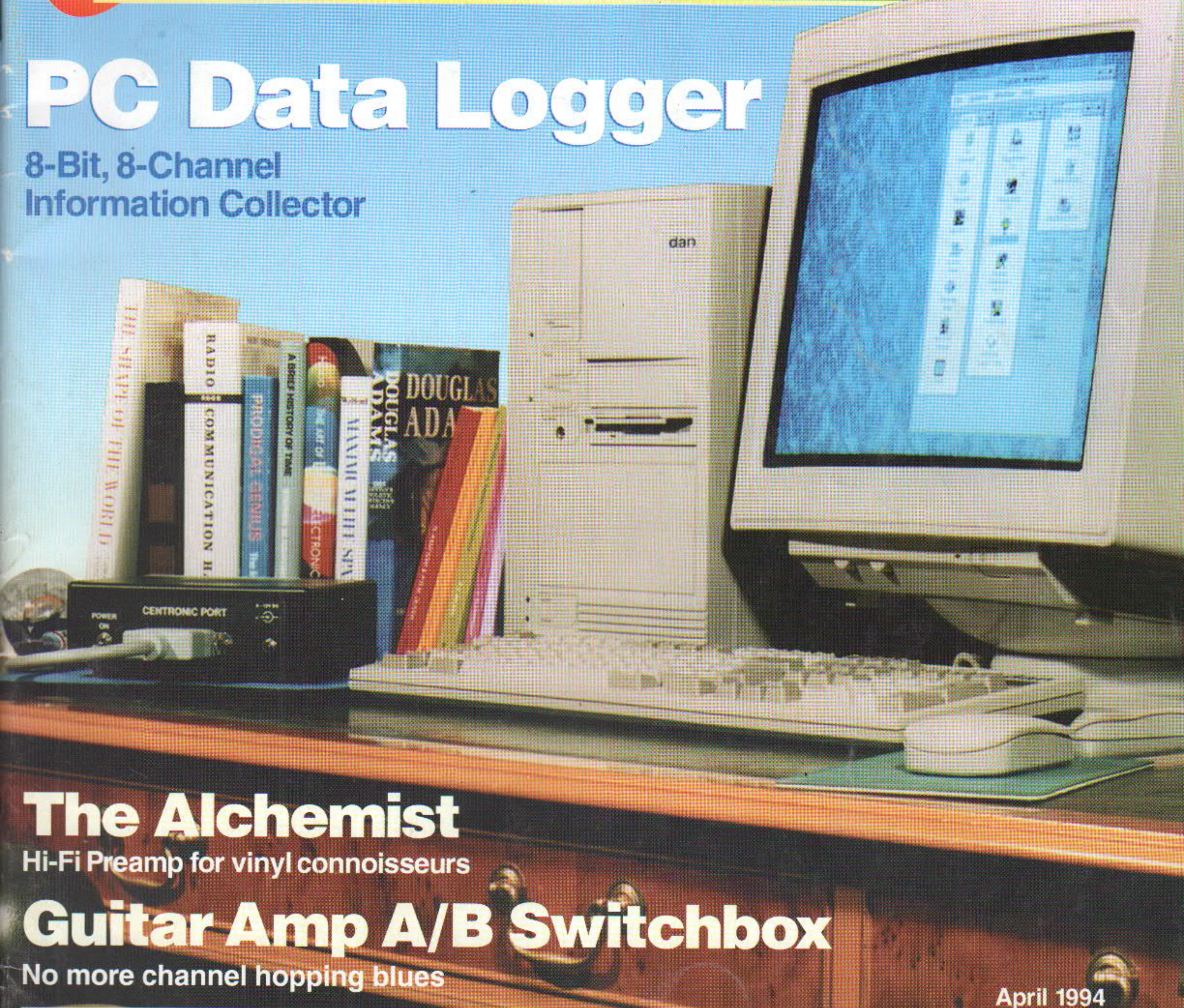
SECURITY-Special offer from Cirkit -see page 61

ELECTRONICS in ACTION

PC Data Logger

8-Bit, 8-Channel Information Collector

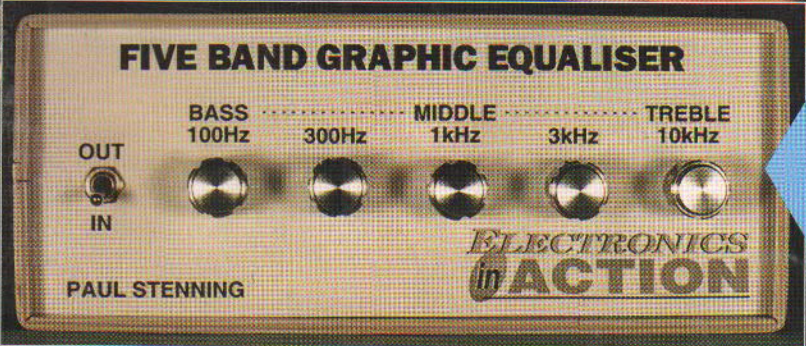


The Alchemist

Hi-Fi Preamp for vinyl connoisseurs

Guitar Amp A/B Switchbox

No more channel hopping blues



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ELECTRONICS in ACTION

ISSUE 7 VOLUME 1

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Operate - you stupid machine!

The idea of using voice commands to operate machines or computers has been around for many years now, but it has only been within our grasp technically in the last decade.
It has surely been a typists dream to speak a letter into the computer making verbal corrections on the way rather than to set fingers tapping on that awkward thing called a Qwerty keyboard. The new technology will clearly benefit those who cannot for a variety of reasons, operate a keyboard by hand.
However, a more seemingly bizarre outcome to this voice responsive technology has already been observed in trials and it is this. People have a tendency to shout abuse at machines if things don't go the way they should. A natural tendency you may think, but should it be? And further still, just as some UK residents think that by shouting at our European cousins in English will make them understand our language, a parallel has been observed with the voice-operated machine. I suppose it's our way of establishing a dominance over a dumb machine. Would we even want the machine to utter a clever reply even it could? There may be a market for voice actuated machines but I don't somehow feel we are quite ready for the machine that can pull a fast one over its operator.

Paul Freeman-Sear

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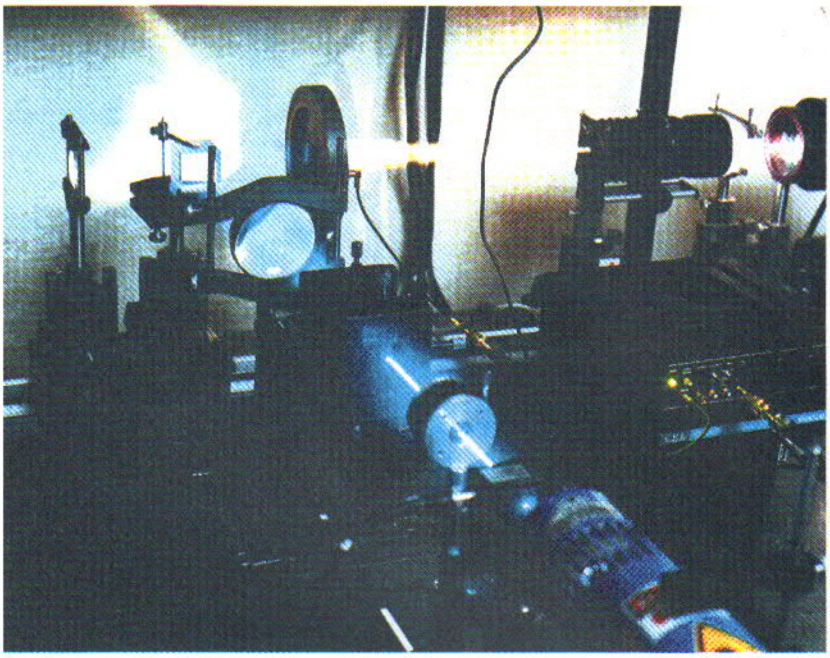
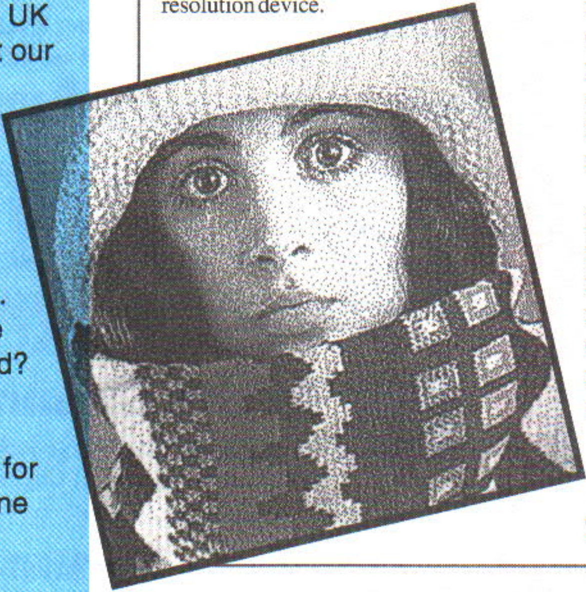


A new method of display

CRL (Central Research Laboratories Ltd.), a subsidiary of THORN EMI, located in Hayes, has launched the highest resolution Ferroelectric Liquid Crystal Spatial Light Modulator (SLM) yet available. This is a 320 x 320 resolution device.



Manipulating optical information in real time is now a viable, low cost alternative to electronic processing for a variety of operations. Examples are comparing and recognising images, beam steering in communications systems, and programmable masking. These are all made possible using high resolution spatial light modulators.

SLMs are devices which act like high speed electronic transparencies taking images from computer memory to modulate light beams. This enables information to be manipulated optically in two dimensions.

In one major application, known as correlation, a stored image is compared optically with a real scene. The system indicates if the stored image

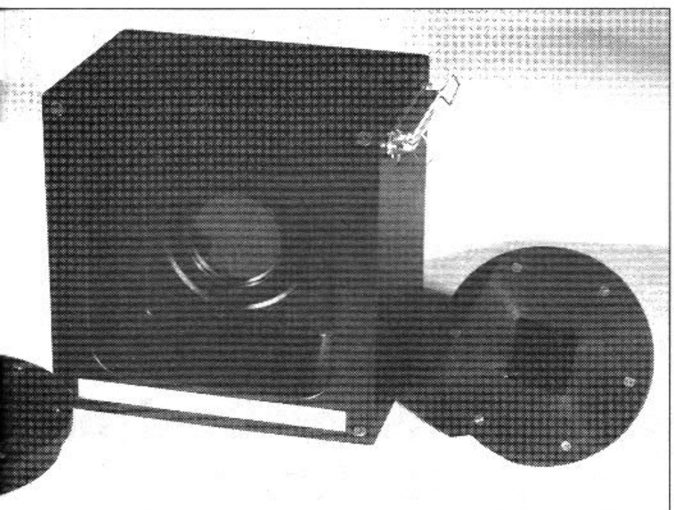
Even Lower Cost Colour Printer

is present in the scene, and if so where it is. CRL is working in collaboration with a group including a car manufacturer to apply this comparing technique in road vehicles, principally to enhance road safety.

In this case, road signs will be recognised by comparing those seen through the windscreen with a library of stored images of signs. The driver can then be given a warning as appropriate; for instance, if the vehicle is approaching a bend too quickly. The new CRL SLM offers the ability to perform these comparisons optically at much higher speeds and lower costs than can be achieved electronically. This technique can already be used in quality inspection on production lines.

A second application is for product marking. Laser marking systems (used for example, for writing "Best Before" dates onto food products and batch codes onto pharmaceutical products) work either by mechanically scanning a laser beam to form the required pattern, or by passing a larger diameter laser beam through a metal stencil to define the marking pattern. The use of an SLM within a laser marking system can eliminate the need for mechanical scanning of the laser beam in the first type of system. This will have an impact on the maintenance costs of systems by removing complex moving parts. The fixed or mechanically changed metal masks of the second type can also be replaced by an SLM. In this case the SLM acts as an electronically 'programmable mask', allowing fast and frequent changing of the marking code to be made.

The CRL SLMs can also be used to manipulate the phase of the light beam passing through them. This means that the SLM can produce 'real-time' holograms. These holograms can be used to steer beams of light between optical fibres, correct telescopic images, or replicate images accurately, all under direct software control. The fact that these holograms are programmable clearly gives advantages over fixed holographic elements made by traditional chemical methods of production.



The 2DX320 SLM is supplied as a development unit with a compact optical head, and a control unit which can rapidly scan through images stored in the device memory. The control unit interfaces to a PC compatible host computer via a custom 8-bit expansion card, and is supplied with Microsoft Windows 3.1 compatible software. The control unit contains an embedded 80386 processor, so the system can also operate in a stand alone mode. The SLM may be configured to match a customer's specific requirement.

Mitsubishi has announced the introduction of its new, cost effective thermal transfer PostScript comparable colour printer for Windows applications. The G370-S high performance, high resolution A4 printer comes complete with a SuperPrint software Windows driver, free consumables starter pack and twelve months on-site warranty for £1395.

The new 300dpi resolution printer package represents a major cost reduction compared to other printers on the market. It makes colour thermal transfer printing more affordable and provides a high quality, low cost total printing solution for the Windows environment at a cost of a low priced ink jet printer. Cost/copy is around 50 pence for colour A4 paper prints and around £1.20 for overhead transparencies.

Notably the new package provides the added advantage of higher throughput, much faster output and superior quality print, with better saturated colours, at a far lower cost/ copy compared to ink jet printers, especially when producing OHP transparencies with colour backgrounds.

Features include one colour plane memory for maximum performance. The G370-S produces high quality, A4 colour prints in 60s and is capable of up to 256,000 colours. Outputs can be on paper or transparency from an automatic, 100 sheet cassette and using special size A4 media, the printer provides full A4 imaging.

The rugged printer is quality designed and built for quality performance. Features include a rugged cast alloy chassis compared to alternatives on the market which use fragile plastic designs.

The SuperPrint Windows driver software provides high quality PostScript comparable printing and comes with 34 fonts plus the capability of speed printing on host PC fonts including Adobe, BitStream, Compugraphic and TrueType. The intelligent software even allows typefaces from different companies to be mixed and matched.

The package provides true WYSIWYG screen fonts and outputs, via a software RIP imaging technology, complex graphics and bitmaps as well as virtually any font on the PC system. Dithering and fine tuning facilities are also provided to improve graphics imaging and to increase colour capabilities.

Miniature FM radio, smaller than a 50p

Maplin Electronics has introduced a mini radio into its catalogue. The auto-tuning, FM radio receiver produces a quality of reception that is normally only expected from radios many times its size. The little radio is provided with an on/off' switch, a seek button and a 'reset' button and a pair of earphones, attached to 800mm of cord, that also doubles as the aerial. To operate, the 'reset' button is pressed once for each station that is automatically tuned in to, until the desired station is found. However, if the user has a favourite station, then tuning is not required every time the radio is switched on, as the last station selected is always remembered when the power is switched off. Ideal for commuters, cyclists and outdoor pursuits.

Half Size Contactless IC Cards

A new contactless IC card has been introduced at the SmartCard '94 exhibition and was designed specifically to be fast and convenient to the user. It would provide reliable access control to mass user systems ranging from ticketing to automatic warehousing and production control, providing authorisation and even proof of payment.

At half the size and double the thickness of Mitsubishi's existing credit card sized version, the new contact less MelCard provides a handy alternative and gives the user a choice of styles. It measures 43x54mm and at 5mm thick provides a robustness and durability to withstand daily wear and tear. It is easily converted, for example into a key fob and thus kept safe by the user.

Mitsubishi's contactless IC cards operate using a read/write device linked to a computer network for data I/O, read and write operations. When the card is presented near to the reader/writer head it automatically transmits data at up to 455kHz. Exact frequencies can be customised to specific applications, allowing the card to operate a ticket barrier for example or read part recognition data in factory automation and CIM.

The card operates at distances of up to 800mm and a typical operation takes less than 0.2s. The mini card has a single chip microcontroller inside and communicates with the reader/writer via half duplex amplitude shift keying transmission. The 8-bit microcontroller could be used in security applications and consumes little power. The SRAM memory provides high speed read and write operations at very low current consumption.

Radio frequency transmission avoids any electrical connections and possible transmission failure.

Under extensive testing, the contactless IC card has proved highly reliable, withstanding extensive bending and torsion tests in temperatures down to -200°C. All electrical and data retention characteristics withstand temperature cycling between -20 and +600°C and is waterproof.

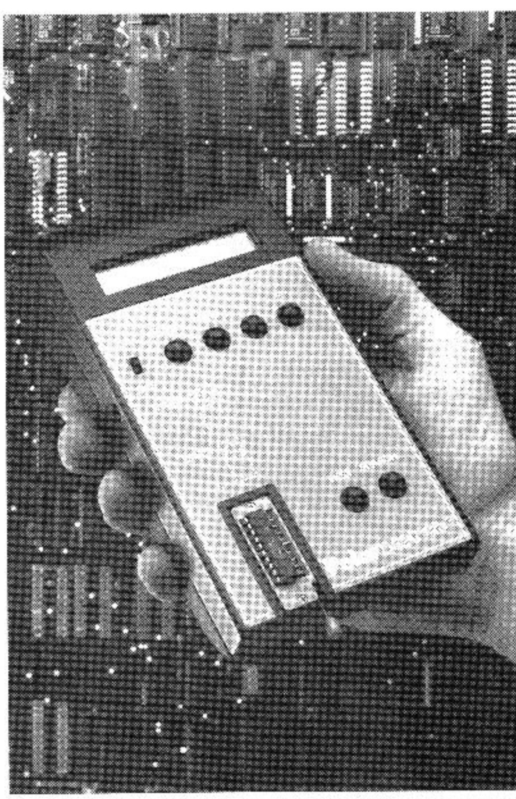
Hand-held digital IC tester

Polar Instruments has introduced a portable IC tester capable of functionally testing the vast majority of logic devices in general purpose use, as well as numerous common memory devices. Designated the Polar D320, the tester costs £180 and comes in a hand-held package weighing 285g, powered by a 9V PP3 cell.

A comprehensive built-in library of over 350 popular standard devices allows test engineers to test suspect digital ICs.

D320 tests digital components with up to 20 pins, and has a built-in library of truth table tests for 74/74LS/74HC TTL and 4000 series CMOS logic, plus checks for 41/44- series dynamic RAMs. If the component being tested does not have markings, or has a manufacturer's coding, the D320 can be switched to search and compare its logic function against the library to identify the generic type.

ICs are tested out of circuit, by placing them in a ZIF (zero insertion force) socket. Using the tester's six control keys and one-line LCD, the user can select a standard test by scrolling through the library, or switch the instrument into search mode. Although the primary application of D320 is in equipment service, in the field or at repair depots, most electronics companies will find the instrument a useful aid in both manufacturing test and goods-in inspection environments.



RemoteControl CarAlarm

A simple, portable car alarm, suitable for any car or van is now available from Maplin. The unit takes power from the cigarette lighter socket via a coiled lead. It also contains its own back-up battery which will keep sounding the built-in alarm siren if it is disconnected. A green LED indicates battery state, while a red LED shows that the main supply is present and doubles as an armed state indicator.

The unit is armed and disarmed by a remote keyring transmitter, using a UHF radio link instead of the infra-red method. The transmitted code is unique, and a processor in the main unit interprets the code upon arming, and then expects to receive the same code for disarming, so another keyring transmitter, even of the same type, cannot disarm it. The price is £39.95 (to incl. vat)

Remote control on information superhighway

Echelon Corporation and Oracle Corporation demonstrated how their technologies will use the information superhighway to support the home automation and energy management market.

By connecting millions of homes and businesses to the superhighway, utility companies like gas and electricity, can reduce the need for new power plants by offering their customers simple and unintrusive ways to reduce their energy bills.

In the demonstration, Oracle's Media Server software sent billing, energy usage, peak load and pricing data from the local utility to homes and businesses. Echelon's Lonworks control network technology acted upon the information to control thermostats, water heaters, dryers, dishwashers and other energy consuming appliances. The two-way communication link between utilities and their customers demonstrated today is expected to accelerate the implementation of DSM programs by the utility companies worldwide.

With high capacity data networks now beginning to reach residential neighbourhoods, Oracle's Media Server could provide homeowners with countless services," said Larry Ellison, President and CEO of Oracle Corp., the world's largest information management software company.

"The Media Server isn't Jules Verne science fiction. Oracle's technical expertise and creative implementation have produced a product that can be a catalyst in implementing the data superhighway. When combined with LONWORKS technology, Oracle's Media Server gives utilities what they need to provide energy efficiency and savings to millions of homes and offices around the world," said M. Kenneth Oshman, President and CEO of Echelon. The delivery of voice, data and video services will have a major impact on the home automation market as well. As utilities provide real-time pricing data over the highway and begin billing customers based on time-of-use, customers and industry will seek ways to reduce their energy bills. Utilities, in turn, will provide new tools and services for customers by installing energy management systems. Consumers, for example, will set energy rates and program energy consuming devices, such as water heaters, clothes dryers, dishwashers to operate when rates are low. Then consumers will add control of lighting, security, sprinklers and other components to make a complete home automation system.

LONWORKS technology was introduced by Echelon in December 1990. Today, Echelon Corporation provides over 700 customers with a full range of hardware and software products to support development, installation, and management of control networks. It is a privately-held company headquartered in Palo Alto, California with subsidiaries in London, Paris, Munich and Tokyo.

Supersensitive nose on a chip

IBM scientists have developed the world's most sensitive heat-measuring instrument. Called a calorimeter, it is a thousand times more sensitive than any similar instrument available today: it can measure the heat generated in chemical reactions with a sensitivity to temperature changes as small as a hundred-thousandth of a degree.

The calorimeter was microfabricated with integrated-circuit technology and is relatively inexpensive. It should prove useful in a large variety of chemical observation, detection, measurement, and analysis applications such as drug design, forensics, and catalysis. When specially configured, the calorimeter can function as a supersensitive 'nose on a chip,' capable of 'smelling' extremely minute quantities of a wide range of substances.

Developed at the IBM Research Division's Zurich Research Laboratory, the technique employs a micromechanical silicon lever that is coated with aluminium. When heated, the lever bends because the two materials expand by different amounts. The amount of bending directly indicates how much heat has been absorbed by the lever. The effect is similar to what happens in an ordinary thermometer. When it absorbs heat, the liquid mercury expands. Whereas markings on the thermometer show how much the mercury expands, the IBM researchers use a laser to measure how much the lever bends; and they can measure bends as small as one hundredth of the diameter of an atom.

In a particular demonstration, a thin layer of platinum was applied to the aluminium-coated silicon lever. In the presence of a mixture of oxygen and hydrogen, the platinum functioned as a catalyst that promoted the combining of oxygen and hydrogen to form ordinary water. In the process, the platinum layer generated heat that was then absorbed by the lever, causing it to bend. By carefully monitoring and measuring that bend, the researchers were able to show that the hydrogen and oxygen do not combine at a uniform rate. The rate actually oscillates with time, a phenomenon previously known to occur but never before sensed with a calorimeter.

The lever in this new calorimeter has a thickness only about a fiftieth of the diameter of a human hair - actually 1.5 microns - and a length of 400 microns. (A micron is one millionth of a metre). An array of hundreds or even thousands of such levers could be integrated on a chip. If each lever were coated and thereby sensitised for the detection of a specific chemical, the resulting combination would function as a 'supernose.' Even coatings such as reaction-specific enzymes and bacteria could be used, and because the calorimeter is so sensitive, chemical reactions involving only a few molecules could be detected.

A typical person can discern several hundred odours, and a trained expert might be able to identify several thousand. While computers have been given the ability to see, hear and touch, they are as yet unable to emulate the olfactory organ - they can't smell. This may soon change. The IBM scientists believe that the apparatus for this technique could be incorporated into a portable package, with the 'nose on a chip' and a laptop computer, to provide an instrument capable of detecting gases and pollutants such as ozone and carbon monoxide and even odours such as that of fish.

The researchers believe that through the use of micromechanics and nanotechnology, their calorimeter, already the most sensitive in the world, can be made many thousands of times even more sensitive. They are already working on that!

Research World

Technical Advances from around the Globe

Magneto optical recording material

Nippon Steel Corp. has developed, with the support of Science & Technical Research Laboratories, a magneto-optical recording material capable of raising current memory capacity by about ten times. The material is a garnet-based one that can be formed as a film on a substrate. It responds to a green light source with a shorter wavelength and is thus suitable for larger-capacity recording and reproduction.

The technical breakthrough has been achieved by controlling the noise resulting from the large diameter of component particles of recording material.

For raising the recording capacity of M0 discs it is believed appropriate to utilize a light source with a shorter wavelength such as green for recording and playing back. The new material can respond specifically to a green semi-conductor laser beam for reproduction.

The Japanese steel maker has succeeded in forming a uniform film of the new material on a 130mm-disc substrate and recording the reproducing data in far larger amounts. Combined with the new material, the new recording method and the optical parts still to be improved, the 130mm M0 disc will have a memory capacity of 3 gigabites - ten times that of conventional M0 discs.

New PC performance monitoring technique

A U.S. motherboard has developed a new PC-performance-monitoring technique, called Power-Shift, that puts hardware and software to work to improve desktop power management.

PowerShift is said to reduce PC power consumption below the EPA established Energy Star limit of 30W for systems based on Intel 486DX2/66 class.

Elitegroup Computer Systems of Fremont, California, has put the technology in a 2 x 4in plug-in module with associated software that it will use in its own motherboards as well as sell to other OEMs. In the future, the module may be shrunk, in cooperation with a chip-set vendor, to a single ASIC.

The PowerShift scheme monitors temperature and various PC operations in real-time to reduce power consumption and limit CPU temperature to 7OC. Using the same scheme, a user can monitor temperature increases to determine how much to increase PC performance for specific applications.

PowerShift hardware initially will be built into IBM and IBM-compatible ISA, EISA, Micro Channel, VESA local bus and Peripheral Component Interconnect motherboards that use Intel 486 and Pentium microprocessors. The company has also tested the technology with Alpha-based systems and will make a version for Alpha under an agreement with Digital Equipment Corp.

The Power-Shift circuit board plugs into an 82-pin connector built into each Elitegroup-manufactured motherboard. The module packs an 80C51SL microcontroller, some ROMs with PowerShift's specialized power-saving and performance-boosting algorithms, and converter circuitry for translating temperature and performance measurements into digital form. Via the connector PowerShift can access sensors and various components throughout the motherboard to collect information.

A closed-loop circuitry scheme, linked to the controller on the module, monitors the motherboard, disk drives and power supply. When those components are not active, PowerShift slows them down without putting systems into the 'sleep' state used in other energy-conservation solutions.

Power-Shift can shut down inactive display monitors and printers if those devices are designed to respond to PowerShift software commands or if Elitegroup writes the appropriate commands. Sensors incorporated into the architecture monitor PC-component temperature as well as environmental conditions. The technology can detect a problem, such as fan or heat-sink failure, in real-time or use a special software algorithm that can predict an increase in temperature and then cool down or turn off the PC before the CPU is damaged.

Pulse-driven vibrator

Toshiba Corp. engineers have improved a conventional ultrasonic LCD cleaning unit by use of a pulsed-wave power supply. The unit is a slit-shower type cleaner that combines a flow of ultrapure water with ultrasonic vibration at 1.4MHz.

It is expected that the cleaning unit will decrease the number of final defects by nearly 20%.

In such cleaning systems, sonic pressure - and therefore washing capability - increases as power increases. A conventional power supply produces a continuous wave that vibrators cannot stand up to very long at peak power. By using a pulsed-wave supply, peak power can be doubled without raising either power consumption or the load on the vibrators.

Substrates with 70 particles per square centimetre were cleaned with the new system, leaving an average of 0.7 particles/cm^2; the conventional unit left an average of seven.

Cleaning an LCD substrate measuring 400 x 500mm takes 45 seconds - about one-fifth the time required by previous cleaning methods. The same principles can be applied to semiconductor manufacturing, especially to replace the brushing and washing stage before photoresist coating.

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Computerized data acquisition systems are widely used within industry and scientific research for the purpose of automatically monitoring physical quantities of a system. These quantities may be temperature, pressure, light intensity and sound level.

The present data acquisition system is an 8-bit analogue to digital converter system with an 8-channel analogue multiplexer and a conversion time of 10µs (in other words, 100000 conversions per second). The specification of the data logger is given in Table 1 and the block diagram of the complete system is shown in Figure 1.

An unique feature of this data logger is that it is directly connected to an IBM-PC via the Centronic port. This has several obvious advantages. Firstly no extra input/output card is required. Secondly there is no need to open the computer case for installing I/O cards and thirdly the data logger enables laptop computers to be used for data acquisition applications. In addition, this device is easy to build and costs less than £20 which is much cheaper than the commercial data logging system available on the market.

Centronic Port

The Centronic port of an IBM-PC, which is also referred to as the printer port or parallel port, is an industrial standard input/output port provided by PCs and is dedicated to interface with printers. A PC at least has one such a port and it is normally labelled as LPT1. Two more printer ports namely LPT2 and LPT3 can be added to the computer by using extra I/O cards. Although the ports were designed for interfacing with printers, they can also be used to interface with other devices, provided a special electronic circuit is incorporated.

Let us have a look of the Centronic port. One can quickly find that the Centronic port connectors on the computer and on the printer are different. The former is a 25-pin female D-type connector (Figure 2(a)) and the latter a 36-pin female Centronix-type

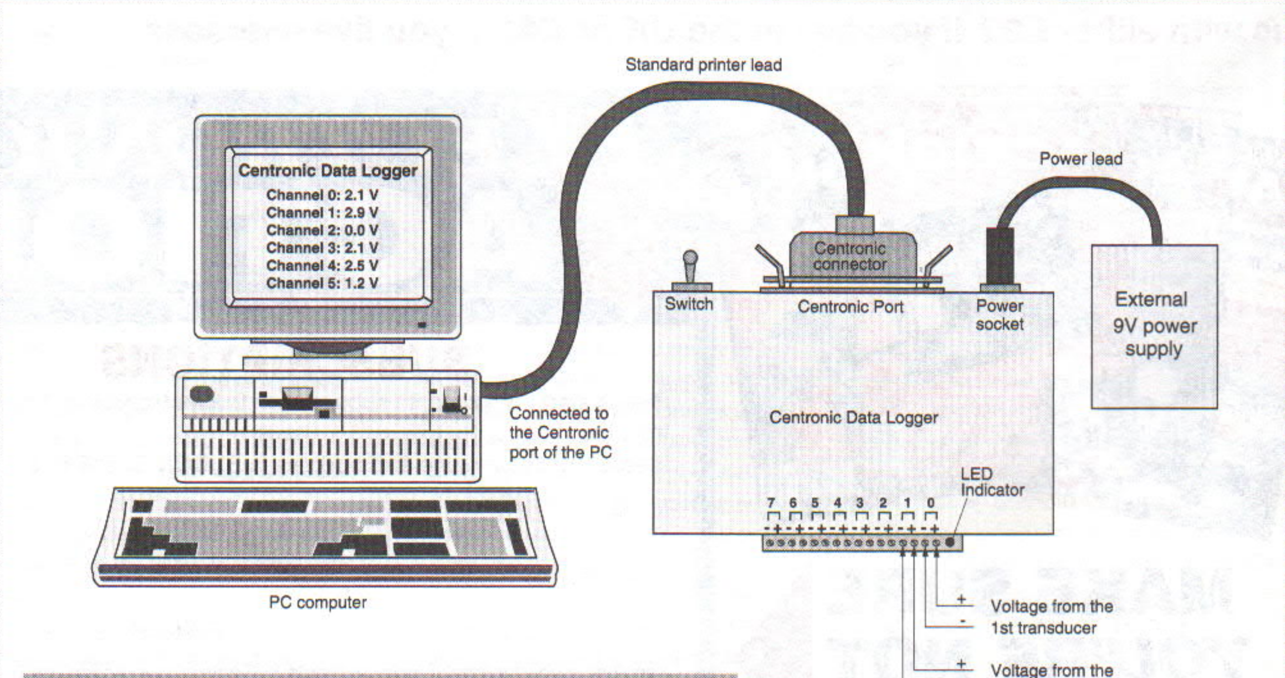


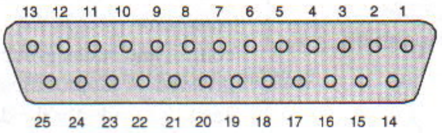
Fig.1 Block diagram of the Centronic data acquisition system

ntrol

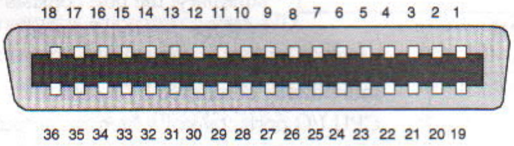
An 8 bit, 8 channel, IBM-PC Centronic data logger by Dr Pei An

Computer requirement	IBM-PC/XT, PC/AT or compatibles
Interface requirement	Centronic ports, LPT1, LPT2 or LPT3
Supply voltage [V]	9 - 12 DC
supply current [mA]	<100
On-board voltage reference [V]	2.55
Number of input analogue channels	8
Analogue input range [V]	0 - 2.55
Resolution [V]	0.01
Input impedance [MΩ]	>2
Sample time [μs]	10
Size (Length×Width×Height) [mm]	180×150×60
Weight excluding DC power [Kg]	<0.2

Table 1 Specifications of the data acquisition system



(a) Pin-out of the Centronic connector on PC computers - 25 pin female D-type connector



(b) Pin-out of the Centronic connector on printers - 36 pin female Centronix-type connector

Pin functions of the Centronic port connectors

Connectors on computer	Connectors on printes	Direction	Name	Explanation
1	1	C to P	STROBE	Strobe data
2	2	C to P	DB0	Data bit 0
3	3	C to P	DB1	Data bit 1
4	4	C to P	DB2	Data bit 2
5	5	C to P	DB3	Data bit 3
6	6	C to P	DB4	Data bit 4
7	7	C to P	DB5	Data bit 5
8	8	C to P	DB6	Data bit 6
9	9	C to P	DB7	Data bit 7
10	10	P to C	ACK	Indicating data received
11	11	P to C	BUSY	Indicating printer busy
12	12	P to C	PE	Indicating paper empty
13	13	P to C	SLCT	Indicating printer on line
14	14	C to P	LF/CR	Auto linefeed after carriage return
15	32	P to C	ERROR	Indicating printer error
16	31	C to P	INITIALIZE	Initialize printer
17	36	C to P	SLIN	Select/deselect printer
18-25	19-30 and 33		GND	Twisted-pair return Ground
	18,34		Unused	
	16		Logic GND	Logic ground
	17		Chasis GND	Chasis ground

'C' = Computer 'P' = Printer

Fig.2 Pin-out of the Centronic port connectors on computers and printers

connector (Figure 2(b)). To link the computer and the printer, a specially designed cable, known as the printer lead, is used. Although the two connector are different in shape, their functions are exactly the same. The pin-out of the two connectors and their pin functions are summarized in Figure 2. Basically the Centronic port consists of 3 input/output groups with each controlled by an I/O ports of the CPU of the computer. These 3 groups are named the data group, control group and status group and the corresponding ports are the data port, control port and status port (see Figure 3). The functions of these three groups are explained below:

Data group: It has 8 latched output lines (DB0-DB7) which are directed from the computer to the printer and is controlled by an output port of the CPU. In operation, it sends data from the computer to the printer.

Control group: The group has 4 latched output lines (-STROBE, -LF/CR, -SLIN and -INITIALIZE) which are directed from the computer to the printer and is controlled by an output port on the CPU. It transfers commands from the computer to the printer for controlling printer operations. It is noted that the -STROBE, -LF/CR and -SLIN lines are the inverted output of the CPU port. The -INITIALIZE line is not inverted.

Status group: It has 5 input lines (-ERROR, SLCT, PE, -ACK and BUSY) which are directed from the printer to the computer and is controlled by an input port of the CPU. It is used by the computer to obtain the current status of the printer. The BUSY line is inverted before entering the CPU. The rest 4 lines are not inverted.

Each I/O port of the CPU has an I/O address. For different Centronic ports such as LPT1 and LPT2, these addresses are different. The following table shows the I/O addresses for LPT1 and LPT2 of PC computers:

Inside the computer, data sent to or received from the I/O ports are 8-bit. The bit functions of these ports are shown in table 3.

There are two methods of controlling the Centronic port. The first one is to use the printer commands in computer languages, for example, 'PRINT' in BASIC and 'WRITELN(LST)' in Turbo Pascal. The other one is to use direct I/O port access commands to control the three ports individually. Let us take an example of controlling the LPT1 port.

Centronic port	Data port	Control port	Status port
PC/XT printer adaptor,	378H 888D	37AH 890D	379H 889D
PC/AT, LPT1	378H 888D	37AH 890D	379H 889D
PC/AT, LPT2	278H 632D	27AH 634D	279H 633D
'H' = Hex, 'D' = Decimal			

Table 2 I/O Addresses of the Centronic port

Bit	Name	Functions
data port bit 0-7	DB0 - DB7	Functions data from bit 0 to bit 7
control port		
bit 0	-STROBE	LOW=normal; HIGH=Output of data
bit 1	-LF/CR	LOW=normal; HIGH=auto line feed after
bit 2	-INITIALIZE	LOW=initialize printer; HIGH=normal
bit 3	SLIN	LOW=deselect printer; HIGH=Select printer
bit 4		LOW=printer interrupt disabled; HIGH=enabled
bit 5-7		Unused
Status port		**Functions**
bit 0-2	UNUSED	Unused
bit 3	-ERROR	LOW=printer error; HIGH=no error
bit 4	SLCT	LOW=printer not on-line; HIGH=printer on-line
bit 5	PE	LOW=printer has paper; HIGH=out of paper
bit 6	-ACK	LOW=printer acknowledges data sent; HIGH=normal
bit 7	BUSY	LOW=printer busy;

Table 3 Bit functions of the input/output ports of the Centronic port

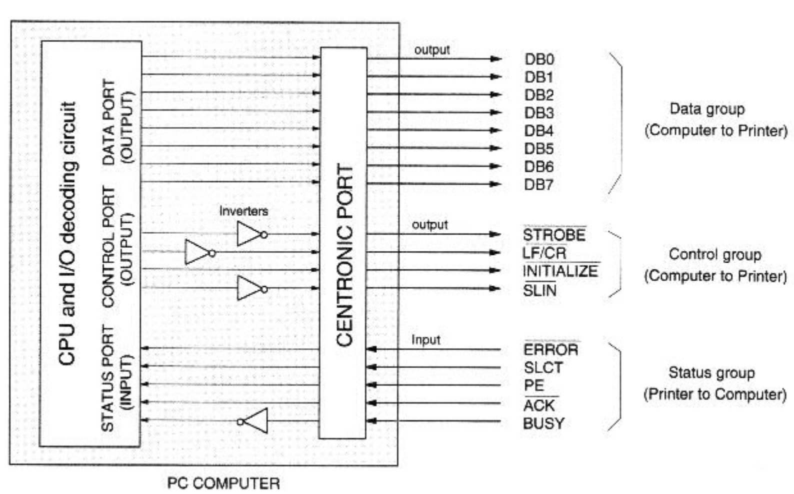


Fig.3 Logical structure of the Centronic port on the computer

For this port, the address of the data, control and status ports are 888, 890 and 889 decimal, respectively. To send data to the data and control group lines, the following commands can be used:

```
OUT 888, X
OUT 890, X     (in BASIC)
```

and

```
PORT[888] := X
PORT[890] := X   (in Turbo Pascal)
```

In which X is the decimal value of the binary bit pattern. To read data from the status group, the following commands can be used:

```
Y  = INP[889]       (in BASIC)
Y := PORT[889]      (in Turbo Pascal)
```

The value Y is the decimal value of the input binary bit pattern present at the status group lines. It should be noted that when writing data to the control group, the 4 output lines corresponds to bits 0 to 3 of port 890 decimal and when reading data from the status group, the 5 input lines correspond to bits 3 to 7 of the port 889 decimal. Also some lines in the control and status groups are inverted. A bit modification has to be made for the data to be sent to the control group and that received from the status port.

So far we have discussed the fundamentals of the Centronic port. As a summary, the port consists of three input and output groups which are individually controlled by 3 separate CPU I/O ports, two of which are output and one of which input. The first port has 8 output lines, the second has 4 and the third port has 5 input lines.

The Works

As shown in Figure 4 the data acquisition system can be divided into four units, namely, the input analogue channel switching unit, A/D conversion unit, interfacing unit and power regulating unit. The complete circuit diagram of the system is shown in Figure 5.

The analogue switching unit incorporates a 4051 analogue switch (IC3) which is a low cost 8-to-1 COMS analogue switch. 8 analogue input lines from channels 0 to 7 are connected to pins 13, 14, 15, 12, 1, 5, 2, 4 of the IC3. One of these inputs will be switched to the output (pin 3) by putting an address at pins 11 (bit 0), 10(bit 1) and 9(bit 2),

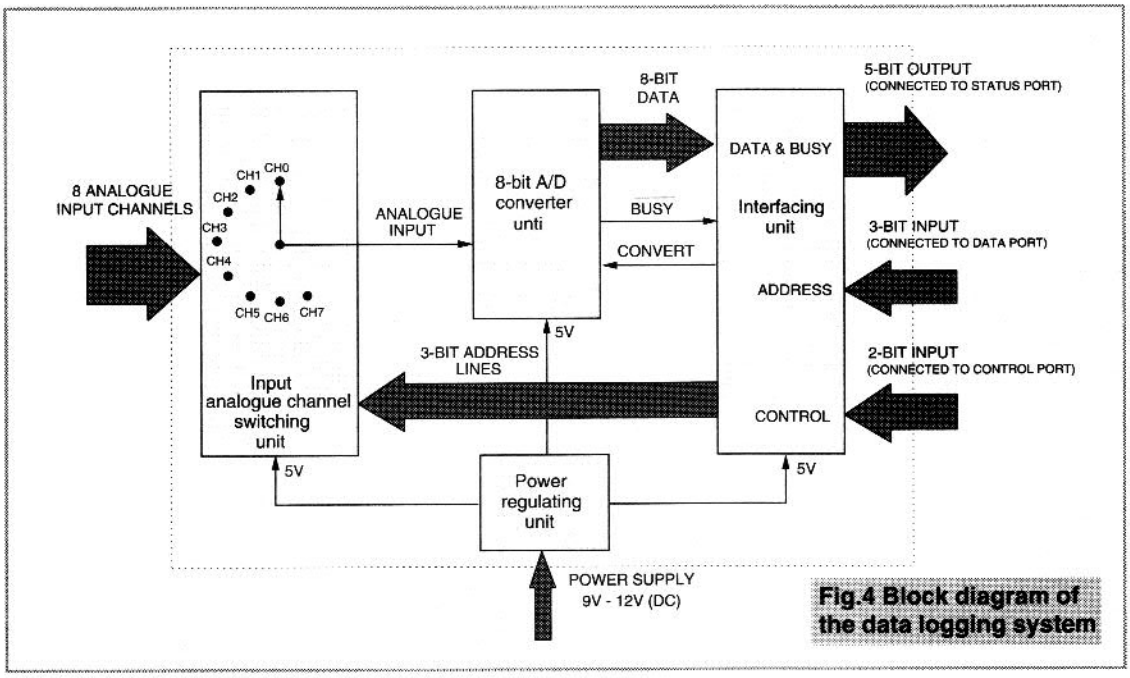


Fig.4 Block diagram of the data logging system

which is supplied by the data group lines of the Centronic port via buffers. The voltages to be measured are connected directly to the terminal blocks (J5) on the data logger (see Figure 5).

The A/D conversion unit uses a ZN448 A/D converter IC (IC1), manufactured by Ferranti, which is an 8-bit successive approximation analogue to digital converter with a guaranteed accuracy of 0.5 LSB and minimum conversion time of 9μs. A clock generator and a bandgap voltage reference are included on the chip. The pin-out of the ZN448 is shown in Figure 6(a). When the -CONVERT input (pin 4) receives a low-going signal, the A/D converter is triggered to start A/D conversion and the BUSY output (pin 1) becomes low. The -BUSY output will go high at the end of the conversion indicating that the conversion is completed. The -RD input (pin 2) is the data enable line which is taken low to enable the data on the output lines (pins 18 to 11) which otherwise are in impedance state. Refer to the circuit diagram (Figure 5), the -CONVERT output (pin 4) is connected to the control group lines of the Centronic port via a buffer. To start a conversion, the computer will send a high-to-low-then-high signal to the -CONVERT line, then it reads the -BUSY output line and check whether it goes to high. When high state is detected, the PC reads data from the A/D converter. A clock capacitor (C2) of a value of 100p is connected across pin 3 and the ground (pin 10) which enables the on-board clock generator to operate at about 800KHz. For other clock frequencies C2 has to be chosen according to the manufacture's data sheet. A negative power supply ranging from -3V to -30V should be supplied to pin 5 (-V) via a tail resistor R3, the value of which has to be chosen according to the input voltages. Table 4 shows the required resistance value in relation for various voltages:

Voltage(V)	Tail resistor (KΩ)
-3	47
-5	82
-10	150
-12	220
-20	330

Table 4 Required resistance values of the tail resistor

In the present circuit, the negative voltage is generated by a diode pump circuit driven from the -BUSY output. The principle is that whilst the -BUSY output is high capacitor C3 is charged to about 4 - 4.5 volts. During a conversion, the BUSY output goes low and the upper end of C3 is also pulled low. The low end of C3 therefore applies about -4V to R3. The time constant of R3 and C3 is chosen according to the clock frequency so that the drop of capacitor voltage is not significant during a conversion. Pin 8 of the IC is the output of the 2.55V on-board reference $V_{ref,out}$. To use this reference, a resistor R1 and a decoupling capacitor C1 are required and $V_{ref,out}$ (pin 8) is connected to $V_{ref,in}$ (pin 7). The input voltage to be measured,

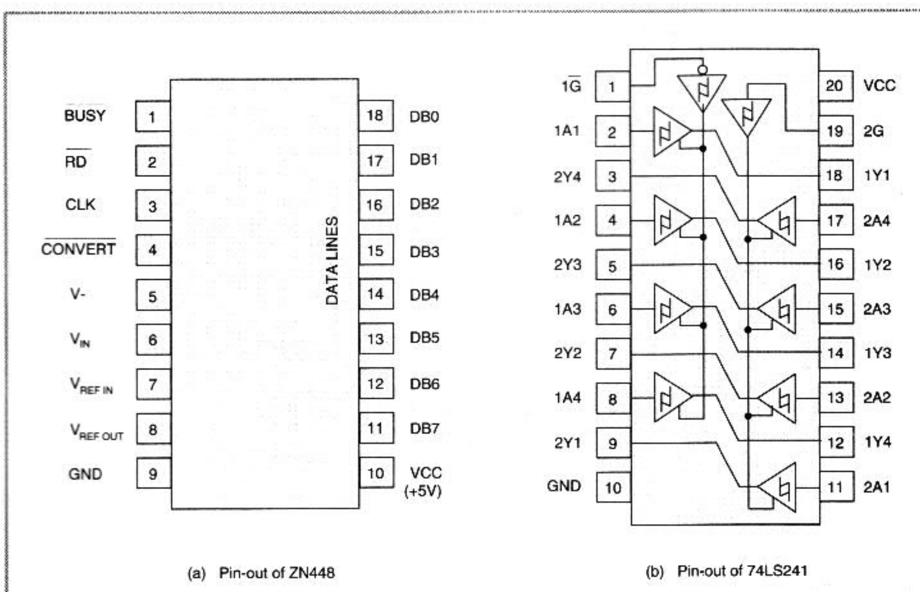


Fig.6 Pin out and pin function of ZN448 A/D converter and 74LS241 buffer ICs

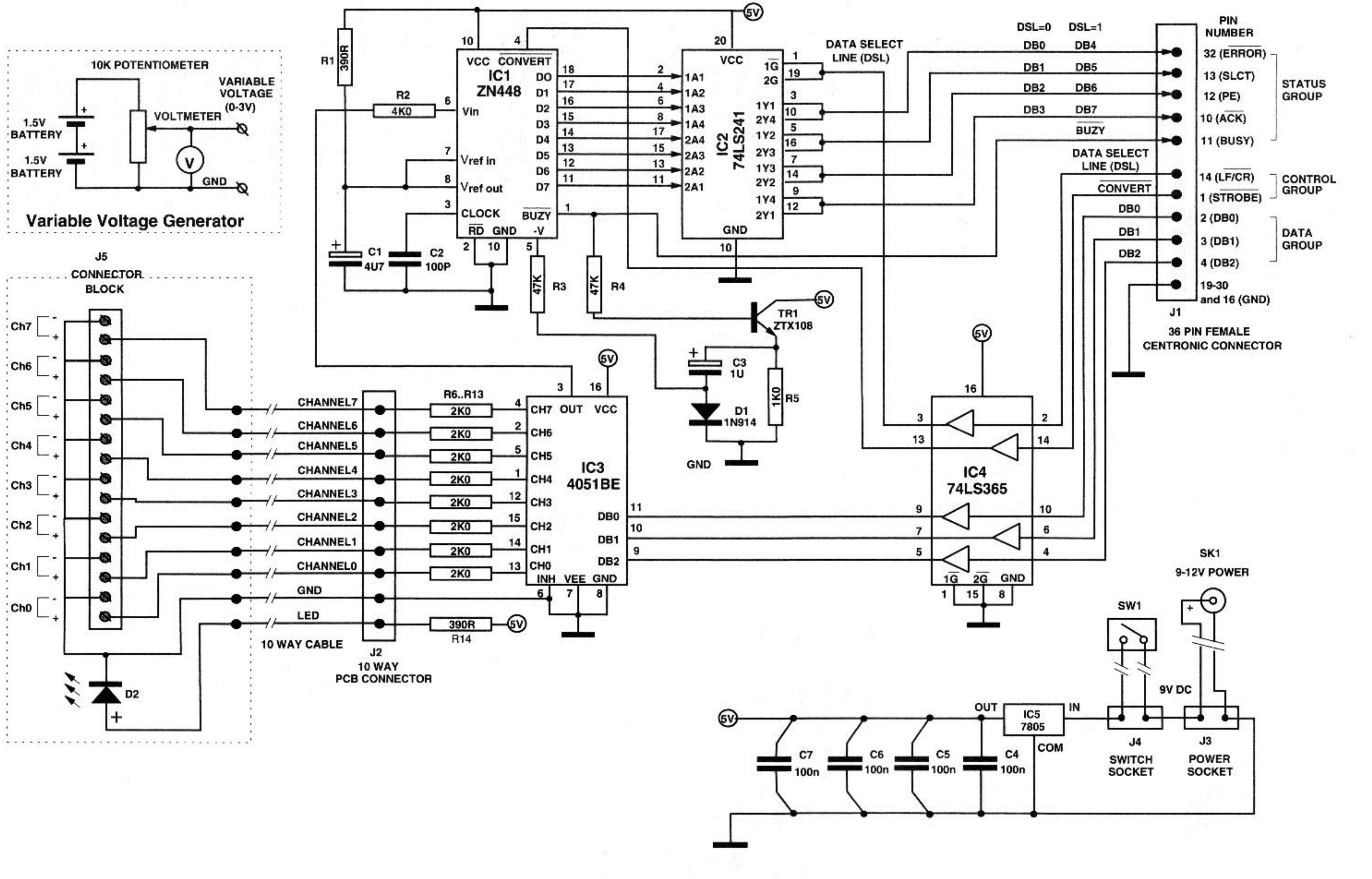


Fig.5 Circuit diagram of the Centronic data logging system

which should be between 0 to +2.55V, is fed to V_{in} (pin 6) via a resistor R2. A 2.55V input voltage will produce a byte of 255 decimal (FF Hex) at the data lines of the A/D converter. The decimal values for other input voltages are calculated using the following equation:

$$\textbf{Decimal Value} = \frac{\textbf{Inputvoltage}}{\textbf{2.55 x 255}}$$

The interfacing unit consists of two chips, a 74LS365 IC (IC4) and 74LS241 IC (IC2), and a 36-pin female Centronix-type connector. 74LS365 is a Hex buffer IC which is used to buffer the output lines from the Centronic port. Since the port only have 5 input lines and one of them has already been used for monitoring the -BUSY output of the ZN448, only 4 lines are left for reading the data. To read an 8-bit byte, the 74LS241 IC, the 3 state octal buffer, is used. The pin-out of the 74LS241 is showing in Figure 6(b). We can see that when pin 1 (the 1st enable input) is taken low, the 4 left hand side buffers works (i.e. the outputs will follow the status of the inputs). When pin 19 (the 2nd enable input) goes high the 4 right hand side buffers will work. If pin 1 and pin 19 are connected together to form a Data Selection Line (DSL), by putting the line low and then high, we can read 4 bits connected to the left hand buffers and the other 4 bits connected to the right hand buffers in turns. Operating in such a manner, the 8-bit data from the A/D converter can be read into the computer(see Figure 5)

The power regulating unit incorporates a 7805 5V voltage regulator for supplying 5V DC to the circuit. A 9-12V DC external power supply is required.

Programming

The control program of the data logging system is written in Turbo Pascal 6. The flow chart of the program is shown in Figure 7. The program is based on the LPT1 port. Firstly, an initialization procedure is performed which sets the -CONVERT input high. Secondly, a 3-bit address is sent to the data logger to select an analogue channel. It is followed by sending a short high-to-low-then-high pulse to the -CONVERT input. After this the computer starts to read the -BUSY output line continuously until the line becomes high. Then the computer sets the Data Selection Line high and reads the 4 high bits from the converter. Next the Data

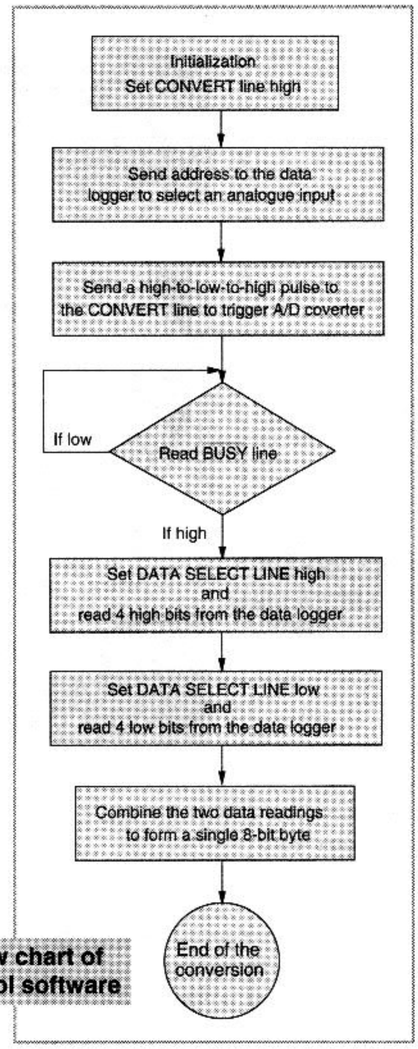


Fig.7 Flow chart of the control software

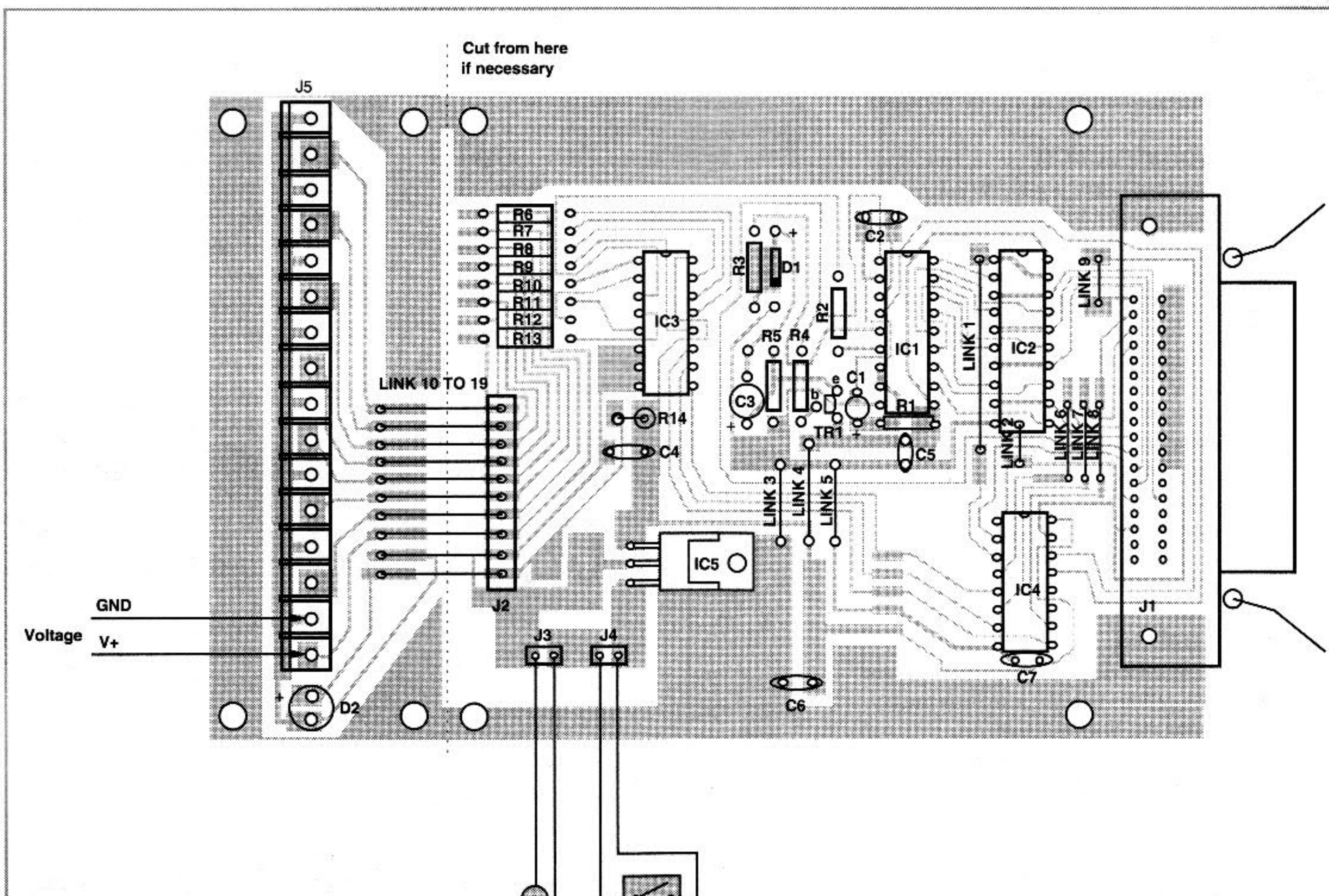


Fig.8 Component layout of the data logging system

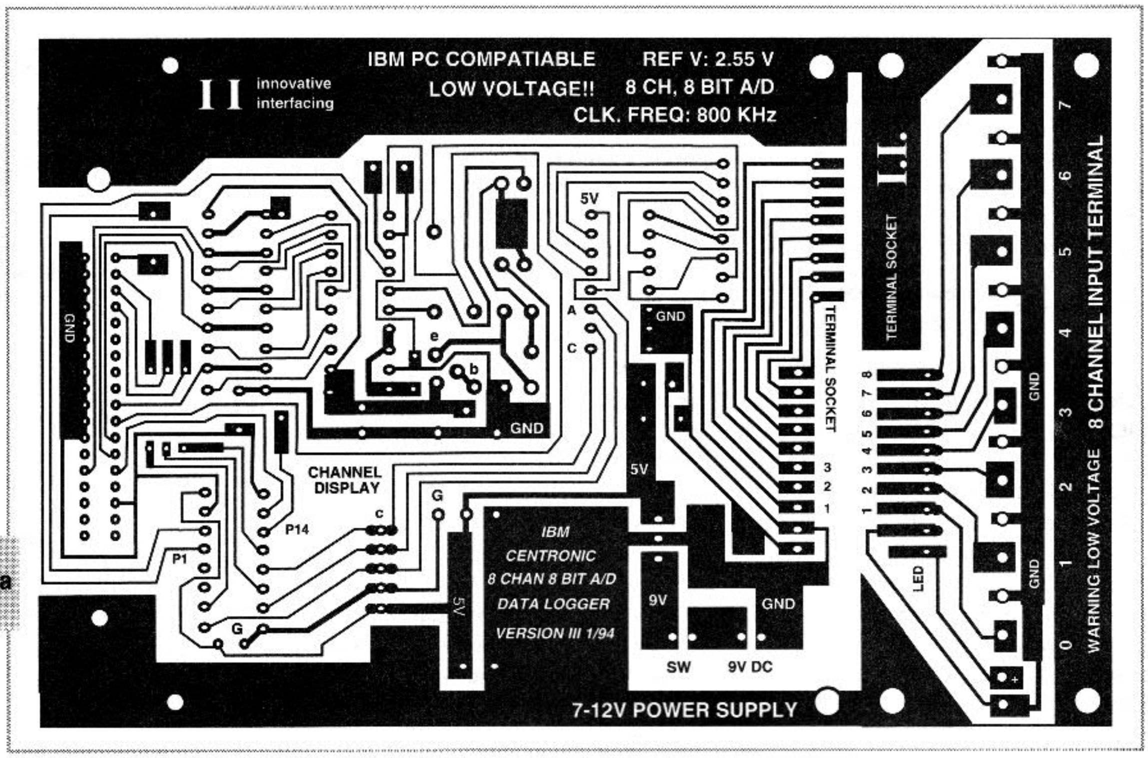


Fig.9 Copper foil pattern of the data logging system

Selection Line is taken low and the computer reads the 4 low bits. The two readings are then rearranged and combined to form a single 8-bit byte which is the byte appeared on the data lines of the A/D converter.

The complete program list is shown on the right. Readers can either type the program into the computer or contact the author for the software written on floppy disks. It is noted that the messages in { } are the explanations and can be omitted when inputting them into the computer.

Construction

This data logger is constructed on a single-sided printed circuit board. The full size foil pattern and component layout are shown in Figure 8 and 9. The PCB is available from the EIA PCB service on page 57.

Components may be mounted on the board in the following order: links, resistors, diodes, DIL IC sockets, capacitors, electrolytic capacitors, PCB connectors, voltage regulators, Centronix female connector and finally the ICs. It is suggested that the DIL IC sockets are used for IC1 and IC3. IC2 and IC4 can be soldered on the board directly.

Testing

After soldering, check all the joints and connections to make sure there are no shorts due to excess solder.

Only when you make sure that the board is properly constructed, can you connect the power supply to the data logger! An oscilloscope can be used to check the waveform at pin 3 (CLOCK) of the ZN448. It should be a 800KHz square wave. A logic probe can also be used for doing this. To connect the data logger to the computer, first of all, switch off the computer and the data logger, then connect the data logger to the printer lead. Next switch on the data logger and the computer. If the computer does not boot up properly turn off the computer, unplug the device and check the board again. If every thing is okay, you can now run the driver program. If the whole system is working properly, the voltages at the analogue inputs should be printed on the computer screen. To test an input channel, connect an 1.5V battery to one of the inputs (Be careful of the polarity!) and use a voltmeter to measure the voltage, that voltage value should appear on the corresponding channel on the screen. A variable voltage generator can also be used to check the system. A simple voltage generator using only two 1.5V batteries, a potentiometer and a voltmeter can be constructed easily. The circuit diagram is shown in Figure 5.

Application Note

There are various applications for this data acquisition system. With some simple transducers, it can be used to measure various quantities such as temperature and pressure, etc. There are many dedicated books and papers on the measurement techniques. Readers are encouraged to read some books and explore the possibilities of using the data logging system for various applications. The author would be delighted to hear any suggestions and ideas on this project.

A copy of the program for the data logger is available from the author at a cost of £3-50. including postage and packing. Please send cheques payable to Dr. P An and send them to the EIA office. EIA

Parts

Resistors

(0.25W, Metal film 1%)

R1,14	390R
R2	4K0
R3,4	47K
R5	1K0
R6-13	2K0

Semiconductors

IC1	ZN448 A/D converter IC
IC2	74LS241 octal buffer IC
IC3	4051BE 8-to-1 analogue switch IC
IC4	74LS365 hex buffer IC
IC5	7805 5V voltage regulator IC
TR1	ZTX108C
D1	1N914
D2	Red 5mm LED

Capacitors

C1	4μ7/10V electrolytics
C2	100p Ceramic disc
C3	1μ/10V electrolytics
C4-7	100n Ceramic disc

Additional Items

J1	36 pin female Centronix-type connector
J2	10 way PCB connector
J3,4	2 way PCB connector
J5	16 way connector blocks
SK1	Power socket
SW1	Toggle switch
LINK1-LINK9	Tined copper wire 24swg
LINK10-LINK19	Multi-core wires

PCB (see page 57)

List of the control program

```
Program Centronic_A_D_Converter;
{This program is written to drive the IBM-PC 8-line 8-bit data logger. The follow program is based on LPT1 Centronic port}
{This program is written in Turbo Pascal 6. The basic version of the program is available from the author}
{Author:  P. An  1/1/94}
uses
    crt;
var
   byte1,byte2,truebyte    :byte;
   bitweight,bit           : array [1..8] of byte;
   i,j,CN                  :integer;
   V                       :real;
   {byte1 = 4 high bits,  byte2=4 low bits,         truebyte = 8 bit byte from the A/D converter}
   {   CN = channel number,                         V    =Voltage in volts}

Procedure initial_bit;
{Initialize binary bitweight and bit}
begin
     for i:=1 to 8 do begin bitweight[i]:=1; bit[i]:=0; end;
     for j:=1 to 8 do begin
     for i:=1 to j-1 do bitweight[j]:=bitweight[j]*2
                    end;
end;{of initial_bit}

Procedure initialization;
{initialize the data logging system}
begin
     port[888]:=0;          {Address=0};
     port[890]:=0;          {CONVERT=1, DSL=1};
end;{of initialization}

Function voltage(channel_number,average_number:integer):real;
{Logging data from a specified channel and averaging the value
     channel_number: channels from 0 to 7
     average_number: number to average the measured voltage}
var
   sum:real;
   ii:integer;

begin
      port[888]:=channel_number;                     {output the selected channel address to port 888}
      delay(10);          {delay 10 mS}
      sum:=0;
      for ii:=1 to average_number do begin
      initial_bit;
      port[890]:=1;       {CONVERT=0, DSL=1}
      port[890]:=0;       {CONVERT=1, DSL=1}
                          repeat
              byte1:=port[889];       {read 1st byte, check BUSY line and wait it to become high}
              until byte1<128; {note: BUSY line is inverted in the PC}
              byte1:=port[889];       {DSL=1, read the high 4 bits}
              port[890]:=2;    {DSL=0}
              byte2:=port[889];       {read the 4 low bits}
                  {binary format of byte1 and byte2
                         byte1: xxxhhhh0 (high 4 bits)
                         byte2: xxxllll0 (low  4 bits)
              note: x=do not care,  h,l=data}
              byte1:=byte1 and 120;   {00011110 and xxxhhhh0 = 000hhhh0}
              byte1:=byte1 shl 1;     {shift 1 bit left,   byte1 = 0000hhhh}
              byte2:=byte2 and 120;   {00011110 and xxxllll0 = 000llll0}
              byte2:=byte2 shr 3;     {shift 3 bits right, byte2 = llll0000}

              truebyte:=byte1 or byte2;     {byte1 or byte2 = llll0000 or 0000hhhh = llllhhhh}
              sum:=sum + truebyte/255*2.55;   {convert the binary value into a voltage, Reference voltage=2.55V}
                                                                                          end;
      voltage:=sum/average_number;
end;{of voltage function}

Procedure crtinitialization;
{show initial data on the screen}
begin
     writeln;
     writeln('****************************************************************************');
     writeln('        IBM-PC 8 input 8 bit analogue to digital converter program');
     writeln('****************************************************************************');
     writeln;
     writeln;
     for cn:=0 to 7 do
     writeln('                Channel ',cn:3,'    Voltage = ');
     gotoxy(10,20);write('Press any key to stop scanning');
end;{of crtinitialization}


procedure display_results;
begin
     gotoxy(40,7+cn);write(V:7:3);   {show results on crt}
end;{of display_results}

{================main program=================}
begin
repeat
      clrscr;
      crtinitialization;
      initialization;
      for cn:=0 to 7 do begin
             V:=voltage(CN,2);   {logging channel CN, average number=2}
             display_results;
                        end;
      delay(400);              {delay for 400 mS}
until keypressed;
     gotoxy(10,19);write('Thank you for running this program');
     readln;
end.{of main program}
```

Intercommun

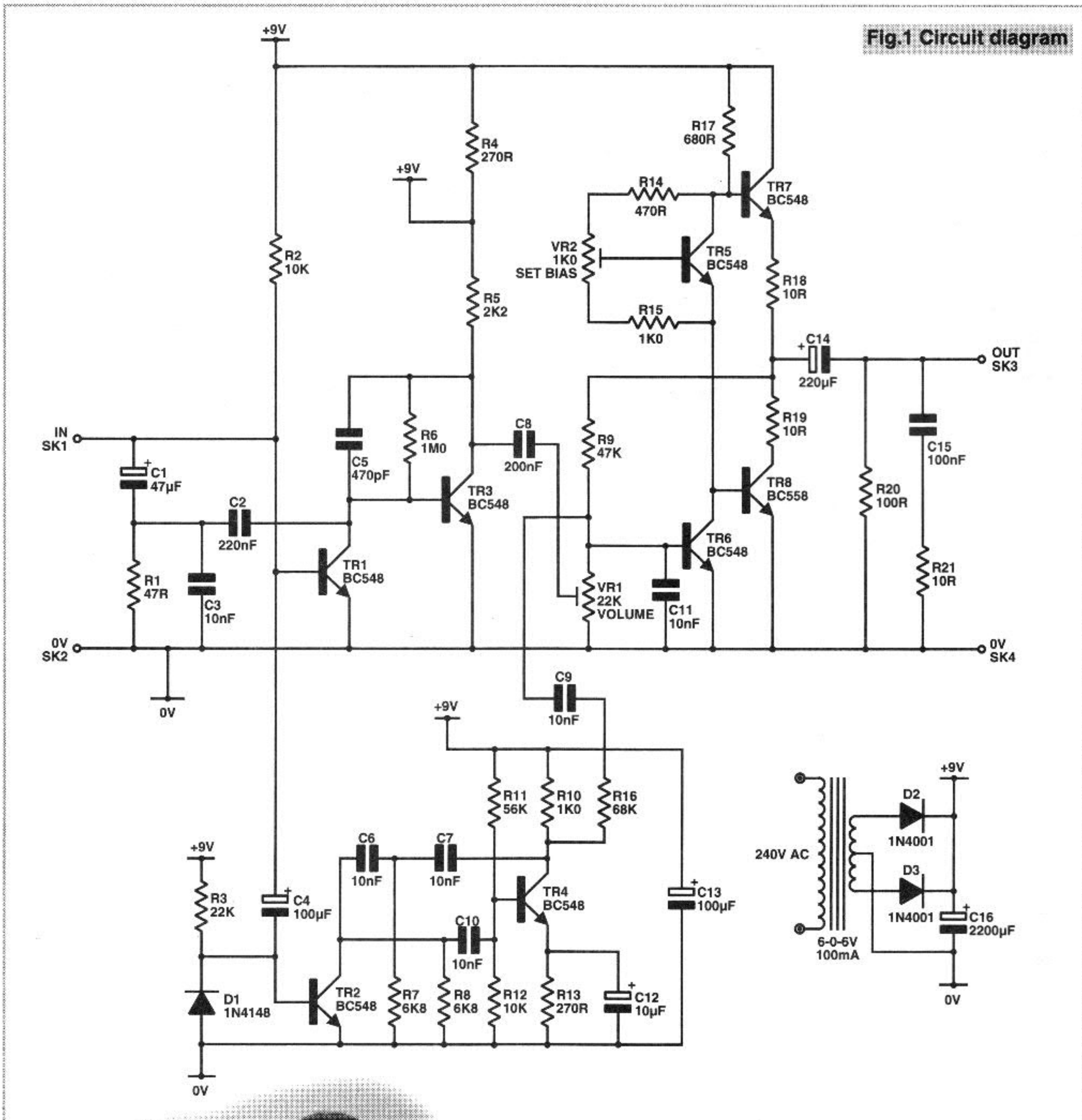
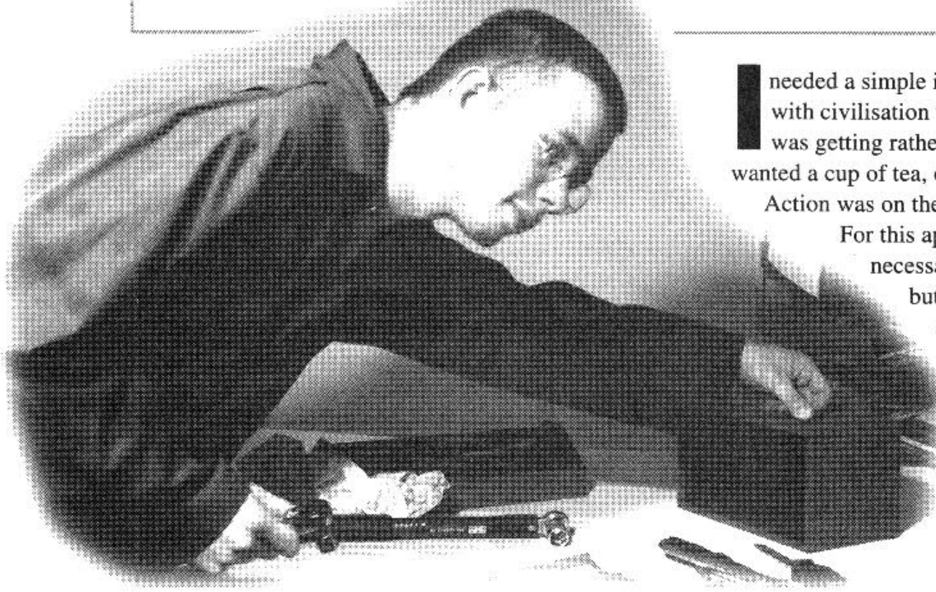


Fig.1 Circuit diagram



I needed a simple intercom system, so that I could keep in touch with civilisation when I was hiding in my workshop! My partner was getting rather fed up of making journeys just to ask me if I wanted a cup of tea, or to tell me that the editor of Electronics in Action was on the phone!

For this application a separate "call" function is not necessary. Instead I opted for a short tone when the talk button was pressed. This is to get the other person's attention, rather like the "bing" sound on the announcement systems in public places. I was originally hoping for a "peep" sound, although it ended up more like a "pweee"!

There is a talk button at each end, so it's impossible to eavesdrop on the other party -

ications

Mark Price keeps in touch with a simple 2 wire intercom.

unlike some cheap commercial systems. However if the remote talk button is replaced with a normal switch, it can be left on so that the system may be used as a baby monitor.

I already had a twelve-core cable between the workshop and the living room, carrying audio from the hi-fi, serial computer data and a telephone extension. There were just two cores left, hence this design for a two-wire system. Any convenient two core cable can be used.

What - No Chips!

I built this unit using bits from the "Junk Box", and assumed others might like to do the same. If you don't have the right chips, there's no option but to buy them. If you don't have the right transistors, you can usually find something similar, and the same applies with most of the other components. Since the circuit doesn't have to do anything exacting, a simple transistor design is ideal.

There is sufficient gain in the system that a person can be heard clearly when talking at a normal volume, about two feet from the unit. Since the person speaking would be pressing the talk button, this is the maximum distance necessary.

Construction

The circuit is assembled on a single sided PCB, available from Electronics in Action (page 57). The component overlay and track layout is shown in Figure 3.

Assembly is straightforward and should present no difficulties. None of the component values are critical, there should be no problems using the value above or below if the correct part is not available. If you are using different transistors, ensure that TR7 and TR8 have a maximum collector current rating of at least 100mA.

Ceramic disk capacitors can be microphonic and are not recommended for C2, C3 and C5. The oscillator phase shift capacitors, C6, C7 and C10, should have a good Q rating or the circuit may fail to oscillate. Disk and dipped polyester types are fine, but the small resistor sized tubular devices are not suitable.

The PCB should be mounted in a suitable enclosure, together with a loudspeaker. A similar box will be needed for the remote unit. The prototype system was built into a pair of small stereo loudspeaker cases, containing 16R oval speakers. These are readily available at car boot sales for a

The Works

Figure 1 is the main circuit diagram, and shows the components mounted on the PCB. Figure 2 is the interwiring diagram, which shows the switching arrangement and loudspeakers.

The requirement for a talk switch at each end on a two-wire system complicated the design slightly. Capacitor C17 is connected in series with the remote speaker, and is short-circuited when the talk switch is pressed (R22 limits the discharge current). The electronics at the local end detects the DC path when the switch is pressed.

TR3 and the associated components form the first audio amplifier stage. When a low resistance DC path is present between SK1 and SK2, TR1 will switch off, allowing TR3 to be biased by R6. The audio signal is coupled to the base of TR3 by C1 and C2.

R1 reduces the input impedance to reduce the chance of noise pickup along the long connecting lead. C3 and C5 remove ant RF interference that may be present and limit the top end of the frequency response to about 4KHz. The low values of C2 and C8 limit the lower end of the frequency range to about 200Hz. This frequency response is adequate for speech, and allows a high gain to be achieved with minimal problems due to hum and noise.

Since TR3 is biased off when the unit is not in use, the gain is low and no hum or noise can be heard.

TR5 to TR8 and surrounding components form a basic class B audio output stage, with a power output of about 200mW RMS into 8R. VR2 is adjusted to give a quiescent current of 2mA, to minimise crossover distortion. Preset VR1 sets the audio gain. In use this will probably be set to maximum, although it is useful to be able to reduce this when testing to avoid feedback.

TR4 and surrounding components form a standard RC phase shift oscillator. The output of this is fed into the power amplifier via R16 and C9. TR2 has been added to short out the signal at one of the phase shift points, disabling the oscillator. This transistor is normally held on by R3, however when one of the talk buttons is pressed it is turned off for about half a second. This time is set by the values of R3 and C4. Thus the oscillator produces a brief tone when a talk button is pressed.

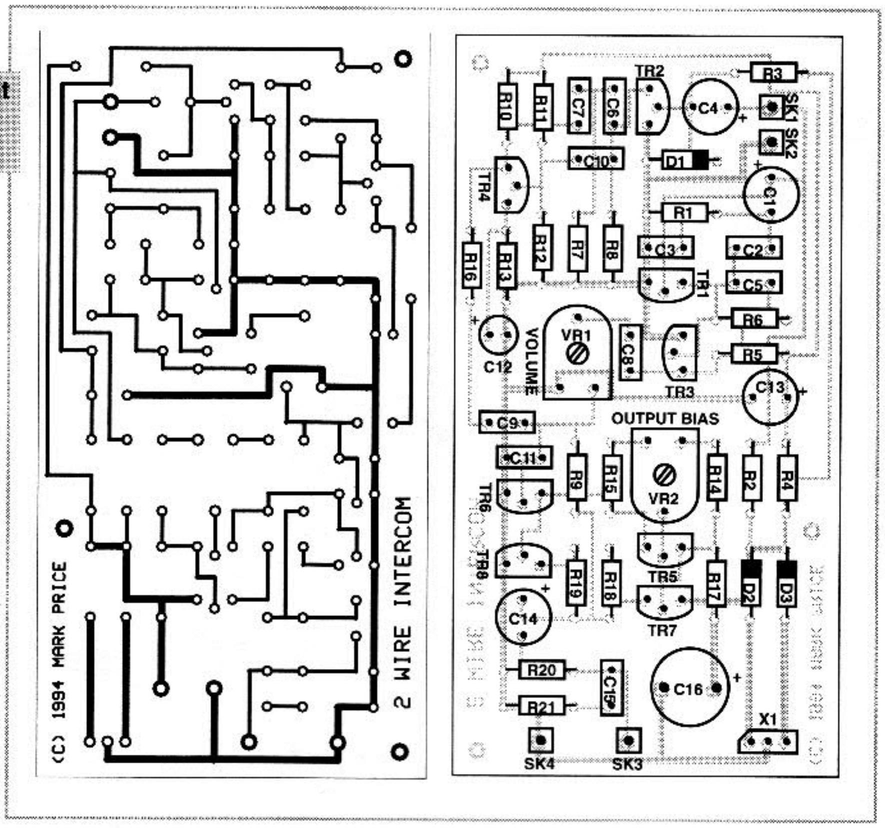
The circuit is mains powered using a small six volt transformer. Since the current requirement when the unit is silent is minimal, a 100mA transformer is adequate. The supply to TR3 and TR4 is additionally decoupled by R4 and C13.

few pounds, complete with a matching defunct stereo record player!

Suitable holes should be made on the top surfaces of both case, for the push button switches. The PCB and transformer can be mounted in any convenient position, in one unit. A suitable connector should be fitted on the rear of each unit for the interconnection cable. If the installation will be reasonably permanent, electrical chock-block connectors will suffice.

The units should then be wired up as shown in Figure 4. If the interconnection cable does not have polarity markings there is a 50% chance that C17 will be the wrong way round! In this case fit two 220uF capacitors in series but opposite ways round as shown.

Fig.2 Component positioning and foil pattern



Testing

Initially set VR1 to the centre position and VR2 fully anticlockwise. Connect the two units together and connect the master unit to the mains. Connect a voltmeter across R18 or R19 and adjust VR2 to obtain a reading of 20mV. This gives a quiescent current of 2mA, which is sufficient to eliminate crossover distortion with 16R speakers. With 8R speakers it may be necessary to increase this to 3 or 4mA (30 or 40mV), this should only be done if distortion is noticeable.

Both speakers should now be silent. Press the talk button on the remote unit. A brief tone should be heard from the local unit, and you should then be able to hear yourself speaking through the system. Check this the other way too. VR1 should be set so that speech is loud enough to be clear without being deafening. This setting can only be finalised once the units are installed, since feedback will be a problem with both units in the same room.

If the volume of the bleep is too loud (unlikely), it can be reduced by increasing the value of R16

In Use

Push the button to talk and release to listen. If both buttons are pressed simultaneously, the master unit will dominate.

The units will pop as the buttons are pressed and released, this is due to the varying bias on TR3. It is useful to hear when the other party has released the button.

You can now keep in touch with your loved one, and enjoy your hobby. However, there is one problem with such a useful communication system installed - it is much easier for your partner to nag you about how much time you spend in the workshop! Make sure you have the master unit, then you can always "accidentally" unplug it!

Parts

Resistors (0.25W 5% or better)	
R1	47R
R2,12	10K
R3	22K
R4,13	270R
R5	2K2
R6	1M0
R7,8	6K8
R9	47K
R10,15	1K0
R11	56K
R14	470R
R16	68K
R17	680R
R18,19,21,22	10R
R20	100R
VR1	22K Horiz Preset
VR2	1K0 Horiz Preset
Capacitors	
C1	47µ 10V
C2,8	220n
C3,6,7,9,10,11	10n
C4,13	100µ 10V
C5	470p
C12	10µ 10V
C14,17	220µ 10V
C15	100n
C16	2200µ 10V
Semiconductors	
TR1,2,3,4,5,6,7	BC548
TR8	BC558
D1	1N4148
D2,3	1N4001
Miscellaneous	
X1	6-0-6V 100mA Transformer
SW1,2	DPDT Push Switch

PCB, Two Loudspeakers (8 or 16R), Two Cases, Two Connectors and Thin 2 Core Flex for Interconnection, Mains Flex.

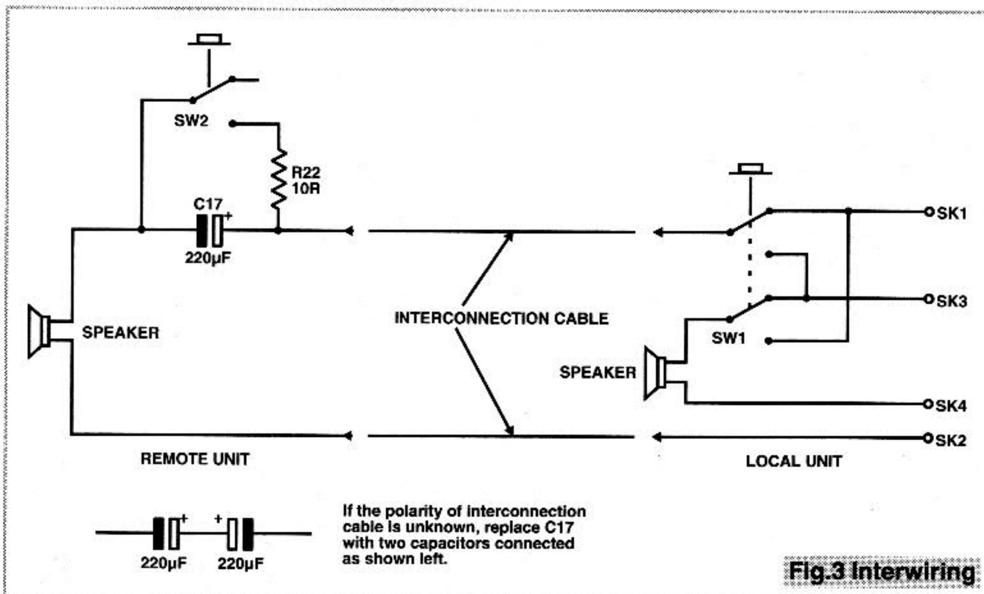
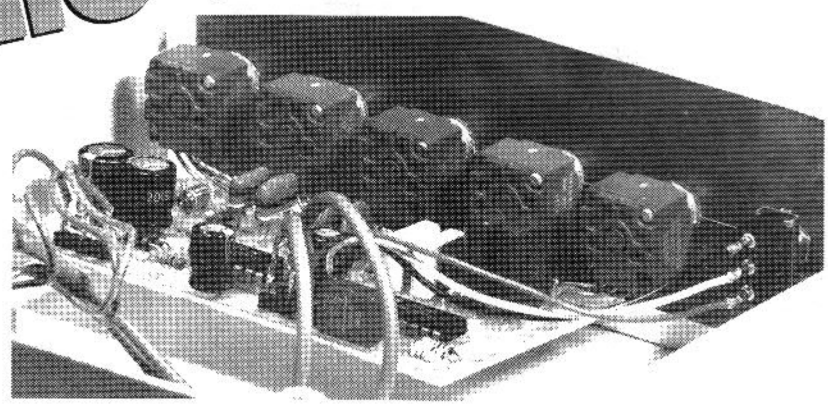


Fig.3 Interwiring

Five Band Graphic Equaliser

by Paul Stenning



Regular readers of this magazine will be aware of my interest in video editing. A Video Effects Unit has already been published, and other video processing projects are planned.

A problem I frequently encounter when copying video tapes is the deterioration in the sound quality. The five band graphic equaliser described here was designed to connect between two video recorders, so that the frequency response can be corrected somewhat. Its use is by no means limited to video recording however, it is a general purpose design that will prove useful for many audio applications.

The five controls each have a range of +/- 10dB at centre frequencies of 100Hz, 300Hz, 1KHz, 3KHz and 10KHz. The 3dB points on each band are at half and twice the centre frequencies. Thus, the 3dB points on the 100Hz control are at 50Hz and 200Hz. With all controls at maximum the unit has a total gain of 15dB. The unit will accept an input of up to about 1V RMS (3V pk-pk) before distortion occurs with all controls at maximum.

I do not possess suitable test equipment to measure noise and distortion, although none was apparent on the oscilloscope trace. I would describe the unit as suitable for good quality stereo equipment, but perhaps

The Works

The complete circuit diagram is shown in Figure 1. This basic circuit principle has been used in several graphic equaliser designs, so I am making no great claims about its originality!

The input is buffered by the first section of IC1, which has unity gain and a consistent output impedance. If any overall gain or attenuation is required, it may be achieved by altering the values of R1 to R4.

To make the explanation of the second stage clearer, assume that all five frequency selective sections have disappeared, as well as four of the control pots. The wiper of the remaining pot is connected to ground via a 1K0 resistor.

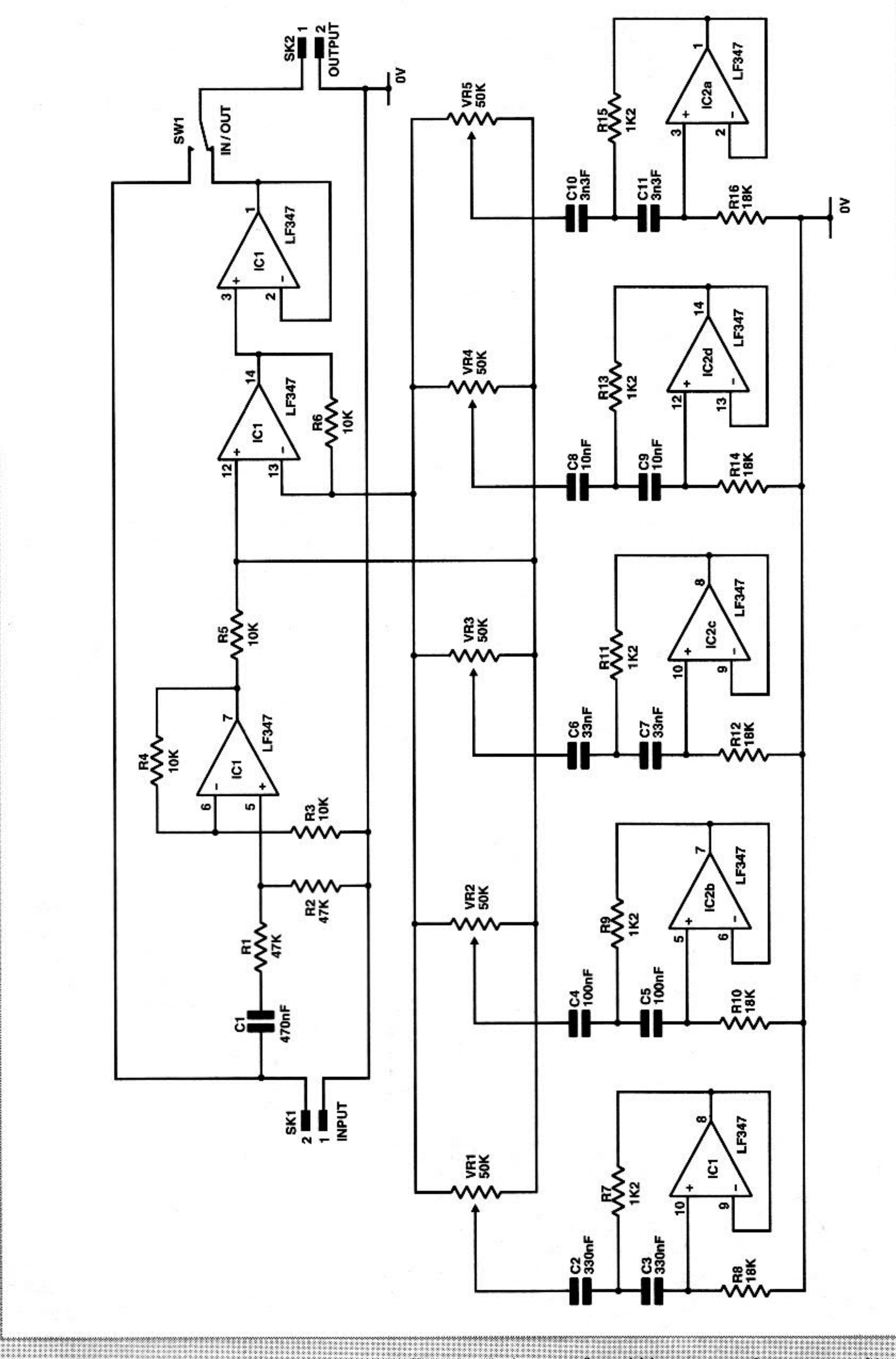
If the pot is in the upper position (fully clockwise), the 1K0 resistor appears between the inverting input of the op-amp and ground, giving the stage a gain of ten. If the pot track resistance is 10K (five 50K pots in parallel), the signal at the non-inverting input is halved, giving a total gain of five.

With the pot in the lower position (anticlockwise), the input to the non-inverting input is reduced to a tenth, and the gain of the op-amp circuit is two, giving a total gain of a fifth.

With the pot in the centre the gain of the whole stage is unity, since the attenuation of the input signal is cancelled by the gain of the op-amp. If our imaginary 1K0 resistor is replaced with a tuned circuit, the effects described above will only occur around its centre frequency. In this circuit we have five tuned circuits giving the five bands.

Traditionally the tuned circuits would consist of a capacitor and inductor in series. Due to the lack of availability of suitable inductors, modern designs use a gyrator circuit to simulate an inductor. This uses an op-amp to reverse the phase relationship of a capacitor, to make it

Fig.1 Complete circuit of Graphic equaliser



appear like an inductor.

Taking the first stage, C4 is the real capacitor and the op-amp and remaining components form the gyrator. The R7 controls the reactance of our "inductor", and therefore the Q of the tuned circuit. In this case we do not want a particularly sharp response so the Q is fairly low. R7, R8 and C3 all affect the "inductance", and I have yet to find the correct formula for calculating this!

The final output of the circuit is buffered by a unity gain op-amp stage. SW1 selects whether the equaliser is in the audio path.

The circuit requires a supply of +/- 12 to 15V, at less than 10mA. This does not need to be regulated but must be smooth and have minimal ripple. The output of a 9-0-9 transformer is full wave rectified and smoothed giving approximately +/-13V across the 220µF capacitors. About a volt is dropped by the 100R decoupling resistors, leaving around 12V to power the circuit.

not true hi-fi.

Although the design is mono, a stereo version could be built using two PCBs and stereo pots. More details on this are given later.

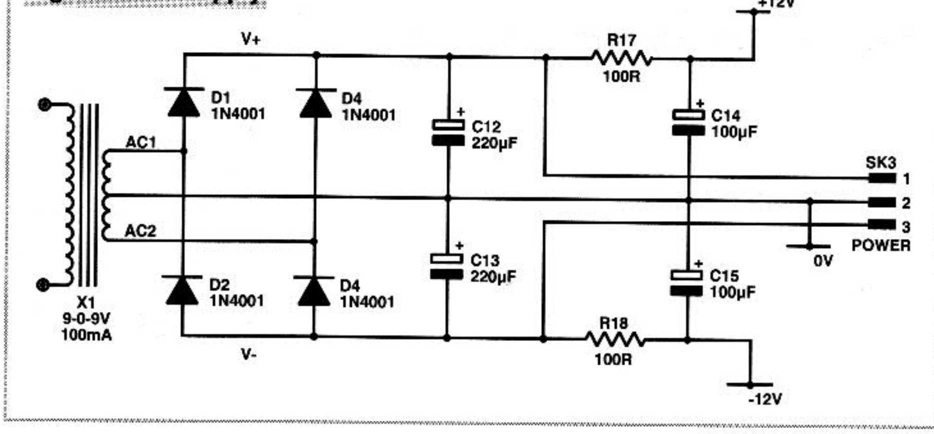
Construction

All the components, except the transformer and pots, are mounted on a single sided PCB. This is 113mm * 51mm, and is available from the EIA PCB service. The component overlay is shown in Figure 2.

There are two wire links that should be fitted first, along with the resistors and diodes. The remaining components may then be fitted. Sockets may be used for the ICs, but this is not really necessary providing they are fitted last and soldered carefully.

The non-polarised capacitors should be reasonable quality types, dipped polyester or mylar types are suitable. Try to avoid the cheap ceramic disk types, for this project. The PCB holes for these components are on a 0.4" pitch, which is suitable for the suggested types.

Fig.1b Power supply



layout, with slider controls and an instrument or desk case.

Whatever case is used, the PCB's should be mounted as close as possible to the control pots. Use short lengths of wire to connect the pot tags directly to the PCB pads. On the PCB, the left pad for each pot is the minimum or anticlockwise end of the track, the centre pad is the wiper, and the right pad is the maximum or clockwise end.

Connect the input socket to the SK1 pads, and the output socket to SK2. In both cases the centre core of the screened cable goes to the left pin. The IN/OUT switch connects to the SW1 pads, with the wiper to the centre pad.

The transformer may now be connected to the X1 pads on the PCB, with the centre tap to the middle pad. For a stereo unit, connect the transformer to the PCB with the diodes fitted, and link the SK3 pads on the two boards together. The mains input flex may be joined to the transformer primary wires with a choc-block connector or similar.

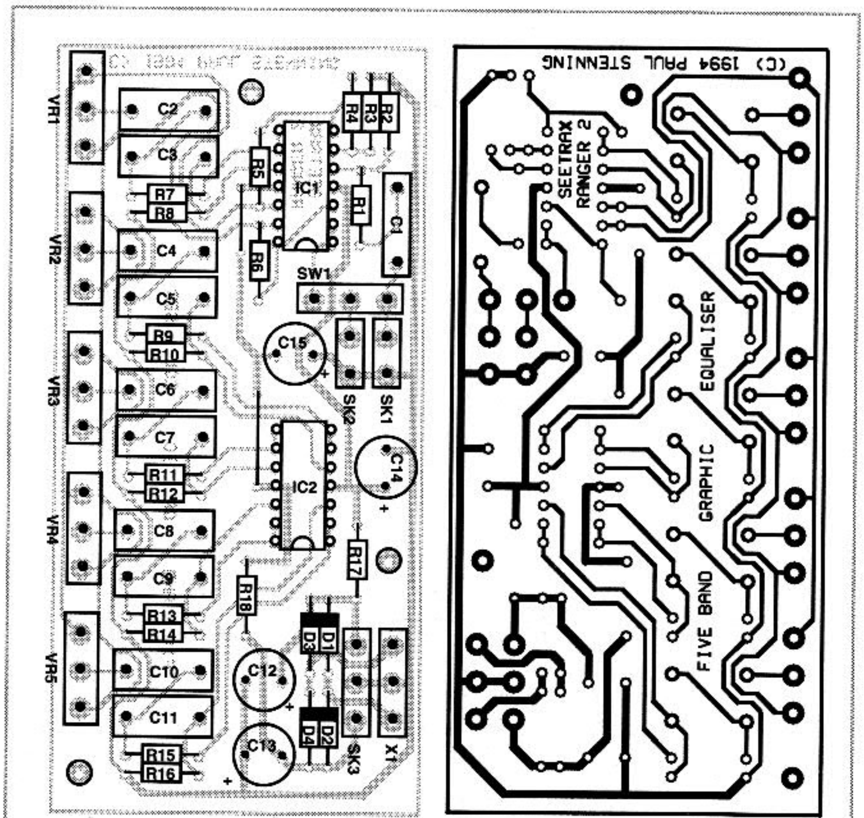


Fig.2 Component positioning and foil pattern

Two PCBs are required for a stereo unit. Do not fit D1-D4, C12 and C13, on one PCB.

The prototype had rotary pots, and was constructed in a plastic case that matched my other projects. Many constructors may prefer a more orthodox

Testing and Operation

There is nothing to set up on this unit, it will either work or fail depending on how well it was put together! These few checks with a test meter will confirm that everything is reasonably OK, before connecting the unit to your audio equipment.

First set the test meter to the 20V range, and check the supplies on one of the ICs. There should be about +12V on pin 4 and -12V on pin 13. Now connect the meter to the output (pin 1 of IC1), the voltage should be 0V or thereabouts. Turn each of the five pots to both ends, and check the output remains at almost 0V. If the output is not at 0V (+/- 0.1V) something is wrong, which should be investigated. Now connect the unit to your audio equipment, cross your fingers, and try it.

If the output of this unit is connected to a video recorder or some other piece of equipment with an automatic level control, you may find that the sound level drops if the 100Hz or 300Hz controls are turned up too far. Most automatic level circuits respond more to the bass frequencies.

Bearing this in mind, faint and grotty recordings can sometimes be avoided by turning the 100Hz and 300Hz bands down a bit to reduce the effect of the level control. Turn the 1KHz and 3KHz up a bit to improve the clarity, and turn the 10KHz down to get rid of any hiss. The result may sound a bit thin, but it is better than a quiet muffled sound with tape hiss.

There's not much else I can say about using this unit. Most people know what a graphic equaliser does, and a little trial and error will show the effect of each frequency band.

Parts

Resistors
(0.25W 5% or better)

R1,2	47K
R3,4,5,6	10K
R7,9,11,13,15	1K2
R8,10,12,14,16	18K
R17,18	100R
VR1,2,3,4,5	50K Pot

Semiconductors

IC1,2	LF347
D1,2,3,4	1N4001

Capacitors

C1	470n
C2,3	330n
C4,5	100n
C6,7	33n
C8,9	10n
C10,11	3n3
C12,13	220μ/16V
C14,15	100μ/16V

Miscellaneous

9-0-9V 100mA Transformer
PCB (see page 57)
Case
Knobs
SPDT Switch
Two Phono Sockets
Screened Cable
Wire
Mains Flex

EIA

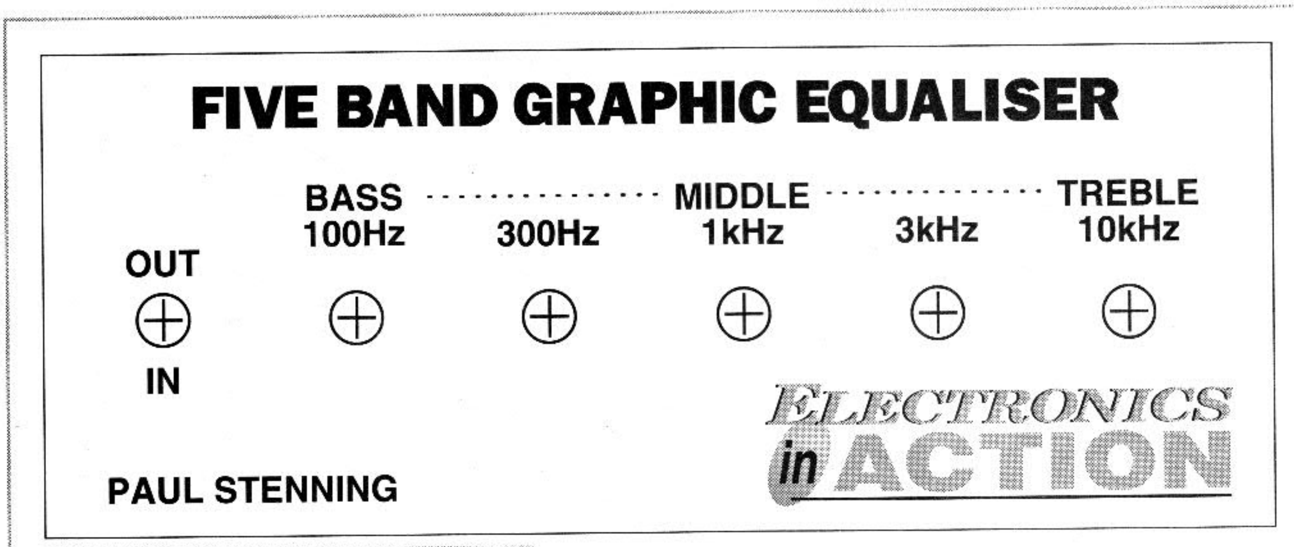


Fig.3 Front panel design (shown full size)

Signal to NOISE

The Editor
Electronics in Action
PO Box 600, Berkhamsted Herts. HP4 1NL

Pro-quality components problem

Firstly congratulations on the continuing high quality of the publication - apart from minor errors it is really very good. Like your correspondent J R Evans (Feb 94) my own sphere of interest is studio quality analogue audio - preferably balanced - and I hope that you will continue to feature circuits of this nature.

Again like Mr Evans I also favour practical designers like Mike Meechan and Ben Duncan who do not pay lip service to much of the hi-fi hype but whose designs deliver the goods both technically and sonically.

For my own part, I suppose I do not undertake a great deal of actual construction mainly for reasons of financial constraints) but when I do the biggest problem that I encounter is actually sourcing pro quality components in small quantities, especially precision capacitors and resistors.

Most component manufacturers are happy to supply literature - although some never bother to reply but I suppose this is indicative of the state of British enterprise.

However, for components a little out of the ordinary I have found that distributors are only interested in orders of 100s. This has recently happened to me in respect of really good quality PSU reservoir capacitors for my present brainchild, an audio power amp, where I wanted audio quality elcos that would fit vertically within a 2U case - easy to find, difficult to buy! (And I'm still looking).

The main reason for the above story is to ask if anyone is aware of any distributors who handle pro components and who would be prepared to deal in small quantities - it would be worth paying a slight premium to ensure component quality.

Finally I look forward to Mike's audio projects in the near future.

A G Crane
King Lynn
Norfolk

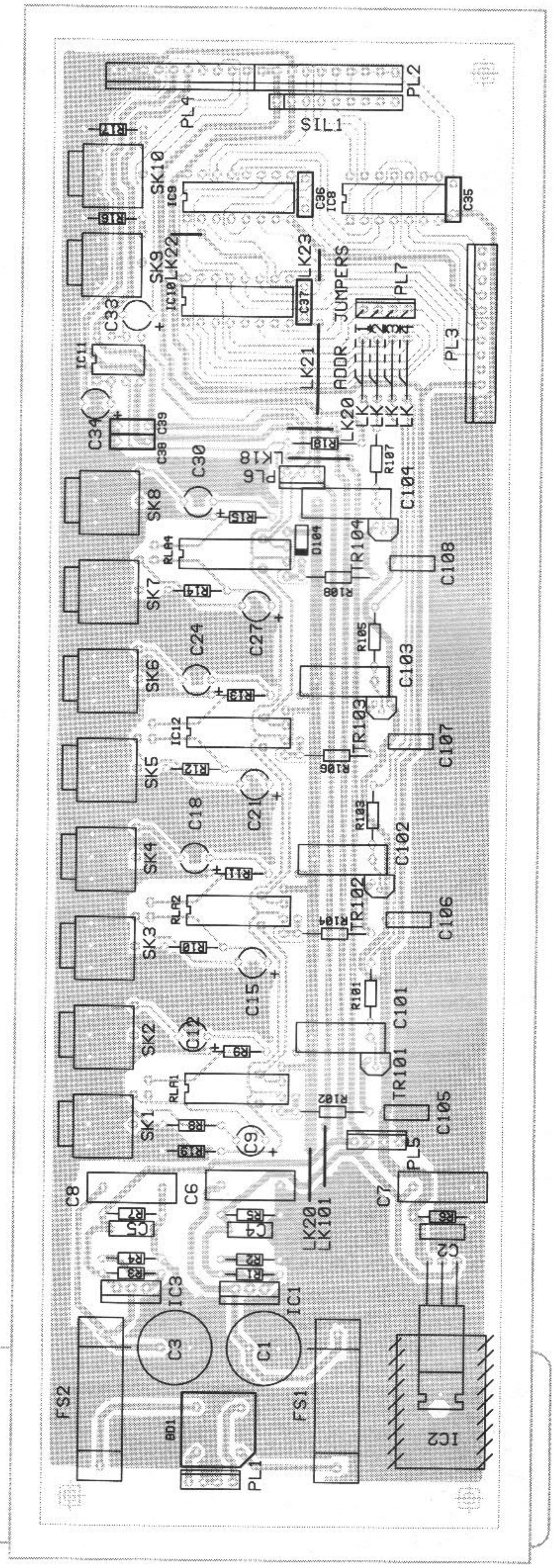
I am writing to you to say thanks for the Photo CD player that I won in your December competition.. I have only recently been able to set it up and I have found the quality amazing.

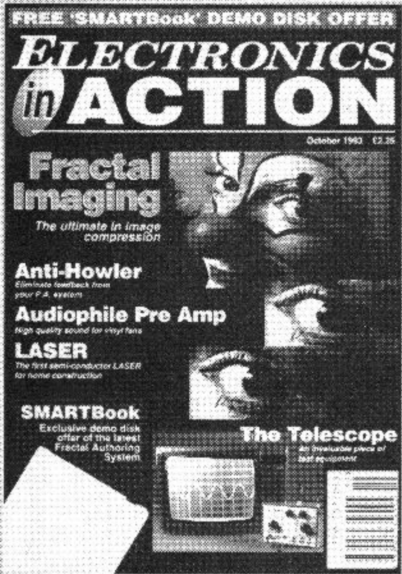
Once again many thanks as this is the first time I have won a competition. Having enjoyed reading Electronics in Action and am looking forward to each issue in the future.

F R Stephens
Worthing
Sussex

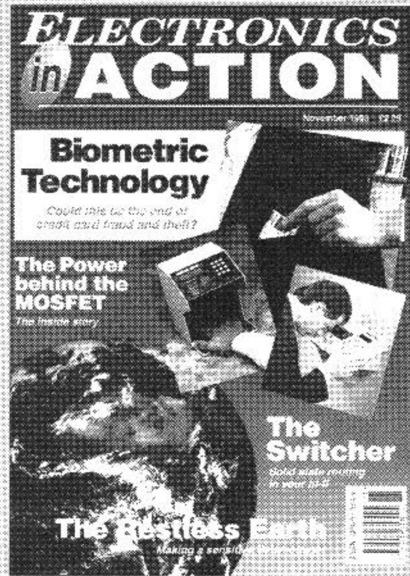
Clang

Owing to a shortage of space last month we were unable to print the component positioning diagram of The Switcher relay board. We reproduce it here.





October 93 ●Fractal Imaging ●The Telescope Pt1 ●Anti-Howler ●Audiophile Pre-amp ●Sine wave generator



November 93 ●Biometric Technology ●The Switcher Pt1 ●Seismometer Project ●The Telescope Pt2

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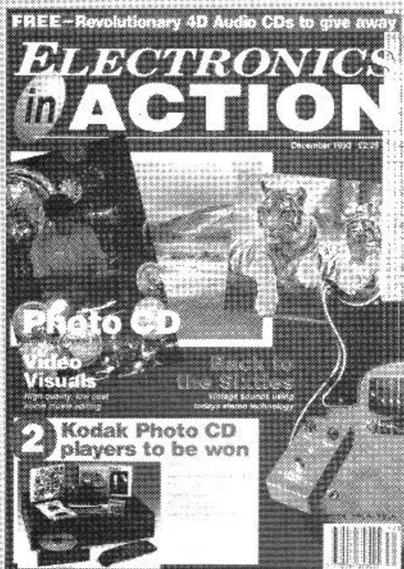

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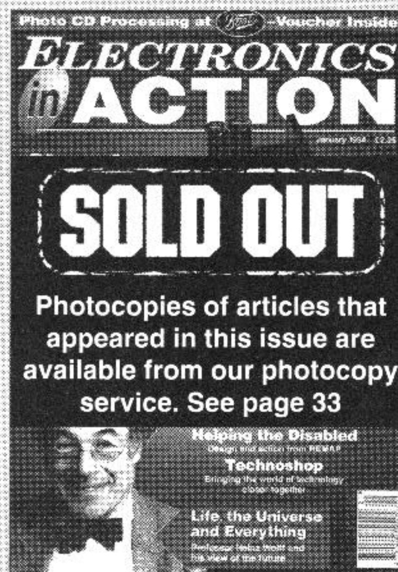

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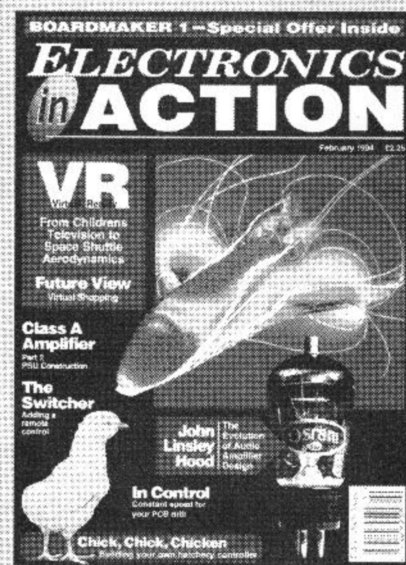
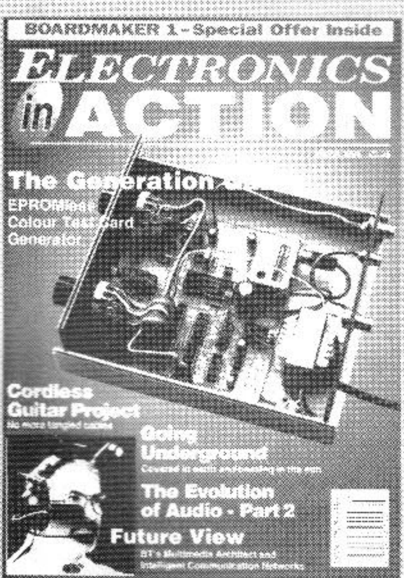


February 94 ●Virtual Reality ●Class A amp Pt2 ●Hatchery Controller ●The Switcher Pt4



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The Evolution of Audio Amplifier Design Part 3

In this part, John Linsley Hood introduces transistor 'Hi-Fi' and the great quasi-complementary swindle.

In the last part of this article I looked at the designs used in early attempts to design audio amplifiers based on transistors. The need at that time was to use inter-stage coupling transformers but this made it difficult to apply enough overall negative feedback to increase the bandwidth and reduce the harmonic distortion to levels which would be acceptable in a hi-fi system.

A solution to this difficulty was proposed in 1956 by H. C. Lin, an ingenious electronics engineer from the USA. His answer was to use a high gain, small signal amplifier stage to provide the necessary voltage gain, and then to reduce its output impedance to a low enough level to drive a loudspeaker load by the use of a push-pull pair of output emitter followers, as I have shown in Figure 1.

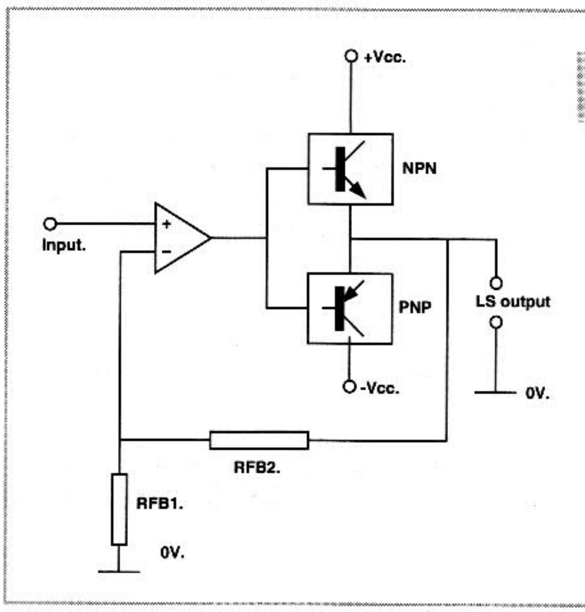


Fig.1 Lin circuit schematic

At the time of the Lin circuit, the only transistors available in any quantity, at sensible prices, were Germanium diffused junction types, made on what was virtually a one-off basis, and their use led to a lot of snags. To start with, since the transistors were made by a one at a time process, they would probably vary considerably from one to another, and any circuit using them would need individual setting up on test, a procedure which might need to be repeated from time to time during use.

Also, the amount of power which could be dissipated in the output transistors was pretty limited, and some form of temperature compensation, usually a thermistor, would need to be included in the circuit to avoid the possibility of 'thermal run-away' in the output transistors at high room temperatures, or if the amplifier got a bit over warm in use.

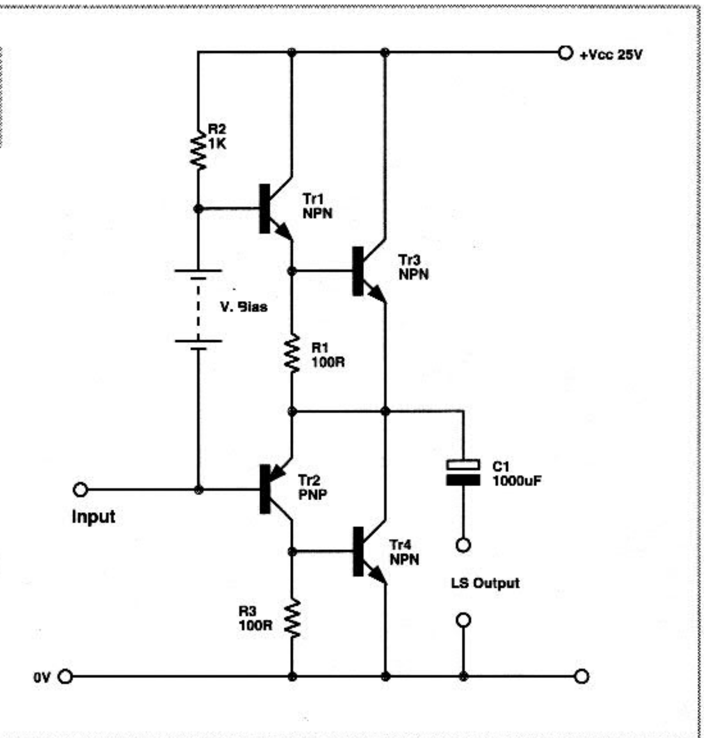
Clearly, this did not yet amount to a system which could be sold as a reliable design to the hi-fi buying public, although Lin had proposed an output emitter-follower circuit arrangement, based on the use of one PNP/PNP and one NPN/PNP output emitter follower layout, which would get around the difficulty that fully symmetrical (PNP/ NPN) power transistor types were not yet commercially available. (This layout is shown, in its +ve rail version, in Figure 2, and became known as the 'quasi-complementary' configuration.)

When, in the early to mid 1960s, good quality silicon power transistors became available, made by versions of the 'planar' process, audio design engineers began to put together power amplifiers, using high gain silicon planar transistors, with typical designs of the kind shown in Figure 3, based on the use of Lin-type 'quasi-complementary' output pairs, which appeared to meet the technical requirements for a marketable piece of audio hardware.

With designs of this type, 30 watt power amplifiers, with output harmonic distortion levels of less than 0.1% at full power, and bandwidths of 10Hz - 100KHz or greater, were easily obtainable, and their triumphant designers - and their employers advertising agencies - proudly, but prematurely, proclaimed the arrival of true transistor operated hi-fi.

The truth was, sadly, that these amplifiers really sounded quite nasty, in spite of their superb claimed specifications. This led to a regrettable loss of confidence, by a sizeable proportion of the buying market, in the engineers and all their doings.

Fig.2 Basic Lin output circuit



'Listener fatigue' and 'transistor sound'

Criticism of the sound quality of transistor amplifier designs started to appear, diffidently at first, but then more vociferously, and terms like 'transistor sound' and 'listener fatigue', were coined to describe the users objections. There were, in reality, quite a lot of problems with these new amplifier designs, and the process of remedying them took at least a decade, and some might say that the process is not yet finished. I have listed the more conspicuous of these `nasties', below, under their various headings.

1 'Crossover distortion'

In any push-pull output system, of the kind shown in Figure 1, there is always the possibility of distortion in the region of the input/output transfer characteristic, where one half of the output push-pull pair hands over to the other. The only certain way of avoiding this is to ensure that both halves of the output pair are working in a straight line part of their characteristics, at a current level which is adequate for them to handle the demands of the signal voltage swing.

This situation would always be the case for the push-pull output stages of valve amplifiers, but would never (or almost never) be true for transistor output systems. In fact, in many cases, the designers deliberately sought to avoid the problems of keeping the bias of the output transistors at the correct level, by setting it to zero, and then relying on the use of massive amounts of negative feedback (NFB) to try to straighten out the residual kinks in the curve... an attempt which was doomed to failure.

This difficulty in push-pull output stages is made much worse by the nature of the 'quasi-complementary symmetry' type of layout shown in Figure 3, in that the transfer slopes of the two halves -the NPN/NPN half and the PNP/NPN half - are very different, as shown in Figure 4a, so even if the output devices are biased so that the two curves join, there will always be a conspicuous kink in overall output curve, as shown in Figure 4b.

This results in the amplifier distortion getting worse as the output power is reduced, so even if the total harmonic distortion (THD) is as low as, say, 0.05% at full output, it may well be 5-10% or more at typical quiet listening

Fig.3 Typical 1965-70 audio amp

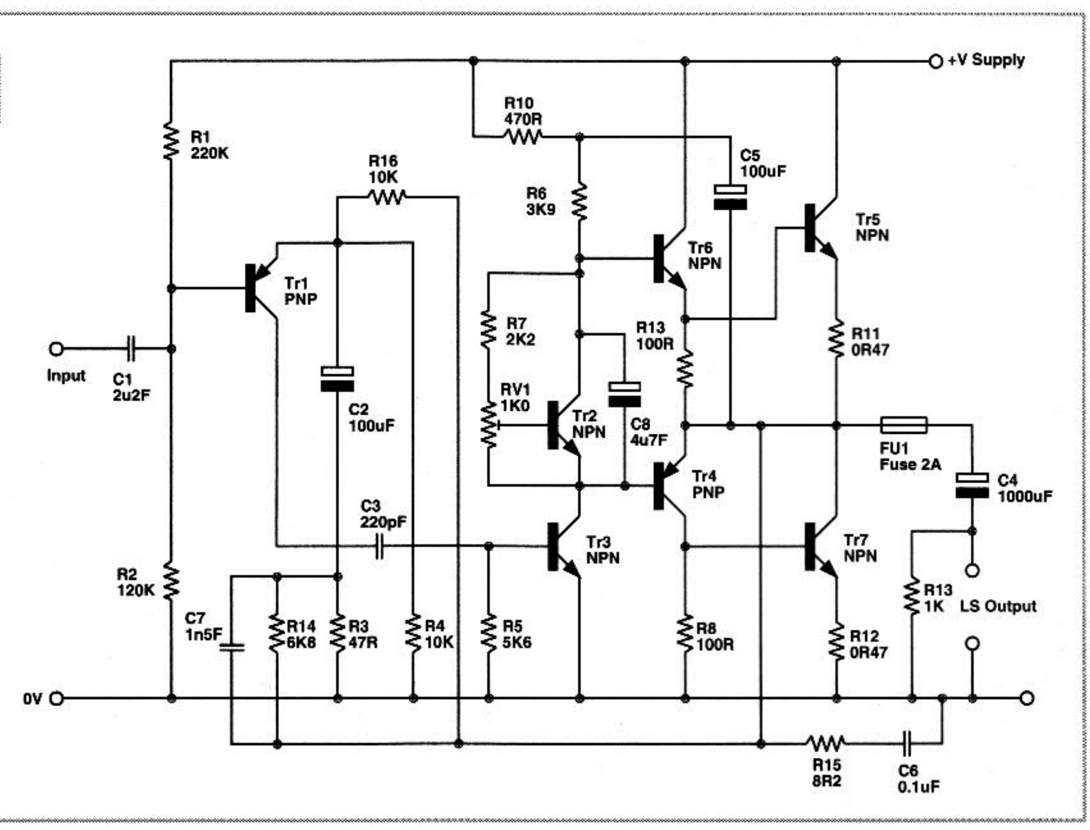
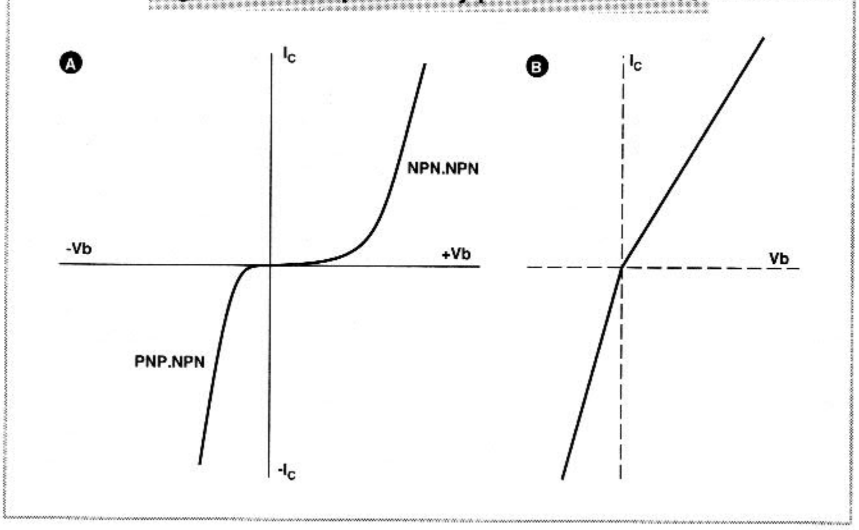


Fig.4 Quasi complementary pair characteristics



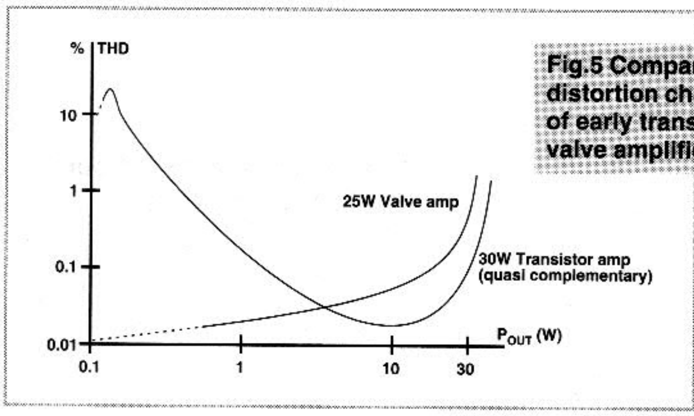


Fig.5 Comparative distortion characteristics of early transistor amp vs. valve amplifier

levels and what is worse, this distortion would be of the sonically unpleasant high-order odd-harmonic type. I have shown this effect in Figure 5, where I have contrasted the output power vs. THD of a typical 1960s transistor audio amplifier with that of a typical 1950s valve amplifier. No wonder the valve amplifier sounded better, but that wasn't the only reason.

2 'Transient intermodulation distortion'

In order to improve the performance of these new 'transformerless' transistor amplifiers, the designers used lots of overall NFB. Much more in fact, than would have been possible with their valve based predecessors, and this had the predictable effect that, left to itself, the whole circuit would oscillate at some high frequency, and measures were therefore needed to prevent this.

The almost invariable method for stabilising such a feedback amplifier, used at that time and since (!), is what is known as 'dominant lag' stabilisation, in which a capacitor, (C3), is typically connected between the collector and the base of the second stage amplifier transistor, (Tr3), as shown in Figure 3. If a sudden voltage transient appears at the input of the amplifier, as part of the input signal, the effect of the negative feedback loop applied to Tr2 base will be to cause Tr1 to be driven into cut-off until C3 is able to charge or discharge to its proper equilibrium level.

The transient paralysis of amplifiers using this type of feedback loop stabilisation was first publicised by Professor Otala, who called it 'Transient Intermodulation Distortion', or 'TID'. It can be avoided by the use of a different type of loop stabilisation, and minimised by an input C-R HF roll-off circuit in those instances where the designers either know or care enough to try to do something about it.

3 Poor stability margins

A further problem with the use of a lot of overall NFB is that it reduces what is known as the amplifier's 'stability margin', and this can cause the amplifier to suffer sudden bursts of oscillation - usually in the MHz region - at parts of the signal output voltage swing, particularly when the loudspeaker has an awkward load characteristic. Usually, amplifiers with good stability margins sound more 'restful' to listen to than those where NFB has been used to excess, and the resulting loop stability margin is inadequate.

It is usually possible to do a quick check on freedom from this type of fault, if one has access to a signal generator and an oscilloscope, by driving the amplifier into clipping, while it is operating into various

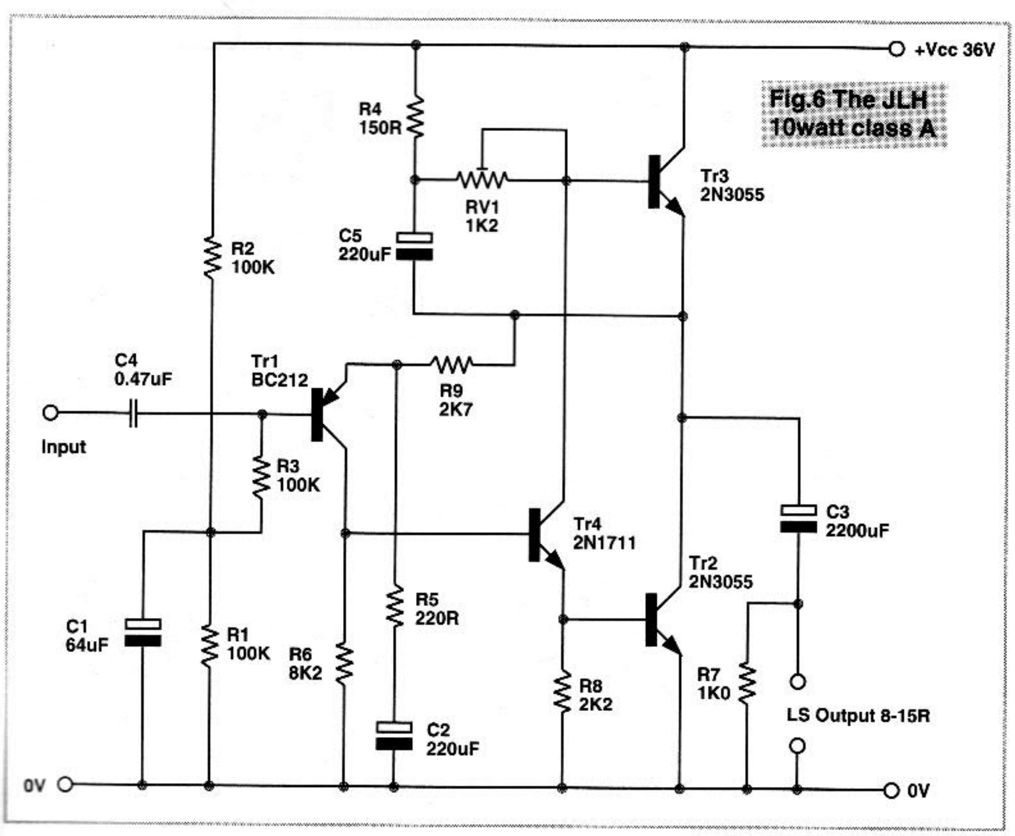


Fig.6 The JLH 10watt class A

types of dummy load. Usually a resistor of the 4-8 ohm range in parallel with a range of capacitors in the range 0.01µF - 2µF, will serve as a load. While one is doing this, one can also check for 'hang-up' following clipping - which usually indicates transient output transistor malfunction. All of these faults spoil the sound quality of the system, without necessarily being shown up in the THD figures.

Class 'A' operation.

Until the mid-1960s my domestic audio system consisted of a 'Williamson' power amplifier, driven by various transistor operated pre amplifier stages; the result of a recent JLH 'anti-hum' modernisation programme. This part of my system updating had been trouble free to put together, since it is easy to design small-signal amplifier stages without running into the raft of problems which beset the design of solid state power amps. However, this was still a 'mono' setup, and I wanted to take advantage of the new 'stereo' LP records which were replacing the older 'mono' discs. I also wanted, if possible, to avoid the need to build another large and expensive 'Williamson' power amp.

Since I had at home an adequately equipped electronics workshop, which I had set up in an upstairs box room, I put together four or five transistor operated

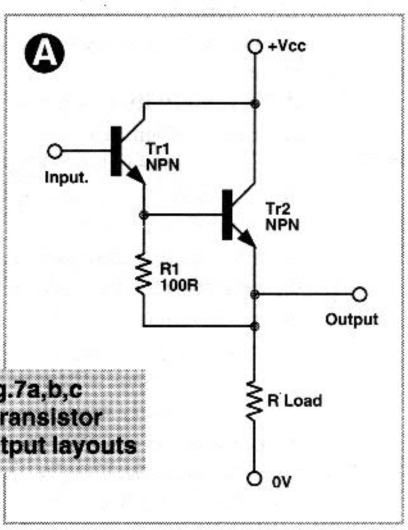
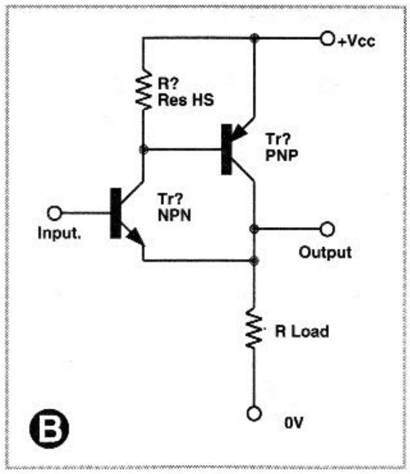


Fig.7a,b,c 2 transistor output layouts

audio power amplifiers; built to various published circuits, for which high performance was claimed; and I sat down to do a thorough listening trial comparing the performance of these with the Williamson. Well, that was my original intention. In reality, it took only a few seconds listening to each to conclude that none of these designs was in the same league in terms of sound quality, as my old valve amplifier. Since I had spent some time in constructing



these comparative transistor operated designs I felt exceedingly let-down by this whole exercise, and was at a loss to know what next to try.

However, some months previously, I had built a transistor operated class 'A' power amplifier, mainly as a technical exercise to see how simple such a circuit could be. This was very much a pin-board hook-up, but it worked and would deliver some 10 watts into a 15 ohm load. So, having been disappointed with the performance of the other transistor power amplifiers I had tried, I went to my junk box, retrieved my hook-up class 'A' circuit, and tried this out as well.

To my astonishment and pleasure, this sounded as good as the Williamson - perhaps, I thought, it was even just a little bit more transparent - and provided a simple answer to my wish to go stereo, since the circuit, which I have shown in Figure 6, was a very easy one to make. I therefore spent the next month or so in constructing a complete stereo system, with a tidy two-channel class 'A' power amplifier to fit in place of the 'Williamson'.

The 10W class 'A' amp.

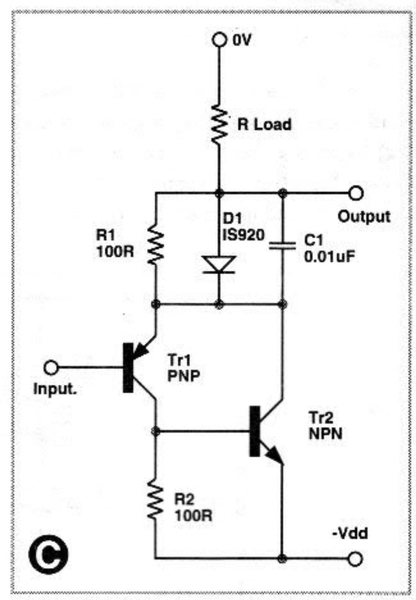
The basic advantage of this circuit design was that it was not a push-pull system, in the normal sense of the term. It could be thought of either as Tr3 acting as an output emitter follower, with Tr4 acting as an 'active' emitter load, or with Tr4 acting as an amplifier, using Tr3 as an 'active' collector load. Since it wasn't a push-pull system it couldn't suffer from crossover distortion, and since both output transistors (which were, conveniently, identical NPN types) were operating in a linear part of their characteristics, it didn't need much overall NFB to reduce the distortion to my target value of 0.05%, so it didn't need any TID introducing stabilisation networks.

I was lucky to have avoided by accident, the various problems that I didn't even know existed at that time, and after a couple of years of use, offered the circuit design to one of our more prestigious technical journals, where it was published. As a design, it worked well, and didn't need adjustments after initial setting up, but I was a bit unhappy about the need to pre-set the operating currents of the output transistors, and, since it wasn't a push-pull system, it was wasteful of current, and ran fairly hot.

One of my fellow designers, at the time, reproached me, in print, for 'sweeping the design problems of class 'B' (low quiescent current) amplifiers under the carpet, rather than attempting to solve them'. This was perfectly true, but the required solutions for push-pull operation were quite some time in coming, and even then were not complete.

Improved low quiescent current push-pull amplifier designs.

It is taken for granted these days, unless you happen to be a 'hot glass' buff, that the domestic hi-fi set up will run cool,



so that it can sit unobtrusively, in a shelf on ones equipment rack. The basis for this expectation was the increasing availability during the 1970s, of better power transistors, and the use of improved output transistor circuit layouts, using either PNP-PNP/NPN-NPN complementary arrangements, as shown in Figure 7a and 7b, or improved 'quasi-complementary' circuits of the kind shown in Figure 7c, which I used in a popular DIY 75 watt amplifier. A version of this output layout was also used commercially, at a later date, in a

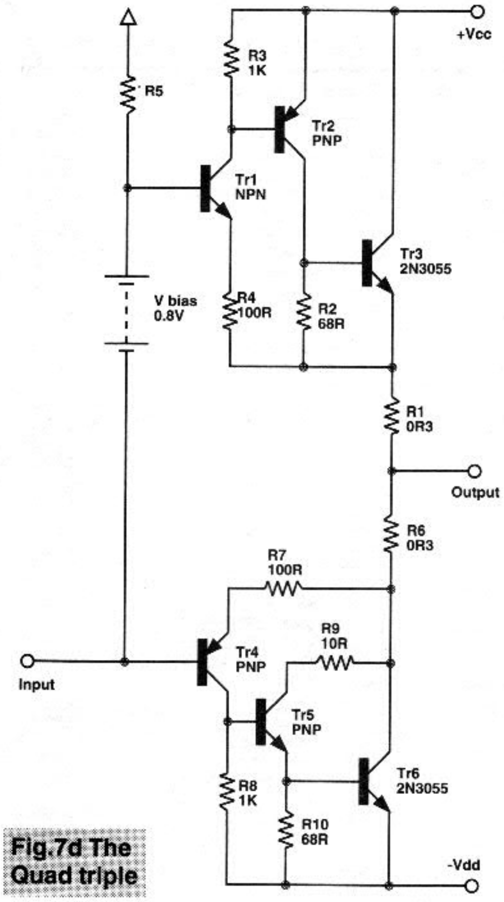


Fig.7d The Quad triple

very successful 'audiophile' power amplifier design.

'Quad' used an alternative three transistor output stage layout in their 'Quad 303' power amplifier, shown in Figure 7d, a power amplifier which has proved very successful in commercial practice, though modern practice mostly favours one or other of the fully complementary circuit layouts shown in Figure 7a or 7b.

In general, the majority of the better commercial solid-state hi-fi systems now are quite satisfactory in terms of listening quality, but there were still a few snags which needed ironing out, and, since 'specmanship' is now the name of the hi-fi advertisers game, much design effort has been expended on getting more '0's behind the decimal point in the THD specification. EIA

NEXT MONTH

John Linsley-Hood probes into:
The so-called 'better' specifications

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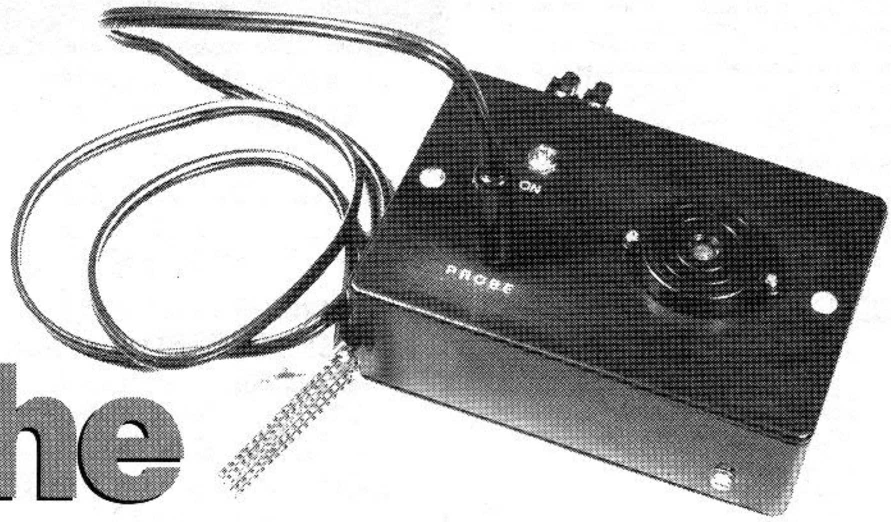
A de-ionised water level detector by Edward Barrow



At the waters edge

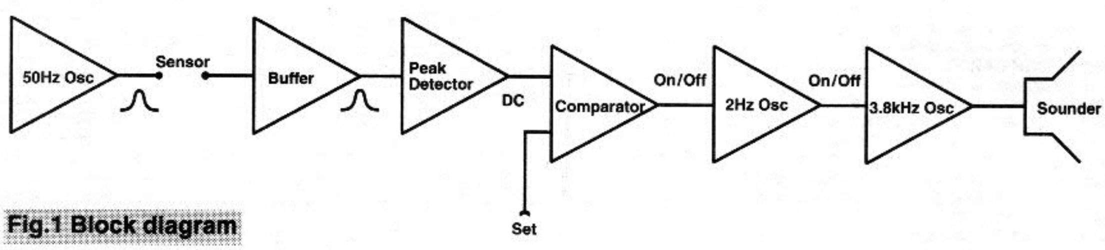


Fig.1 Block diagram

This project started its life over dinner with my potential father-in-law who is a chemist. Being an absent minded chemist in the classical vane he was having problems when his 'water de-ioniser' overflowed due to lack of attention. So he asked me if I could come up with a potential solution to his problem, modern form of 'dowry' I suppose. This I felt obligated to do not for the sake of his daughter's hand but rather because he was footing the bill!

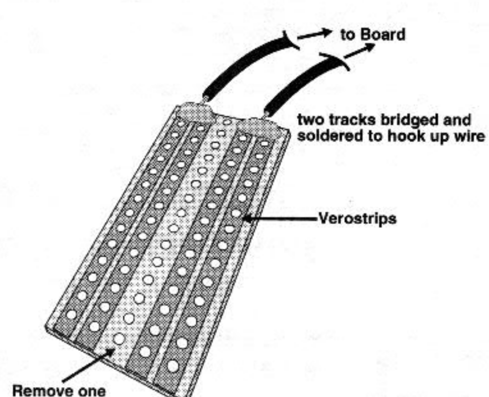


Fig.2 Simple sensor

To understand the working of this circuit it is best to glance at the block diagram in Figure 1. As this project was designed for use with de-ionised water certain problems had to be overcome, the main one being its high resistance. This arises because the process of de-ionising by its nature involves the removal of the very charged particles which are responsible for its conducting properties. A second problem is that the currents passing through the solution must not create new ions and thus re-ionise the water.

This latter problem can be remedied by using an AC current to sense as it produces no resulting current. The high resistance of the water is countered by using a high input impedance buffer on the returning signal. This minimises the current drawn by the sensor through the liquid. On the other hand however using AC as your medium does mean that the resulting detector is prone to mains 50Hz pick-up. This problem is made worse by the high impedance used in sensing. So some pull down impedance is needed. Another unexpected problem can be caused by pick up from across the two wires that are used to connect the circuit to the sensors. This I found out when I used screened wire for connecting the sensor to the board. Unfortunately this has a capacitance of about 320pF per meter and so relays the signal from output to input even when there is no liquid to act as a conductor. This is especially true for the edges of a nice clean square wave, as it contains higher harmonics. It does not need a fertile imagination to see that this will play havoc with any AC detection system further on. To counter these tendencies the sharp edges (the higher harmonics) are firstly removed by lowpass filtering. Also to calm down the input impedance with respect to AC some capacitance has been included, this helps mitigate the effects of stray capacitance and mains pick-up.

Detection of the AC signal is done by means of an active peak detection system. This is basically built around a diode which feeds a capacitor (memory). Here the diode only conducts when the input signal is higher than the previous one, so

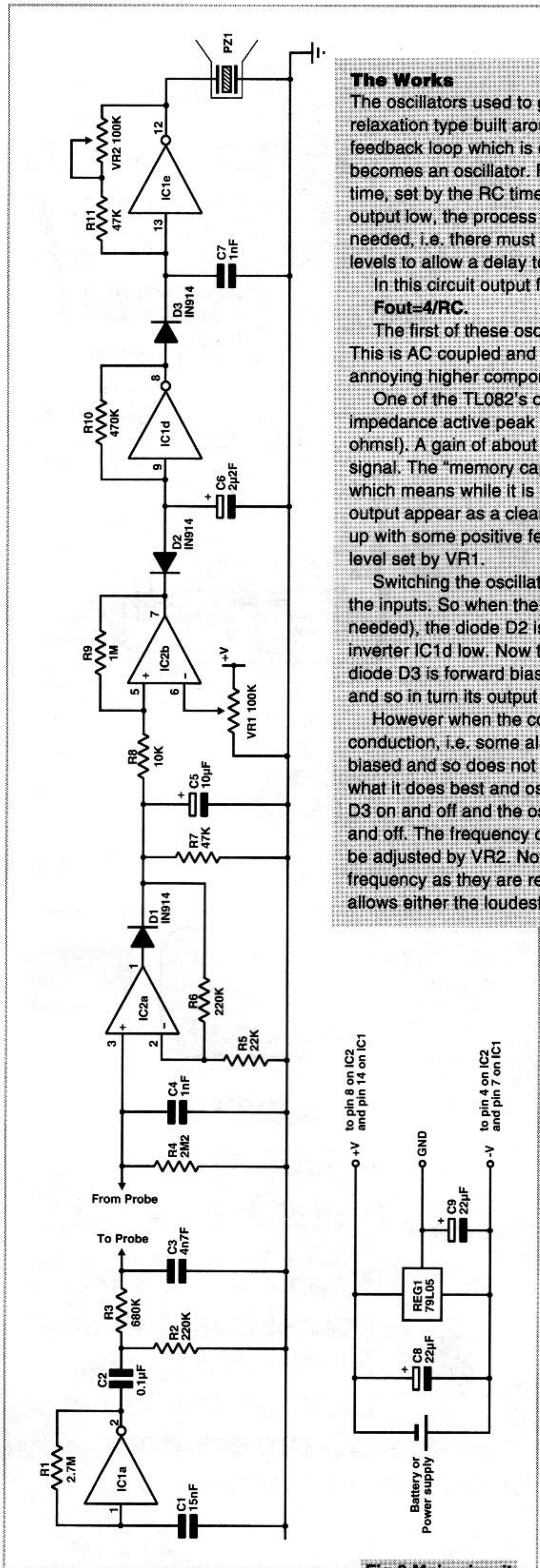


Fig.3 Main circuit

The Works

The oscillators used to generate all signals in this circuit are of a simple relaxation type built around a Schmitt trigger inverter. Wired up in a feedback loop which is delayed by a simple RC network, an inverter becomes an oscillator. For example, say its output is high, after a fixed time, set by the RC time constant, the input goes high thus forcing the output low, the process is repeated on and on... Some hysteresis is needed, i.e. there must be some differential between the switching levels to allow a delay to be manufactured.

In this circuit output frequency is given by;

Fout=4/RC.

The first of these oscillators generates the reference signal of 60Hz. This is AC coupled and filtered at 60Hz by a simple RC filter to remove annoying higher components.

One of the TL082's op-amps are used to build a high input impedance active peak rectifier (its input resistance being 1 trillion ohms!). A gain of about 10 is given to restore what can be a weak signal. The "memory capacitor" is set with a time constant of about 5s, which means while it is set quickly, it only resets slowly, thus making its output appear as a clean DC source. The comparator has been wired up with some positive feedback to ensure clean switching about the level set by VR1.

Switching the oscillators on and off is done by using diodes to gate the inputs. So when the comparator is in the off state (i.e.; no alarm needed), the diode D2 is forward biased thus forcing the input of the inverter IC1d low. Now this means its output is now high, similarly the diode D3 is forward biased and so holds the input of inverter IC1e high, and so in turn its output low.

However when the comparator is triggered by some form of conduction, i.e. some alarm is needed, the diode D2 is now reverse biased and so does not conduct. Thus the oscillator (IC1d) is free to do what it does best and oscillate. This output alternately turns the diode D3 on and off and the oscillator (ICle). Thus the audible tone turns on and off. The frequency of the tone is set in the 3800Hz range and can be adjusted by VR2. Note that piezo sounders do have an optimum frequency as they are really low frequency crystal oscillators. So VR2 allows either the loudest or the most annoying tone, or both, to be set.

the highest one is retained by a capacitor which acts as a memory. If the input is less than the previous one then the diode does not conduct and the value across the capacitor remains the same. A resistor to ground is used to reset the capacitor. The prefix "active" only implies that an op-amp is used to cure the problems caused by the 0.7 volt diode drop.

A comparator is used to compare this DC output with that of a set voltage, and its output is used to trigger the sounding part of the circuit. So when the AC signal rises above a certain set level the alarm sounds.

The noise in this circuit is generated by using 2 oscillators feeding into each other. The first generates a 2Hz square wave and this is used to turn on and off a second oscillator which oscillates at 3800Hz. The latter feeds the piezo sounder.

Construction

This circuit can be powered by a PP3 9V battery or an equivalent DC source. A 79L05 has been used to generate a ground line roughly at the midpoint. A negative regulator was used as it sinks current better than a positive one which is an important criterion for insuring stability. A piece of veroboard was used to make the sensor (see Figure.2). I removed the central track to make it more immune to dirt forming a bridge and the problem of surface tension causing a film of water to stick over the tracks even after the level of the water has receded. Some silicone repellent can also be smeared between the tracks as an added protection against this.

Separate the copper tracks where required firstly. Then solder in the link wires, diodes and resistors. After this the IC sockets, capacitors, presets and the regulator. Make sure the capacitor polarities are the right way round. Also be sure to tie the unused CMOS inputs to ground to prevent problems. ICs can then be plugged in and the circuit tested.

Testing and Setting up

The oscillators can be tested easily with a 'scope and the 2Hz one with a meter. To test the peak detector short out the sensor and observe its output which should go from low to high. By the way the alarm should also sound at the same time. If not check the polarity of the diodes are correct.

Only two presets need to be adjusted. The first VR1 adjusts the triggering level of the alarm so it is quite easy to set. Place the sensor in the liquid in question and set it so the alarm just sounds, then turn it a little further to be sure of consistent operation. Remove the sensor, dry if necessary, and the alarm should go off. The second preset has been explained before and adjusts the alarm frequency.

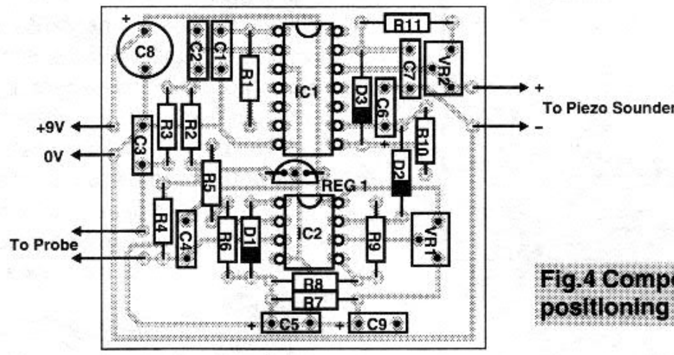


Fig.4 Component positioning

Parts

Resistors

R1	2M7
R2,6	220K
R3	680K
R4	2M2
R5	22K
R7,11	47K
R8	10K
R9	1M
R10	470K
VR1,2	100K

Capacitors

C1	15nF
C2	100nF poly
C3	4n7F poly
C4,7	1nF poly
C5	10µF tant 16V
C6	2µ2F tant 16V
C8,9	22µF tant 16V

Semiconductors

IC1	40106 hex Schmitt trigger inverter
IC2	TL082 dual FET input op-amp
D1-3	1N914
REG1	79L05

Additional Components

PZ1 Piezo sounder
PCB (see page 57)
9V battery
case

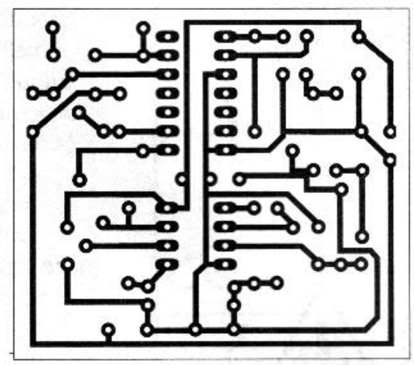


Fig.5 Foil pattern

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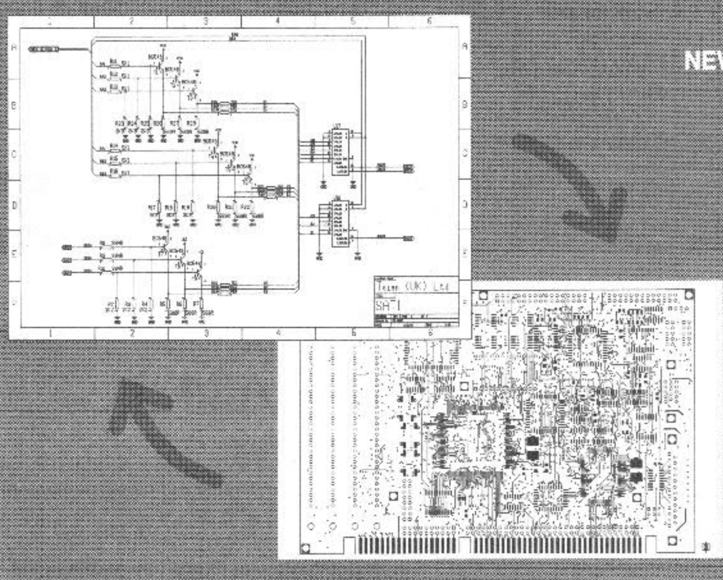

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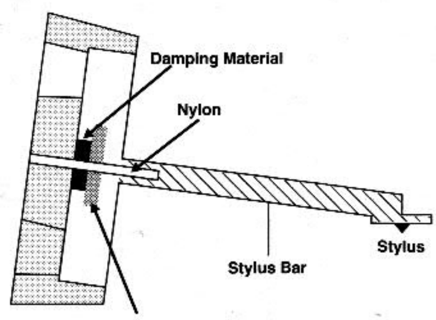
The Alchemist Moving Coil Head Amp

Fig.1 Stylus mounting with damping control



Mike Meechan gets to grips with another pre-amp design for the hi-fi enthusiast.

Part 1

The cartridge.

Readers *au fait* with the Audiophile RIAA project of the first issue of EIA (October 1993) are probably wondering why I omitted a moving coil stage from said preamp. There are two reasons. Firstly, I'm a firm believer in the *minimalist* approach to engineering. Being a Scot, money - and the saving thereof - is a subject very dear to my heart. It follows that any project that I'm involved in is engineered with cost uppermost in mind -this isn't to say that I abandon all performance considerations because they depend, ultimately, on cost. Rather, I'll look for ways to achieve a certain level of performance in a given field, whilst keeping the bank manager happy about my approach to the more fiscal aspects of everyday life. It could be summed up in one rather naff, advertising copywriters phrase - performance for peanuts...Furthermore, I chose not to include a front end stage suitable for moving coil cartridge preamplification because it would have cost more and would - I then thought - have minimal appeal. Readers of magazines such as this are susceptible to the same pressures and temptations as everybody else. To use the vernacular, "Where am I coming from?" Read on.

We've already mentioned the major technological upheaval that the sound recording industry has undergone in the few years since the birth of digital optical storage and retrieval systems for audio. Despite all of the excellent attributes of CD, and there are indeed many, analogue recordings using vinyl discs and mechanical recording/ retrieving systems have been around for over one hundred years, and much of the music of famous composers, orchestras, bands, and the sounds of historical events have only been captured in the intricate excursions of the analogue record groove. The format persists in the countless millions of discs hoarded in audiophile archives, music libraries and radio stations, as well as in the homes of personal devotees.

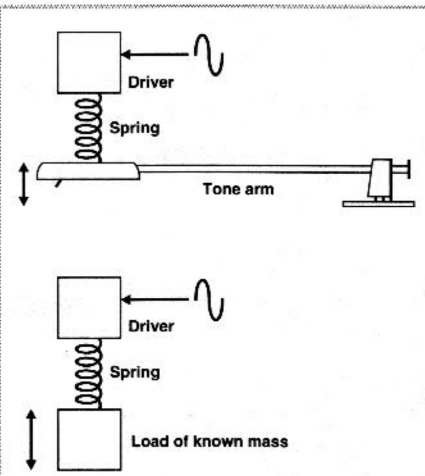


Fig.2 Method of measuring dynamic mass of Tonearm Tonearm (or cartridge vertical) resonant frequency is found by playing a special test record, with signals at specific frequencies, and recording the frequency at which the cartridge output is highest. Dynamic mass of the tonearm is calculated by suspending the complete arm/cartridge assembly from a spring (connected just above the stylus pivot), and connecting this spring to a loudspeaker-type driving force. The spring is then excited vertically at various frequencies, and the resonant frequency of the assembly noted. Next, the tonearm is freed from the spring, and precisely-valued weights attached in its place. Dynamic mass of the tonearm equates to the mass of attached weights at which the resonant frequency is the same. Once both mass and frequency are known, compliance can be readily calculated.

The contents of such discs can never totally be re-recorded using modern-day digital techniques, so it remains of vital importance that the art of preserving, restoring and reproducing such material remains both in the present, and in years to come. Aficionados of the format must remain optimistic that the apparatus necessary to continue doing so remains for the foreseeable future, and beyond.

One of the unassailable attractions of the CD format must be that it is great for the AVERAGE listener. It's robust, the discs themselves will tolerate SOME abuse, there are no pops or clicks, and cuing up and playing a disc requires absolutely no manual dexterity whatsoever. So damaged tonearms and styli become a thing of the past...

But vinyl, too, has its strengths. Some audiophiles claim that they prefer vinyl discs to CD for one reason and one reason only - they can hear the difference. It's a very controversial subject - scientists versus subjectivists - and blind A/B listening tests have been used in an effort to prove or disprove the claim. Whatever your beliefs on the subject, it is regarded as fact that the harmonics of certain instruments - piano and violin, for instance - extend into frequencies above the accepted ceiling of the human beings ears - ie 20kHz. Proponents of analogue claim, therefore, that it is something of a backward step to stop frequencies above a certain threshold when it's taken over a hundred years for analogue technology to advance sufficiently to be able to reproduce them. It is for this reason, that the low sampling frequency of the format means that the reproduction of CD can be perceived as unnatural because all sounds above a 20kHz maximum are filtered out.

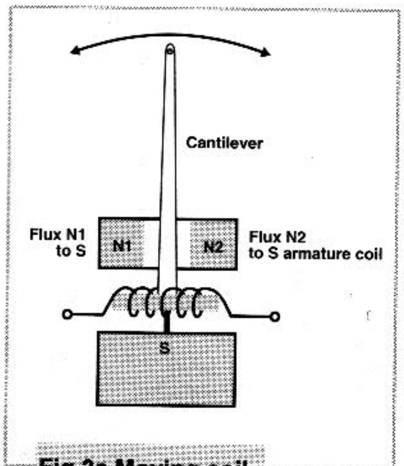


Fig.3a Moving coil cartridge

Rebellion of the Record Lover

Because of these problems, inherent at present to some compact disc reproduction systems, there are a certain number of Luddite listeners, for want of a better phrase, who still happen to like and believe in vinyl. Put another way, these miscreants think it better that CD coexist happily with the old and quaint format known as vinyl. Not for us (yes, I count myself among them) the vast vinyl sell-off (or SELL-OUT). We believe, that it is much better to improve the component parts of the analogue system, and continue using it as a viable high fidelity alternative (or complement) to CD.

Articles in the main are either pro-vinyl and anti-CD, or unequivocally vice-versa. It is the purpose of this article to extol the virtues of vinyl and perhaps broaden the minds of some of our readers who are, perhaps, CD junkies through and through. A new generation of engineers and technologists appears every ten years or so. Perhaps some of you out there belong to this youthful fraternity and it hasn't occurred to you to give vinyl a fair crack of the whip. I hope that I can, change your minds, but if this isn't the case, at least raise some awareness of what is presently a very topical subject.

Unfortunately the tide has now turned sufficiently that I face a somewhat uphill struggle.

It remains a sad fact of life that Compact Disc has all but displaced vinyl from the shelves of the retail outlets, and sales of CD and cassette, despite the bizarre pricing anomaly, far outstrip those of the vinyl format. The classical labels - Nimbus initially, followed closely by Deutsche Grammophon - were the first to announce that future recordings would be available only on CD or cassette, and back catalogue on vinyl would be available only until stocks were exhausted. More recently, this is happening with all new releases, and the only way to track down prized and treasured old vinyl is via the second-hand shop or the collectors fayres.

It is to these misguided, well-meaning miscreants of the audiophile world that this project is dedicated - if you look very closely, you'll see that my tongue is very firmly in my cheek...However, before presenting the project, it is worthwhile to look at the labour of love that is the low-noise designer's realisation of a high performance, moving-coil preamp. As a slight, but pertinent aside, the project was named The Alchemist because there seems to have been so much myth and folklore associated with the magic that is low noise design, a discipline that seems, for many audio engineering students, to a have its roots more in black art than science. It is the purpose therefore, of the preliminary part of this paper to dispel some of these myths before presenting the reality in the form of a tangible audio project.

Firstly, we must look at what is involved in getting audio information, in a mechanical form, onto and ultimately from the disc in question.

A Short History

Around the 1870's, Thomas Edison used a cylindrical phonograph and aluminium foil to reproduce sound. The "flat disc recording", as it was called, didn't appear until 1887, and it is Emil Berliner who is accredited as being the inventor of a format which has persisted until the present day. Even the most fervent proponents would be hard-pushed not to admit that the reproduction of sound from a vinyl pressing approaches perfection. Nevertheless, where these limitations are appreciated, the attraction of the vinyl disc format, and the scope for improvement, can be seen (or heard).

From Needle to Loudspeaker

The creation of the recording itself, the design of the apparatus required to extract this information (the cartridge), and finally, getting the information off the disc are the cause of many problems which must be surmounted if the system is to be successful and the resulting sound acceptable.

As far as electromagnetic transducers, the one found at the end of a tonearm has a much harder life than most of its family. In addition to converting the groove modulations of the record into an electrical signal, it must also support the tonearm.

The transducer can be called any one of a number of names - phono pickup, phono cartridge, or needle. The method by which the cartridge converts energy determines the classification under which it falls. Under the piezoelectric classification comes the inexpensive, low-fi and utterly avoidable crystal and ceramic types. Moving magnet (MM), moving coil (MC), and induced magnet (moving iron), on the other hand, are known as electrodynamic-type cartridges. These types use the principle that when a magnetic field intersects a wound coil, an electric current will be generated. While moving magnet cartridges have a magnet attached to the stylus tube or cantilever, and the coils are stationary, moving coil types work on the opposite principle, with the magnet fixed and the coils moving. (The moving iron type uses a magnet and coil which are fixed, and a slug of soft magnetic iron which moves instead of the magnet, and is magnetised by it). Happily, technology has advanced sufficiently that the various materials which might one day have found their way into the stylus assembly - cactus needles, whale bones, all kinds of metals, gemstones, plastics and wood, to name but a few - have all been superseded!

Because of the interaction of magnet and coil in these types of cartridges, any amplifier sees a decidedly non-linear source impedance at its input. With reference to Faraday's law of induction, induced voltage is proportional to the relative velocity of both the magnet and coil parts of the assembly.

The design of the cartridge must ensure that a linear relationship exists between the position of the stylus cantilever assembly and the magnetic flux (since the signal voltage generated at any instant in time is proportional to rate of change of flux with respect to time). Rate of change of stylus position with respect to time will thus be proportional to the signal voltage. However, the groove shape is proportional to the integral of the signal waveform, so the groove excursions - the waveform imprinted in the vinyl - are not directly proportional to the signal voltage.

This means that the signal voltage is proportional to the velocity of the stylus, and the signal SLOPE is proportional to the ACCELERATION of the stylus. Consequently, the cartridge cantilever assembly and associated suspension, and the magnet/coil system, must form a resonant mass-spring system if high signal slopes are to be reproduced with any degree of fidelity.

The Appliance of Science

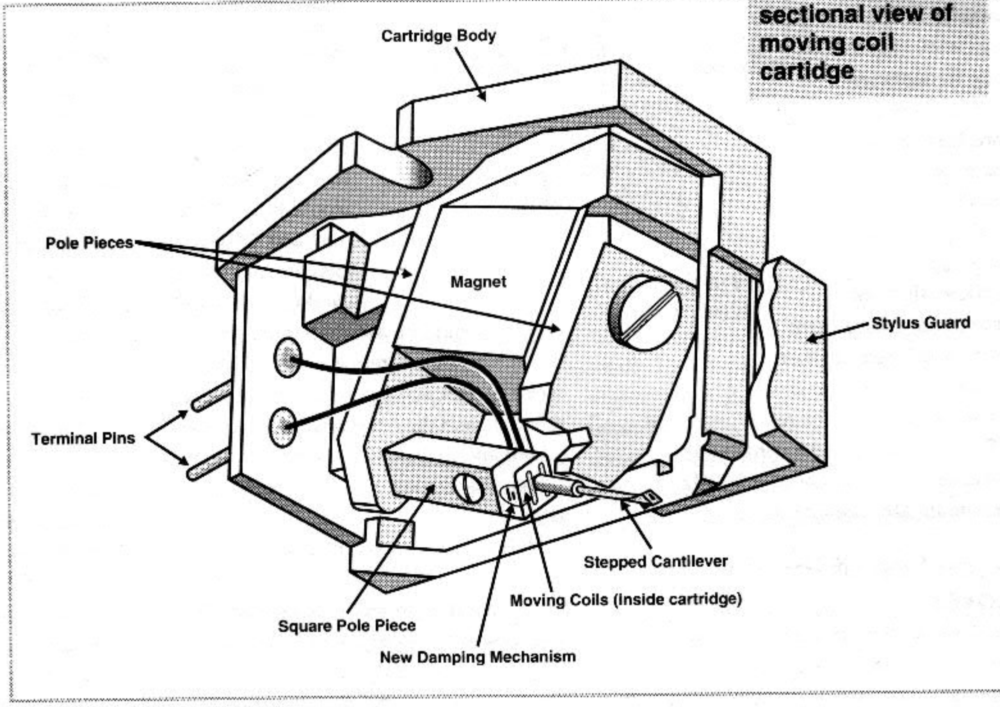
"Springiness" and mass determine the amount of force required to move the stylus. Using the damped mass-spring model of a magnetic cartridge, we can predict that the resonant frequency will depend upon the "springiness" of the cantilever's suspension, and on the mass of the stylus cantilever assembly. "Springiness" is given the symbol k, the spring constant, and is represented numerically. K is defined in terms of the force needed to bring about a certain compression or extension of the spring, so stiffer springs have a higher k value. Spring constants are almost unusably low numbers, so the reciprocal of the spring constant - 1/k - is quoted in preference by cartridge manufacturers. This reciprocal is called compliance. Compliance of the cantilever or stylus is the ability of the assembly to react to groove modulation, and it is measured (statically or dynamically) in cm/dyn or µm/mN, with a lower compliance figure equating to a stiffer suspension system. Dynamic compliance gives us the means to calculate the resonant frequency of the tonearm/cartridge assembly, and so measure the effective mass of the tonearm. Compliance is calculated as follows;

Where:
c is the compliance in cm/dyne
f is the frequency in Hertz
M is the tonearm mass in grams

At resonance, there is no longer a linear relationship between the impedance of the cartridge and the driving force on the stylus. This non-linearity results in distortion of the waveform. However, shifting the resonant frequency to a point in the spectrum which is below the lower audible limit helps to overcome this. This can be achieved either by increasing the mass or the value of the compliance (since the cartridge resonant frequency is a function both of mass, and of the compliance of the cantilever and suspension system). Lowering of the mass is the more desirable method, since the stylus is then able to respond better (more quickly) to the changes in the record groove. Compliance is thus altered until a resonant frequency which is suitable - typically below 10Hz - is then achieved. The most desirable range is between 8 and 12Hz since resonance below 8Hz will produce instability of the tonearm, and will result in poor tracking of any records with warps.

It is also possible to alter resonant frequency by lowering the Q of the system. This is done by introducing mechanical or electrical losses into the system. The most widely-used method is to introduce friction into the cantilever suspension assembly using rubber mounting blocks. Desired mechanical damping is achieved, whilst the absorption of energy (into the load resistance of the cartridge preamplifier), lowers the electrical Q of the system. See Figure 1. It would be correct to say that the reproduction of sound from a vinyl disc owes as much to complex mechanics as it does to electronics.

Fig.3b Cross sectional view of moving coil cartidge



Moving Coil Cartridges

This type were among the first to be used and employ one heavy magnet, and the cantilever assembly, (which cannot be replaced by the user). The MC cartridge is insensitive both to input load impedance, (typically in the order of 5 to 100 ohms), and to capacitive loading, so that long cables can be driven without detriment to the frequency response. Regrettably, the low impedance which creates these benefits also means low output - typically some 20-30dB below that of the moving magnet type, when referenced to an established sensitivity of 1mV/cm/s). Very careful amplification of the cartridge output signal is thus required if noise performance isn't to be unduly compromised. A further downpoint of the MC type is that tracking forces are much heavier, although sound quality from the moving coil cartridge can be very good, with distortion figures typically lower than the moving magnet type. The very fast response to transients in any musical passage (as a result of the very low impedance and inductance of the coils (much less than the 0.3 - 1H of the MM type), and a very rigid and strong cantilever (necessary to support a heavy magnet assembly) gives a flatter and more extended frequency response. Furthermore, better channel separation (some 30-40dB compared to the 20-30dB of the fixed coil type) is achieved because the stylus assembly and the coil system are in much closer proximity.

All of the above means that construction of the coil assembly is particularly critical. Flaws in this area which can lead to problems include numbers of unsupported turns, which can set up vibrations in the assembly, and generate random output at HF, and improperly-secured lead-in and lead-out wires, which can vibrate in the magnetic field, and cause colouration of the output signal. In spite of this, the moving coil, because of the extended frequency response, and excellent transient characteristics, has traditionally been favoured over other types by the true audiophile fraternity. See Figure 3.

Moving Magnet Cartridges

This type of cartridge appeared much later than the MC, originating in Europe in the late fifties. Its durability and low relative cost when compared to the MC cartridge (no separate head amp required) have helped it to become the most popular example of the phono cartridge. It has high compliance, low dynamic tip mass, and the large number of turns in the coil assembly provide a reasonably high output voltage capability. Although the basic principle hasn't changed much since its first appearance, it has been refined to such an extent over the years that modern-day cartridges in the vanguard of the moving magnet type can produce outputs well above the audible frequency ceiling (typically 50kHz in some examples). However, the rising inductive component of the cartridge impedance, which has a typical resistive component of 200R-1k, means that the output level MUST diminish (or disappear) at frequencies higher than this. The unique electromagnetic characteristics of the moving magnet cartridge mean that any input stage intended for use with it must have well-defined impedance at all frequencies, (and despite the worst excesses of the cartridge), if performance is not to be compromised. See Figure 4.

Variable Reluctance (Induced Magnet)

Although their physical construction differs, performance characteristics of these are almost identical to those of the moving magnet cartridge. A small armature, in the shape of a cross, swings between four pole pins and coils, whilst a stylus bar, which has the stylus at one end, is secured to the armature at the other. 45° of motion to one side cause reverse voltage induction. This allows push-pull operation of the coils, and thus reduces harmonic distortion caused by non-linearities in the magnetic field. The coils also provide hum bucking (rejection) with crosstalk components bucked out, so channel separation is good, regardless of frequency. See Figure 5.

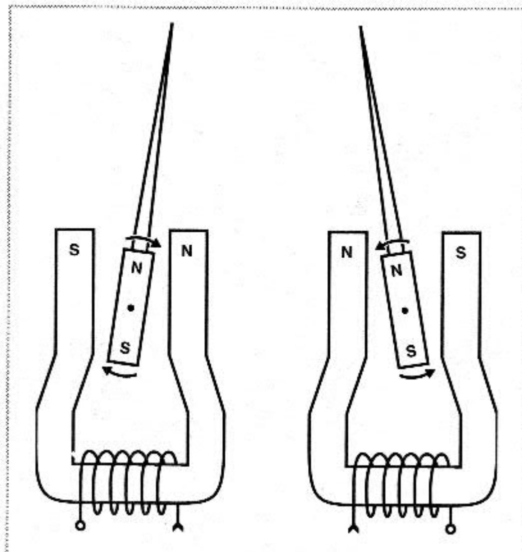
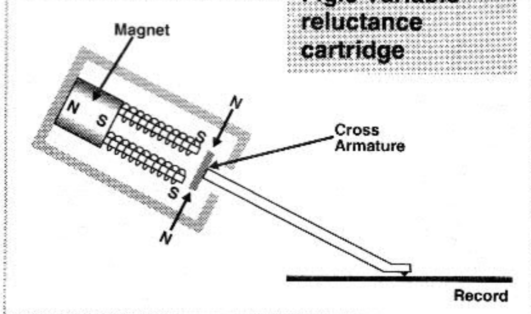


Fig.4 The moving magnet cartridge

Other Types

The other types of cartridges in existence (but which we won't discuss in detail) are the semiconductor cartridge and the piezoelectric (crystal or ceramic) type. The latter type belong to group known as constant amplitude (or pressure sensitive) cartridges, since they give an output which is proportional to the force applied to the stylus, and so produce an output voltage which is independent of frequency (no equalisation is therefore required).

Fig.5 Variable reluctance cartridge

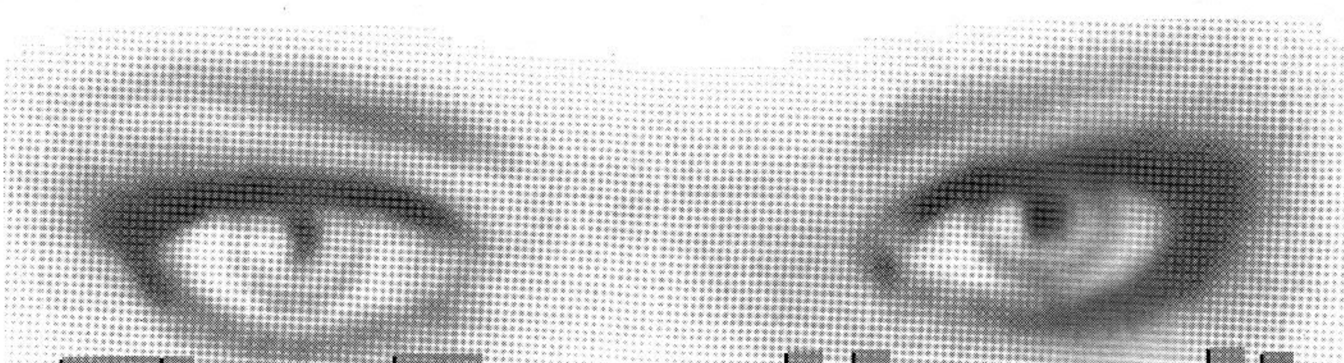


Electrical Loading

Electrical loading of the cartridge, at the amplifier input, is of paramount importance if overall frequency response isn't to be needlessly impaired. It's a pointless exercise - and very wasteful of design time and resources - to have an amplifier fitted with an RIAA equalisation network which is accurate to 0.1dB across the audio spectrum, but which is connected to a cartridge where has an incorrect value of shunt capacitance has been connected across it. Input capacitance, as specified by the cartridge manufacturer, is the TOTAL capacitance of all the conductors between the cartridge and the amplifier input. This includes cartridge connectors, tonearm wiring (both to ground and between conductors), connecting leads, preamplifier board layout, and shunt capacitance on the board. Incorrect values typically cause a peak or resonance in the circuit, somewhere between 7 and 8kHz, before the response rolls off prematurely in the upper HF part of the audible spectrum. Aside from the effect of electrical loading at high frequencies, the cartridge may also suffer because of the effective mass of the tip, since this effectively determines how close the coupling between stylus and groove wall is. Forces in effect during movement of this mass at high frequencies can actually deform the groove, which delays the acceleration of the stylus, and slurs high frequency sounds.

Next Month

We look closely at noise - what causes it, how we can reduce its effect upon our system, real semiconductor applications - before presenting The Alchemist project.

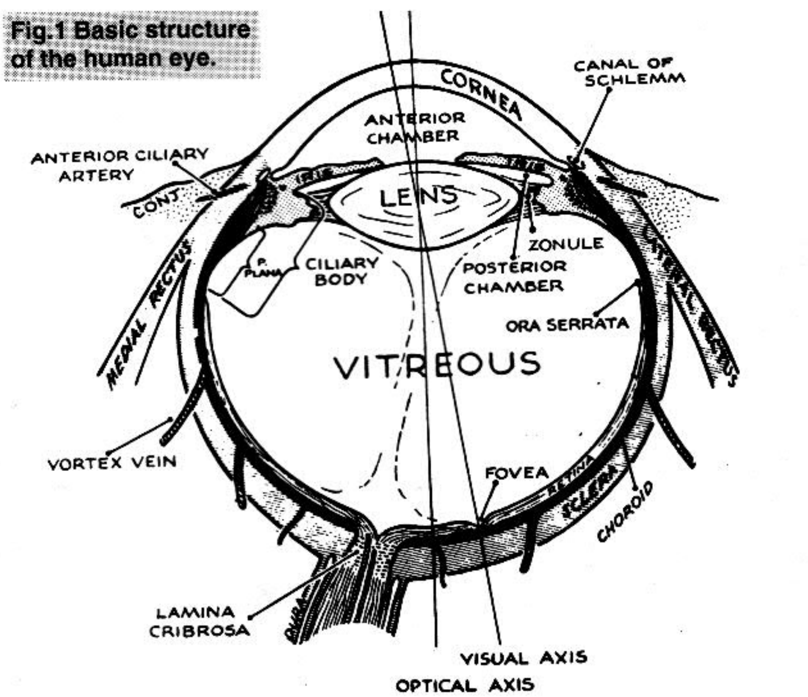


The Eyes Have It

Ophthalmic Excimer Lasers by Douglas Clarkson

From being a scientific curiosity, excimer lasers are now becoming increasingly utilised as a means of directly modifying the focusing characteristics of the human cornea in order to rectify basic vision defects such as short sightedness. A new range of 'third generation' machines are now providing higher levels of treatment accuracy and patient benefit.

Fig.1 Basic structure of the human eye.



All About the Eye

The focusing ability of the eye is described in diopters. This can be expressed in 1/f where f is the effective focal length of the eye. Often it is the excess or shortfall of the eye's focusing which is referenced e.g. a short-sighted eye will have around an excess of 5 Diopters and a far sighted eye a shortfall of 5 Diopters. There are several contributions to the overall focusing undertaken by the human eye. The front surface of the cornea has a significant focusing effect due to the change in refractive index (air-cornea surface). The lens which is situated behind the cornea in the anterior chamber has an additional element of focusing. The lens is attached around its periphery by fine ligaments which can be drawn tighter and relaxed by muscles in the ciliary muscle. This allows 'fine' focusing on objects at varying distances from the eye. The basic structure of the eye is indicated in Figure 1.

It is quite common for the eye to develop so called short sightedness where the eye's optics tend to focus light too strongly. The net result is that the plane of the focused image is presented in front of the retina and the image on the retina is blurred.

Fig.4 Placido image which is projected onto the eye in order to determine relative focusing ability across the cornea.

Standard remedies to date have included the wearing of spectacles and contact lenses. Both these approaches bring benefits of correcting visual defects. About a quarter of all adults are myopic to some degree.

With age, the optical 'fitness' of the eye diminishes. The degree of accommodation provided by the ligaments attached to the lens can decrease as the lens becomes increasingly 'stiffer'. So called long-sightedness arises when the eye is not sufficiently strong to focus images on the retina. Instead images are brought to a focus beyond the retina.

The front surface of the cornea can develop asymmetry so that images cannot be focused on the plane of the retina. This is the condition known as astigmatism. Figure 2 shows the three basic types of eye conditions which result in blurred images being formed at the cornea.

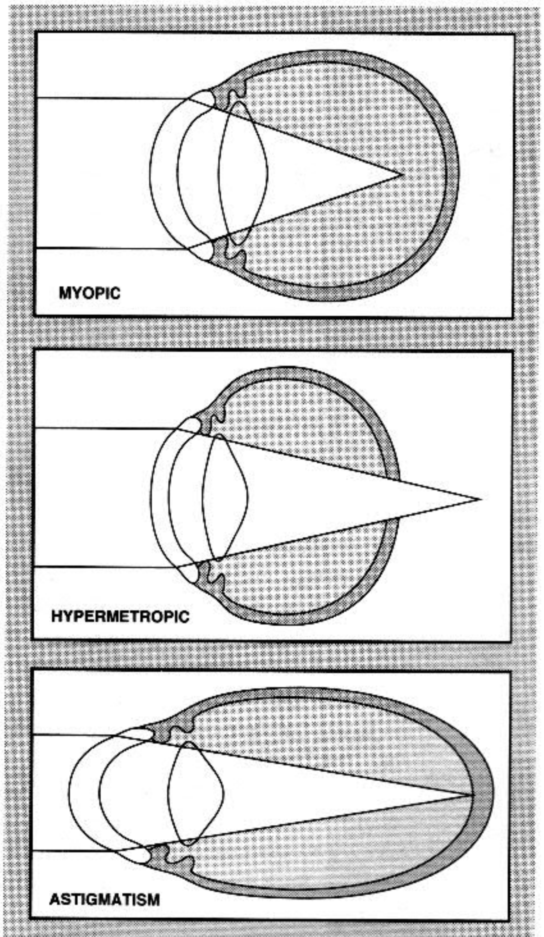


Fig.2 Basic types of eye conditions which result in blurred vision

Surgical Alteration of the Cornea

During the 1980s various methods were investigated for direct surgical intervention in order to rectify some of these defects. In the radial keratotomy procedure, a series of between four and eight spoke-like incisions are made in the cornea in order to decrease its curvature and move the focal plane of images backwards. This procedure is primarily a treatment for myopia. In a trial of over 757 eyes treated in this way in the USA and completed in 1991 it was found that the procedure was more successful in older patients than younger ones and that the procedure could more readily rectify low to medium degrees of myopia - corresponding to corrections of between 1.5 to 5 diopters. The trial found that while the technique led to improvements in 'natural' focusing ability planned changes in focusing ability could not always be achieved.

Ophthalmic Use of Excimer Lasers

During the mid 1980s interest focused on the use of lasers for direct change of the optical properties of the cornea. Excimer lasers can selectively remove cell layers from the core of the cornea - between the outer and lower layer. Once this technique called photorefractive keratectomy had been demonstrated, the technology was developed for precise control sculpting of the cornea. Photorefractive keratectomy (or PK) was fundamentally different from the previous surgical technique of radial keratotomy. While the surgical technique relied on wound healing to pull the cornea flatter, the laser method, by skimming off layers from the cornea does not weaken the structural integrity of the eye.

To date PK has been mainly used for the treatment of short sightedness and various types of astigmatism.

Basic Ophthalmic Use of Excimer Lasers

Excimer lasers used for this technique operate typically at a wavelength of 193nm - in the band of UVC radiation. Energy is delivered in a series of ultra short pulses of duration between 10 and 20 nanoseconds with maximum pulse energies typically of 0.5J. The energy density required to ablate the corneal tissue is around 120 milli-joules/cm^2.

The laser energy removes a finite thin layer of cornea tissue and is typically about 0.25 micron per pulse. The interaction time is so short that there is insufficient time for heat energy to build up in the treated tissues. Prior to treatment, the thickness of the cornea is accurately measured in order to retain an adequate thickness.

While this gives a general outline, there is considerable sophistication in cornea sculpturing techniques. It is possible, to alter the size of the treatment beam by an iris like device. This method, allows a varying thickness to be removed from the cornea in order to achieve required cornea profiles. If this method was adopted then the cornea would present a staircase profile as shown in Figure 3. This is prevented by the use of an oscillating mirror to move specific pulses over a variable area so there are no abrupt gradations.

Small plumes of smoke produced by the laser energy are visible when the cornea is being sculpted. Typically the laser will have forced air ventilation to prevent smoke contamination of laser optic elements. It is of course vital that the eye does not move during the PK procedure. An assembly can be secured to the eye under suction in order on immobilise it. Systems are also in use which incorporate 'eye tracking' where any motion of the eye is compensated for automatically.

The use of such lasers requires high accuracy. The cutting effect of the laser is after all proportional to the total delivered energy at the treatment site. Excimer lasers, however, may vary their output powers significantly during a single day of operation. This is the result of interaction of complex variables within the excimer laser system. Most systems will be calibrated before a patient undergoes treatment to ensure removal of a predetermined layer of cornea tissue. For this test a specially fabricated target consisting of metal foil bonded onto a plastic laminate is placed at the treatment zone of the excimer laser. A specific series of laser firings are undertaken with each one removing a very thin layer of metal film from the target surface. The system will measure the number of pulses required to remove the metal film and modify the energy of each pulse fired subsequently in order to meet calibration criteria.

In assessing of patients for excimer laser sculpting, it is essential to accurately determine the refractive properties of the eye prior to and after treatment. It is important to identify eye conditions for which PK would be

Fig.3 Staircase corneal profile which would be produced if oscillating mirror not used to 'blur' energy gradients over the cornea.

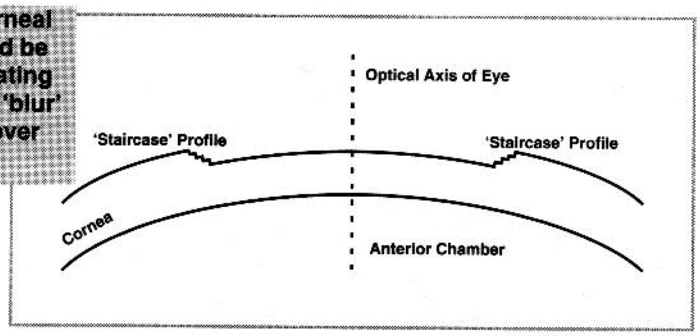
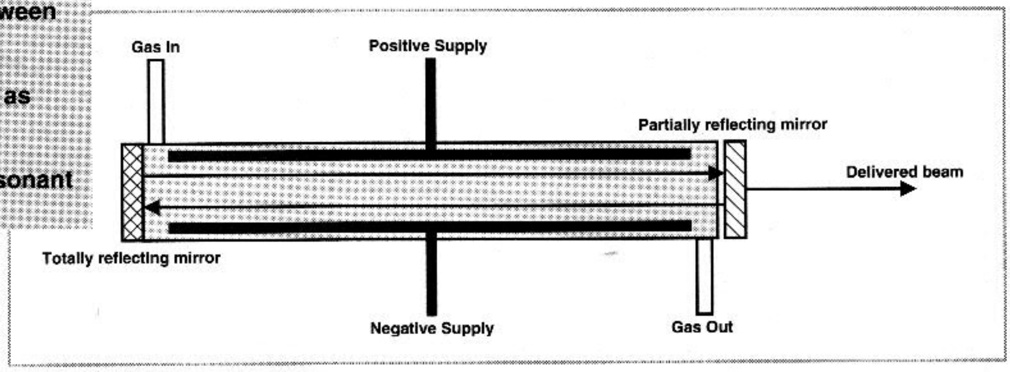


Fig.5 Basic laser resonator. The lasing medium is contained between two mirror resonators so that photons released by stimulated emission can build up intensity as they are reflected from the end mirrors. One mirror is partially reflecting so a portion of the resonant energy can 'escape'.



suitable. This can be rapidly undertaken using a corneal topography system. Figure 4 shows how a so called Placido image comprising 16 alternate black and white rings is projected onto the eye. Light which has passed through the eye's refractive path is then captured by a Charge Coupled Device camera comprising 6000 pixels and the image is processed by a computer to determine the relative focusing ability of the eye. Figure 5 shows the history of how the refractive properties of an eye changed with conventional radial keratotomy - where the cornea is incised with eight incisions. In this example the patient had 3D of myopia and was reduced to 0.25D.

The process of erosion of cornea thickness can usually be configured as a process of a cylindrical contour to correct for astigmatism and a circular cut to correct for myopia. It is now possible for the automated vision profile of an eye being treated to be passed from such a vision analysis unit directly to the computer in the PK system so that correction is 'tailored' for the patient.

There are also free hand modes available where the operator can move the excimer beam over areas where non standard modes of corneal tissue removal are indicated.

Part of the preoperative test is the measurement of the thickness of the cornea. This ensures an adequate tthickness of corneal tissue. Without removal of this outer cell layer, the PK procedure cannot go ahead.

It is possible also to monitor the degree of regression of the PK treatment. While in most cases there will be a minor degree of regression where the eye will lose some of its short sighted correction, it is possible for more serious regression to occur.

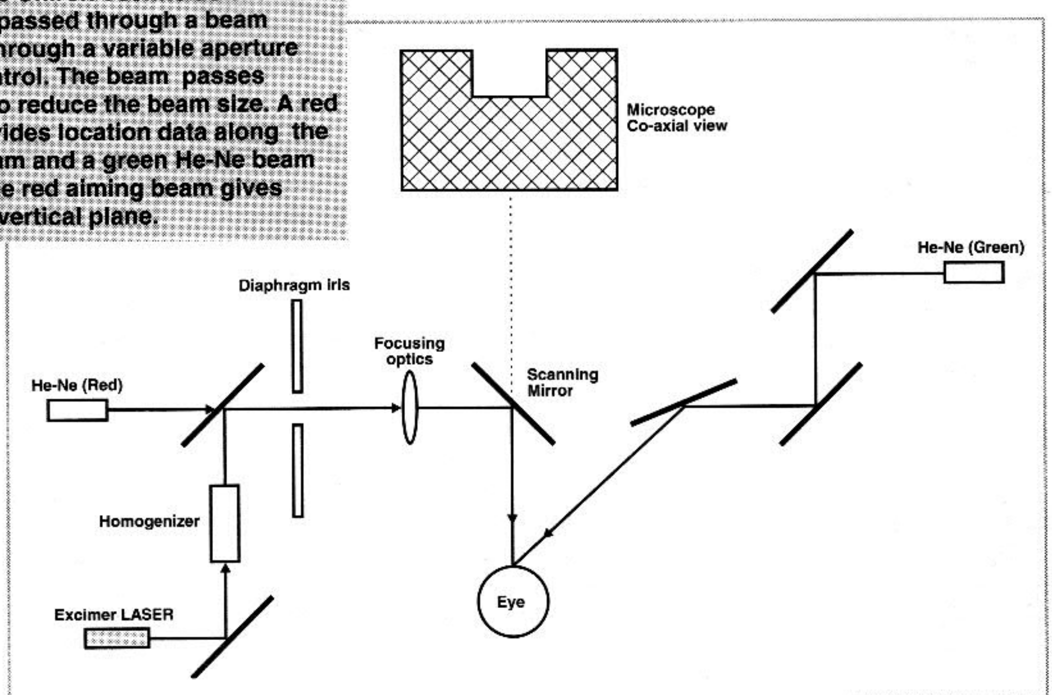
Figure 8 shows a relatively stable excimer PK procedure where there has been only a slight degree of regression.

Main Features of Excimer Lasers

Excimer lasers belong to a family of lasers which use chemical reactions of stable noble gases such as Xenon and Argon with unstable Halogen atoms such as Chlorine and Fluorine. Chemical reactions do not normally tend to take place in mixtures of such gases. It requires excitation of a high voltage discharge across the tube or electron beam or microwave excitation for short lived chemical compounds to be generated. The short lived compounds exist for short times in raised energy levels. The unstable bound compound can break down into the free components and in so doing release energy. The excited molecules exist only for a short time - at most 20ns.

When molecule population in excited states has been established it is necessary to establish an optical resonator within which light can be released by stimulated emission of radiation. Such a resonator is shown in Figure 5. If a 'dimer' releases by spontaneous emission, a photon of light in the direction along the axis of the resonator, then this photon can induce other excited dimers to release light by stimulated emission. Photons are released with similar energy, direction and phase. A pulse of light will sweep along the resonator and be reflected from the faces of the resonator. While for many resonators it is necessary to have high values of reflectivity, low values of around 5% can be adequate for excimer lasers. One face of the resonator

Fig.6 Key elements of the Chiron Technolas excimer laser. Laser radiation is passed through a beam homogeniser and then through a variable aperture unit under computer control. The beam passes through various optics to reduce the beam size. A red He-Ne aiming beam provides location data along the axis of the treatment beam and a green He-Ne beam when co-incident with the red aiming beam gives accurate location in the vertical plane.



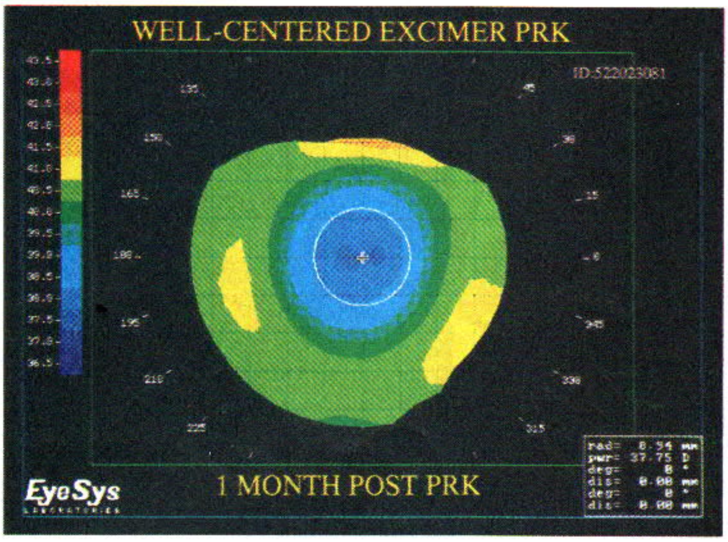


Fig.7 Indication of how the refractive properties of an eye which underwent conventional radial keratotomy can be monitored prior to treatment and after treatment. In this case the patient had 3D of myopia which was reduced to 0.25D.

will transmit laser radiation out of the resonant cavity and into the delivery optics. Argon Fluorine gas mixtures are typically used for excimer lasers used in ophthalmology.

The gas becomes slightly depleted after each gas change. A gas cylinder will typically contain 100 gas fillings of the resonant chamber. Gas in the chamber will slowly degrade, so that if the system has not been operated for 48 hours it is advisable to renew the gas in the resonant chamber.

Key safety features can be built into the excimer gas handling procedures. A filter system can for example remove the reactive halogen (fluorine of chlorine) from the charge of used gas. The stable noble gas such as Argon or Xenon is released to air.

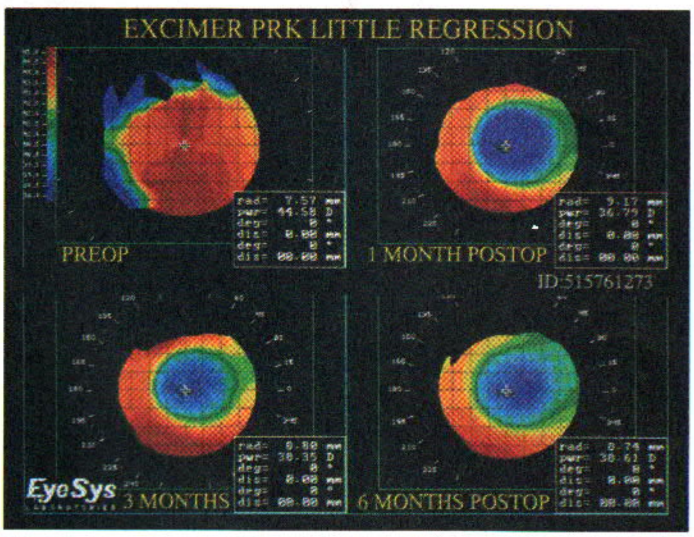


Fig.8 Example of excimer PK procedure with relatively little regression.

Figure 6 shows the key elements of a modern excimer laser such as the Chiron Technolas Keracor 116. Radiation emitted from the excimer laser is input into a homogeniser unit to produce a more even beam energy cross section. Radiation is then reflected into a variable aperture unit so that the cross section of the delivered beam can be controlled. The beam then passes into a series of focusing optics to reduce the treatment beam cross section. A scanning mirror in turn reflects the beam down onto the treatment site. This mirror can be rapidly moved in order to even out effects produced by different aperture widths and corresponding beam profiles.

A red He-Ne aiming beam (633nm wavelength) is established coaxial with the treatment beam so that the target area of the treatment beam can be identified. In addition it is important to identify the absolute height at which the excimer energy is to be delivered. This is undertaken by the use of a separate green He-Ne laser (543 nm wavelength) set at approximately 30 degrees to the vertical axis of the treatment beam.

Variable	Value
Maximum power at laser site	1W
Maximum pulse energy	450mJ
Wavelength	193nm
Pulse length	18ns
Repetition Rate (max)	30Hz
Fluence test pulse count	63 +/-5
Treatment energy density	120 milli Joules/cm^2
Ablation layer per pulse (cornea)	0.25 microns

Table 1: Typical output parameters of the Chiron Technolas Keracor 116 Excimer Laser. The conversion efficiency of the laser system is low - around 0.1%.

A 'ruggedised' PC is used as a control system for generating the laser energy and its delivery. Special precautions are required to prevent interference from the high voltage laser system affecting the PC.

Table 1 summarises the performance details of the Chiron Technolas Keracor 116 Excimer Laser. The energy density at the treatment site can vary between different manufacturers so that different thicknesses of cornea are removed with each treatment pulse.

Summary

Modern technology now makes possible the use of excimer lasers for the sculpting of the cornea to correct focusing defects which would normally be remedied with spectacles or contact lenses. There is no doubt that while the excimer technology may have advanced significantly in terms of levels of control of the corrective procedure, the technique will always require clinical skills of the highest level in order to ensure that only appropriate eyes are treated and that the treatment which is undertaken is expertly done.

Thus while contact lenses can be fitted in the high street by a qualified optician, at present the skill level required is that of a consultant ophthalmologist with broad experience of invasive ophthalmic procedures. This is both to check for abnormal eye pathology prior to treatment and to achieve a high level of skill in the delivery of the excimer laser energy.

Also, even the use of the more modern forms of contact lens has not been proved over sufficiently long periods of time to determine the relative safety of such devices. Problems encountered relate to infection, irritation and reduced oxygen levels in the cornea. So also PK and associated techniques will require a considerable time before a true perspective can be obtained on the relative safety and permanence of the treatment.

There is no doubt that the technological component of ophthalmic excimer systems is developing rapidly.

at the Channel Hop

If you have those, can't get enough of those, channel switching blues! Then Daniel Coggins has the low noise medicine

A guitar A-B box is used to select different channels on a (basic) guitar amplifier in order to provide different sounds or volume levels, or indeed two separate amplifiers or effects. I use it to switch channels on my old VOX AC30 - great sounding amps, but channel switching gives much more flexibility from these and other 'simple' amps. By simply treading on a footswitch, it is possible to make the guitar louder with a different tone in an instant, which guitarists find irresistible! This design was developed out of frustration and disappointment

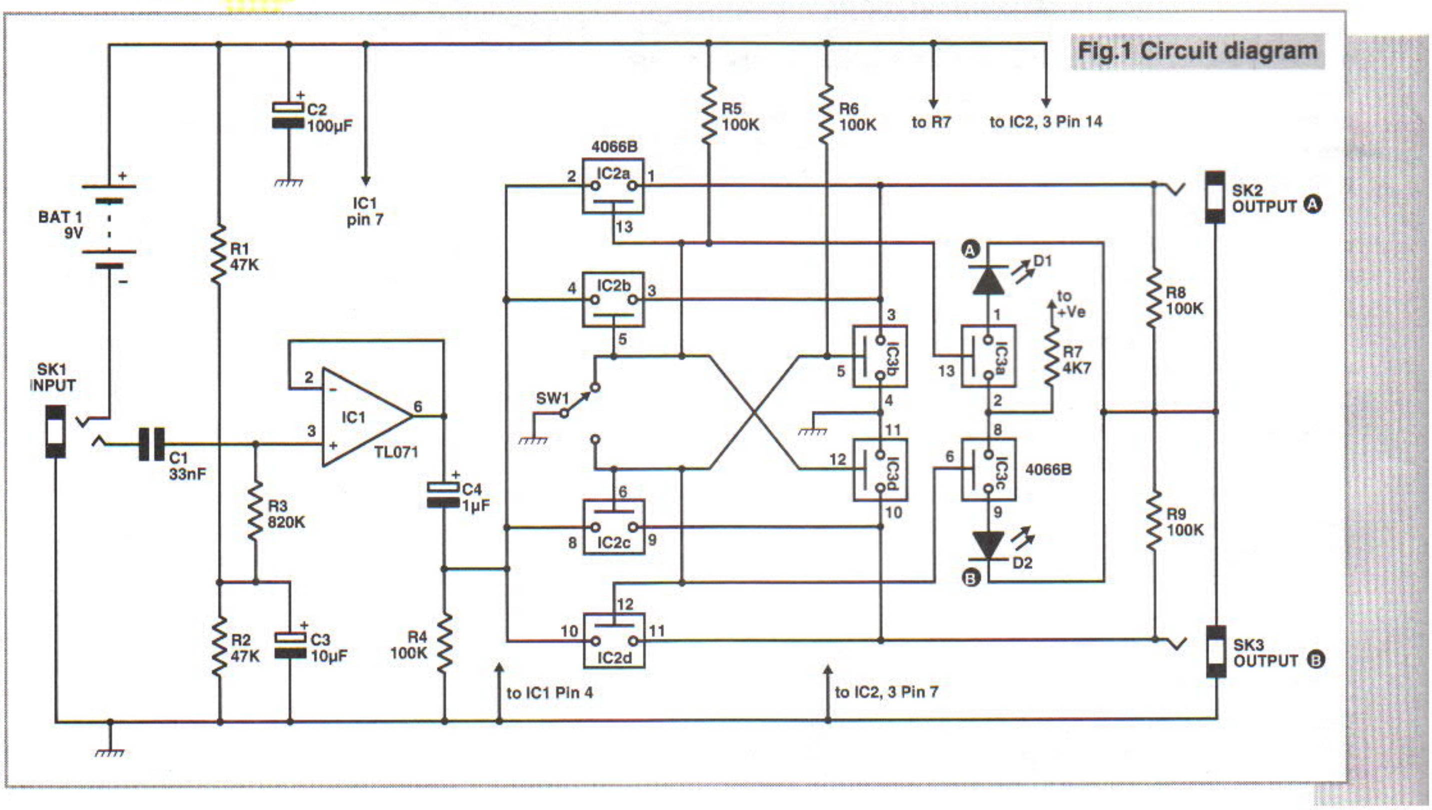


Fig.1 Circuit diagram

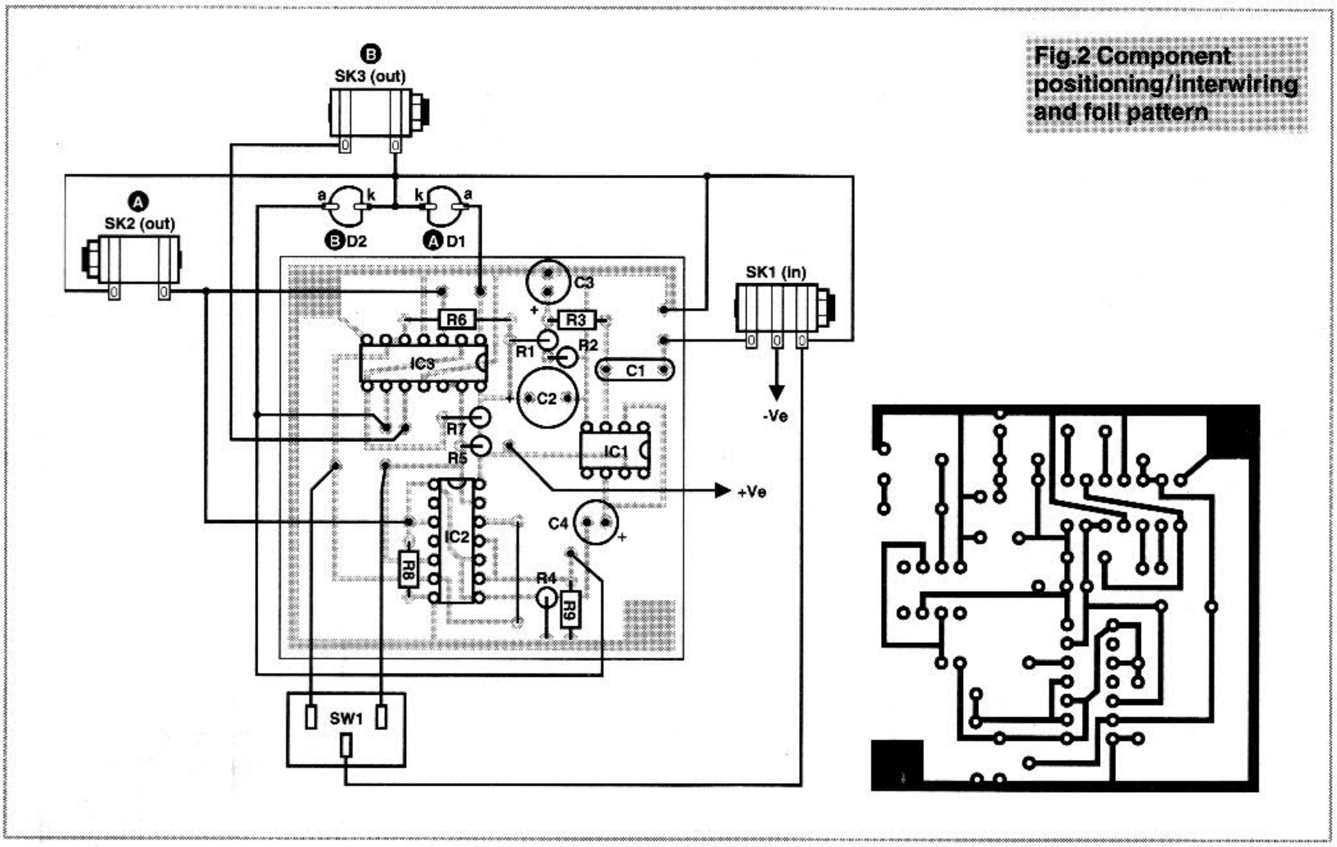


Fig.2 Component positioning/interwiring and foil pattern

with a commercially available A-B box. Why disappointment? Well, in order to explain, the circumstances need to be examined.

Electric guitars generally produce low output signals with a high impedance that have to travel through long cables to what is effectively quite a high gain amplifier, with a high input impedance. This is an inherently inefficient system, because cable capacitance causes significant treble loss, and even microphony (if it's really cheap). Also, hum pickup and RF breakthrough can result. But the problem that really emanates from the speaker is one of switching the signal on and off. Just unplugging a lead from an amplified guitar can result in hideous loud crackles - and a simple changeover switch will probably sound just as bad, especially as it wears.

This is normally heard as a loud, unpleasant crackle or thump and it could damage speakers, or at best result in extreme noise if followed by effects.

The unit I purchased overcame this by 'silencing' the signal as the changeover was made. This effectively masks the noise of the switch contacts, whose air gaps and resistance are made evident as noise. This method is very annoying in practice because the sound disappears

The Works

The circuit is quite simple; on plugging in a jack to the input socket, the battery is connected to the rest of the circuit (so unplug this when not in use) and supplies the IC's and LED's. C2 decouples any glitches from the supply rail which might be heard at the outputs due to DC fluctuations.

R1 and R2 form a potential divider, to produce a half-supply rail, necessary to accommodate IC1.

IC1 is a TL071 low noise JFET op amp, ideal for this application where it is used to buffer the input signal. It is configured as a non-inverting voltage-follower, and the half-supply rail decoupled by C3 is fed to it through R3. This sets the input impedance to 820K, which will suit all guitar pickups and incur no loss of treble. C1 couples the guitar signal to IC1. C4 decouples the buffered signal, with a charging path provided by R4, to prevent any thumps on switchover.

IC2 and IC3 are CMOS analogue switches. Their 'off' resistance is typically hundreds of megohms and with a 0-9V supply the 'on ' resistance is about 120 ohms. In this design, I used the two 'spare' gates (IC2b and IC2c) to halve the 'on' resistance to 60 ohms for lower loss. The switches are turned on by putting a 'high' level (i.e. greater than half-supply voltage) on the control pin, and turned off by connecting the control pin to a low level (0V).

R5 and R6 are 'pull-up' resistors which hold all the control pins at a 'high' level, in turn switching 'on' all the switches. However, the footswitch (SW1) grounds certain control pins to pass the signal to one of two outputs and to prevent the signal going to the other socket. For instance, if we were to consider SW1 in the position illustrated in Figure 1:

Switches IC2a and IC2b are both off, so the signal cannot pass to output 'A'. Also IC3a is 'off', so D1 will not light. IC3d is 'off', so the signal passing from C4 via IC2c and IC2d (both on - fed by R6) will reach output 'B'. This is indicated by D2, which is switched on by IC3c. Output 'A' is muted by IC3b. When SW1 is switched over, the opposite conditions exist, and the signal will emerge from output 'A'. Confused? Well, don't worry- it works, anyway.

R7's value was chosen to compromise between sufficient LED brightness and acceptable current consumption - approx. 3.7mA, which will give long life from a PP3 battery. R8 and R9 are used to prevent any excessive static charges from damaging the 4066's- should one of the output leads come into contact with some psychedelic guitarist's synthetic shirt or a Heavy Metal bassplayers spandex trousers...

completely for a second or so, and sounds to all the world like a bad tape drop-out.

Also, the offending unit had terrible hiss levels which meant that placing devices such as distortion pedals or compressors after it was out of the question. Why did I buy it in the first place, you ask? Good question, but I'm not naming the manufacturer!

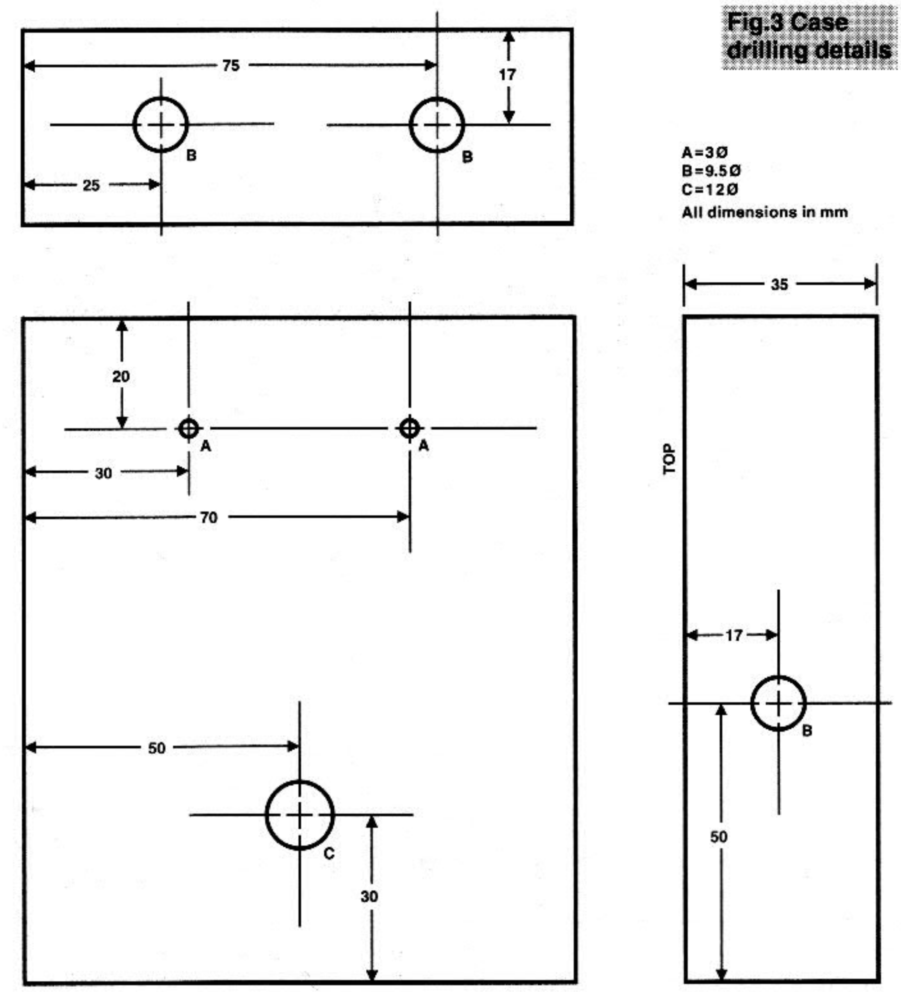


Fig.3 Case drilling details

Design Considerations

So I set about designing my own A-B box. The most important thing was for it to be musically transparent; in other words, low noise and with minimal impairment of the instruments' tone. Obviously a purely mechanical switch is simple but noisy and dodgy, even. The best method is to use a mechanical footswitch to control an electronic one. There are hi-fi grade electronic switch ICs around but they are not cheap, and are probably of too high a quality for this application.

I settled for an array of CMOS analogue bilateral switches which cost pence rather than pounds, and still give good performance.

Some careful thought went into wiring these up to minimise their minor drawback of producing a small audible 'pop' as they open and close.

One low-noise op-amp is used to buffer the signal, as this eradicates further significant signal degradation from further cabling, and from the switches themselves. CMOS switches give better audio performance at lower impedances.

All this is enclosed in a sturdy low-profile die-cast box.

The Signal Path

A signal from a musical source is fed into a buffer amplifier and subsequently directed to one of two outputs. This is achieved by controlling a series of electronic switches with a DC voltage selected by a mechanical footswitch. In either condition, the selected channel signal switch closes, along with a similar switch to power an LED. Simultaneously, an extra switch mutes the unselected output socket to prevent noise or crosstalk escaping through it. When the footswitch is pressed again, the other channel is selected in exactly the same way.

Construction Details

Referring to Figure 2, start with the PCB and solder in the resistors first, followed by the capacitors, making sure that you've put them in the correct way round. Take greater care with the ICs, especially the CMOS ones, that is to say, avoid charging yourself up before handling them, although 'B' suffix devices are supposedly quite robust with regard to static. If you want to be sensible, use some IC sockets - preferably the turned-pin variety, as they give a more reliable contact. Then if you are unlucky enough to destroy your chips (again, be sure to fit them correctly), it's a simple job to replace them. Be sure to fit the LED's with their correct polarity, for some reason I'm hopeless at identifying them.

Refer to Figure 3 for drilling details, making sure that all the parts fit their respective holes. The case will look more impressive if it is sprayed with some coloured car paint. Rub-down letters can then be used to label the LED's and sockets, and the unit given a name. Ever imaginative, I called mine 'A-B Switchbox'.

Fix the lettering with many coats of clear lacquer otherwise the finish will soon deteriorate, believe me. Fit the sockets and footswitch and solder some wires to them (colour coding is invaluable here), and loom them separately, so that the footswitch doesn't interfere by means of stray capacitance. Use screened cable between the input socket and the PCB to further counteract this. Join the screen only at one end to avoid earth loops.

The LEDs can be pushed into the 3mm holes and then secured with a small blob of epoxy resin. Foam rubber is very good for supporting and insulating the PCB and preventing the battery from knocking around inside the case. I use this rather than bolts, purely for cosmetic reasons.

Testing and use

Assuming that you have double-checked all your wiring and component orientation, the A-B BOX is ready for testing. Connect an ammeter (on mA range) between the case and the battery negative terminal. The reading should be no more than 3.7mA. If it differs greatly from this, then there is something wrong, so check things over again.

Assuming that you are luckier, and all reads well, plug your guitar/bass or keyboard into the input and press the footswitch several times to ensure that the LEDs are lighting and changing state. Select channel 'A' and connect your amplifier to output socket 'A'. The sound should emerge untainted from your amp.
Compare the sound here with that of your instrument going straight into the amp with a single, shorter lead - there should be little audible difference. Now press the footswitch - silence should result. Turn up the volume of your amp, and play some sounds - there should be no trace of it from the amp. Now turn the amp down and repeat the process for channel 'B'. If all is well, you can start to experiment with some applications of this gadget.

In Use

Being a low noise device, the box shouldn't be too critical as to where it is placed in the signal path. But, the nearer it is to the guitar, the better the signal quality will be, because the cables, no matter how good they are, will have less loading effect on the signal, resulting in a clearer, stronger sound. However no audio processing unit is totally noise free, so try to avoid connecting it before a compressor as they tend to accentuate even the smallest amounts of noise. Why not experiment?

A great advantage of an A-B box is the fact that by splitting the signal to one of two paths you can have multiple effects pedals set differently in each path for rhythm/lead sounds. For example, channel 'A' could be designated the rhythm channel, and have an overdrive pedal connected after it with a soft tone setting, to connect to one channel of your amp.

The lead channel 'B' could have a different distortion pedal with a more 'biting' tone, followed by a digital delay line for echo. The obvious beauty of this is to reduce the complex 'tap-dancing' routine that most gadget-bound guitarists suffer from - and with an LED indicator to boot!

An obvious application would be to connect one channel to a high-powered amplifier for loud, clean sounds with the other channel connected to a lower powered valve amplifier turned up almost 'flat-out' for distorted sounds.

Another use would be to connect one output to your amp and the other to an electronic tuner, so that in performance situations the sound of a half-tuned guitar is not heard by the audience. One word of caution, though - the CMOS IC's employed in this design will start to distort (in a valve-like fashion) if the driving signal is too high. This is only likely to occur at line levels, and is one of the reasons that it is best suited to guitars, whose signal is around 30dB below line level. It is up to you to decide how critical this would be for your application.

Food For Thought

As it stands this pedal is quite versatile, but with a little thought and application could be expanded or modified to perform many different applications, not necessarily involving guitars at all! Besides, this magazine is not a music magazine as such, but a vehicle for ideas, and I hope this article will not only be of use to the twangers, but of general technical interest.

Back to the possibilities - IC1 could introduce 6dB of gain by disconnecting pin 2 from pin 6 and connecting a 100K resistor in between, with another 100K resistor connected between pin 2 and the half-supply rail (C3 positive). The A-B Box will then substantially boost the signal. If it is too much then R8 and R9 can be replaced with 100K log pots, with the wipers connected to the output sockets, to adjust drive levels. A second op-amp, wired as a mixer/summing amplifier could combine both outputs as a single channel, resulting in a rather useful booster pedal. E/A

Parts

Resistors
all 1/4W 5% carbon

R1,2	47K
R3	820K
R4,5,6,8,9	100K
R7	4K7

Capacitors

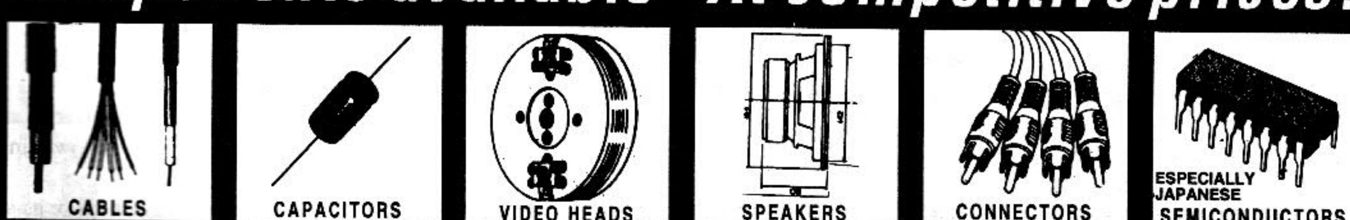
C1	33n Mylar
C2	100µ/16V radial electrolytic
C3	10µ/16V " "
C4	1µ/16V " "

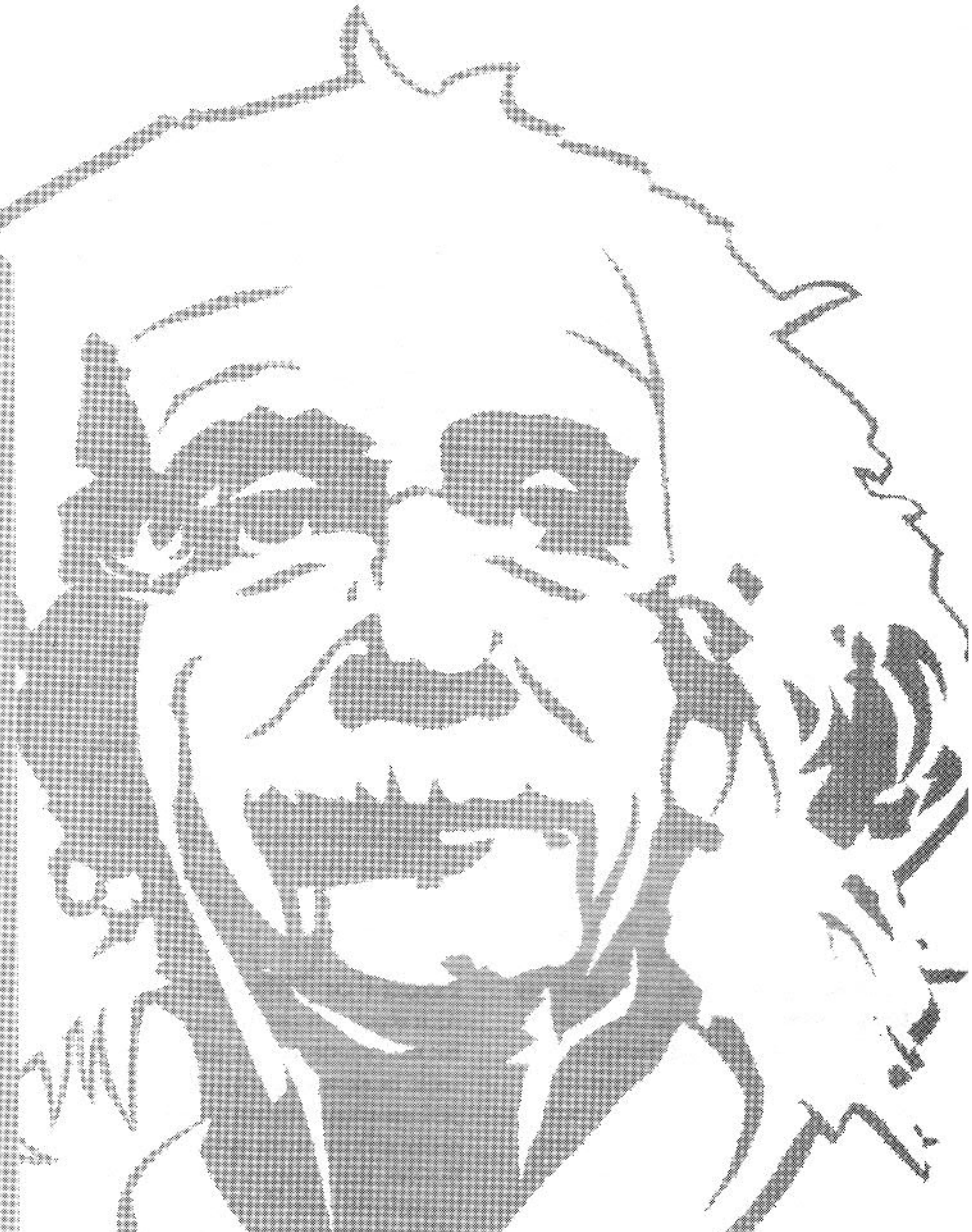
Semiconductors

IC1	TL071 low noise JFET op-amp
IC2,3	4066B CMOS analogue quad bilateral switches
D1	3mm red LED low current preferable
D2	3mm green LED low current preferable

Additional Items

SW1 SPDT Heavy duty footswitch (Maplin)
PCB (See page 57)
IC sockets (1 x 8 PIN, 2 x 14-PIN)
PP3 9-V Battewry and clip
Diecast case 120 x 100 x 35mm (RS/Electromail Cat No 225-209)
Stereo 1/4" Jack socket
Mono 1/4" Jack socket (2 OFF)
Screened lead
wire
solder
Rub-down letters
spray paint





Ideas Forum

The page to get you thinking about what to develop next

Ideas never come easy do they? Some say that talking to a like minded person will bring out the best in you. The more you talk, the greater the chance that an idea will come out in conversation. Also to some it depends on what the weather is like or how much sleep you have had the previous night

All great inventions start as little notions that get scribbled down and expanded upon, and that's what the Electronics in Action Ideas Forum is all about. Now you are the inventors.

Whatever happened to the 'Beta lights' commonly used in the 60s. on the end of flick switches. Those radioactive lights were not by any means new, having previously been used to illuminate dials in aircraft cockpits during the war. Could this natural energy be converted to light, heat or any other form to save on battery power in portable equipment.

If you have any suggestions or have developed any of the ideas that have been appearing in this column we would love to hear from you, feel free to drop us a line.

Electronics in Action, PO Box 600, Berkhamsted Herts. HP4 1NL

April

TV Screen control

There are various ways to initiate commands using a TV screen, a mouse or roller ball are the standard ones. Not so standard, but also in use are cordless joystick controls using infrared beams and also Touch screens. This last one has excellent applications where the general public are involved and it is quick to operate but the smallest area in which to take action is typically thumbprint size. However, there could be other fast response ways to initiate more accurate commands.

Solid state LASER pencil to point and activate areas on the screen. As the spot is easily seen, it would be ideal for speedy operations in computer games and CDi. As we all tend to use our fingers for pointing at things, the unit might be portable enough to be strapped onto the back of the finger.

A good sniff

With IBM developing the 'nose on a chip', (see news item) there must be many applications where minuscule changes in temperature could alert warnings ie. body surface temperature changes. On this basis, it could be an excellent detector for some Biofeedback techniques like controlling headaches.

Level Detection

Most level detectors monitor rises in liquid levels and usually rely on marked changes in resistance owing to ions present. Those who rely on oil (kerosene) for heating often run out of this organic liquid at the worst possible time without warning. There must be a simple solution to this problem.

Weather Sense

The air we breath contains positive and negative ions. The negative ones are said to make you feel good. It would be interesting to know the ion concentration and polarity at any time.

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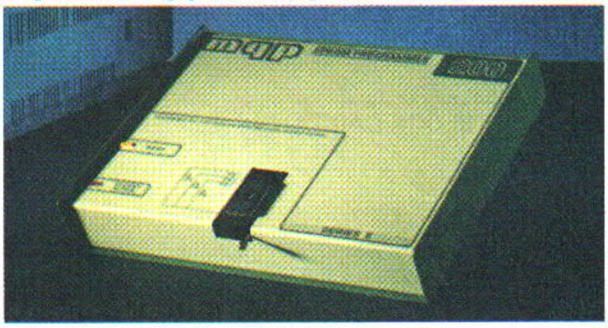

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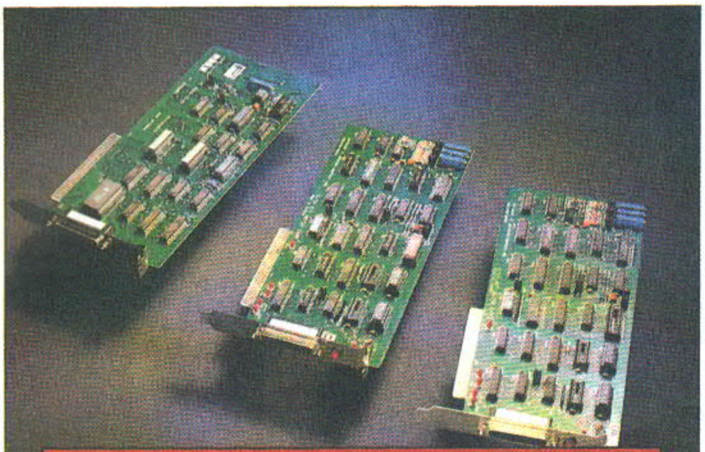

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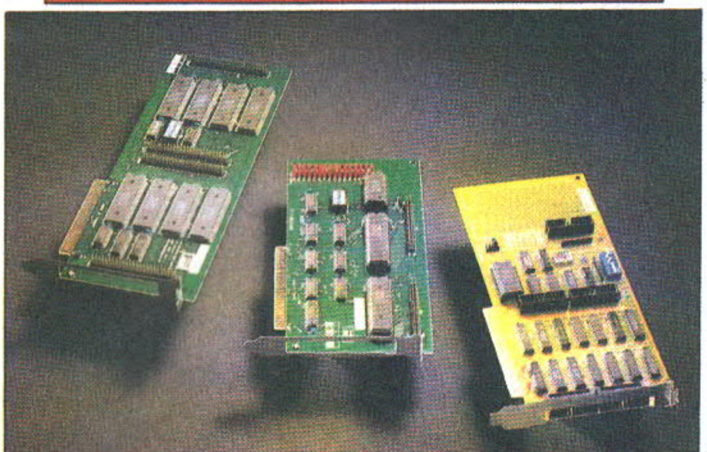

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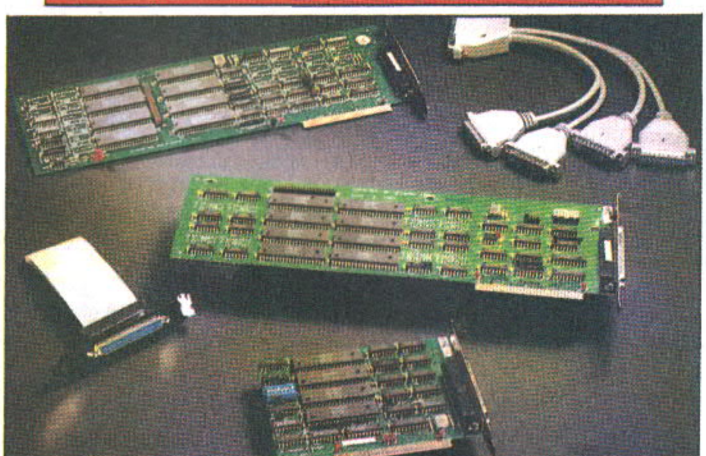

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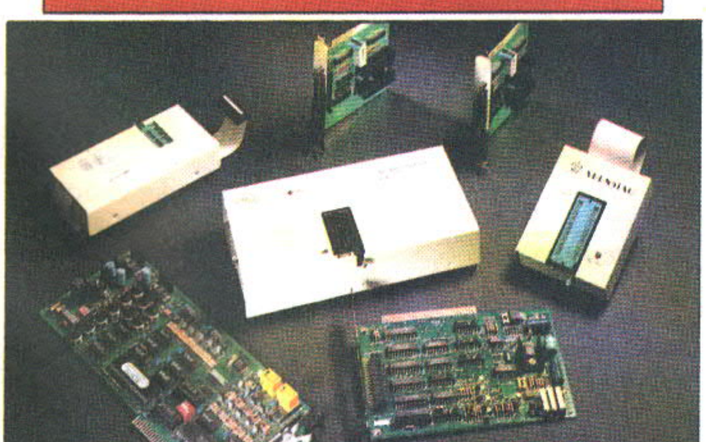

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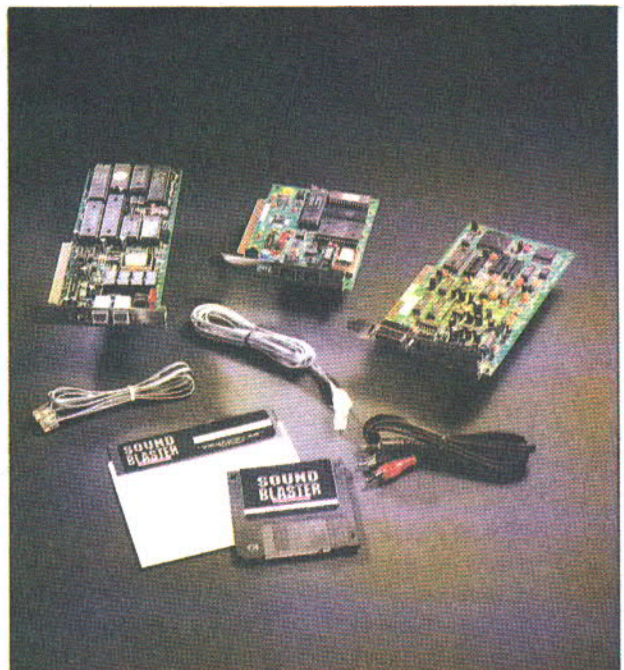

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Electronics in Action in co-operation with The Technology Exchange Ltd., the international technology matchmaking service based in the UK, brings you each month a selection of technology partnership opportunities to which you are invited to respond.

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For this issue of Electronics in Action, we are presenting a series of offers of licence, joint venture and patents rights for sale from organisations in 34 countries.

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KEY

Example: SPOLSU (Status, Offer, Source)

Status: Indicates the stage of development.

P	Patent or design only	M	Laboratory model	W	Working prototype
U	Pre-production units available	F	In current production	C	Commercialised

Offer: Indicates the type of agreement sought.

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Source: Indicates the type of organisation making the offer.

C	Limited Company	C	Educational Institution	R	Independant Research Organisation
G	Government Research	P	Private Individual		

210061 M L U

Metal Insulator Semiconductor - Field Effect Transistor using Germaniumnitride

the fabrication of self-aligned planar metal-insulator-semiconductor transistors on indium phosphide compound semiconductor. A new insulating material germanium nitride has been developed for use in the fabrication process of the transistor. Used for very high frequency (40-100 GHz), high power (3-6 W/mm), and high gain (5-15 dB) and high efficiency (40-50% microelectronics devices and circuits and very low noise/high power amplifiers for applications in photonics (optoelectronics).

708843 M S U

Parametric Oscillator formed with a multiple quantum well optical wave guide

Miniature semi-conductor device with power levels comparable to laser diodes, narrow linewidth, and wavelength electrically tunable from 0.9 to 10 microns. Compact: low cost: continuous output radiation: no cooling required.

409812 W L U

Manufacturing battery operated devices

need a variety of electronic components to function. Reducing the number of components occupying premium circuit board space is a key to manufacturing cost effective products. A device have been developed that reduces the number of components required in battery operated products. The elimination of these components on the circuit board produces a major cost savings in the manufacturing process, while still maintaining the quality of the product.

508842 M S U

New family Cuprate Superconductors with high TC

Critical current densities greater than 35 x 10^+7 amp/sq cm at 132 degrees K in a 4KOe field.

208841 M S U

High resolution wideband guided wave optical analog-to-digital convertor

Based on a new algorithm. Enhanced frequency range.

608968 W L C

Halogen ceiling light 'SKY 10'

150 W ceiling light equipped with three low voltage 50W halogen light spots fitted with dichroic bulbs; 38 degrees adjustable spots. Ceiling light in steel - aluminium, spots of plastic material. Safety transformer. Fused. Intensive lighting.

708969 W L C

ION implantation

For production of electronic components, clean room ion implantation service. Energy from 5KeV to 6MeV. Dose: 1E11 to 1E18 At/sq m -

Continued on page 62

PIR ALARM KIT

only £34.95 (Usual price - **£45.48**)

To combat the worrying trend of increasing numbers of burglaries and thefts, Cirkit have introduced a simple to install but very effective intruder alarm. It is ideal for club houses, sheds, garages, shacks or single room installations as well as caravans, trailers or boats.

The alarm combines a PIR (Passive Infra Red) detector for general coverage with magnetic switches for additional door and window protection. It is easy to use with a single key for set or reset, has a mains power supply, optional battery back-up and operates with a 2½ minute exit time and 15 second entry delay.

The kit consists the combined PIR detector and alarm box, three magnetic reed switches, compact high power siren, mains power supply, and full comprehensive instruction manual. An optional PP3 battery can be added for power failure protection.

Specification

Power	12V DC or AC adaptor
PIR coverage	$100m^2$
Exit delay	2.5 mins
Entry delay	15 secs
Alarm reset time	60 secs
Dimensions	140×90×56mm (PIR /alarm box)

Please print your name in **BLOCK CAPITALS**

Please send .... Passive Infra Red alarm Kit(s) at the special price of **£34.95** each plus **£1.40** for postage and packing.

Method of payment

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Telephone No ....

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Park Lane, Broxbourne Herts. EN10 7NQ

Tel. (0992)448899 Fax. (0992)471314

Continued from page 60

types: B, As, Ph, H, He, Si, Ge, Be etc. Advantages: avoids large investments. Cost reduction - immediate use. Applications: production of silicon and AsGa components; development of new processes.

309415 W L/J C
Automatic vacuum cleaner
moves under automatic control; all the sequences are piloted by a powerful electronic system. Self-monitoring to detect malfunctions by microprocessor. No programming. No understanding of electronics necessary for the user. This system improves control over worker time and guarantees thorough cleaning, including under furniture, beds etc.

909416 W S C
Smart cards
The card is realised by duplicate moulding in one operation including the printing of the two faces. The cost price is half of the present cost price. The investments are half of the investments at present. Phone cards, bank cards, medical cards, toll.

509216 W L U
Canal clathrate complex
as electronic and cationic conductor for use in solid electrolytic cells. The unique crystal structure of this novel canal clathrate complex of benzophenone and a polyiodide salt results in both electronic and cationic conductivity. This material is used either as the electrolyte or as an electrode in an electrolytic cell.

309476 F J C
Identification systems
A remote sensing identification system which uses low frequency electro-magnetic communication units and passive mobile tags which can be read at a distance. The communication units may be stand alone units, with own power supply or interface with IBM-PC. The tags may be either fixed code or have a readable memory and come in various forms such as credit card format, thick industrial cards or buttons. Applicable for management of automated manufacturing, material handling systems, identification of luggage, containers, vehicles or animals etc.

909441 C M J
Pattern identification computer technique
based on neural network artificial intelligence. The proposed projects aim at the development of specific capabilities such as identification of cancer cells on prints produced by any medical imaging system; speaker recognition and signature verification; finger print identification; access control systems; the evaluation of polygraph tests; and the identification of explosives and other chemical substances.

109463 F J C
Compact uninterruptable power supply
Very compact uninterruptable power supply systems based on the innovative technology of pulse width modulation protecting sensitive equipment (eg computers) against variant power supply by providing an output voltage that is stabilised and sinusoidal. Integral self charging batteries take over instantaneously when power is interrupted and operates at the high frequency of 20,000 Hz making this a quiet system. The compact size simplifies installation.

609508 C J C
Electro-luminescant lamp manufactured in rolls
An advanced generation electro-luminescent (EL) lamp with high intensity is receptive to a fully continuous manufacturing process in rolls which can be cut to individual specifications. EL's are energy economical with long service life. They are suitable for various applications eg billboards, road signs, backlighting for computer screens etc.

409365 W L U
Current steering
CMOS logic family. Integrated digital logic circuitry that steers electrical currents and minimises switching current transients, thereby improving the operation of digital and analog circuitry on common substrates.

408725
Magnetic antenna system
with the characteristics of an active in-phase de-attenuation in automatic operation, designed as a combined transmitting and receiving antenna. Remote control unit designed as a blind current transfer element for resonance point adjustment. Vertical radiation angle adjustable.

108745
Stereo sound ray loudspeaker
The nonophonically controlled system acoustically generates the audiophase components within the total emission required for stereo.

708726
Magnetic antenna system
with in-phase, automatically controlled de-attenuation amplifier. Range 1.6-500 MHz. Iron ferrocarbonyl coupling for transmission and receiving operations, remote controllability, inside operation, power level on test unit 1000 Watt Hf (max). Receive/transmit switch-over not necessary.

908647
Hologram robotic lighting
The system consists of a centralised illumination fitted with high pressure lamps which deflect light through fibre optic light guides and balances it with the aid of optical elements. Application areas: architecture and automotive industry.

108645
Fully automatic insertion and completion machines
for passive electronic elements such as bases, pin and terminal strips, plugs, spring contact pins and other small parts. Precise joining processes with high place/hour capacity.

408648
Lighting fixture with intergrated air circulation
and cleaning device for use in rooms with poor ventilation. Space saving and inexpensive because the lighting fixture simultaneously houses the fan and filter etc.

808419
Low voltage halogen lamps
3 lamps (150W) with low voltage (50V), lamps can be swivelled, aluminium steel. Safety transformer, fuses. Decoration and illumination purposes.

408761
Nesting end stage for stepping motors
automatically calculates the path of motors (up to 600 W), dependent on inertia, friction and motor torque. Modest space requirement, low mass, self-learning function. Applications: robotics, machine tools.

308688
Inert gas testing
Electronic testing and measuring system with electronic gas sensors for testing and measuring inert gases.

808732

Intergrated switching circuits

Method to produce integrated switching circuits and Schottky diodes. Process to apply epitactical layers, to form oxidic insulation layers with ion implantation and precipitation of polycrystalline silicon and silicon nitride.

408749

Mobile reciever aerial

Extremely pliable rod aerial made of monocrystal alloyed material for mobile receivers, eg car radios, radiotelephonic devices. Maximum length 600 mm, diameter 1-5 mm. Aerial tested under extreme conditions during a 2 year field trial.

808744

Electronic control unit for television cabinets

Remote controlled door activation.

508755

Acoustic call system

Mains-independent acoustic call system (especially for bedridden patients). Battery operated call system foregoes the standard of conventional mains-operated devices for the sake of maximum reliability and availability.

808747

Telephone call charge meter

Telecommunication accessory: call charge meter for older telephones, for third party call charge calculation and control of own charges.

808756

Silent alarm

Alarm signal exclusively for one person. Of special importance in caring for the seriously ill, and also for shift workers.

208754

Electronic foot starter for household sewing machines

the foot starter contains an adjustable resistor which influences the control electronics to obtain speed control. The resistance characteristic of the slip ring can be adapted to the customer's requirements.

708738

Electronic drive technology

precision drives for micrometre and submicrometre range. A position controlled linear drive on the basis of a screw thread reluctance motor was created which converts the rotational motion of the rotary field directly into linear motion. Step resolution approx 15 micrometres. Shearing force up to 80 N.

708735

Chip resistor in thin film techology

including manufacturing process. Roll by roll production under application of HT films and use of high vaccuum processes. No waste products. Application in all fields of electronic equipment technology.

8736

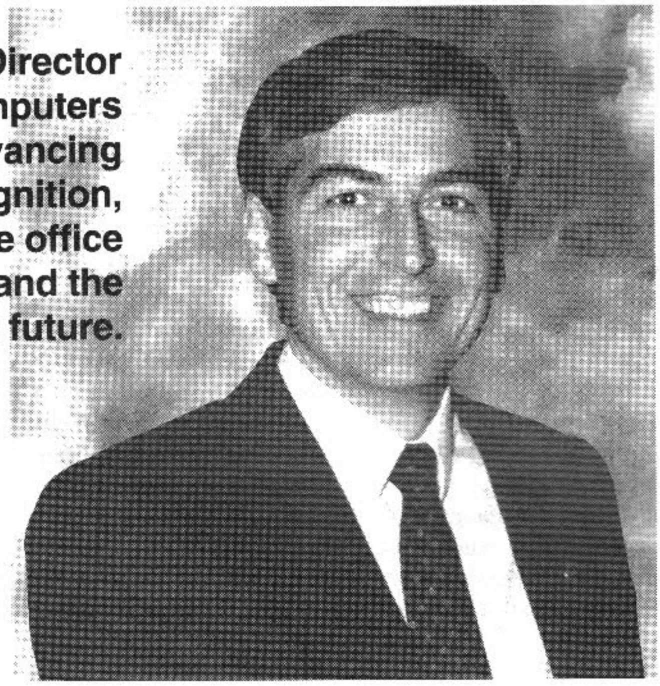
Chip capacitor including manufacturing process

Roll by roll production under application of HT films and use of high vaccuum processes. No waste products. Application in all fields of electronic equipment technology.

MORE NEXT MONTH

Future View

The realities of voice recognition and its future implications



John Mitchell, Managing Director of Alltypes Business Computers discusses the rapidly advancing technology of voice recognition, its integration into the office environment and the possibilities for the future.

For many years, the concept of controlling a computer and or generating text by means of the spoken word has been confined to the realms of science fiction. However, since its commercial introduction in 1990 and the development of PC power, voice recognition for dictation and other large vocabulary applications is now a reality. This article discusses the implications of this radical technology, and Alltypes Business Computers are leading the way forward by integrating voice recognition for the majority of today's computer users i.e. non typists, into the office environment.

Introduction

Excepting the introduction of certain limited vocabulary systems in the 1980s, the launch of general purpose large vocabulary systems came in 1990 from the American company, Dragon Systems. The end product was a result of extensive research and development led by Jim and Janet Baker the company founders.

DragonDictate now leads the market alongside other speech recognition products offered by companies such as IBM. It is interesting to note that until now, the speech recognition products offered by IBM were derivatives of the DragonDictate system, produced under license. Since its introduction, DragonDictate have introduced second generation products into the marketplace in 1993. The first of these products, retained the original active vocabulary of 30,000 words; however, in response to a changing market and to provide speech recognition to a wider range of users, Alltypes launched the Dragon 5,000 word Starter Edition at the end of 1993 for less than £1000.

The DragonDictate system is a speaker dependent, large vocabulary dictation system

The potential of the DragonDictate products was realised during the early stages of launch by John Mitchell, Managing Director of Alltypes Business Computers, who quickly sought to represent Dragon Systems in the UK through their trading division, AllVoice Computing. The end result, is a winning combination of the radical technological advancements provided by the Dragon speech recognition engine and Alltypes' many years expertise in word processing and office automation. Alltypes has integrated the Dragon system into a number of business applications providing voice based solutions to not just word processing but to document management, and more specialist areas such as medical and legal.

Applications

The obvious application of large vocabulary speech recognition is in word processing. The concept of being able to produce and edit a document by means of the spoken word is by far the most exciting and obvious prospect. Performing repetitious tasks also lends itself to voice recognition and is achieved by the use of "voice macros" that command certain combinations of keystrokes. These keystrokes are usually associated with a relevant voice command or utterance such as "Print Document" to perform a printing function or "Standard Contract" to call up an entire contract document. Alltypes are the current market leaders in this area of voice recognition and provide a library of voice commands, regular phrases and even entire documents for word processing and associated applications. Leading on from this, is the integration of voice recognition with other business applications such as spreadsheets and databases.

The latter applications often go against the principles of large vocabulary voice recognition, in that they usually only require a limited vocabulary for operation. In this situation, the "active" vocabulary is limited to accommodate this. This is an area of work that Alltypes also specialises in.

Speech recognition has already created opportunities for people with disabilities and is often solely responsible for employment rehabilitation, such as the recently publicised RSI case of Simon Crosby, a computer programmer, now working again as a result of a speech recognition system supplied by Alltypes.

potential of a computer system that you could talk to. Initial ideas were based around pattern matching, but it was quickly realized that in order for any computer type system to be able to deal with human speech, the requirement was not only that of an acoustic template, but an intelligent model that represented all the possible permutations and combinations presented by the spoken word. Combine this concept with the inconsistencies of human speech and you will be some way towards contemplating the problems facing the pioneers in this work.

The theory of this technology is far

on to work for Exxon and IBM, before forming Dragon Systems, during which time, they had rapidly built up a number of patents from their work.

It is worth mentioning one of the largest problems of speech recognition that has been overcome by various research teams all of whom profess to have arrived at the solution independently. The problem was the variation of the speed at which words are spoken. The technique that addresses this problem is called dynamic time warping. The result is an elastic word model that can be shrunk or stretched in order to accommodate a "best-fit" of the

The Technology

The DragonDictate system is a speaker dependent, large vocabulary dictation system. Following an initial 90 minute tutorial, the user builds up a set of exclusive "voice-files" which is constantly changing according to the use of English, the environment, and even the changes in the users' voice due to a cold! In this situation, the system can be configured to revert to "normal" use following recovery or adapt back automatically as the voice changes!

In order to examine the nature of this technology, one has to consider the origins of speech recognition. In the early 1960s, AI pioneers realised the

beyond the scope of this article, suffice to say that the responsibility lies with the Russian mathematician Andrei Markov who's work that commenced at the start of the century, concentrated on the probabilities of sequences of events. His statistical methods have since been applied in many fields that have required an element of modelling. None more so than in the field of voice recognition where, in the 1980s, two research teams - one under Fred Jelinek at IBM and Jim and Janet Baker, then students at Carnegie Mellon University, Pittsburgh hit upon the idea of using Markov Statistics in speech recognition at roughly the same time. The Bakers went

word being spoken.

Current, second and third generation Dragon products, based on the principles described above, still rely on discrete speech. That is to say, the user is required to pause briefly between each word that is spoken into the system. The pause is the cue that "kickstarts" the Dragon recognition engine into action. This is not as significant a disadvantage as it may first seem. Users soon get used to the system and are quickly exceeding dictation speeds of 50 words per minute. Although some might argue that a good typist can type in excess of 100 wpm this is not the critical measurement. This comes from the consideration of throughput. The traditional cycle of dictation, typing, proof reading and correction dramatically reduces the figure quoted above whilst the throughput speed of the speech recognition system remains.

With all potential problems seemingly addressed, later research has resulted in advanced levels of Markov modelling that takes into account, the context of the speech. This is of particular importance when dealing with words such as to, too and two where there is no audible difference in what is being said. Third generations of Dragon products will take into account what has been said in choosing phrases such as "too many" instead of "two many."

Implementation

One might suggest that the upgrade to voice recognition is achieved by means of an installation of an expansion card and relevant software. Certainly to make a suitable PC, "voice-aware" this is the case, but this is just the beginning. We at Alltypes, are very conscientious of the importance of the implementation of voice recognition for a new installation. Current technology does not allow for a "plug-in and go" type of product. Although the strategy of newer generation computer products, is often to simply flood the market, Alltypes and Dragon recognises that this is currently not a practical or viable method.

The recommendations of Alltypes, for each and every customer investing in voice recognition technology, amount to a minimum of two days training for each new user. The resultant added-value from this training, can be equated to that of implementing voice recognition in the first place. Indeed the two are complementary.

The Psychology of Change

Whilst Alltypes are selling systems at a dramatically increasing rate, there is still an inevitable resistance to change with technology of this kind. The very nature of this technology would, to some, suggest a means of replacement for the traditional typist or secretary. Alltypes' experience, past and current, does not provide much evidence to support this claim. In areas such as legal practice, local government and medicine, secretarial staff are often shared and are consequently over resourced. The implementation of the AllVoice DragonDictate system in these areas, has alleviated some of the workload and has resulted in improved efficiency of document production, a point of view that is often publicly endorsed by clients.

Resistance to change is sometimes demonstrated at the other end of the company infrastructure, as senior members of staff in legal and medical areas often refuse to have a computer at their desk, regarding it as a demotion, or a task that is below them. By providing voice, as the primary means of input, Alltypes are able to offer an alternative that provides a new status to the user, often resulting in fierce competition for the use of the first system!

The other main hurdle curiously is often the IT department, who are often unaware of this technology. Their reaction rather than to see and immediately implement the astounding benefits for their organisation can be to protect their IT strategy which previously had not allowed for the possibilities of direct document production.

Society as a whole could well see radical changes as voice recognition is implemented in public information systems

The Future

With advancements in this technology over the last five years, the next five should see voice recognition on all new computers destined for the office. The inevitable advent of continuous, large vocabulary, speaker independent systems will bring about a complete change of culture in all aspects of computing. The issues discussed above will change, as certain roles in business will require different skills.

Society as a whole could well see radical changes as voice recognition is implemented in public information systems, telephone booking systems, banks, etc. the possibilities are endless and are only limited by our imagination and the associated, and often dedicated, research and development that goes in to these systems.

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