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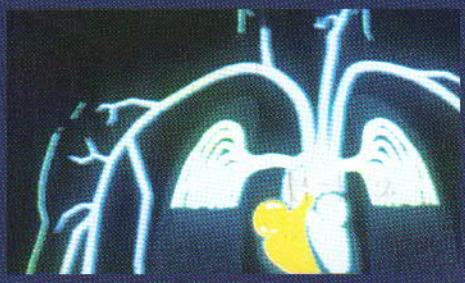

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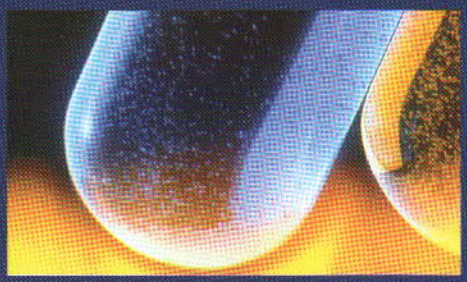

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ELECTRONICS in ACTION

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Light, Electricity and Man

The connection between man and electricity is closer than we think. For if we look at the central nervous system of our bodies we will find an electrical system of communication. Tiny electrical impulses cause limbs to move and it is also thought electricity could be responsible for our thought processes when braincells communicate with each other.

This issue of the magazine contains a number of items which look at the health of our bodies.

Acupuncture has long been used in China to help relieve many ailments and it is now finding far greater use within western medicine. The acupuncture needle is said to stimulate communication lines within the body to readjust the flow of energy. A balanced body is a healthy body according to Chinese philosophy. Our article suggests a modern alternative to needles, that of alternating electricity.

This idea to relieve pain electronically happens to be used for a specific purpose by some pregnant women just before giving birth and is suggested as a convenient alternative to drugs.

Light of our lives

It is SAD (Seasonal Adjusted Disorder) that can affect many of us in winter time. This disorder very often causes depression to set in and scientists think they are nearer to the cause - a lack of sunlight. As Douglas Clarkson shows in his article, light can affect our lives in many ways.

Paul Freeman-Sear

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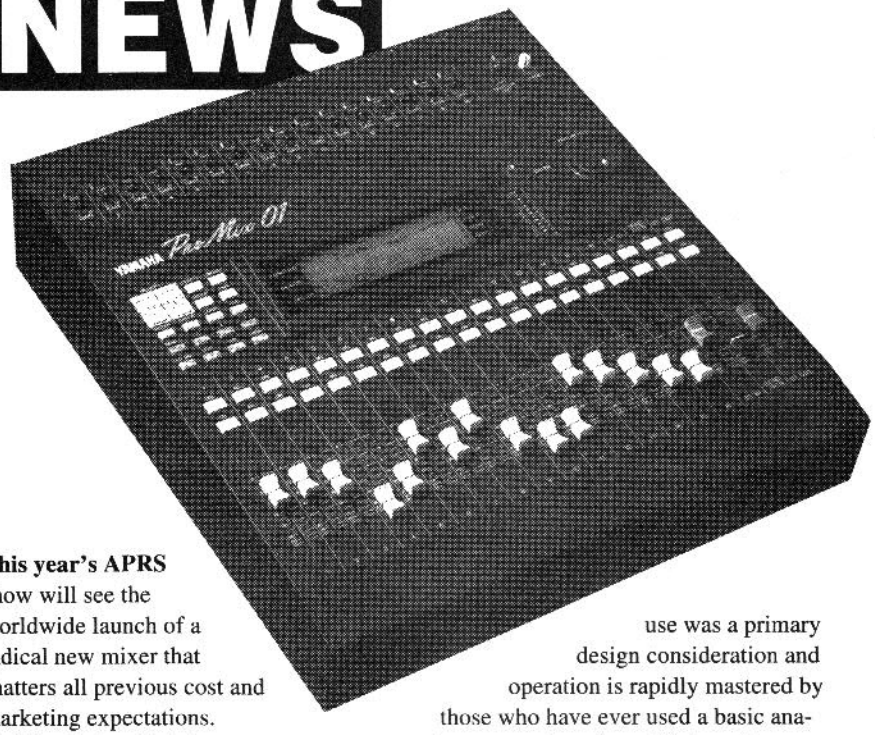
NEWS



First Mass Market Digital Mixer

This year's APRS show will see the worldwide launch of a radical new mixer that shatters all previous cost and marketing expectations. ProMix 01 is a digital programmable mixer aimed squarely at the mass market and employing technology that most of the professional audio industry still regards as ground breaking.

ProMix 01 features 18 inputs with 20-bit AD conversion (16 balanced line/mic, eight with phantom power and a dedicated stereo input) and stereo digital and analogue (20-bit DACs) outputs. Internal processing is at least 24-bit, with three band parametric equalization, on all 18 input channels, employing 36-bit processing.

Yamaha has employed the experience of three generations of digital console design, to devise a compact mixer that incorporates the power and flexibility of an assignable device within an ergonomic design that ensures ease of accessibility of all functions from the surface controls.

A familiar console layout, with motorised faders for every channel, is combined with a large LCD - graphically displaying everything from EQ curves to effects parameter settings - along with a large data entry wheel and dedicated parameter access keys. Ease of use was a primary design consideration and operation is rapidly mastered by those who have ever used a basic analogue console and an effects unit.

Total instant recall and full dynamic automation capability are at the head of the operational power of the ProMix 01. 50 programmable Memories allow all digital mixing parameters to be recalled instantly - faders mutes, pans, equalization, aux send levels, internal digital effects, built-in compressors and gates stereo/mono channel configurations and more. In addition to the total instant recall, all digital mixing parameters can be automated using any MIDI sequencing software.

Applications where ProMix offers major advantages over existing console technology are as wide ranging as the mixer is unique. From the more obvious automated mixing and submixing tasks to live sound applications where mix, equalization, dynamics and effects settings can be preset and changed at the touch of a button, to the compact power and high spec digital audio that it offers as a location recording and broadcast production console.

And last and very far from least - the price: £1599 ex-VAT.

World's Smallest Tantalum Capacitors

These ultra-miniature surface mount chip capacitors, believed to be the world's smallest moulded tantalums, have been added to the Flint range.

The new tantalums offer a range of values from 0.47 to 2.2 micro-Farads in a tiny, 0805-size, 2mm x 1.25mm x 1.2mm package. The devices are likely

New Liquid Crystal Display Project

Eden Group Limited has joined seven other international research bodies to investigate ferroelectric liquid crystal applications in a project called 'Profelicita'.

This Esprit-funded project aims to develop components like the new flat panel display for the commercial market.

The project will provide three components, a customised integrated circuit, a touch input system and a Ferroelectric Liquid Crystal Display (FLCD).

The amalgamation of these will provide a display sub-system for use in a variety of IT products.

The advantages of Ferroelectric technology is that it requires very low power and can be produced at low cost. The FLCD modules will make them ideal for future portable IT product developments.

One major benefit is ferroelectric technology's ability to retain an image with no power - reducing consumption and prolonging battery life.

Unlike other alphanumeric liquid crystal displays, another advantage is that the drive voltages required for the FLCDs are much lower. This enables a reduction in the size and cost of integrated circuits used in drive electronics.

FLCD technology also provides a high contrast ratio over a wider viewing angle. As such, FLCDs give a much clearer image than the other liquid crystal displays and give FLCDs a further distinct advantage from the user's perspective.

As part of the Profelicita project, it is intended that early commercial applications of FLCDs will be exploited in market-led products and by the production of FLCDs for OEMs. This display module will be used in a number of portable IT products at a later date.

The project will also explore the potential of FLCDs to provide analogue grey levels at an acceptable cost. If achieved, this will allow commercial applications of FLCDs in video products.

Other international participants in the project, which is led by the GEC Hirst Research Centre in the UK, are Crystaloid Europe, Consorio Eagle, SELECO, Univ. Politecnica de Madrid, University of Rome "La Sapienza" and the University of Stuttgart.

HP licences Infrared technology

Hewlett Packard has taken an important step forward in the race to set a standard for Infrared connections by selling licences for the technology.

The aim is to make the HP SIR (serial infrared) system a standard for Infrared, not just for computer to peripheral links, but for all engineering and electronic applications which would benefit from data transfer without the need for bulky cables.

With three products already successfully established in the marketplace - the OmniBook sub-notebook PC, the 100 LX palmtop and the HP Vectra XM PC series - HP is already a market leader in infrared connections. Both these machines use infrared for cordless serial connections for printing or data transfer.

Licences have already been sold to several companies in the UK who expect to launch products within the next few months.

It is expected this technology will provide the connection between portable equipment and peripherals without the need for cables.

World's largest conductivity rate

Japan's Superconductivity Research Laboratory has developed a superconductor with the world's largest conductivity rate. The superconductor has a current density of 15,000 A/cm^2 at 77 Kelvin and 3 Tesla.

The previous highest conductivity rate was at 5,000 A/cm^2 in superconductors made from Yttrium, which was also developed by the laboratory.

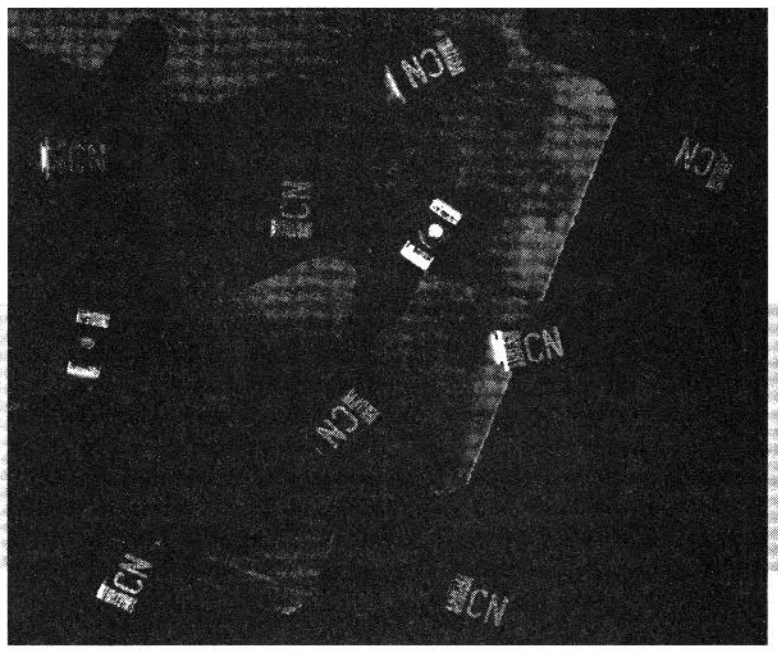
There are two types of the new superconductor, one made from a blend of Neodymium, Copper oxide and Barium, and the other from Samarium, Copper oxide and Barium.

The laboratory is affiliated with the Ministry of International Trade and Industry.

The researchers found a new method of increasing the rate by controlling the oxygen around the substances when they are melted down for processing.

This method, dubbed the oxygen controlled melt growth process, gives birth to numerous pinning centres. Pinning centres have the effect of stabilizing magnetic flux, and the more that exist, the larger the current density.

The new superconductor can be applied for such uses as superconducting magnets that lift linear motor cars, and also for energy storage.



to be of particular interest to designers of portable stereos, VCR cameras and hearing aids, and are suitable for use over a temperature range of -55 °C to +125 °C. Despite their small size, SVS series capacitors can be used at up to 16V, have a leakage current of 0.5 micro-Amp.

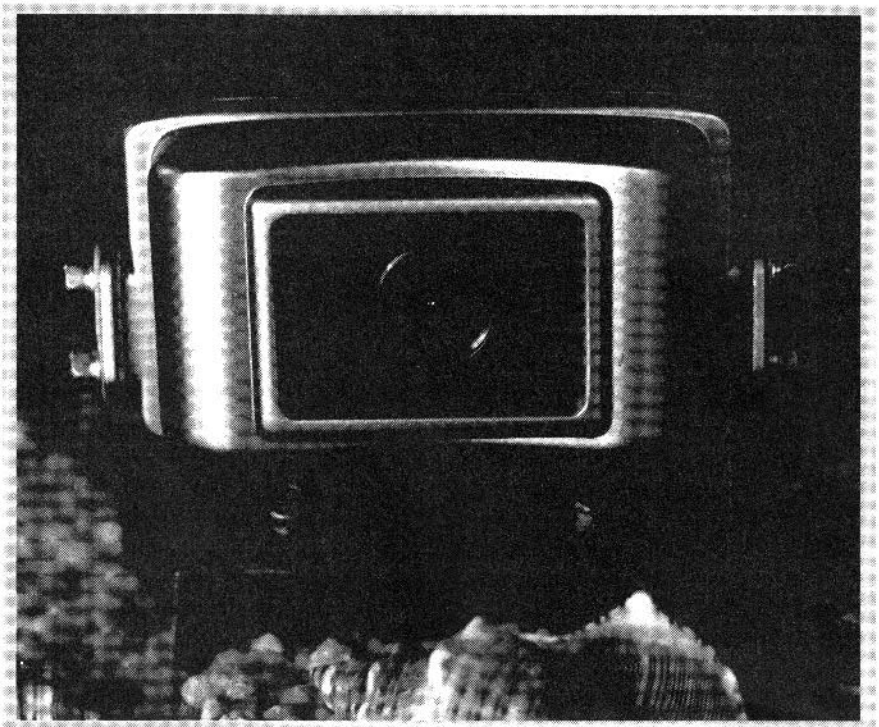
Smartcards Information Pack

An information pack on Smartcards by the IEE Technical Information Unit has recently been published.

The pack contains summaries of technical papers selected from the IEE's INSPEC database. It includes the technology, cryptography, case studies of smart cards in financial transactions, security/access control, medicine, token payment systems, and other areas. There are also chapters listing books, reports and conference proceedings held in the IEE Library; International, European, and British standards; smart card suppliers in Europe; market data; and European conferences on smartcards.

Today we find our wallets and purses filled with numerous bank and credit cards. Soon these may all be replaced by smartcards - similar in appearance, but embedded with a microprocessor capable of handling much more information than the current magnetic strip cards. With this capacity comes a corresponding increase in functionality - we could find these cards replacing not only the notes and coins in our pockets, but also that large bunch of keys, our driving licences and passports. Perhaps we might even look forward to having just a single multifunction card to carry.

Already the smartcard technology is being used for payment in public telephones, access to services such as home banking and subscription television and for payment for public transport and parking. Smartcards are also finding applications in the business, government, financial, medical and health services. Trials and real applications are burgeoning around the world. Since its first use in France in the late 1980s, smart card technology has developed into a product that is expected to ship over 600 million units by 1996.



Low Light Camera for Mobile CCTV

Mitsubishi has announced an addition to the CV-550 Series of mobile CCTV systems featuring a brand new, compact camera capable of providing high quality displays in poor lighting conditions down to 1Lux.

The new system is being introduced in response to customer requests for a low light use in adverse lighting conditions. Mitsubishi C-Vision systems are now widely used by the quarrying and mining industry as well as municipal authorities throughout the UK.

These mobile CCTV systems eliminate the many problems caused by blind spots at the front, rear or side of an extremely wide range of vehicles, enabling drivers to manoeuvre safely.

Mitsubishi's C-Vision systems are the first of their kind to achieve approval to BS415 the electrical safety standard. The systems can withstand knocks and vibrations up to 2000 rpm.

As well as waste disposal vehicles and road sweepers, C-Vision systems can also be used on coaches, PSVs, trains, forklift trucks and marine applications, including fishing trawlers. C-Vision systems are available in the UK from Vision Techniques of Blackburn, Lancashire. Telephone: 0254-679 717), who can also

fit, as optional equipment, multi-camera switching, a washing system to clean the camera lens and a bullet-proof, polycarbonate cover which is said to be ideal for quarrying and mining applications. The C-Vision cameras can also be supplied with a motorised, protective shutter which is activated at switch-on.

Phone numbers to change again

The National Code Change (NCC), known as Phoneday, is the introduction of a new national telephone numbering system. The impact of Phoneday will be as far reaching as the introduction of the very first STD codes in 1958 and it is important to prepare early for the changes.

Phoneday has been specified by Oftel as the best way to increase capacity, address the acute shortage of new numbers in some areas and make way for new business and consumer telephone services well into the 21st century.

There are a number of key dates associated with Phoneday they are:

16 June 1994: Mercury and BT open up access to the new codes across their networks. There exists the possibility that some calls dialled on the new numbering systems will get through from this date.

1 August 1994: marks the start of parallel running, when all of the new codes will be available across the UK. Between this date and Phoneday itself, users will be able to use both the old and new numbering systems.

16 April 1995: This date is Phoneday, the day when all area telephone codes in the UK will change. From this day onwards, users can use only the new codes.

What will the change involve?

After an extensive consultation process, Oftel has identified a clear and simple to

understand scheme involving the minimum of disruption for those concerned. On Phoneday, a one will be inserted after the first zero of all national dialling codes. For example, Exeter **0392** xxxxxx will become **01392** xxxxxx, London **071** xxx xxxx will become **0171** xxx xxxx, and so on.

In addition, completely new area codes will be introduced in Leeds, Sheffield, Nottingham, Leicester and Bristol, as these cities have a particularly acute shortage of numbers. The changes will be as follows:

Leeds: 0532xxxxxx - 01132xxxxxx
Sheffield: 0742xxxxxx - 01142xxxxxx
Nottingham: 0602xxxxxx -01159xxxxxx
Leicester: 0533xxxxxx - 01162xxxxxx
Bristol: 0272xxxxxx - 01179xxxxxx

The majority of non geographical codes, such as 999, 112, 100, mobile phone numbers, free 0500 and 0800 services and premium rate services, will remain the same. However, the Mercury Direct Dialling Paging number - 0523 523 523 - will change to 01523 523 523.

To bring the UK in line with the rest of Europe, the international access code will be changed from 010 to 00.

What does this mean for businesses?

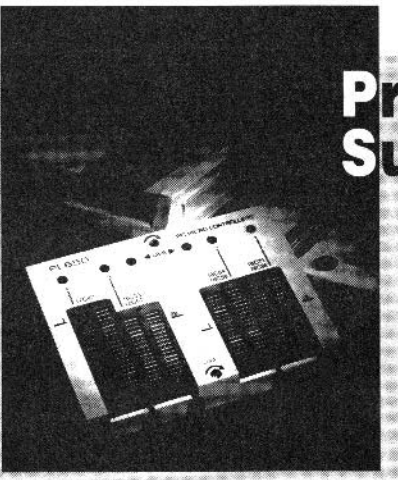
Whilst April 1995 may seem a long way off, the new numbers will be fully operational from 1 August 1994 and will run alongside the old codes for eight months. Some new codes will be in operation from 16 June 1994, when BT and Mercury begin opening up access to the new codes across their networks.

What will businesses need to do?

Approximately half of the changes which businesses need to make will be telecommunications related, and half will relate to office administration issues. Businesses will need to modify their telephone systems to recognise the new codes. Publicity material and stationery needs to be changed.

Equipment needing modification includes internal telephone exchanges or PBXs, key systems, least-cost routing equipment, fax machines, alarm systems with automatic dialling, modems, payphones and programmable memory phones.

Anyone wishing to enquire about Phoneday can Free Call 0500 04 1995 free of charge, 24 hours a day, 365 days a year.



Programmer Now Supports PICS

The L9000 programmer from Lloyd Research Ltd. now supports Arizona Microchip's range of PIC processors such as 16C5X, 16C71/84 and 17C42 with the PL650 socket module.

The L9000 is ideal for production programming because it can either operate in stand-alone mode or be operated from a PC or from a batch file on a PC.

The PL650 was developed using the latest algorithms from Microchip.

Great care has been taken to optimise programming times. Most devices can be programmed in about three seconds. Devices which are typically programmed in serial mode on development programmers are programmed in parallel mode to increase speed.

The L9000 programmer has a unique double operation mode. In production mode, all operations are simplified and two verifies are performed to ensure devices operate at both high and low Vcc.

The L9000 mainframe has positions for two modules. If a PIC module is fitted in one position, another module can be fitted in the other position for other microcontrollers or EPROMs. The facility to cater for two or more different families makes the L9000 a cost effective and versatile programmer.

The most powerful notebook computer in the world

UNIX workstation users looking to take their systems on the road can now enjoy the performance of PowerPC technology in the world's most powerful notebook computer.

The IBM RISC System/6000* N4O is the industry's first PowerPC-based notebook workstation. It combines the power of the PowerPC 601* microprocessor and AIX, IBM's standards-compliant version of the UNIX operating system, in a lightweight colour notebook computer.

Running at 50MHz, the N40 is more powerful than not only any notebook computer but also many desktop workstations.

"While mobile computing has exploded in the PC space, we are just now entering the phase when breakthrough technologies like the PowerPC are enabling the development of robust portable computers for UNIX," said Robert Youngjohns, AIX Business Manager for IBM UK. "By focusing on our customers' demands for a combination of power, portability and compatibility, we've taken an important first step toward redefining this emerging category."

The 3.1kg N40 features a 9.4-inch TFT (thin film transistor) active matrix colour screen that provides wide-angle viewing in 256 colours. The N40's video memory supports up to a 1280 x 1024 image, which can be viewed via a pan and zoom feature on the TFT display or via an externally connected monitor. Also featured is IBM's TrackPoint II pointing device, which is located in the centre of the keyboard and eliminates the need for an external mouse.

The N40 operates from an internal battery and will be available with the RISC System/6000 N40 External Battery Pack that can extend battery life up to four hours.

With AIX for N40 Version 1.1, a version of AIX/6000 optimised for the portable environment, the N40 enables software developers or architectural engineers, for example, to make real-time changes at customer locations, rather than having to return to the office to make those changes.

Communications and networking features include external ports for Ethernet network support; SCSI-2 diskette drive support; and support for PCMCIA adapters that will provide Token Ring network connectivity and, in the future, support for ISDN and wireless adapters.

Other standard features include a removable disk drive with a 340 MB capacity; main memory support from 16MB to 64MB; an external display port supporting 1280 x 1024 resolution and up to 256 colours; ports for an external mouse, keyboard and Appletalk printers, and a built-in speaker and microphone.

Research World

Technical Advances from around the Globe

Nanowire arrays

By forcing metallic liquids into porous insulating media, researchers at the US Naval Surface Warfare Centre have created "nanowire arrays" consisting of 200nm-diameter wires that are 50 microns long. The arrays could play a number of roles in advanced microelectronic designs as multiple interconnecting wires, or photosensors. The arrays can also be engineered to transmit photons as well as electrons.

The process uses a commercially available microfiltration composite called Anopore, which is built from aluminium oxide. The challenge was to find a means of forcing conductors in the liquid phase into the porous medium. Surface tension becomes a strong force at such small dimensions, preventing liquids from penetrating into the Anopore medium.

The solution was to pack the conducting material behind the Anopore in a hollow tube. The tube is then put under high pressure and the temperature raised to a point just above the melting point of the conducting material, at which point it is forced into the porous medium, solidifying into wires. Various metals and semiconductors have been successfully injected with the method.

The wire arrays, with a density of 500 million wires/cm^2, may also turn out to be interesting electronic systems in their own right. The tightly packed array of conductors in an insulating medium form a "nanocomposite" material with properties different from the constituents of which it is formed. The researchers, working in conjunction with scientists at Polytechnic University and Digital Instruments Inc. have set up a special electron-microscope system for mapping the electrical field produced by charged nanowire arrays.

Flywheel battery

Lawrence Livermore National Laboratory, Westinghouse Electric Corp. and a new company called Trinity Flywheel Batteries Inc. of San Francisco, have entered a two-year, $5 million co-operative research and development agreement (Crada) to develop a flywheel battery for power-line conditioning.

The use of a flywheel battery would help factories, laboratories and computer centres ride out brief power interruptions, which most consumer electronics endure routinely but which can disrupt integrated circuitry.

Livermore researcher Richard Post has spent the past 20 years developing flywheel batteries and has developed one with a carbon-fibre wheel four times stronger than steel, able to withstand up to 1 million pounds of tension per square inch and able to spin up to 9,000 rpm. The target is a peak discharge of 100kW, or about 150 hp.

Trinity will produce the batteries for Westinghouse's Power Generation business unit. It expects to deliver the first breadbox-sized units in early 1995.

Examining EMI complications

As systems get smaller and external sources of electromagnetic and radio frequency interference grow, designers will have to examine their systems for potential EMI complications. To keep interference from becoming a major problem, researchers are exploring ways to make multichip modules immune to EMI.

Working at the request of the US Air Force Office of Scientific Research and Rome Laboratory System Technology, researchers at the Georgian Tech Research Institute have analysed the EMI susceptibility of several MCMs. These modules are becoming more popular, but most designers do not know much about their EMI immunity.

Although the project is funded by the military, the issue will not be limited to commercial markets. The impact of EMI on MCMs will be just as great as it is on system design in industrial and commercial environments.

RF and communications are big areas. In transmitter and receiver modules, both military and commercial, handhelds and larger units, it will become very important.

Harnessing Static Electricity

Personnel at North Carolina State University are trying to harness the power of static electricity. They believe that the force will one day be used to control the shape of aircraft wings, satellite assemblies, and antennas.

"Most people think of static electricity as a nuisance, particularly around electronics, but it's actually a useful force that lets us change the shape of materials on demand," says Barry M. Silverberg, associate professor of mechanical and aerospace engineering at NCSU.

Static electricity occurs when electrons build up on the surface of a material. Silverberg and a team of students have proved that such charged materials attract and repel each other in a predictable and controllable manner. "Scientists have known about electrostatics for a long time, but until recently, didn't have the mathematical tools and design techniques to put it to use," says Silverberg. "Now we have the technology to create and control the distribution of charge on thin metallic surfaces."

Silverberg's team intends to put its knowledge to work by developing a flexible satellite antenna. "A satellite is essentially a drum with a few attachments like solar arrays and reflector dishes," he says. The reflectors are typically rigid and small to prevent warping from alternating hot and cold exposures in space. Reflector mounts also are rigid, so the entire satellite must turn to look in a different direction. Because of their inability to focus and scan, several satellites are often needed to get a complete picture.

The NCSU antenna avoids this problem because its reflector is a flexible membrane that's shaped by static electricity. Metal plates, charged by the satellite battery, sit behind the reflector. By controlling the voltage on each plate, the satellite's computer can manipulate the electrostatic forces that shape and direct the reflector assembly.

Signal to NOISE

The postbag breaks and the letters spill out

Not so Foolproof LEDs

In a letter in the June issue of EIA Paul Stenning described a foolproof way of identifying the cathode and anode leads on an LED. This method will not in fact work for many high intensity LEDs. Mr Stenning also described the semiconductor material used in LEDs as silicon. This was presumably a slip of the pen as I'm sure he is aware that LEDs are actually manufactured from a wide variety of more complex semiconductor materials such as GaAsP.

Andrew Chadwick
Hull

A Case for Engineering Design

My letter regarding the standard of the projects in EIA, published in the May issue, certainly seemes to have stirred a reaction, particularly from Mr Coggins whose project was the subject of some of my criticism. I did not intend to imply that his circuit was a 'Heath Robinson' creation, simply that I felt there was room for improvement. Although Mr Coggins and Mr Stenning's letters in the June magazine raise many issues that deserve a reply, I will restrict myself to two points.

Mr Coggins may be happy with his personal philosophy of 'if it works it's OK" but he ought to be aware that the engineering world operates on different principles. Good design is characterised by achieving the required results with the minimum of resources. Unnecessarily exceeding specifications is as reprehensible as not meeting them. My objection to using a second 4066 IC was that it would give no significant increase in performance. Neither Mr Coggins nor Mr Stenning bothered to quantify the improvement, simply stating that it must be worth the cost of forty pence for the IC. However on this basis why not increase the value of the amplifier coupling capacitors by a factor of ten for instance? That would certainly increase the bandwith which is surely another improvement in performance at little cost.

Mr Coggins also seems to have a problem with what he calls the 'classical' approach. If by this he means a theoretical and analytic approach to circuit design then I quite agree. Engineering design in any field is about solving real problems and consequently often relies heavily on sensible approximations and rules of thumb in situations where the theoretical equations are insoluble. However this balance of theory and practice is not the same as blind experimentation which Mr Coggins seems to champion as a path to innovation. Innovation comes from people asking informed questions and not being satisfied with something that simply works.

Andrew Chadwick
Hull

A 10 bit Datalogger?

I am writing for some advice after reading your datalogger project in the April edition of EIA. Since reading the project I have set out to build a water quality datalogger, based on your own design.

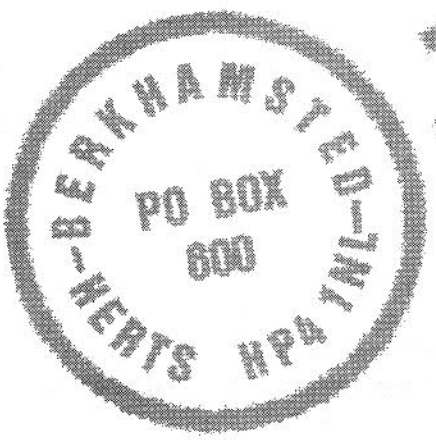
The datalogger will be connected to eight probes which will store data from water samples collected from the waste disposal sites which we operate. The data collected will act as a guide to the level of pollution in and around these sites. For the record, below is a list of the eight probes which I am currently researching

	Criteria	Units	Probe Type
1.	Temperature.	Centigrade.	Thermistor.
2.	pH.	no units.	Combination electrode.
3.	Conductivity.	us/cm	Cell.
4.	Ammonium.	mg/l or PPM.	Ion selective electrode
5.	Chloride.	mg/l or PPM.	Ion selective electrode.
6.	Potassium.	mg/l or PPM.	Ion selective electrode.
7.	Nitrate.	mg/l or PPM.	Ion selective electrode.
8.	Dissolved oxygen.	mg/l or PPM.	Ion selective electrode.

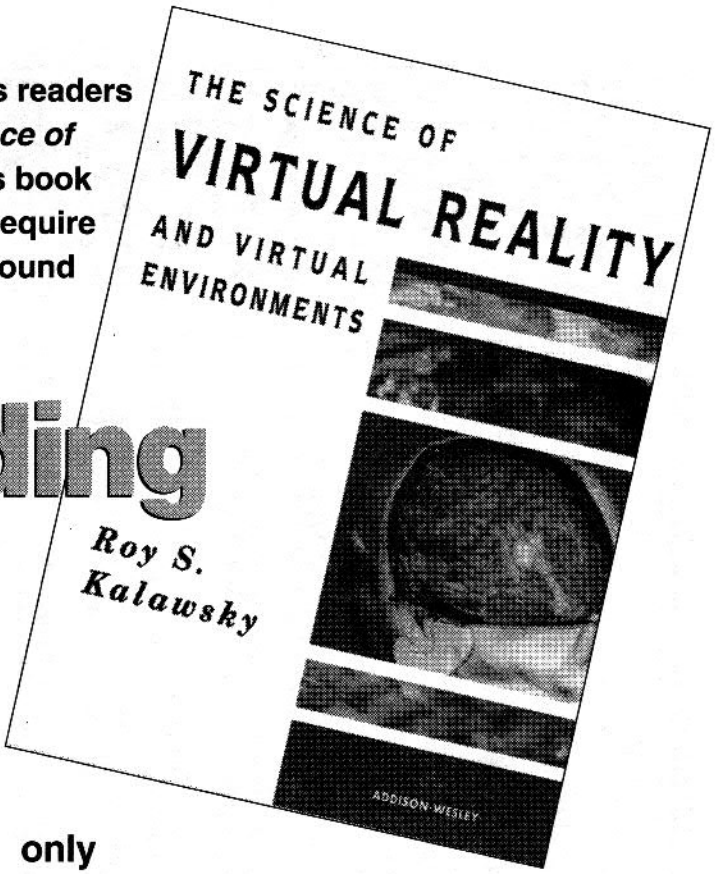
I have built your system as a guide and now wish to improve this to a 10 bit system to achieve a greater degree of accuracy. Can you recommend a 10 bit ADC which will easily act as an upgrade for the system? If you can, any advice on alterations to the circuit and the program will be much appreciated.

Gavin Lonsdale
Lincwaste Ltd.
Lincoln

It is great to see our projects are finding many real applications. No doubt Dr Pei An will reply. -Ed.



Electronics in Action is pleased to offer its readers Roy Kalawsky's fascinating book - ***The Science of Virtual Reality and Virtual Environments***. This book provides a wealth of material for those who require a thorough scientific and engineering background in Virtual Reality whether they be scientist, engineer, student or layperson.



Virtual Reading

Professor Roy Kalawsky is head of the British Aerospace Virtual Environment Laboratory

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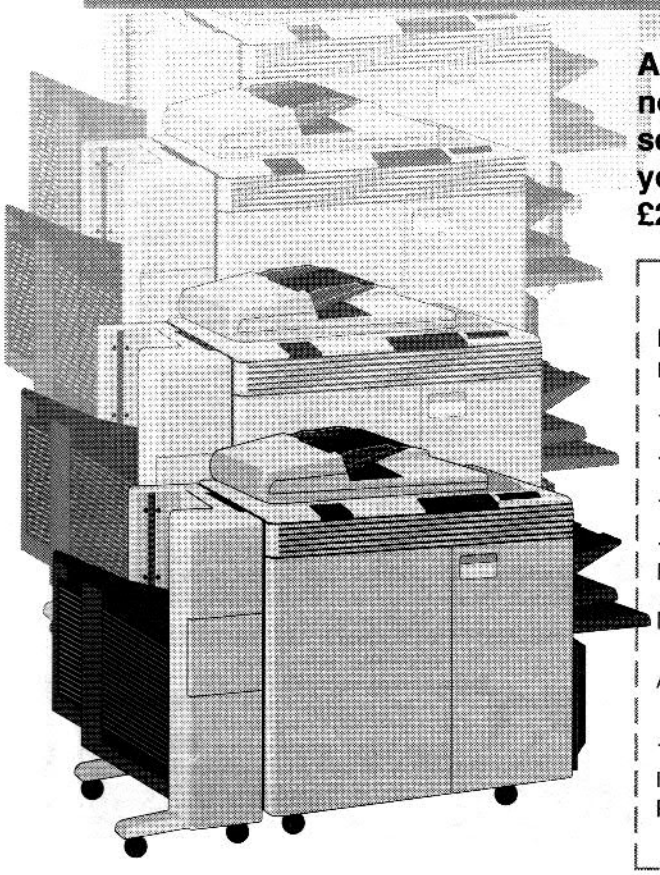

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1.0	–	–	£0.05	£0.06	£0.15
2.2	–	–	£0.05	£0.06	£0.18
4.7	–	–	£0.05	£0.08	–
10	£0.05	£0.05	£0.06	£0.08	£0.44
22	£0.05	£0.05	£0.09	–	–
47	£0.06	£0.06	£0.11	–	–
100	£0.06	£0.09	£0.11	–	–
220	£0.09	£0.12	£0.31	–	–
470	£0.15	£0.19	£0.67	–	–
1000	£0.22	£0.29	–	–	–
2200	£0.37	£0.57	–	–	–
4700	–	£1.11	–	–	–

ELECTROLYTIC AXIAL CAPACITORS

µF	16V	25V	63V	100V	450V
0.47	–	–	–	£0.15	–
1.0	–	–	£0.10	£0.10	£0.19
2.2	–	–	£0.10	£0.10	£0.22
4.7	–	£0.09	£0.10	£0.10	£0.34
10	–	£0.12	£0.12	£0.12	£0.48
22	–	£0.09	£0.13	£0.17	£1.06
47	£0.10	£0.11	£0.16	£0.20	–
100	£0.10	£0.13	£0.21	–	–
220	£0.13	£0.18	£0.42	–	–
470	£0.21	£0.24	£0.69	–	–
1000	£0.33	£0.40	£1.05	–	–
2200	£0.52	£0.64	–	–	–
4700	£0.90	–	–	–	–

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LM381	£2.70
LM386	£0.48
LM387	£1.60
LM392N	£0.79
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*Supplied on mounting plate with terminal posts

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			Copper Clad	Uncoated
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25 Pin	£0.48	£0.50
9 Way plastic cover		£0.30
15 Way plastic cover		£0.33
23 Way plastic cover		£0.36
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DPDT CO Toggle	£0.76
DPDT CO Toggle (biased)	£1.20
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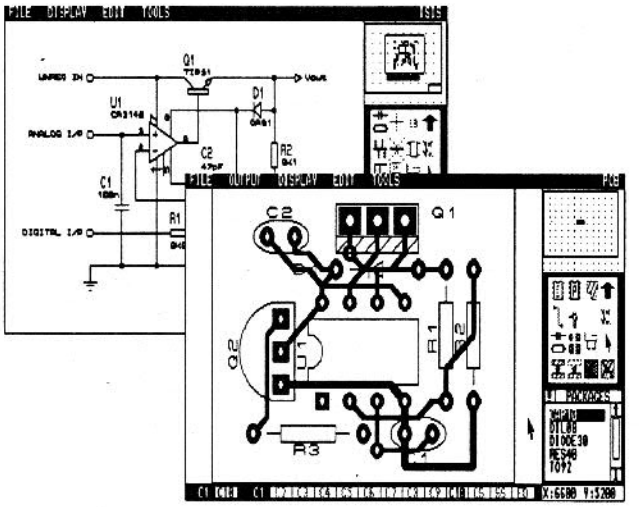

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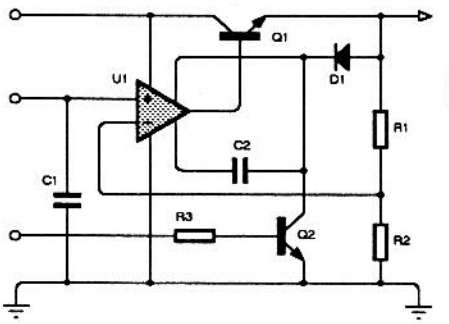

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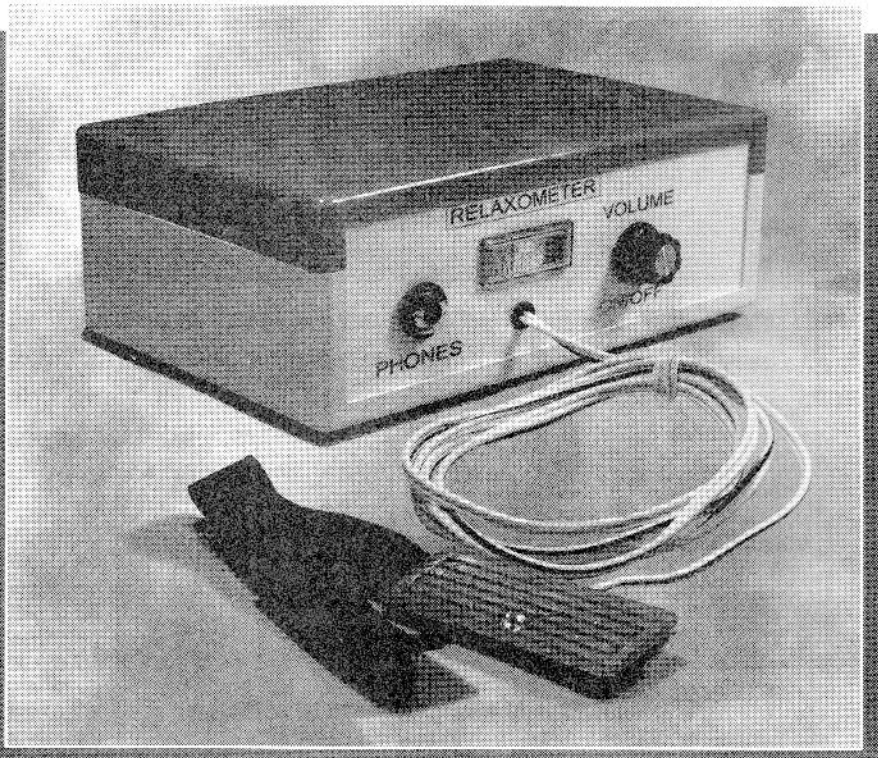
The kids are screaming, the car is broken, the garage is leaking and the fridge has decided to shut down! What do you do? Easy - plug yourself into...



the Relaxometer

a handy Biofeedback device by David Arlan

The general idea of this project is that, by means of an audible tone (and visually, by means of a meter), the machine indicates how relaxed you are. The user then tries to bring his or her state of relaxation under conscious (rather than automatic) control, guided by the pitch of the tone and to a much lesser extent, by the reading on the meter. Using the machine regularly over a period of time, the user would hope to reduce their general level of tension and stress. One of the main features of the design is the use of an 'aural illusion' - the sound equivalent of an optical illusion.

Normally, if a person is in a relaxed state, the skin on the palms of the hands would be dry, whereas under stress, the skin would be damp or clammy. A dry hand allows electric current to be conducted only with difficulty - it has a high electrical resistance, whilst under stress, moisture on the hand allows electric current to be conducted more easily; it has a lower electrical resistance. The Relaxometer measures the resistance of a hand by means of metal electrodes, which remain firmly connected to the hand using an elastic and Velcro attachment. A small, fixed voltage (of 1 volt) is applied to the electrodes and the resulting, small, electric current is then measured and controls the pitch of the tone and also the meter reading.

The circuit described here is capable of measuring skin resistance over a very wide range (without any need for manual range switching) all at a very high sensitivity. The sensitivity is such that, extremely small changes in stress or relaxation, of which the user may not be consciously aware, are accurately indicated by a change in pitch from the loudspeaker. In other words, the machine can indicate a move towards relaxation or conversely, getting more stressed even though the user might not immediately be conscious of it.

The Relaxometer has a very wide, metered, skin-resistance range of 1K to 8M, though it is actually capable of measuring resistance from about 100 to tens of megohms (but at reduced accuracy). The metered resistance range of 1K to 8M, however, was thought to be perfectly adequate for normal use: anyone with a skin resistance of less than 1K probably needs to seek professional medical help and a skin resistance over 8M would indicate that the user was past all help, medical or otherwise!

The sensitivity of the Relaxometer has been set at about 15 octaves change in pitch of the tone, (up or down), for each halving or doubling in skin resistance, (respectively) and the meter has been calibrated with a logarithmic scale

Fig.1 Block diagram

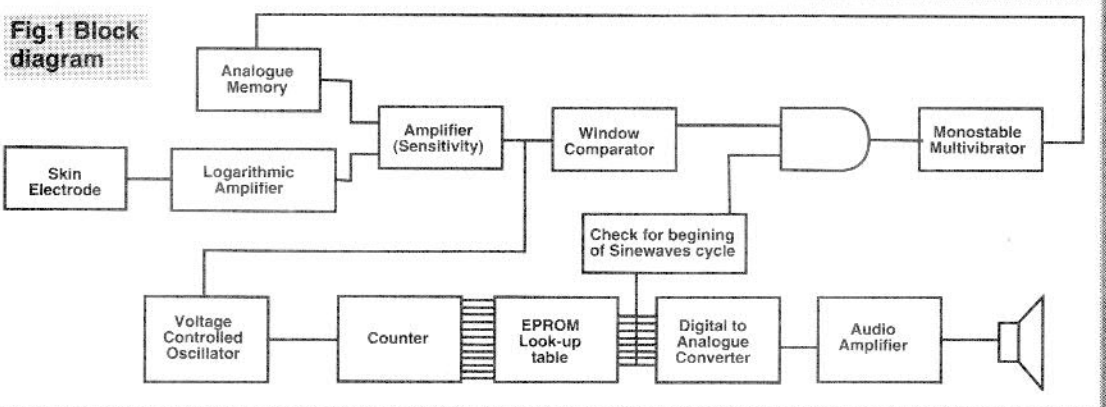
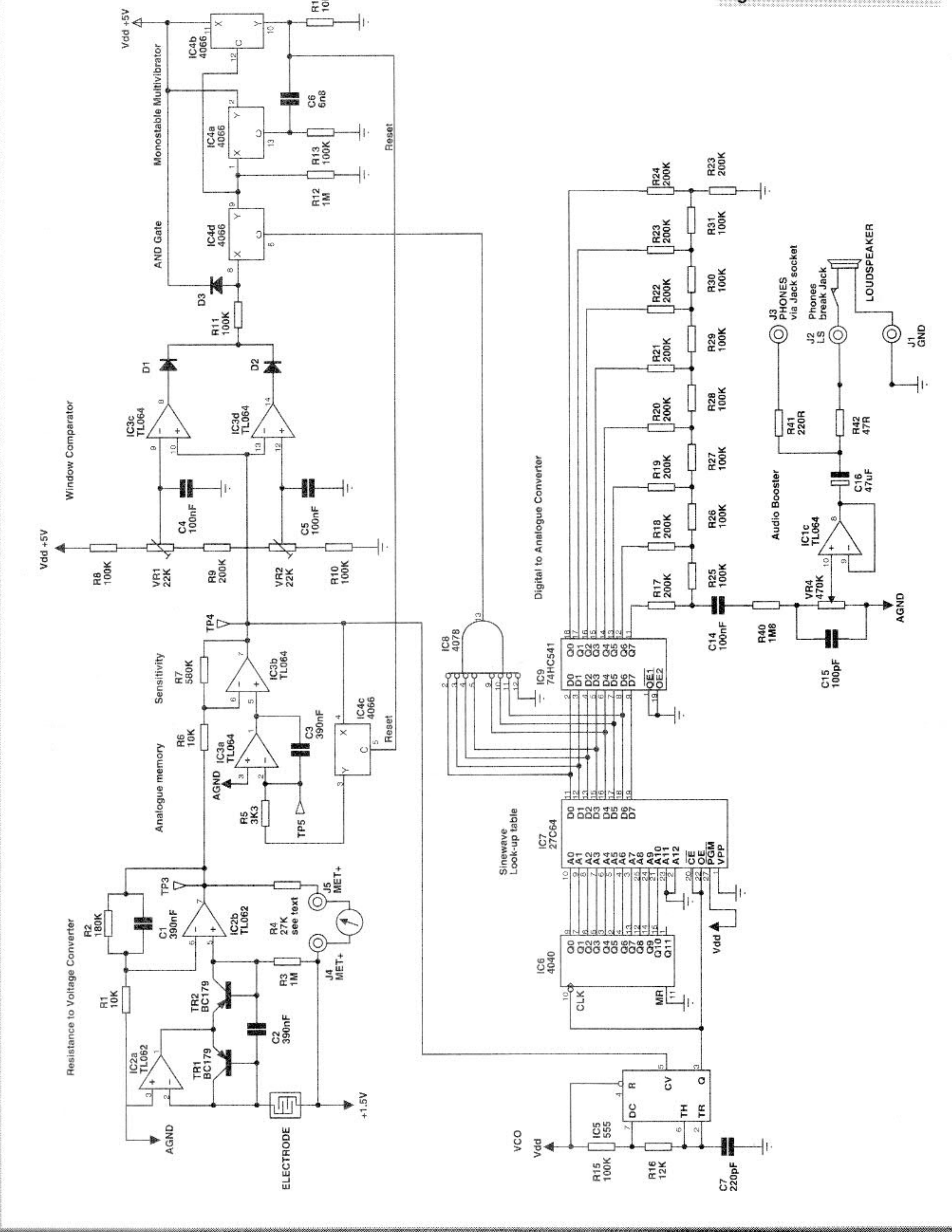


Fig.2 Relaxometer circuit



- each graduation on the scale indicating a factor-of-two resistance change. For example, if a person's skin resistance changed from 100K to 200K, the sound coming from the loudspeaker would fall by 15 octaves in pitch, a frequency ratio of $2^{15}:1$ (=32768:1) and the meter pointer would move by one division downwards on the scale. Since the Relaxometer can measure resistance over a range of 1K to 8M, (a ratio of $2^{13}:1$), to get this sensitivity over such a wide resistance range would require, with normal circuits, (i.e. without the aural illusion to be described) an audio oscillator capable of changing over a frequency ratio of $2^{195}:1 = 5 \times 10^{58}:1$ and would very quickly be inaudible (ultrasonic) even if it were possible to build such an oscillator.

Helical Pitch

The aural illusion is based on an idea by B. Herbert which he called 'helical pitch'.

The graphs below are Fourier analyses of an idealised helical pitch generator, showing how the aural illusion works. The output from the generator consists of many pure sine waves, added together, and sounded simultaneously.

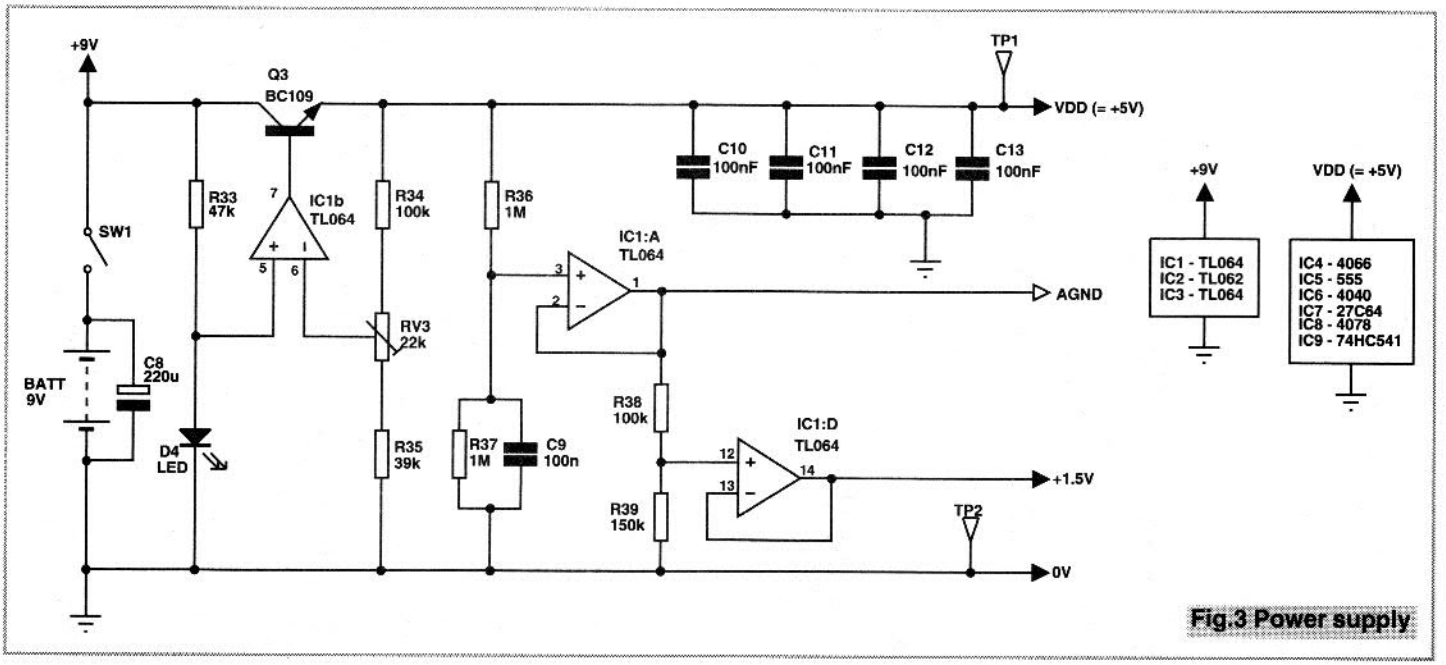
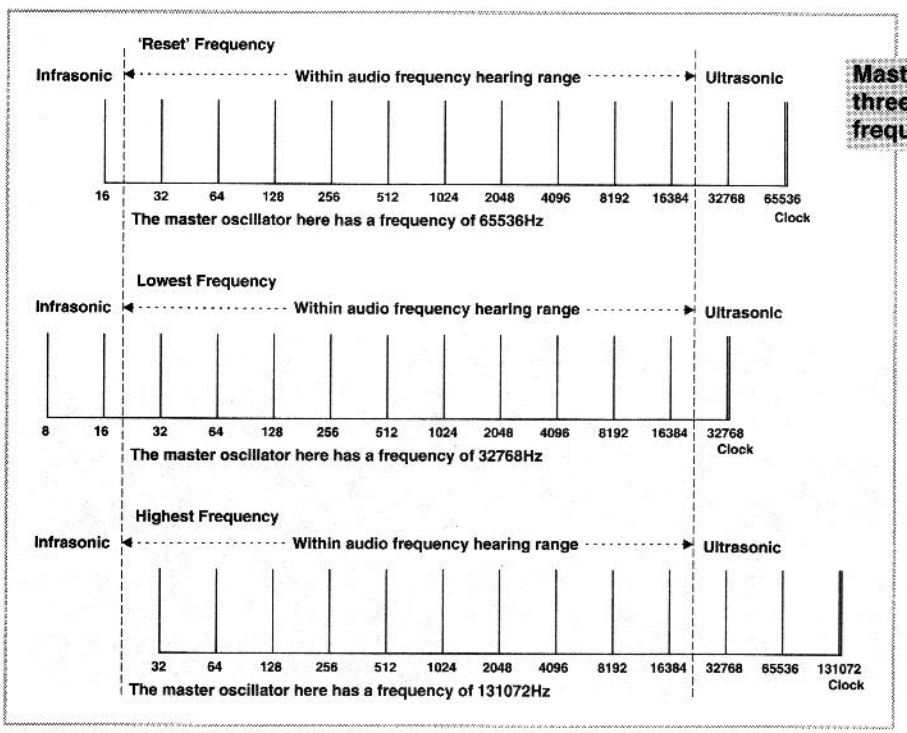


Fig.3 Power supply

Each of the sine waves has a frequency set exactly a factor of two (twice and half) the frequency of its neighbours on each side. The sine waves are 'locked on' to a continuously-variable master oscillator - as the frequency of the master oscillator is changed, all the sine waves change exactly in step. The graphs show the results of setting the master oscillator at three different special frequencies: the first - the reset frequency - at 65536Hz; the second - the lowest frequency used - exactly one octave lower, at 32768Hz; the third - the highest frequency used - exactly one octave higher, at 131072Hz. The frequency limits of hearing are usually taken to be within the range 20Hz to 20000Hz, and these limits are shown in each of the three graphs as dotted lines. All of the frequencies outside these limits, therefore, are inaudible. It can be seen that, even though the master oscillator has been set at three different (special) frequencies, the sound actually audible (which has frequency components contained within the dotted lines) is the same in each case.

Here's an example of what would happen in practice. Starting at the reset frequency of 65536Hz, the continuously-variable voltage-controlled master oscillator mght increase its frequency steadily. Eventually, it would reach the maximum frequency exactly one octave (twice the frequency) higher, at 131072 Hz. Immediately it had reached this frequency, it would automatically be switched to the reset frequency, exactly one octave lower, and would continue to rise as before. Since the sound is exactly the same at the 'reset' and at the maximum frequencies, there would be no audible break, and the pitch of the sound would appear to be rising continuously. A similar process would occur if the pitch of the sound were decreasing, except that the switching (trigger) point would occur at the lowest frequency, exactly one octave below the 'reset' frequency.

For the actual Relaxometer circuit, I used lowest, reset, and highest frequencies of 35 kHz, 70 kHz and 140 kHz, respectively and these gave good results. I used only 11 terms of sine waves in the prototype with frequency ratios of 1:2:4:8:16:32:64:128:256:512:1024. These were worked out on my computer, using a program written in MS-DOS QBASIC and the binary-weighted results were loaded into an EPROM, (Erasable Programmable Read Only Memory) using an EPROM programmer. The EPROM operates as a 'look-up' table. I used a 27C64 (8k X 8) EPROM but only 2048 bytes of memory are programmed for the Relaxometer. Since only 2048 bytes are used, the 'sine' waves at the higher frequencies are synthesized using only a few distinct voltage levels - for instance, the highest frequency has only two distinct states. However, even at the lowest clock frequency used, (35 kHz), all the harmonics of this are ultrasonic, so in practice this doesn't matter very much.



Master oscillator at three different frequencies

The Works

The operation of the complete circuit can be broken down into several simple, fairly standardised building blocks.

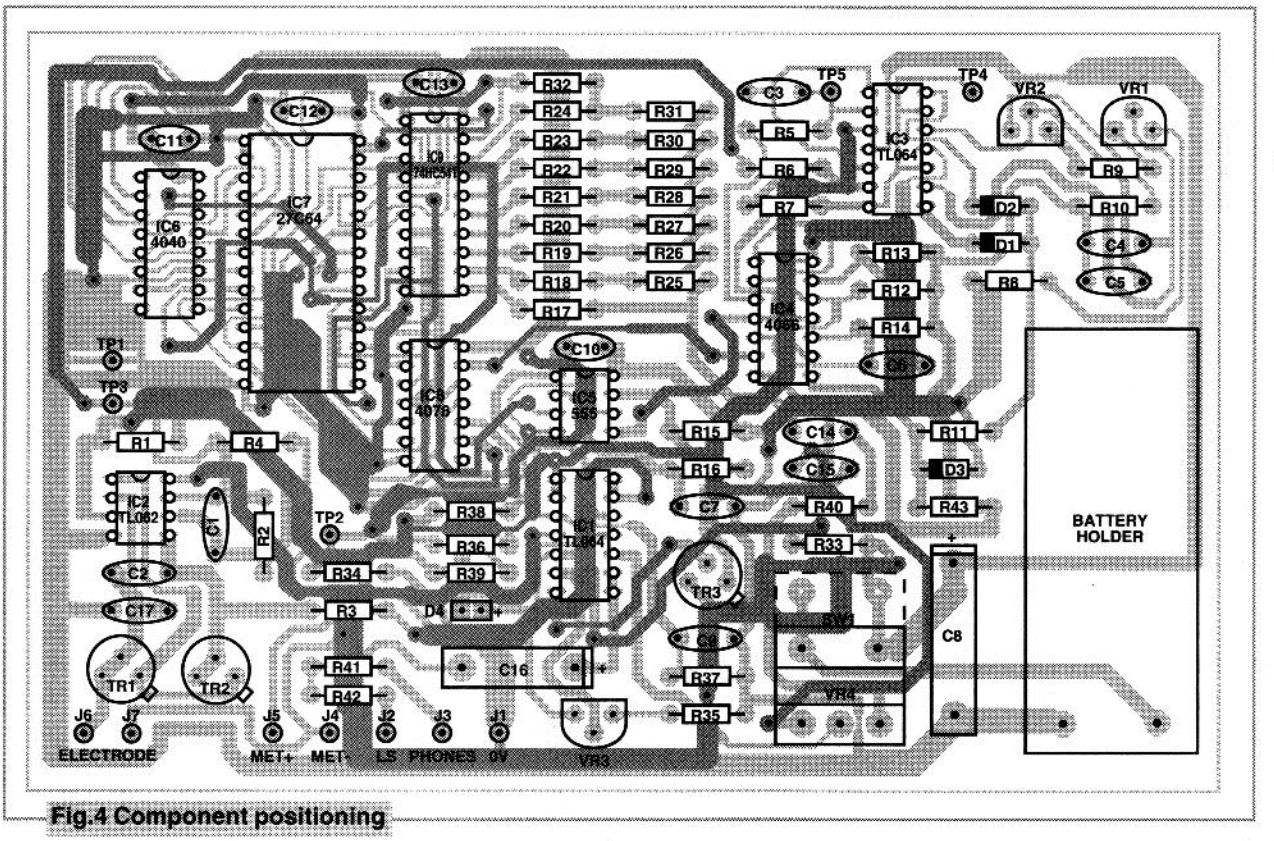


Fig.4 Component positioning

Logarithmic Skin-resistance to voltage converter

For a skin resistance of 1M, the ELECTRODE and R3 are balanced, and, assuming that PNP transistors Tr1 and Tr2 are a matched pair, the voltage at the output of IC2b should be at AGND (Analogue Ground). I used matched BC179 transistors here but almost any small-signal, matched silicon transistors would do. For each halving or doubling of skin resistance, the voltage across Tr1 (base-emitter) rises or falls by about 18mV respectively, and the voltage at IC2a output rises or falls (relative to AGND) by the same amount. This increasing or decreasing voltage is passed on to the non-inverting input of IC2:B via Q2, which maintains an almost constant voltage drop across its own base-emitter junction. IC2:B is connected as a non-inverting amplifier with a gain of about 19, therefore a change in resistance by a factor of two results in a voltage change at IC2:B output of about 1/3 volt.

Analogue Memory (Sample and Hold) Block

Assume that the 'reset' line is high, which closes the CMOS switch IC4:C.

IC3:B output (pin 7) will reset to AGND (analogue ground). IC3:A output (pin 1) will copy the output of IC2:B.

When the CMOS switch is opened by the reset line going 'low', low-leakage capacitor C3 will hold, (i.e. memorise) at IC3:A output the voltage which was previously present at the output of IC2:B.

Now that the switch is open, any change at the output of IC2:B will be amplified (and inverted) by op-amp IC3:B, which, together with resistors R6 and R7, is connected to have a gain of 56 times.

Window Comparator

If the output of IC3:B goes higher than 3.75 volts (= 3/4 VDD) or lower than 1.25 volts (= 1/4 VDD), then the output of window comparators IC3:C or IC3:D (respectively) will go 'high'.

AND' gate, IC4d

CMOS switch IC4:D is connected as a logic AND gate, and its purpose will be explained later.

Monostable Multivibrator using IC4a and IC4b

These CMOS switches are connected as a monostable multivibrator. A positive-going voltage applied to IC4:A (pin 1) results in a single positive-going voltage pulse of about 500 µs uration at IC4:B pin 10. This resets the circuit. The circuit has a 'snap' action and would be quite useful for other circuits provided that the length of the pulse needn't be precise. The output pulse duration, in this circuit, is by no means critical, but it MUST be longer than the time taken for the 'reset' circuit to settle (i.e. more than about 100 µS.)

Voltage Controlled Oscillator

IC5, the 555 (CMOS) timer/oscillator is connected as a VCO. A positive-going input ramp voltage (at pin 5) changing from 1/4 VDD (1.25V) to 1/2 VDD (2.5V) to 3/4 VDD (3.75V) produces a negative-going frequency sweep at its output (pin 3) ranging from 140000Hz to 70000Hz to 35000Hz respectively.

Counter IC6, 4040 and Look-up table EPROM IC7

This provides 2048 incremental addresses for the EPROM.

The first 2048 address locations of the EPROM contain the binary-weighted results of adding together the sums of 11 terms of sine waves, each subsequent (ascending-value) term being a factor of two higher than each previous term. i.e. the sine waves have a frequency sequence of:-

1 : 2 : 4 : 8 : 16 : 32 : 64 : 128 : 256 : 512 : 1024

The EPROM is switched 'on' for only 2 µs at a time by the V.C.O., and this saves battery power. The whole circuit uses about 5 mA and a PP3 9 volt battery makes a suitable power source. The prototype works down to a battery voltage of about 6.5 volts.

Digital to Analogue converter IC9 is a buffer and its purpose is to hold the values of the output of the EPROM when the latter is switched off (which is most of the time). Its correct operation relies on the fact that there is a (rela-

tively) large amount of capacitance associated with IC7 outputs/IC9 inputs which holds the output voltages of IC7 virtually at the positive (+5V) power rail when IC7 is in its 3-state 'off' mode.

The buffer is followed by a simple R-2R type digital to analogue converter which proved to be perfectly adequate in this particular application. This D/A converter has the advantage of using very little battery power compared with dedicated converters such as the ZN426 (a low-power IC D/A converter) uses as much current (5mA) as the whole of the Relaxometer circuit.

NOR gate IC8

The purpose of this is to check the output of the EPROM for the digital code word '128' (decimal), which is the first digital value of the waveform. (It would also check for zero, but it has been 'fixed' that zero never occurs in the EPROM. The circuit therefore only resets when the window comparator limits are exceeded AND when the NOR gate detects the decimal number 128, and these occur only at the beginning, and exactly half way through the sum-of-sinewaves waveform cycle. Without this refinement, the circuit makes a clicking sound when it resets.

Power supply

This is a standard stabilised power supply powered by a PP3 battery. The reference voltage is any red-coloured LED. The power supply has to be capable of supplying steady currents of about 5mA and short-duration (2us) peak currents of about 20mA (for the EPROM), and virtually any low/medium power NPN transistor could be used for Q3.

Audio amplifier

IC1c boosts the power from the digital-to-analogue converter to drive a small loudspeaker or headphones. C15 provides a top-cut tone control and could be omitted if desired.

Construction

The circuit is built on a double-sided printed circuit board measuring 6-1/4" by 4" and fits neatly into a Vero type 215 case, measuring 7" X 4" X 2-1/2". If you decide to make your own PCB (ready made PCBs are available from our At Your Service page) then the (51) through-via links should be soldered in (on BOTH sides of the PCB) first. Next, solder all the resistors, followed by the non-electrolytic capacitors. The diodes should be soldered next. Make absolutely sure to connect these the right way round. In order o identify the anode (+ve) lead of the light emitting diode, this is often shortened, relative to the cathode (-ve) lead, by the manufacturers. The various connector-pins (J1 to J7) and test-point pins (TP1 to TP5) can be soldered next. I used integrated circuit holders in the prototype to hold the I.C.s and these should all be orientated so that pin 1 is nearest to the back of the PCB. It would certainly be advisable to use an IC socket for the EPROM (IC7). If you solder the ICs directly to the PCB then be very careful to avoid damaging them by static electricity. In any case, it would be best to leave the EPROM (IC7) and the 74HC541 (IC9) unsoldered or disconnected until the VDD power line has been correctly adjusted to 5 volts by RV3. The electrolytic capacitors can now be soldered in, taking care to connect them the correct way round. The PP3 battery holder can now be soldered.

Setting up

Before switching on the machine, turn preset RV3 (VDD adjuster) fully anti-clockwise to ensure that VDD is below 5 volts. Connect a test meter between TP1 (0 volts) and TP2 (VDD). Turn on the power and adjust RV3 clockwise until the test meter reads +5 volts. IC7 and IC9 can now be inserted/soldered.

Connect a suitable meter (about 100uA FSD) to solder pins J4 (meter negative) and J5 (meter positive). The connecting wires need to be about 4" long. Connect the loudspeaker to solder pins J1 and J2, using wires about 8" or 9" in length. All connector pins are located on the front of the PCB. Temporarily connect a 120K fixed resistor between J6 and J7 to simulate a remarkably-steady skin resistance.

Turn on the power/volume control and adjust the volume to a comfortable level.

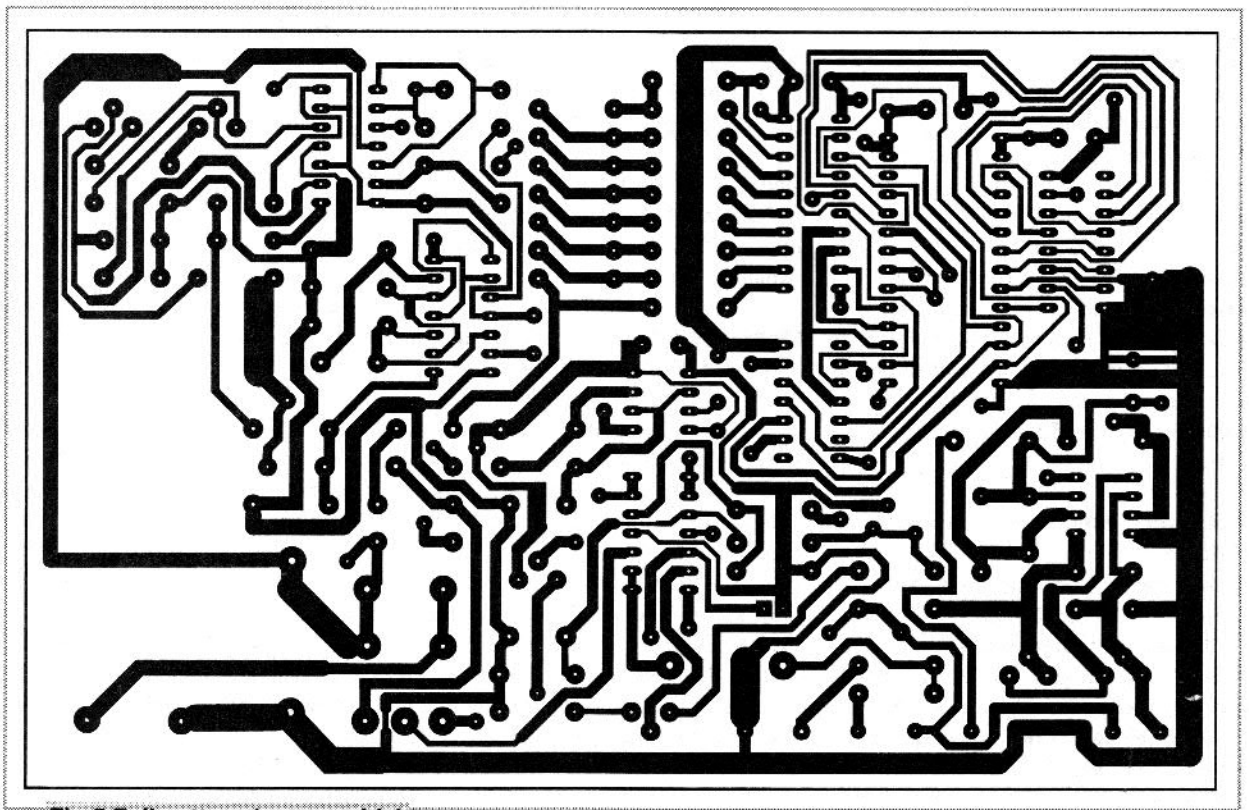
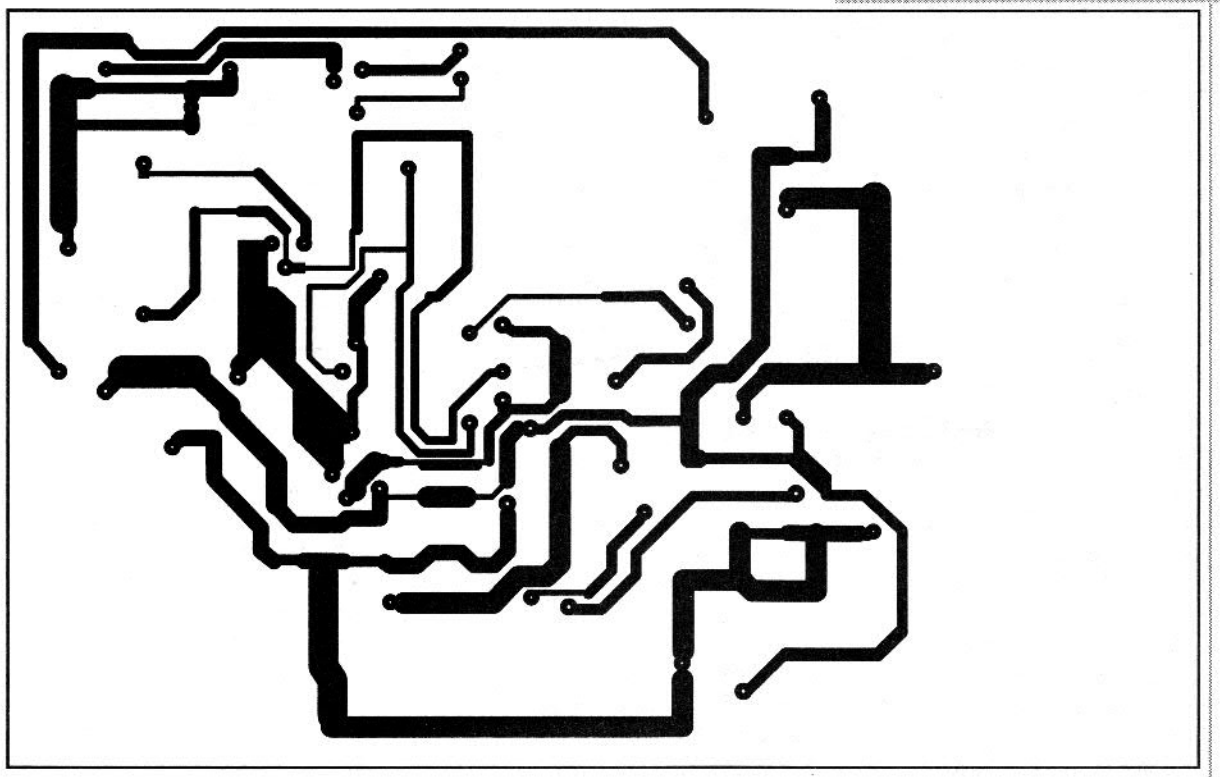


Fig.5 Foil pattern (copper side)

Fig.6 Foil pattern (component side)



The reading on the meter should be about 1/2 FSD, or marking '7' if you have calibrated the small panel meter between 1 and 14. It will probably be necessary to alter the value of R4 (56K) to achieve this reading. Effectively, R4, the meter series resistor, has to be adjusted so that the meter can read between 0 and 4 volts full scale.

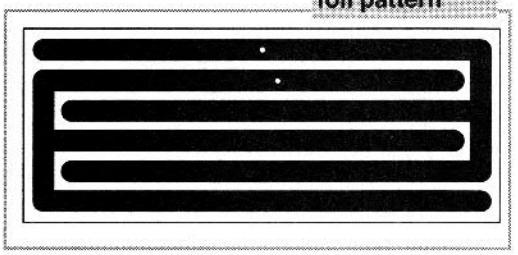
Connect the temporary 'set up' circuit (see diagram) to TP1 and TP2 and the slider of the 100K pot to TP5. This circuit sources or sinks current into or out of IC3a inverting input and simulates a steadily increasing or decreasing skin resistance (without affecting the meter reading).

The pitch of the sound from the loudspeaker should be either rising or falling, the rate of which depends on the position of the 'set up' potentiometer. Turn this pot (one way or the other) until the pitch of the sound is falling at a fairly slow rate (say, one octave every five seconds). You will probably hear a 'jump' in the sound as the circuit resets every octave. Adjust RV1 until the 'jump' in the sound disappears. In other words, the pitch of the sound should appear to fall indefinitely with no apparent gaps. Now, turn the 'set up' pot the other way until the pitch of the sound rises slowly. This time, adjust RV2 until the pitch of the sound appears to rise continuously. This completes the setting up.

The Front Panel.

Drill the front panel holes to size as shown in the diagram. The main difficulty will be cutting out the rectangular hole for the meter. Probably the best way to do this is to drill several small holes near to the edge of the rectangular marking and then to file away the remaining metal to the required size. A paper overlay can then be fixed to the drilled panel.

Fig.7 Electrode foil pattern



The Skin Electrode.

The skin electrode comprises a small single-sided PCB on which are etched two non-touching comb-like copper tracks. A flexible twin-wire cable connects to either track. The electrode is placed so that the copper side of the PCB is against the palm of one hand and is kept firmly in place by means of an elastic-and-Velcro arrangement.

Making the Skin Electrode

In order to stop any oxidation of the copper electrode surface duing use, it is best to tin it beforehand - simply melt and spread a small amount of solder onto the copper surface using a soldering iron. The twin connecting cable needs to be about 4 ft or so in length. Remove about half an inch of insulation from the end of the cable and feed the copper ends through the back of the electrode PCB and solder each of the bared wires to the copper-electrode side, removing any excess wire. The cable should then be glued (at right angles) to the back of the electrode PCB. Cut off a length of about 9" by 3/4" elastic and stick this to the back of the electrode PCB, over the cable. Cut off a 2-1/2" length of Velcro and stick the smooth side of the Velcro on top of the elastic. Stick the smooth side of the 'other' half of the Velcro at the other end of (but on the opposite side of) the elastic. The non-electrode end of the twin cable needs to be fed through the hole in the front panel and its ends soldered to J6 and J7 on the main PCB.

Fitting the loudspeaker

Carefully drill small holes in the lid of the Vero box (to let the sound out) and glue the loudspeaker directly under these holes. Use a length of twin connecting cable to connect the speaker to the corresponding speaker pins on the front of the PCB.

Using the Relaxometer

For best results, wash and thoroughly dry your hands. Make sure that the metal surface of the electrode is clean and dry. Attach the hand-electrode to (either) hand in such a way that the metal sur-

face is face down against the palm of the hand, just below the bottom of your fingers as shown in the diagram. The flexible insulated cable can be placed between the two middle fingers. Taking the elastic (attached to the hand-electrode) around your hand, join the two pieces of Velcro. The hand-electrode needs to be 'comfortably tight' against the skin. It doesn't need to be very tight.

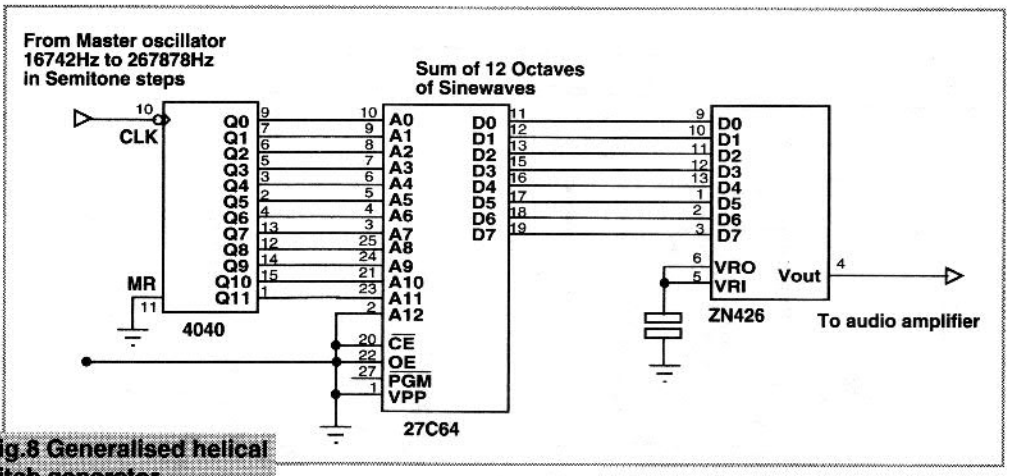


Fig.8 Generalised helical pitch generator

Turn on the machine and adjust the volume to a fairly low audible level. The sound can become irritating if it is adjusted to too high a level. It will take a few seconds for the sound to settle.

With the fingers of your free hand, press the hand-electrode against the palm of the other hand, slowly and gradually increasing the pressure. You should hear that the pitch of the tone rises quickly as you increase the pressure. The increase in pressure improves the electrical contact between the electrode and the hand, reducing the electrical resistance. This makes the pitch of the tone go up. Now, slowly and gradually release the pressure on the electrode. You should hear that the pitch of the tone goes down. It is important to remember, whilst using the Relaxometer, to keep the hand absolutely still, otherwise the machine will give confusing indications.

With the machine switched on and the hand-electrode attached, lie down on your back or sit in a comfortable chair. You may wish to note the meter reading at this point. Close your eyes. Just to prove to yourself that the machine really does work, think strongly of something stressful! You should hear that the pitch of the tone rises very rapidly. Now, think of something relaxing. You should hear that the pitch of the tone falls as you do so. Unfortunately, it's much more difficult to become relaxed than to become stressed, so the pitch of the tone is likely to fall at a slower rate than when it rises. Do whatever-is-necessary to keep the pitch of the tone falling. You will probably find that the maximum length of time that the pitch of the sound falls is about ten minutes and after this time, the tone will start to rise and to keep on rising whatever you do. The reason for this is (probably) that the electrode itself traps any moisture on the hand. Slip your hand out of the electrode assembly and wipe clean your hand and the electrode with a paper tissue or by other suitable means. Probably, using the Relaxometer for two, ten-minute relaxtion 'sessions' each day would prove to be beneficial.

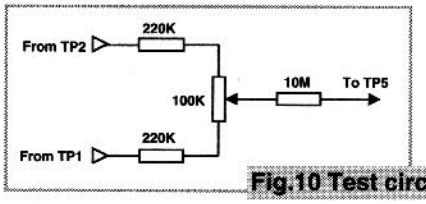


Fig.10 Test circuit

Other applications and experiments with 'Helical' pitch

A generalised helical pitch generator can be built and its circuit diagram is as shown. One application might be as a new sound for a music synthesizer. A master oscillator on the synthesizer might generate frequencies (at semitone intervals) between, say, 16742.4 Hz and 267878.4Hz, which divide down by powers-of-two to middle C' (= 261.6Hz). This would give a range of four octaves of helical pitch. Although the musician would play the synthesizer over a four-octave range, the sound would appear to be contained within a one-octave range. Playing a musical scale, for instance, over four octaves, the pitch of the sound would appear to be going round and round within one octave.

The EPROM might be programmed with the sum-of-sinewaves sequence 1:1.5:2:3:4:6:8:12:16:24:32:48:64:96:128:192:256:384:512:768:1024

The ratio between the 1st and 2nd; 3rd and 4th; 5th and 6th terms etc. - which have frequency ratios of 1:1.5 (or 3/2) is called a perfect fifth, and that between the 2nd and 3rd; 4th and 5th; 6th and 7th terms etc. - have frequency ratios of 1.5:2 (or 4/3) and is called a perfect fourth. Since the helical pitch generator produces all audible octaves of these frequencies, a peculiar effect is produced, because the brain cannot tell whether the musical interval sounded is a perfect fourth or a perfect fifth - the sound appears to switch between the two intervals. A corresponding optical illusion effect is produced when a 3D object, such as a cube, is drawn in two dimensions on paper. The brain cannot decide whether the 'cube' has six faces, the apex being nearest to the viewer, or three faces, the apex being furthest away from the viewer. The optical illusion, in the case of a cube, occurs because the 'whole' (3D) has been reduced to a 'part of the whole' (2D), whilst the aural illusion in helical pitch occurs because only a part of the audible spectrum (20Hz to 20kHz) is apparent to human

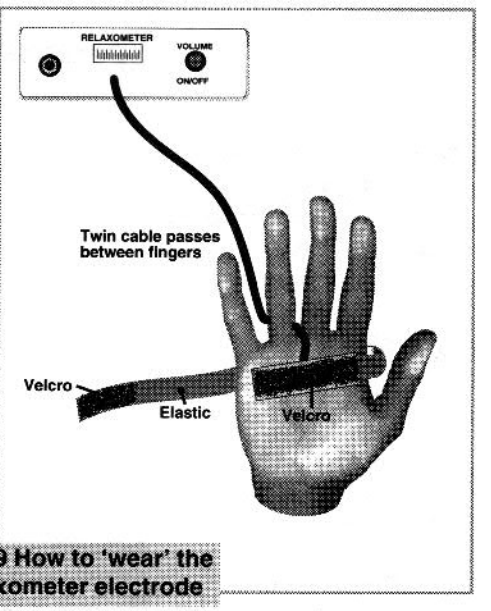
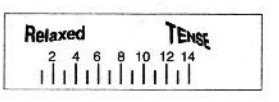


Fig.9 How to 'wear' the relaxometer electrode

Fig.11 Meter face



hearing -the illusion might not work for dogs or bats or small children!

Hard to get parts

The rectangular-faced panel meter is often sold as a VU meter and is often calibrated with a decibel (dB) scale. The size of the rectangular face is 1.35" X 0.55" and requires a front panel cutout of about 1.4" X 0.6". An overlay scale, calibrated from 1 to 14 can be glued over the VU scale and each calibration mark on the scale would represent a doubling or halving in skin resistance. For the Relaxometer project, the readings on the meter are only intended as a rough guide to average skin resistance, and using the machine over a long period of use, (weeks or months, say,) you might notice that the average reading on the meter had changed (hopefully downwards) by one or more divisions. The usefulness of the machine lies in the fact that even minute changes in skin resistance are indicated by the change in pitch of the tone from the loudspeaker and for the most part, the meter can be ignored or even omitted altogether, (in which case the project needs to be renamed a Relaxo!)

Combined potentiometer/switch with PCB pins for both the pot and the switch.

These are quite hard to come by, as the switch part of the combination normally has a mains-type switch (with lugs) rather than a low-voltage switch (with PCB pins). Room has been left on the PCB to accommodate either type, though the all-PCB-pin type is to be preferred.

A suitable, fully-programmed 27C64 EPROM can be obtained from the author, for £5.00 including post and packing, and has four diffeent helical pitch sounds (each using 2048 bytes):

1 A single-note sound as used in the prototype and using frequency ratios of: 1:2:4 ..... 512:1024.

and for experimental use:

2 A chord sound using frequency ratios of: 1:1.25:1.5:2:2.5:3:4:5:6:8 .... etc.

3 A 'perfect fifth/perfect fourth' sound using frequency ratios of: 1:1.5:2:3:4 .... etc.

4 A major third/minor sixth sound with frequency ratios of: 1:1.25:2:2.5:4: etc

The address to send your EPROM order to is: 16 Clewley Grove, Quinton, Birmingham B32 1QZ.

Parts

Resistors

All 100K and 200K resistors and R16 MUST be 1% tolerance. The rest are 5% tolerance. 1% tolerance resistors could be used throughout.

R1,4	56k
R6,14	10k
R2,3,12,36,37	1M
R5	3k3
R7	560k
R8,10,11 R13,15,25 R26,27,28	100K
R29,30,31 R34,38 R9,17,18 R19,20,21 R22,23 R24,32	200K
R16	12K
R33	47K
R35	39K
R39	150K
R40	1M8
R41	220
R42	47
R43	2M7
VR1,2,3	22K vertically mounted presets
VR4+SW1	470K log pot combined with an on/off switch. Ideally, both the pot and the switch should have PCB pins. There are 'extension' holes in the PCB if the switch is a mains power type with eyelets rather than pins.

Capacitors

C1,2 C3,17	0.33uF polyester layer 0.3" pitch
C4,5 C9,14	0.1uF polyester layer 0.3" pitch
C10,11 C12,13	0.1uF ceramic 0.2" pitch
C6	6.8nF polyester layer 0.3" pitch
C7	220pF polystyrene 5% or better
C8	220uF/10V electrolytic axial lead
C15	100pF polystyrene (optional - can be omitted - used for 'top cut' tone control)
C16	47uF/10V electrolytic axial lead

Semiconductors

IC1,3	TL064
IC2	TL062
IC4	4066
IC5	555 (MUST be CMOS-type 555)
IC6	4040
IC7	27C64 or 28C64
IC8	4078
IC9	74HC541
TR1,2	BC179 (or any other general purpose silicon PNP transistor) these should be a matched pair for best results
TR3	BC109 (or any other general purpose low/medium power NPN transistor)
D1,2,3	1N4148 (or any general purpose silicon diode)
D4	LED (use any cheap red Light Emitting Diode)

Additional Components

Main PCB and 'Electrode' PCB

J1,2,3,4,5,6,7	PCB terminal pins
TP1,2,3,4,5	Test Points. Use PCB terminal pins as above
Battery Holder	PCB mounting PP3-type
Loudspeaker	Use any small loudspeaker (4Ù to 64Ù)
Headphone socket	1/4" stereo switched jack socket
Meter	small rectangular-face 50uA - 1mA meter movement size of meter face is 1.4" X 0.6" R4 needs to be adjusted to suit meter sensitivity
Case	verobox type 215
Cable	About 4 feet of twin-wire general-purpose cable to connect the electrode to the main circuit board
Knob	one knob required for ON-OFF switch / VOLUME control

PROGRAM 1

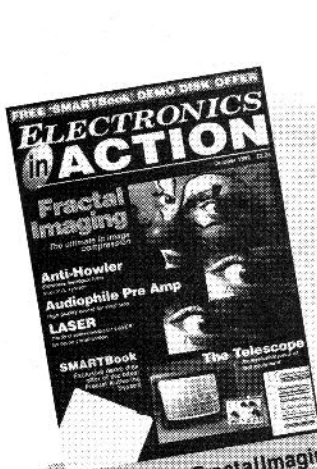
This is the basic program as used in the EPROM within the prototype of the Relaxometer

```
REM *****   RELAXOMETER SUM-OF-SINES WAVEFORM  ******
REM ************************************************
REM    This program works out the sum of the addition of sine waves of
REM    the form   y = sin(x) + sin(2x) + sin(4x) + sin(8x) etc..
REM    and saves them in an ASCII format file onto a hard disk.

      DATA 1,2,4,8,16,32,64,128,256,512,1024

      bytes% = 2048
      n$ = "RELAX.ASC"
      PRINT "Please wait...    Press `ESC'  to exit!"

          OPEN n$ FOR OUTPUT AS #1
          pi# = 3.1415926536#
          radianincrement# = 2 * pi# / bytes%
          angle# = 0: REM all sinewaves start at zero phase angle
          scale = 18.84738: REM scaling factor fits waveform into 255 levels

   FOR address% = 0 TO (bytes% - 1)
          IF INKEY$ = CHR$(27) THEN END
          amp = 0
       FOR g = 1 TO 11
          READ term
          v = SIN(angle# * term)
          amp = amp + v
       NEXT g
          RESTORE
          y = amp * scale + 128
IF y <> 128 AND y > 127 AND y < 129 THEN IF y > 128 THEN y = 129 ELSE y = 127
          y = CINT(y)
          a$ = CHR$(y)
          angle# = angle# + radianincrement#
          PRINT #1, a$;
   NEXT address%

   CLOSE
   END

SUB hex80 :

END SUB
```

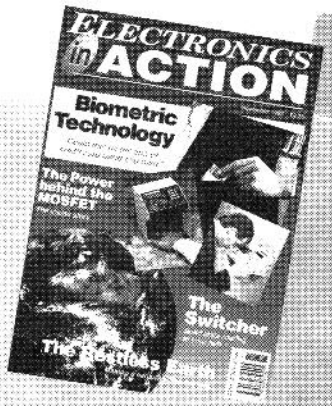
PROGRAM 2

Those of you wishing to experiment with different sounds should use this program

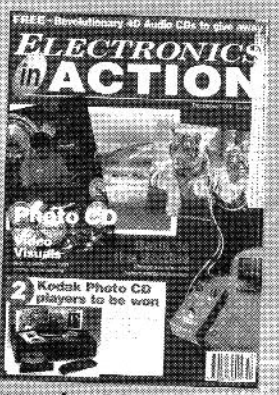
```
REM ******* RELAXOMETER SUM-OF-SINES WAVEFORM *******
REM ************************************************
REM    This program works out the sum of the addition of sine waves of
REM    the form   y = sin(x) + sin(2x) + sin(4x) + sin(8x) etc..
REM    and saves them in an ASCII format file on a hard disk.
REM    The following DATA statement must be altered if you wish to
REM    experiment with different 'helical pitch' sounds.

      DATA 1,2,4,8,16,32,64,128,256,512,1024
      CLS
      scale = 120: REM temporarily sets the size of each separate sinewave

INPUT "How many bytes of memory do you wish to program"; bytes%
INPUT "How many sinewave terms are there in your DATA statement"; terms%
INPUT "Enter filename: use the extension  .ASC (for ASCII) "; n$
PRINT "Please wait...    Press `ESC'  to exit!"

          OPEN n$ FOR OUTPUT AS #1
          LET max = 0
          pi# = 3.1415926536#
          radianincrement# = 2 * pi# / bytes%
          angle# = 0: REM   set starting angle of sum-of-sinewaves. All
                      REM:  sinewaves start at zero phase.
   REM:   the next section works out the necessary scaling factor so that
   REM:   the sum-of-sines waveform can fit within 255 voltage levels

   FOR address% = 0 TO (bytes% - 1)
          IF INKEY$ = CHR$(27) THEN END
          amp = 0: REM the instantaneous amplitude of the sum-of-sinewaves
       FOR g = 1 TO terms%
          READ term
          v = SIN(angle# * term)
          amp = amp + v
       NEXT g
          RESTORE
          amp = amp * scale
          IF amp > max THEN LET max = amp
          angle# = angle# + radianincrement#
   NEXT address%
          LET scale = scale * 127 / max: PRINT : PRINT
          PRINT ; "SCALE WAS FINALLY "; scale; "     Please wait..."
          angle# = 0

   FOR address% = 0 TO (bytes% - 1)
          IF INKEY$ = CHR$(27) THEN END
          amp = 0
       FOR g = 1 TO terms%
          READ term
          v = SIN(angle# * term)
          amp = amp + v
       NEXT g
          RESTORE
          y = amp * scale + 128
IF y <> 128 AND y > 127 AND y < 129 THEN IF y > 128 THEN y = 129 ELSE y = 127
          y = CINT(y)
          a$ = CHR$(y)
          angle# = angle# + radianincrement#
          PRINT #1, a$;
   NEXT address%
     CLOSE
     END
SUB hex80 :
END SUB
```



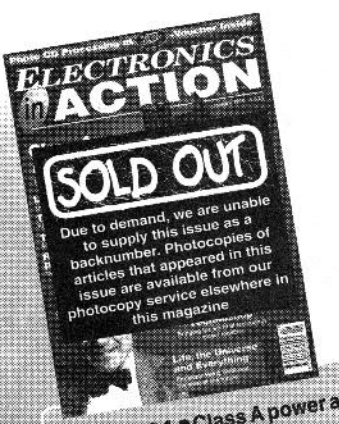
October 93 ● FractalImaging ● The Telescope Pt1 ● Anti-Howler ● Audiophile Pre-amp ● Sine wave generator



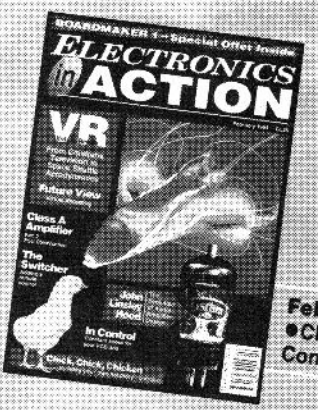
November 93 ● Biometric Technology ● The Switcher Pt1 ● Seismometer Project ● The Telescope Pt2



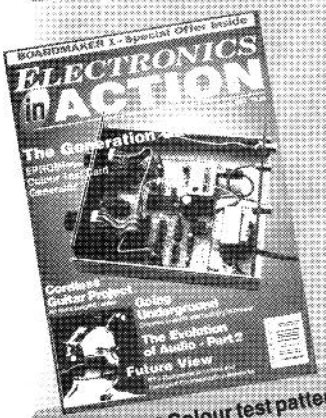
December 93 ● Photo CD ● 4D Recording ● Video editing unit ● Stereo tremolo unit ● The Switcher Pt2



January 94 ● Class A power amp ● The Harmoniser ● Remote control extender ● The Switcher Pt3

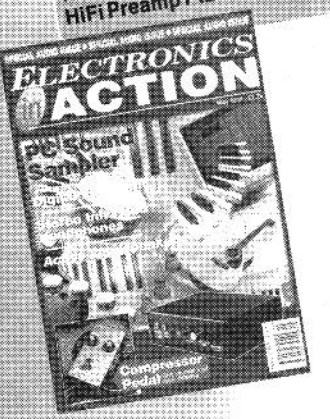


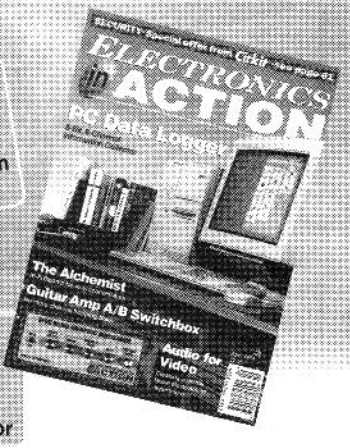
February 94 ● Virtual Reality ● Class A amp Pt2 ● Hatchery Controller ● The Switcher Pt4



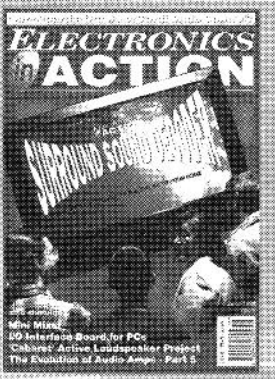
March 94 ● Colour test pattern generator ● Cordless guitar project ● Plug-in mains wiring tester ● Intelligent Communication Networks ● The Switcher Pt5

May 94 ● Digital Sound Sampler for PCs ● Digital Echo Unit ● Active Loudspeakers ● Audio Compressor ● Stereo Infra Red Headphones ● The Alchemist - HiFi Preamp Pt2





April 94 ● 8 bit, 8 channel data logger for PC ● 5 band graphic equaliser ● The Alchemist - HiFi preamp ● A/B Switchbox for guitar amp ● Water level detector



June 94 ● Surround Sound Decoder ● Mini Mixer ● Active Loudspeakers Pt2 ● I/O Interface for PC ● Smartcards

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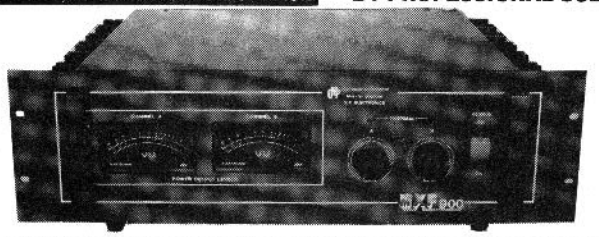

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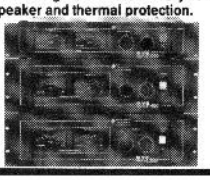

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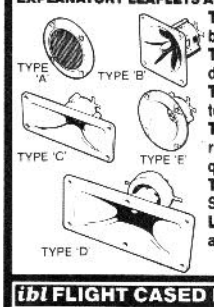

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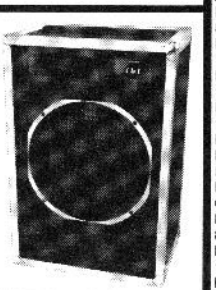

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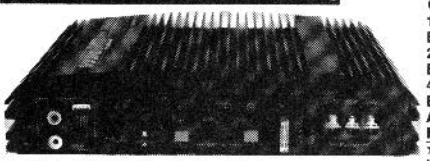

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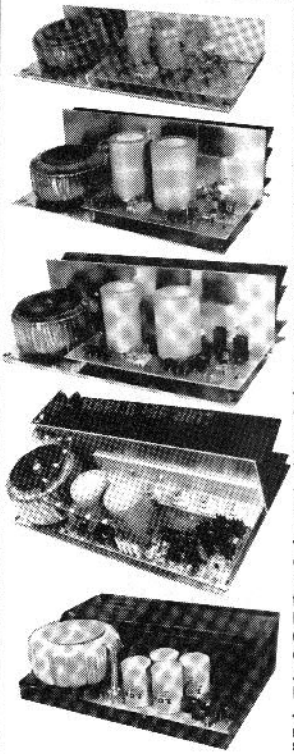

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
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PRICE £64.35 + £4.00 P&P

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

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

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
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NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

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RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. **PRICE £46.71 + £3.50 P&P**

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RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. **PRICE £50.72 + £4.00 P&P**

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RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. **PRICE £13.65 + £2.50 P&P**

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

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

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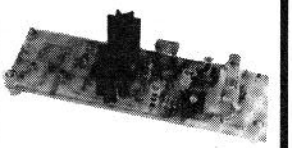

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the Mains Manager

by Mark Price

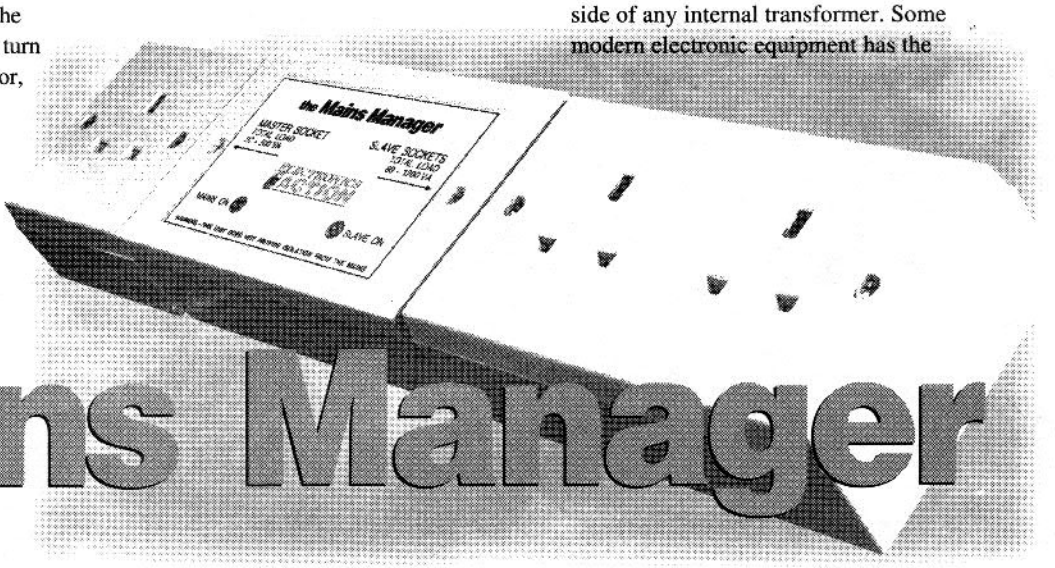
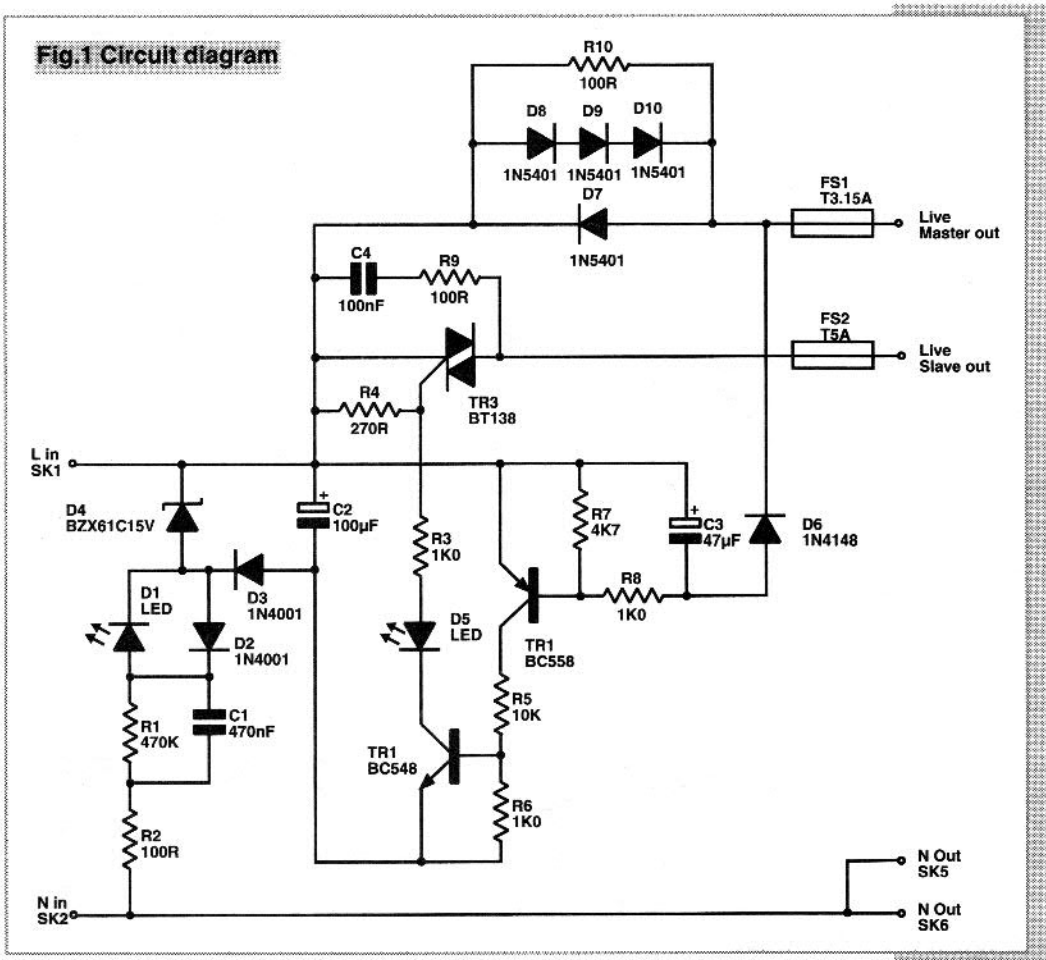


Fig.1 Circuit diagram



The Works

The full circuit is shown in Figure 1. The unit operates by sensing current from the master socket. D8, D9 and D10 act as the sensor and will drop about 1.8V when current is drawn. D7 carries the current on the opposite half cycles. The resulting 1.8V half cycle pulses charge C3 via D6. This capacitor will retain sufficient charge to hold TR2 on for about 200ms after the controlling load is switched off.

When TR2 is on, TR1 will also be switched on. This turns on triac TR3, which will then power the slave load. C4 and R9 form a snubber network to ensure the triac turns off cleanly with an inductive load. LED D5 indicates that the unit is operating.

C1 and D4 are effectively in series across the mains. The resulting -15V pulses across D4 are rectified by D3 and smoothed by C2. R2 limits the switch-on surge current, and R1 rapidly discharges C1 when the unit is unplugged. D1 will light whenever the unit is plugged into the mains; the current on the opposite half cycles are carried by D2.

If you've got a computer system, do you forget to switch off the printer sometimes. The problem is the number of separate power switches to turn off each night - PC, monitor, printer, modem, table lamp, radio - the list goes on! Normally these are connected to one of those four way trailing sockets, which will be plugged into one wall socket. If that socket is accessible, the equipment could be switched off there. In my case the socket is in the corner, behind the desk.

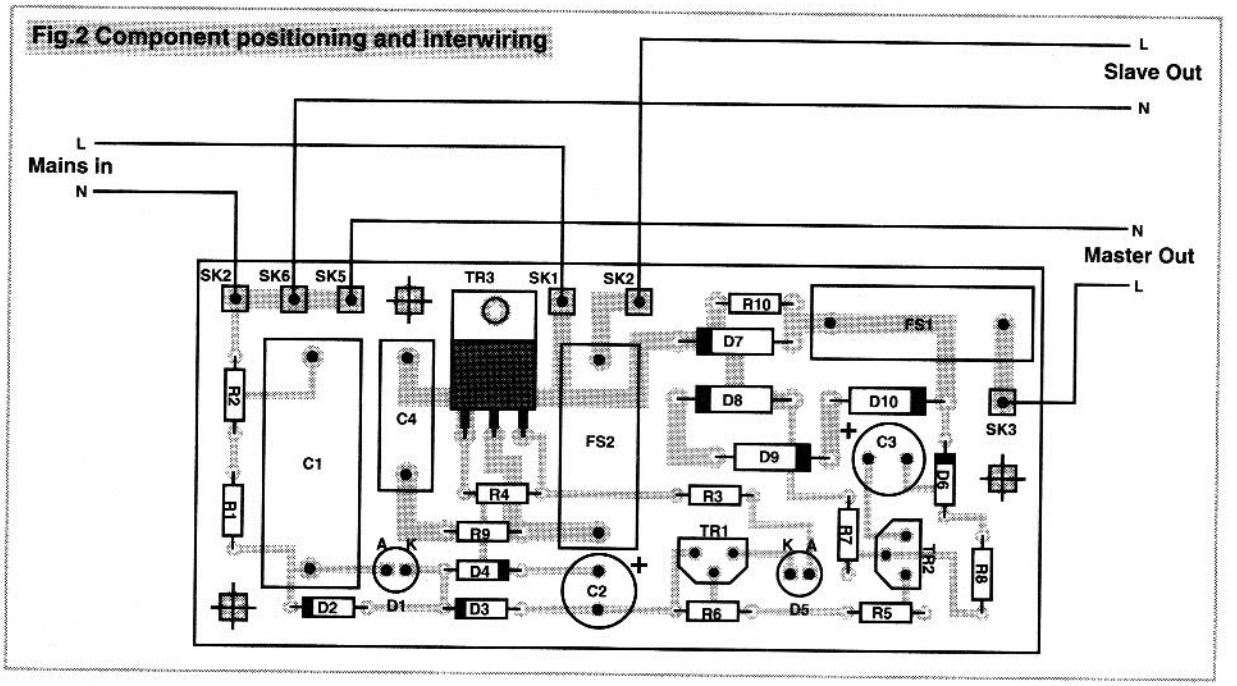
So what's the solution? This Mains Switcher will allow you to turn all the equipment on or off, by operating the switch on just one item. When you turn off the switch on the PC, the monitor, printer and other bits are powered down automatically. You can choose which item controls the system, by plugging it into the master socket - so you can use the table lamp to control everything if you want.

The unit works by sensing if current is being drawn from the master socket, if so it powers up the other (slave) sockets. The load on the master socket can be anything between 20 and 500VA, and the load on the slave sockets can be between 60 and 1200VA. None of the equipment used requires modification.

The unit may be useful for controlling hi-fi equipment, or your electronic test equipment. At Christmas time, you could use your indoor flashing tree lights to flash the lights on the tree outside! The options are limited only by your imagination.

The item connected to the master socket must be switched on the primary side of any internal transformer. Some modern electronic equipment has the

Fig.2 Component positioning and interwiring



power switch on the secondary side. Since these will continue to draw a small current from the mains when supposedly switched off, they will not control this unit correctly.

One important safety point. Although this unit removes the power from the equipment being controlled, ***IT DOES NOT PROVIDE ISOLATION FROM THE MAINS***. Before working inside any piece of equipment connected to this unit, it must be unplugged.

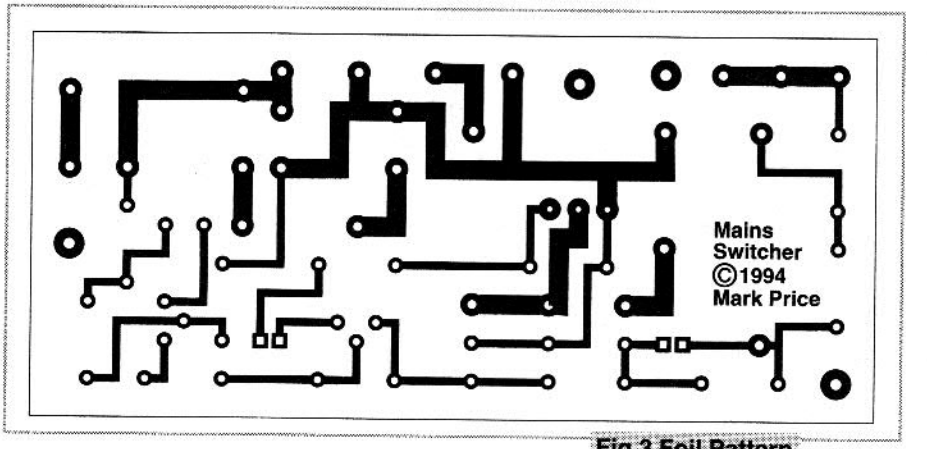


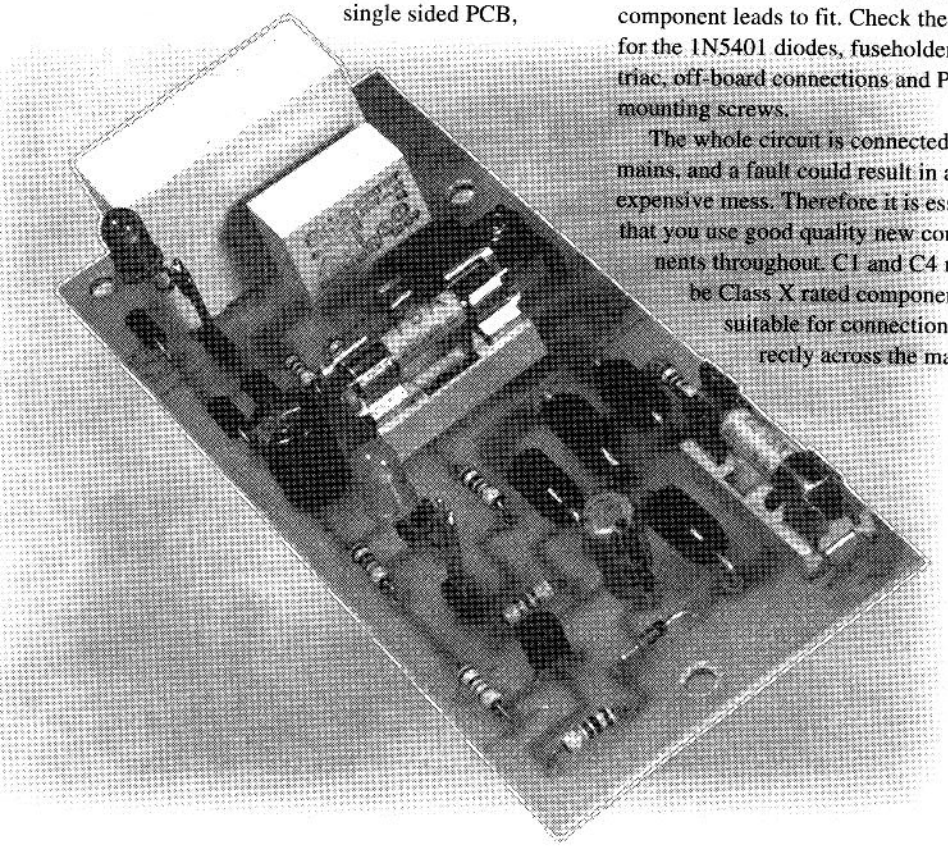
Fig.3 Foil Pattern

Construction

The PCB component overlay and track layout are shown in Figure 2.

The circuit is constructed on a small single sided PCB, which is available from Electronics in Action. You may need to enlarge some of the holes in the PCB, to allow the component leads to fit. Check the holes for the 1N5401 diodes, fuseholders, triac, off-board connections and PCB mounting screws.

The whole circuit is connected to the mains, and a fault could result in an expensive mess. Therefore it is essential that you use good quality new components throughout. C1 and C4 must be Class X rated components, suitable for connection directly across the mains.



Take extra care when assembling the PCB, to ensure that all components are fitted correctly and all soldered joints are sound. All the wide PCB tracks carry significant current, and should be reinforced by adding solder along their whole length.

The LED positions should be fitted with terminal pins. Once the PCB is fitted behind the front panel, the LED leads can be soldered to the pins.

The PCB is designed to fit into a standard electrical double socket surface box. A double blanking plate is used as the front panel, and is drilled to suit the LEDs and PCB mounting screws. The PCB is mounted on 25mm long INSULATED spacers, with the components towards the panel.

A front panel overlay is given in Figure 3. This may be photocopied and fixed to the panel with clear self adhesive vinyl sheet. Note that if this overlay is used the LED holes will not be directly above the LED positions on the PCB. Bend the LED leads to suit.

Screw the mounting box to a suitable

piece of wood, with the master socket (single unswitched) to the left and the slave sockets to the right. Any number of slave sockets can be used to suit your requirements, bearing in mind the maximum total load rating of 1200VA. Before mounting the boxes, remove cable knockouts at the top of each end. Cable clips should be used to secure the incoming flex.

Three core mains cable rated at 5A or greater should be used, and the earth wire is connected directly to the socket terminals. The socket terminals are intended for much larger cable, so the wire ends should be folded over twice and tinned first, to ensure a reliable connection.

The completed unit must not be permanently connected to the household wiring. It may only be connected by a length of flex and a 13A plug. Make sure the fuse in the plug is rated no higher than the flex being used, 5A will generally be suitable.

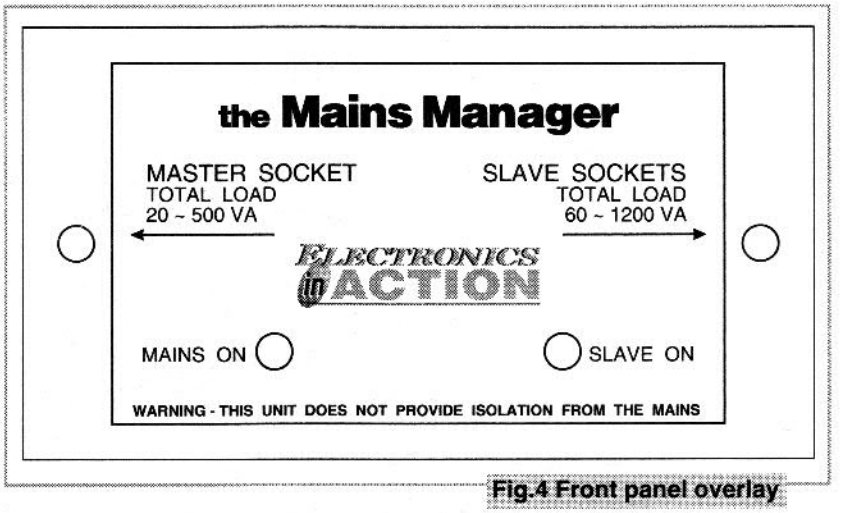


Fig.4 Front panel overlay

Testing

THIS UNIT CONTAINS DANGEROUS MAINS VOLTAGES. DO NOT OPERATE UNLESS ALL COVERS ARE IN PLACE. MAINS ELECTRICITY CAN KILL. PLEASE BE VERY CAREFUL.

If the unit has been carefully constructed there is no reason why it should not work first time.

Do not plug anything into the master or slave sockets initially. Plug the unit into the mains, via an RCD or earth leakage circuit breaker if possible. The Mains LED (D1) should light and the Slave LED (D5) should re-

Connect a table lamp to the master socket and switch it on. The lamp should operate as usual, and the Slave LED should come on when the lamp is on. Now plug a second lamp into a slave socket. This second lamp should come on whenever the first lamp is switched on. Both lamps should be at full brightness and should not be flickering. If the above check is successful, the unit is working correctly, and can be put into use.

Parts

Resistors (0.25W 5% or better)

R1	470K
R2,9,10	100R
R3,6,8	1K0
R4	270R
R5	10K
R7	4K7

Capacitors

C1	0.47µF 250VAC Class X
C2	100µF 25V
C3	47µF 16V
C4	0.1µF 250VAC Class X

Semiconductors

TR1	BC548
TR2	BC558
TR3	BT138-600 or other 10A 600V triac
D1	Green LED
D5	Yellow LED
D2,3	1N4001
D4	BZX61C15V (15V 1.3W zener)
D6	1N4148
D7,8	1N5401
D9,10	

Additional components

FU1	T3.15A 20mm Fuse in PCB fuseholder
FU2	T5A 20mm Fuse in PCB fuseholder

PCB Double blanking plate and 30mm surface box.
Single unswitched socket and 30mm surface box.
Sockets and 30mm surface boxes as required for slave sockets.
13A plug with 5A fuse.
5A (or greater) 3 Core mains flex.
Piece of wood for backing board.
Wood screws.
Cable tacks.
M3 screws and 25mm insulated spacers.

Police, Thieves...

Once thought to be the reserve of 007, electronic tracking of cars is now available to everyone. Dominic Shales investigates.

Car theft techniques have moved on apace: thieves have learned to bypass or disable most alarms and immobilisers and all seems doom and gloom. Thieves' ever greater grasp of electronics coupled with new levels of audacity have again led to a further increase in car thefts over the past year and the car manufacturers and public are looking more to the electronics industry for help. Car security is one of the fastest moving fields in electronics, with manufacturers and security companies investing millions in research and development - yet it has never been long before the bad-guys catch-up.

However a unique new vehicle tracking system called Tracker, is now offering an ingenious electronic solution to the problem of car theft. Tracker, which is operated by all 51 Police forces in mainland Britain, uses a small transponder which is concealed in any one of 30 locations within a car. When the theft of the car is reported, Tracker is activated and the unit's signal is detected by Police cars fitted with Police Tracking Computers (PTC's) enabling rapid location and recovery of the vehicle. PTC's have also been installed in helicopters, and at fixed sites including airports, seaports and on motorways around the country.

Ralph Kanter, Chairman of Tracker Network, says: "Since we launched TRACKER in September 1993, it has firmly established itself as the only real solution to car theft."

Are these claims true? Tracker Network has invested some £8 million in setting up the system in Britain, and the results are speaking for themselves - since its launch in September 1993, Police action initiated by Tracker signals has led to the recovery of approaching 200 vehicles worth some £2.75 million. Sales of TRACKER are increasing at around 30% per month and as the number of cars equipped with the system increases, so will the level of recoveries and arrests.

Not surprising that the Police are so enthusiastic: "these results confirm our best hopes and demonstrate the great value of the Tracker system," says Assistant Chief Constable John Abbott, Chairman of the Association of Chief Police Officers' Vehicle Tracking Group. "This success will increasingly cause thieves to think twice about stealing other people's vehicles."

Motor manufacturers have taken an interest in Tracker and Ford, BMW and Saab recently announced that they are now offering it as a dealer fitted option. Further announcements from major manufacturers can be expected later in the year. Mr. Kanter is right, TRACKER really is establishing itself fast as the only effective vehicle security system on the market.

The technical aspects of the TRACKER unit itself can not be divulged, as Ian Sandford, Technical Director, explains: "The essence of Tracker is that the thief does not know if a car is equipped with a transponder - even if he did know he would not be able to overcome it. For security reasons it isn't possible to give any detailed description of how the system functions or where it is located. Suffice to say it works, extremely well."

Despite Tracker's necessary reticence on the finer details, the background technology is interesting. The IT systems which are controlled from the company's offices in Uxbridge are impressive, more so considering that everything has been set up in only two years. A central PC system located at Uxbridge registers details of customers and their vehicles equipped with TRACKER Network Units (TNU's). The National Transcommunications Ltd. (NTL) network of four linked Regional Operation Centres (ROC's) is used to issue radio broadcast instructions to the TNU's using: a Regional Activation Computer (RAC), a NTL Monitoring Computer and Remote Transmission Computers (RTC's) connected via leased line modems to terminal servers.

"Essentially, Tracker Network runs an on-demand direct response radio station which tunes into an exclusive audience - individual TNU's," continues Sandford. "When the owner of the car reports the theft we activate a signal which is only detected by the transponder in question. A Police Tracking Computer in range of the activated transponder displays an identification number, from which Tracker can give the number plate and description of the stolen vehicle."

The Central System comprises of:

- A Registration and Activation System (RAS)
- A Transmission System (TS)

The Central system runs on a SUN SPARCstation IPX, under the UNIX operating system. It is linked to a Wide Area Network (WAN) for connection to the NTL Transmission System, and to a Local Area Network (LAN) for access by the Tracker Network customer services staff using personal computers.

The Registration and Activation system is built using ORACLE database, menus, forms and tools.

It manages the main business functions of Tracker Network, including:

- The system activates the transmitter in the stolen vehicle, from valid information given by the customer and the police, and then passing instructions to be broadcast to the TNU in a stolen vehicle via the transmission system
- Deactivation of a stolen vehicle following its recovery
- Sales Order Processing
- Scheduling and controlling installation of TNUs in customers' vehicles
- Maintenance of customer and vehicle information
- TNU stock intake, by recording the unique serial numbers of each TNU held in stock
- Management reporting (statistics, audit trails, sales data etc.)
- System management (database backups, system configuration, user authorisation, etc.)
- Transmission of test messages.

The Transmission System manages the interface with the NTL transmission network, scheduling and routing commands from the RAS to the RAC computers on the NTL WAN, using an application level communications protocol over DECnet. The Transmission system checks and logs the successful receipt of all commands, retries and failures, flagging any failure for attention by the Tracker Network systems manager.

The system is quick, easy to use and effective. In the first week of its operation, two Police Officers carrying out a training exercise in Preston came close to being arrested by fellow Lancashire Constabulary Officers who believed that the signal on their computer was leading them to a "smoking-gun" recovery. The police computer allows Police Officers to locate the stolen vehicle using direction and distance indicators. The accuracy is surprising. When a Peugeot 205 1.9 was reported stolen in Middlesex, Police followed the Tracker signal to a large industrial unit in Hayes, narrowing down the exact location of the vehicle within minutes, and eventually leading to the discovery of a major 'ringing' operation of some 100 stolen vehicles ranging from a JCB back-hoe loader to sports cars. More recently the first recovery of a Tracker equipped HGV led to five arrests and the finding of a further 30 stolen vehicles in Reigate, Surrey.

Insurance Savings

Because of the savings for owners and insurers alike, the insurance industry has also been attracted by Tracker. Over 50 insurance companies including giants such as Norwich Union, Sun Alliance, Royal Insurance, General Accident and Cornhill are now offering discounts averaging 10% to the private motorist. Ralph Kanter hopes that as Tracker continues to prove itself, the discounts will continue to grow, thus providing a real reward and incentive to those people saving their insurance company considerable sums of money.

Derek Plummer, Marketing Manager of Norwich Union says: "We anticipate that Tracker will make a significant contribution to reducing theft damage and claims, with subsequent premium savings."

Premium discounts are also offered on Tracker equipped commercial vehicles by 13 insurance companies and as the number of commercial vehicles and fleets fitted with the system grows, it is hoped that the number and value of commercial discounts will rise.

Tracker is not a new development technologically, having operated in certain states in the USA for the last 8 years. Although the company can not yet claim any tangible impact on crime figures in this country, statistics from the US lead us to hope for a dramatic success story - in Boston, the car crime capital of the US and one of the Tracker states, car crime has dropped by 41% whilst the national average has risen in the same period by an astonishing 34%. From this it seems a formidable and electronically foolproof deterrent to the car thief. EIA

...and the Electronic Informer

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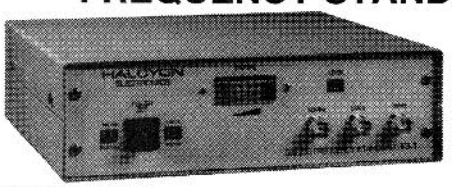

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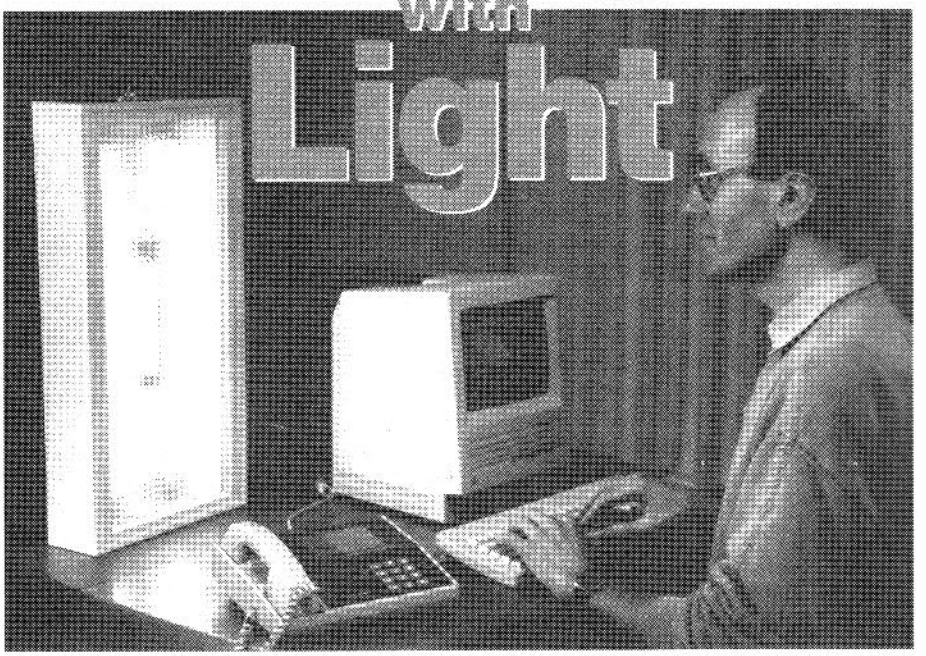
Living with Light

A Report by Douglas Clarkson



As more and more everyday technology makes use of optical processes and the ability to manipulate light increases there is a need to find out more about the effects of light on the human individual. Take for example the new technology of Virtual Reality. The psychological and physiological implications of this new tool have not really been considered.

There are many subtle ways in which the 'environment of light' has changed with the development of 'better' forms of interior lighting. Science has yet to catch up in detail with the possible effects of rapid replacement traditional methods of lighting with the introduction of the newer forms.

In many ways scientific interest in the effects of light on the individuals has been focused at determining damage thresholds for skin and in particular eyes. At a time also of the introduction of new and intense forms of light sources such as lasers, there has been a significant level of interest in assessing 'safe' levels of exposure.

Thus the emphasis has been directed to assessing the maximum amount of light which can be tolerated rather on determining the minimum amount of light that is necessary to maintain specific levels of base physiology. Taking one extreme of the standard for light exposure, therefore, we would be ultimately safest blindfold in a dark basement. While we would be at zero risk of light damage, some researchers indicate that this would impair body metabolism.

Unfortunately, this emphasis on damage thresholds has led to a neglect of equally valid research into the general effect of light exposure on individuals. There is perhaps more interest now in the relationship between bodily (and mental) health and exposure to light. In reviewing the substantial literature of the subject, it is apparent than for more than 100 years this area has been investigated by numerous researchers. Just when it seemed that their findings were being taken seriously by the scientific and medical community the rapid emergence of the pharmaceutical industry in the mid 1950s eclipsed their discoveries. It is only now that light is being re-evaluated as a therapy in order to regulate the body's own ultra complex mechanisms.

Facts about photons.

There are a lot of photons about. If we consider a simple tungsten electric bulb rated at 100 Watts which delivers say 10W within the visible spectrum of between 400nm to 700nm, then at a distance of one metre the average Intensity of light is around 0.32mW/cm^2. Each photon carries with it a bundle of energy which is proportional to the frequency of the radiation and inversely proportional to the wavelength according to the following standard physics equations:-

E = hf —— (1)
= hc/L —— (2)

E is the energy of the photon (Joules)
h is Planck's constant (6.626 x 10^{-34} joule second
f is the frequency of the radiation (Hz)
L is the wavelength (metres)
c is the speed of light (3 x 10^8 m/s)

Table 1 gives the energies of a range of typical colours within the visible spectrum and also details of numbers of photons incident in specific areas per second.

This table shows that even down to the level of a medium sized body cell there is still appreciable photon flux (photons per second) incident on the cell. Note also that for a fixed incident intensity (Watts/cm^2 or Watts/m^2) the flux of photons increases with the wavelength. This is because there is less energy for every photon with increasing wavelength.

Wavelength (nm)	Colour	Energy J x 10^{-19}	Flux at 1mW/cm^2	Flux per 3 micron diameter cell
400nm	blue	4.96	2.01 10^{15}	1.42 10^8
500nm	green	3.97	2.52 10^{15}	1.78 10^8
575nm	yellow	3.45	2.90 10^{15}	2.05 10^8
600nm	orange	3.30	3.03 10^{15}	2.14 10^8
650nm	red	3.05	3.28 10^{15}	2.31 10^8

Table 1: Photon related information

Thus if someone lay on a sunny beach for an hour and exposed (a modest) square metre of skin to sunlight for an hour at an assumed average intensity of 10mW/cm^2, the total body flux of photons would be in the region of 1.0 times 10 raised to power 24. Comparing this to someone who works in a dimly lit environment for an hour where there is minimal skin exposed (0.01m^2) and the illumination level is 0.05mW/cm^2, then photon flux would be about a factor of 20000 less. Thus there are large variations of exposure to light at the level of total number of incident photons. Variations will also occur in the spectral content of the light and this could also be significant

Mechanisms of Interaction

Surprisingly little is known about the interaction of light with the human body though the volume and range of work in this area is growing within the 'orthodox' medical establishment. This interest is in some way driven by scientific curiosity but also by the hope that light therapy can be developed as a cheaper alternative to existing means of treating various conditions - e.g. with drugs. There is also increasing awareness of the importance of colour in influencing emotional and mental factors.

At the physical level there would, however, appear to be three main divisions of interest. One relates to reactions within the skin and associated tissues, one with the blood, and one relating to the stimulation effect of light on the retina. Some known light induced effects are described.

Blue light Treatment

The medical condition of hyperbilirubinemia (neonatal jaundice) occurs when new born infants accumulate bilirubin in skin and body tissues and is related to delay in the infant liver being able to cope with its metabolic demands following birth. It has been shown that blue light around 450nm will break up this compound safely. Most Special Care Baby Units in hospitals will have several special incubator units which can deliver blue light from special fluorescent tubes. The babies eyes, however, are always protected during treatment.

Blue Light Hazard

While blue light (on the skin) can be beneficial to the new born, the retina of the eye is more susceptible to blue light hazard. In the retina, of the three types of colour receptor cells, blue green and red, the blue receptors are more susceptible to damage. Figure 1 shows a relative weighting curve of the so called 'blue light' hazard proposed by the ACGIH (American Conference of Governmental Industrial Hygienists). There is maximum sensitivity at around 435 to 440nm. Most everyday light sources (excluding the sun) have relatively low levels of blue light contained in their spectra and so do not represent a problem for prolonged viewing. Damage, however, can quite easily be sustained from looking at the sun.

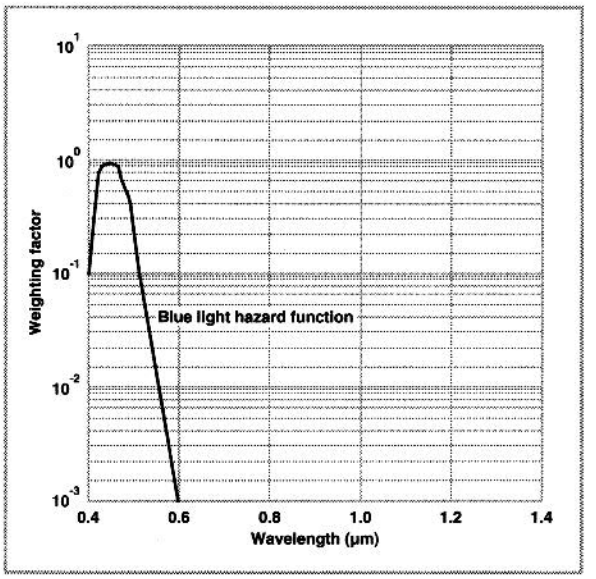
Thus while light at 450nm is useful when absorbed by tissue in the neonate, it could be damaging to the blue cones of the retina. Thus the question of good and bad in terms of light exposure should always be related to considerations of where and how much.

Vitamin D

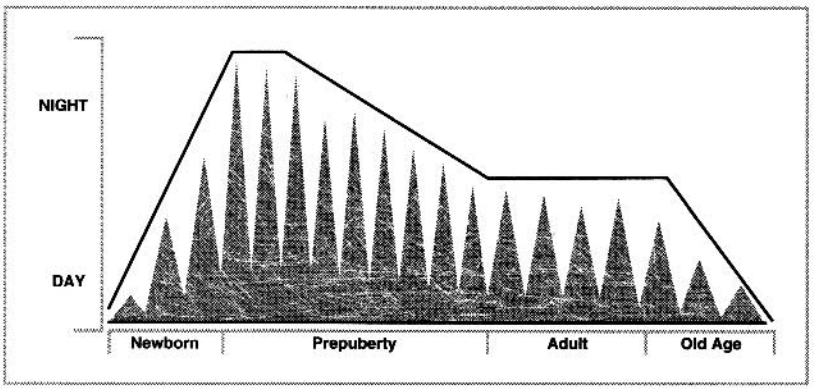
Vitamin D is an essential compound to enable the body to absorb calcium and phosphorous. When lacking in children the disease of rickets develops and in adults the condition of osteomalcia. Ultraviolet light, particularly the component around 280nm, acts as an agent to synthesise Vitamin D in the body. A daily intake of 400 International Units (IUs) per day is recommended and clinical symptoms are evident when daily intake fall below 70 International Units. Exposure to UVB radiation over a yearly cycle acts to top up the body's reserves of the vitamin. This is one instance where UVB radiation (in moderation) is good for you.

Individuals particularly at risk from vitamin D deficiency are for example the elderly confined at home or in a hospital/ nursing home environment. It has been shown that the addition of a component of UVB to the normal lighting of such an environment results in an improvement in vitamin D status of such individuals.

The increased incidence of osteoporosis, however, is also taking place at a time when increasing numbers of the aging population are receiving less vitamin D stimulation via incident light - is there a link?



Body Regulation: Melatonin Cycle



One of the key functions of the pineal gland is to manufacture the powerful hormone melatonin in response to stimulus from the hypothalamus which is geared to the body's biological clock. Figure 2 shows how melatonin levels are at a maximum during night and reduce during the day and also change with period of life. Melatonin is released in response to darkness and levels become reduced from exposure to light levels in excess of about 1500 lux. Maximum levels are attained during childhood and tail off into old age. In recent Swiss studies with mice which were given added melatonin in their night time drinking water compared with a control group, it was found that the group with the added melatonin lived some 20% longer. In the human system, melatonin production tails off with old age.

SAD : Seasonal Affective Disorder

The condition of Seasonal Affective Disorder (SAD) is a recognised medical condition characterised by drastic mood swings and depression that in its worst presentations can lead to suicide. It is associated with winter in the northern hemisphere and as many as 10% of inhabitants of the USA can feel the effects of the disorder with higher levels of incidence with greater latitude. Perhaps the reason that the condition was only identified by a Dr. Norman E. Rosenthal in 1981 is that the symptoms are so common that they had been accepted as normal.

The condition of SAD is thought to arise from high levels of melatonin triggered by lack of exposure to natural

illumination. Thus it is important to get out in the fresh air and natural light as much as possible.

A widely used method of treating' SAD is to expose the patient to approximately 2500 lux of light level from six 40W full spectrum fluorescent lights. Treatment times vary typically from half an hour to four hours. For such treatments to be effective they have to be undertaken daily for the period when normal light levels are insufficient.

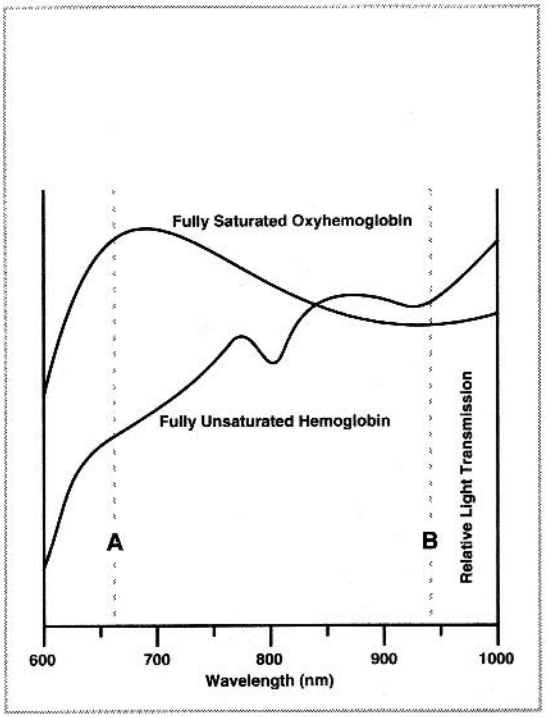
Work has also been undertaken in the treatment of alcoholism and drug addiction. The form of treatment with light acts therefore as a metabolic trigger for the body's own complex chemistry and is probably preferable to administration of anti-depressant drugs.

There appears to be a gradual falling off of melatonin production with age. While high levels of melatonin may be undesirable, a gradual switching off of meletonin production may also be undesirable. Is it the case that exposure to bright sunny days and dark nights will establish a stronger pattern of melatonin production than a situation where there is daily exposure to low levels of 'day time' light and possibly a semi-lit night?

It appears that the patterns of illumination, in relation to duration, brightness and spectral content has a direct effect on the melatonin cycle and hence on a range of key body parameters. There may also be other key hormones influenced by incident light which are not yet apparent .....

The Work of Dr. J.N. Ott

Dr. J.N. Ott first became aware of the influence of light on living systems when undertaking time elapsed plant photography for Walt Disney during the 1950s and 1960s By observing the responses of plants and germinating seeds to various types of light, it became very clear that spectral content was crucial to such processes of growth. The broad range of work that Dr. Ott undertook included studies which compared the performance/behaviour of school students under various forms of artificial lighting. There was conclusive proof that the use of full spectrum fluorescent lights had the ability to make students less aggressive, more attentive and generally perform well. Standard 'cool' fluorescent tubes with limited spectral output had the opposite effect.



There was ample evidence that children were able to learn better under full spectrum lamps and that some forms of learning difficulty could be remedied by exposure to 'correct' spectral light. Today Ott Light Systems of Santa Barbara sell a broad range of 'Dr. Ott' approved light products. One main selling item is a special table top lamp designed to compensate VDU terminal users for the spectrum of light to which they are typically exposed.

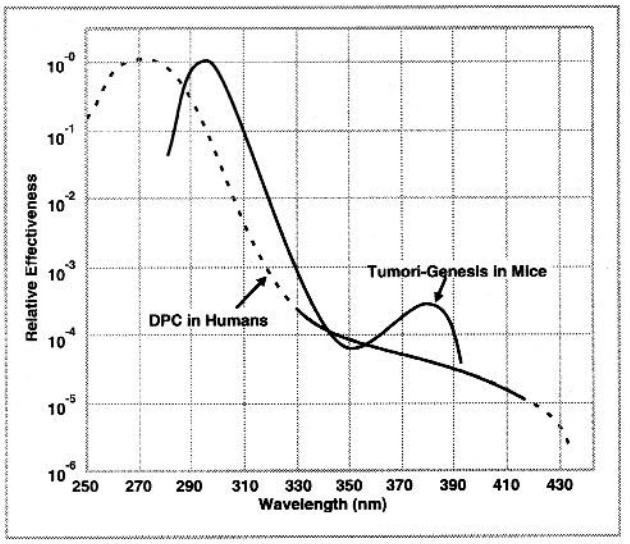
Figure 3 shows a lamp unit supplied by the Ott Light Systems Inc. for correction of illumination for indoor working.

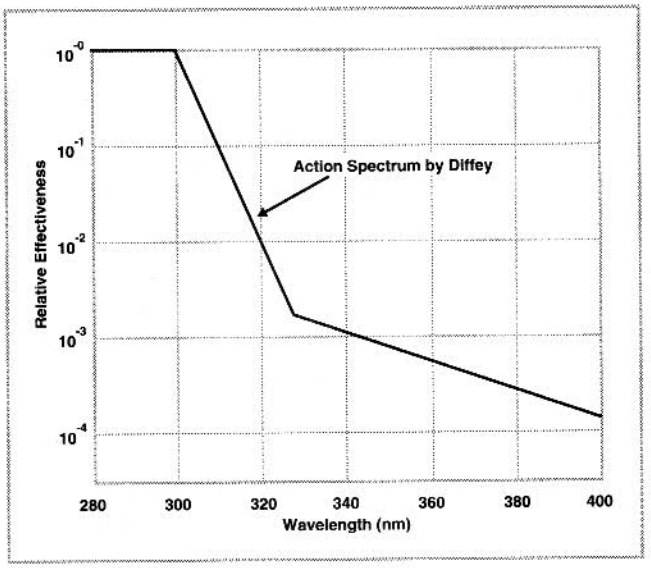
Physiotherapy Lasers

There is growing interest in the use of low power so called physiotherapy lasers' though the possible mechanisms involved are not clearly understood. Some of the more surprising results of medical research come when a simple experiment is undertaken to confirm that no 'effect' of a treatment should be observed. This was the case when patients with chronic pain were treated in a cross over trial using low level He-Ne laser radiation. Patients were not aware of what treatment they were receiving and had given up hope of being treated by any method. One group had a first period with treatment and then a period without light treatment. Another group received initially no treatment and then subsequently did receive treatment. The results indicated that patients became more pain free after having had the low level light exposure and they could not be 'tricked' into feeling better when they did not receive the light treatment.

It is understood now that the stimulation of tissue using so called transcutaneous electronic stimulation units at voltages of around 15 V at pulse rates of around 10 Hz results in the central stimulation of endorphins in the Cerebral Spinal Fluid of the brain and thus raises pain thresholds - the body's own pain relief system is being switched on. It is possible that stimulation of sites in the body with suitable sources of light can achieve the same results in a process analogous to acupuncture? Such experimental results would suggest so.

This field of photo-biology has been extensively research by Dr. Mary Dyson at the Department of Anatomy and Cell Biology at Guy's Hospital, London. While there are many clues as to possible modes of interaction of light at the cellular level, it is probable that light interaction influences the metabolism of Calcium ions across cell membranes and that the site of the interaction is within the cell itself. Large macrophage cells involved in tissue repair and healing are specifically responsive to light stimulation. It can be demonstrated that such effects vary as a function of wavelength and that while some wavelengths stimulate such effects - others can suppress them. Light which is pulsed appears to have more effect - indicating that cells like to be reminded of the stimulus acting on them. The light does not need to be coherent - expensive laser sources may not be necessary.





This approach to 'healing the body' is more one of stimulating the body's own defences to fight illness and disease - after all, the body has potentially all the apparatus to do this most effectively.

Optical Characteristics of Blood

Cells in the blood are exposed to light at various body interfaces. It is estimated that the entire volume of blood circulates through the retina every two hours. Little is known of the effect of sunlight or light in general on blood cells. The optical properties of blood, however, change as a result of physiological conditions.

The transmission of light in blood is wavelength dependent and is a function of the amount of oxygen bonded to Haemoglobin. One of the most widely used items of medical monitoring equipment, a pulse oximeter, uses this principle of relative optical absorption at two wavelengths to measure oxygen saturation in the blood. All that is required is to attach a probe containing a pair of transmitters LEDs and receiver diodes to a finger, toe or ear and the level of oxygen saturation of Haemoglobin can be measured. This gives a direct indication of the uptake of oxygen by the patient and will warn very rapidly if the patient has stopped breathing or if the oxygen supply to the patient has been interrupted.

Figure 4 shows the typical absorption curve used in such estimations.

UV Radiation: Friend or Foe

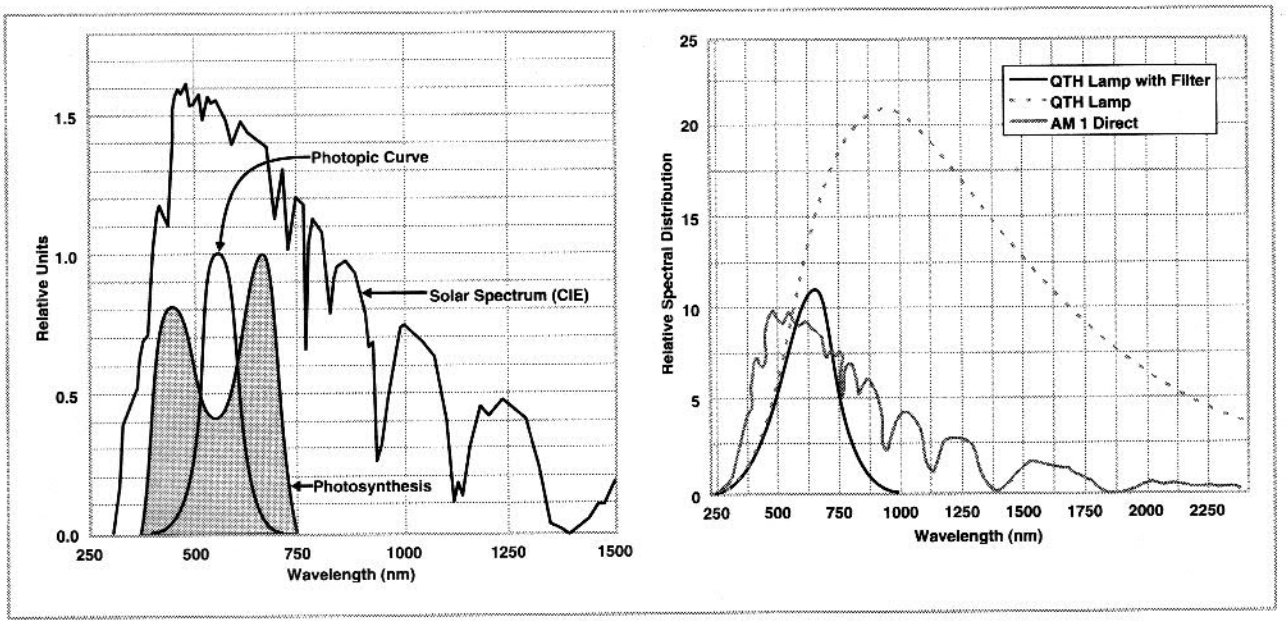
The consideration of 'good' and 'bad' in medical education tends to be redefined in the light of more broadly based research. From once being 'good' for the individual, UV is now regarded by many health education advisers as being 'bad'. This relative level of 'good' and 'bad' is referenced in connection with incidence of malignant melanoma and non malignant skin conditions. The incidence of these conditions in a specific ethnic group increases with exposure to ultra violet radiation. What has not been investigated, however, is the effect of lack of exposure to UV radiation on general bodily health. Ultraviolet radiation is conveniently broken down into convenient wavelength extents, being described as either UVA, UVB or UVC in increasing order of photon energy. Table 2 outlines the wavelength bands corresponding to the regions of radiation.

A typical way of expressing an effect in photobiology is by means of an action spectra. Figure 5 indicates an action spectra of DNA damage (DNA to protein crosslinking) to in vivo human cells and tumour creation in mice as a function of wavelength. There is a strong ultra violet dependence in both curves indicating that UV radiation, especially shorter wavelengths can act to degrade DNA and possible trigger cancer once significant DNA damage has taken place. It is difficult, however, to relate these curves to threshold levels of exposure which would result in skin cancer in humans. The in vivo studies with human cells are also more vulnerable than normal cells shielded by epidermal layers of skin.

Region	Wavelength Limits
UVA	400 - 320nm
UVB	320 - 280nm
UVC	280 - 200nm

Table 2: World Health Organisation Classification of Ultra violet regions.

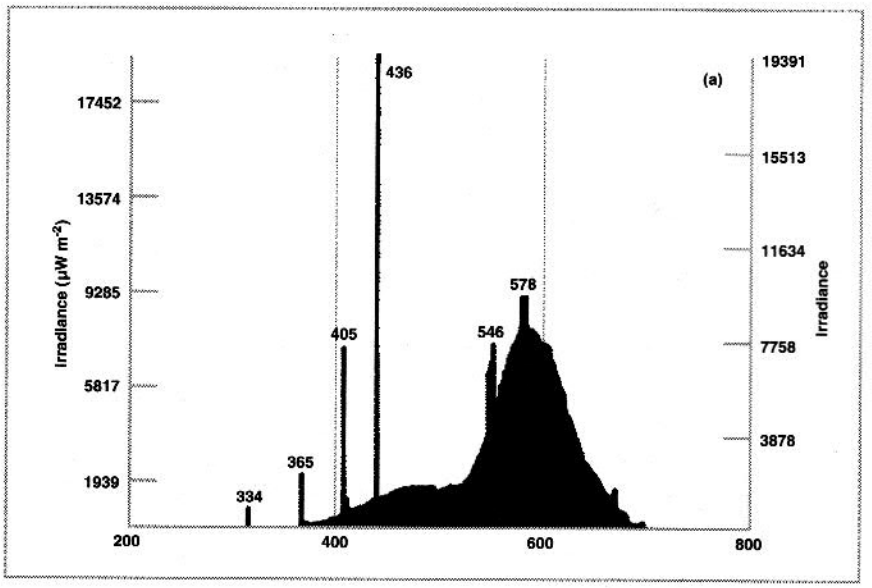
In terms of the sunburn effect, Figure 6 shows the so called Diffey' curve which indicates the amount of erythemal (reddening) response associated with UV radiation. This indicates a plateau up to 298nm followed by a rapid fall off of skin sensitivity as the wavelength is increased. Thus UV radiation at 315nm is some 100 times less likely to cause sunburn that the same amount of energy at 298nm. With a constantly changing UV spectrum with time of day and cloud cover it becomes complex to 'measure' levels of daily exposure.



It is likely, however, that the role of UV radiation will come to be better understood as a combination of risk factors associated with various benefit factors - just now the benefit factors have been overlooked. In reference to vitamin D production, however, absence of UV would normally result in Calcium deficiency in humans.

Fluorescent Lighting: Friend or Foe

Figure 7a indicates the solar spectrum, the photopic curve of the human retina



response and the photosynthesis response of plant metabolism. Figure 7b indicates for comparison the solar spectrum, a 3000 K tungsten lamp output and the lamp with a long wavelength filter.

The radiation from the sun is characterised as black body radiation with a temperature of between 5600 and 6000 K. Typical incandescent light sources such as tungsten filament lights will have a characteristic light 'temperature' of between 2700 K and 3000 K. The higher the 'temperature' of the light source the more radiation is emitted at shorter wavelengths as the curve is shifted down to lower wavelengths.

Figure 8 shows for comparison the output spectra of a white light fluorescent tube. The output spectra from such fluorescent sources is a complex interaction between the spectra within the mercury vapour tube, phosphors in inner layers of tube, glass of the tube and any filter/luminnaire placed over the tube to scatter and diffuse the output light.

There is considerable interest, also, in investigating the effect on individuals of the spectrum of incident light. There have been various studies undertaken to evaluate effects of different forms of fluorescent lighting on individuals. Most lighting regulations relate to the perceived brightness of light sources which is assumed to peak at around 550 nm and fall off at longer and shorter wavelengths. Provided the weighted value of the light meets relevant limits, there are no regulations relating to the relative wavelength content of the light spectra.

While there are physiological effects such as formation of vitamin D and breakdown of bilirubin in infants, there must also be a range of effects which have as yet not been identified. It remains, therefore, to piece together this 'physiological' jigsaw to obtain a more detailed picture of what is going on.

Fluorescent Flicker: Comfort 41

The advantage of fluorescent lighting is that illumination can be achieved with better energy efficiency. The disadvantages are that the output spectra can be limited (not full colour) and a considerable proportion of the spectrum is flickering - i.e. it varies with each applied mains cycle. Natural sources of light like the sun and the tungsten filament lamp are essentially 'static' i.e. they do not vary with time. It is thought that this unnatural fluctuation in the stimulation of the retina can lead to migraine and at worst trigger epilepsy. In a recent survey of office workers it was determined that as many as 40% considered that office lighting produced headaches or affected their eyes.

In association with the Medical Research Council, Cambridge Optical has developed a glass for prescription lenses which reduces considerably the flicker component of fluorescent sources. Figure 9a shows the typical energy spectrum of a fluorescent light and figure 9b the relative spectrum when viewed through Comfort 41. Trials of Comfort 41 by the Birmingham and Midland Eye Hospital indicated a four-fold reduction in migraine from 6.2 per month to only 1.6 per month. A blue placebo lens showed no reduction. In trials with office workers, a reduction of 38% in number of days when eye strain was experienced was reported.

Perhaps, however, if such lighting is a cause of such problems, effort should go to change the flicker rate so that the eye was not influenced, rather than give people smart spectacles to wear.

Psychological and Emotional Effects of Colour

While it is possible to identify unique physiological effects of light on the human system, it is more difficult to evaluate possible psychological and emotional interactions. Colour, is, however, taken very seriously by many sectors of industry. Extreme care is taken to use the correct colours for advertising, packaging and general decoration. The basic premise used is that the colour significantly affects the activities and mood of individuals in a specific environment.

Colour consultants are, for example, commonly asked to co-ordinate colour into a wide range of locations. There is a general consensus in the use of colour. The main distinction is between 'warm' and 'cool' colours. Warm colours include reds, oranges, peach and pink while 'cool' colours include blue and green and combinations. Environments, however, tend to present with a functional preference. Thus a school gymnasium should be active and dynamic - which is emphasised by warm red and oranges. A waiting room in a doctor's surgery should be 'cold' - emphasised by greens and blues. Restaurants should generally be peach and pink - 'appetising' colours. Cool tones should generally not be used since this will tend to 'wind down' activity. Colours are not considered, therefore, on an 'anything will do' basis.

In selecting colour schemes, however, a range of factors can be important. Small rooms give the impression of being larger if they are decorated in a predominantly light colour. Conversely a large room can be made to seem smaller by selecting a darker shade. A long room can be made smaller by painting the further apart walls a darker colour. In manufacturing facilities with high ceilings and roofs, these can be painted a darker shade to reduce the impression of working in a large space.

Rooms which are south facing can be toned down by inclusion of some cool colours. North facing rooms which receive little sunlight can be toned up by the inclusion of warm colours. Hospital rooms can be generally decorated with cool colours but with option to include pictures or hangings which suggest warm colours.

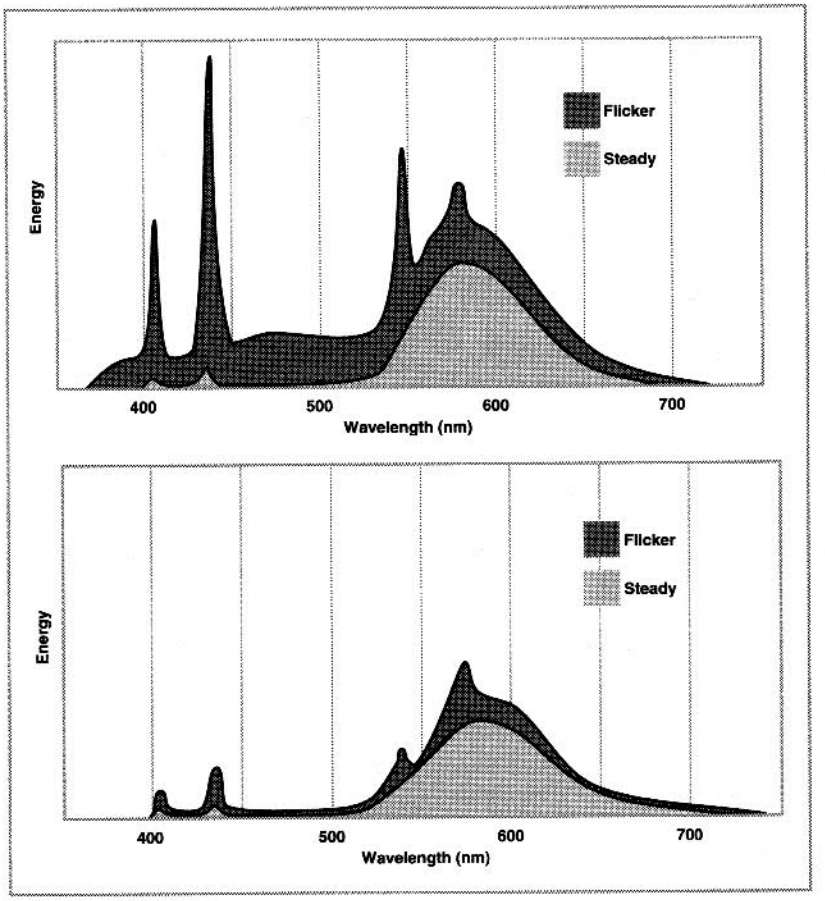
Colour consultants generally have to assess what 'mood' or 'tone' is required in specific environments and also take into account patterns of artificial and natural light and also existing carpets and soft furnishings.

There is increasing awareness, however, of the value of full spectrum fluorescent lighting. Certain types of fluorescent light with a limited spectral output are banned in public buildings in Germany. In moves also to encourage more efficient use of energy, the manufacture of certain inefficient fluorescent lights is being phased out in the USA. The preference will be for more inefficient, smaller diameter tubes with better colour rendering values. Of all the many directives with the EEC, there are apparently none which relate to the spectral output of fluorescent lamps.

In its booklet 'Color Dynamics for the Home' the Pittsburgh Plate Glass Company references the effect of colour environment on individuals. In estimations of muscular, mental and nervous activity, normal white light registered 23 units, with slightly higher levels for blue and green. Yellow was found to raise the activity level to thirty units. Individuals tend to respond after as little as five minutes exposure to a specific colour.

While colour may seem rather a superfluous factor in the 'real' world, the truth may me quite revealing. In one case history, however, the high rate of absenteeism in a London factory was considerably reduced when the blue colour lighting which made the female staff look sickly and ill was neutralised by painting the grey walls with a warm beige colour. This is an example of a striking improvement in financial losses due to sickness absence.

People feel cooler in areas painted with 'cool' colours. In one factory a cafeteria was initially painted with light blue walls. Staff complained about feeling cold and the temperature was increased though complaints persisted. The area was redecorated and the walls painted orange. Staff complained about feeling too hot although the temperature had not been increased. Everyone was happy when the initial temperature setting was restored.



Pioneers of Colour Therapy

There have been many individuals over the years who have studied the use of colour in promoting health and curing disease. One of the early pioneers of light in medicine was Dr. Edwin Babbitt who in 1878 published 'the Principles of Light and Colour.'

He developed a range of treatments in which filtered natural and artificial light was focused on selected areas of the body. The more comprehensive so-called Spectro-Chrome system of colour healing was developed by Dr. D.P. Ghadiali around the turn of the century. Some typical conditions and associated treatments were as follows:-● Orthodox medicine in the USA tried to make life as difficult as possible for practising colour therapists.

Perceived Colour as a Specific Therapy

While these forms of colour therapy had been related to specific exposure of parts of the body, a certain Dr. H.R. Spitler began to research into the effects of colours as seen by the eyes around 1910. Spitler maintained that the portions of the brain controlling the autonomic nervous system and the endocrine system were also connected to the eyes by the shortest, most direct and most highly organised nerve pathways in the brain. In this theory, light could be used as a tool to stimulate and possibly regulate imbalances with both systems.

It is considered by practitioners of such 'central' stimulation that the main effect is triggered by the specific mode of electrical activity initiated primarily in the cone cells in the retina. With models of specific red, green and blue receptors within the retina, specific colours would tend to initiate specific patterns of electrical activity.

This form of colour therapy is used to link into emotional blockages of individuals. Colours are identified with which the patient feels 'uncomfortable'. After exposure to the specific colours, such therapists claim to be able to unravel emotional blocks which had presented in psychological and mental difficulties. This is a rather novel way of using colour as a therapy.

Condition	Colour Prescription
heart, circulation, reproduction	purple (overstimulation) scarlet (underactivity) magenta (balancing)
paralysis (physical)	green/yellow red/yellow
paralysis (senses)	red to above two
pain, bleeding abscess	indigo

Reading Better With Colour

Helen Irlen, the Californian psychologist received considerable publicity during 1988 on the topic of tinted lenses as an aid to reading for dyslexic children. While there appeared no single 'magic' colour tint which would help children read better, careful selection from a range of around 140 separate lenses often resulted in improvement in reading skills. In some cases the improvement was dramatic. It is thought that the process of using tinted lenses suppresses colour related electrical stimulation of the brain which interferes with other cognitive skills such as reading.

Colour Therapy as Alternative Medicine

Various forms of colour therapy which have never been taken seriously by orthodox medicine are now firmly established within Alternative Medicine. There is no doubt, however, that the neglect of investigation of such treatments by orthodox medicine has delayed achieving greater understanding of how the body and the person as a whole responds to light.

Conclusion

Research into the exposure of the human body to light has tended to be dominated by work to determine threshold levels which resulted in damage to skin and eyes. This has almost fostered a mentality that the safest light level is no light at all. Only now is it being appreciated that light can interact with the human organism in many beneficial ways and that the condition of malillumination may in fact develop when the body is not exposed to adequate levels of 'spectrally correct' light.

Conditions such as 'sick building syndrome' may have components of contribution from levels of malillumination. Considering, also, the huge sums lost through sickness absence generally, it is surprising more work is not undertaken to begin to shed light on the matter.

Further Reading

Light: Medicine of the Future - Jacob Liberman: Bear and Company, 1991, (excellent read)

Colour and Music in the New Age: Corinne Heline

Colour, Rudolf Steiner, London , Rudolf Steiner Press, 1982

Light Radiation and You, Dr. J.N. Ott, Greenwich CT, The Devin-Adair Co., 1982.

Seasons of the Mind, Dr. N. E. Rosenthal, New York, Bantham, 1982.

The influence of ocular light perception on metabolism in man and in animal, Fritz Hollwich,New York, Springer-Verlag, 1979

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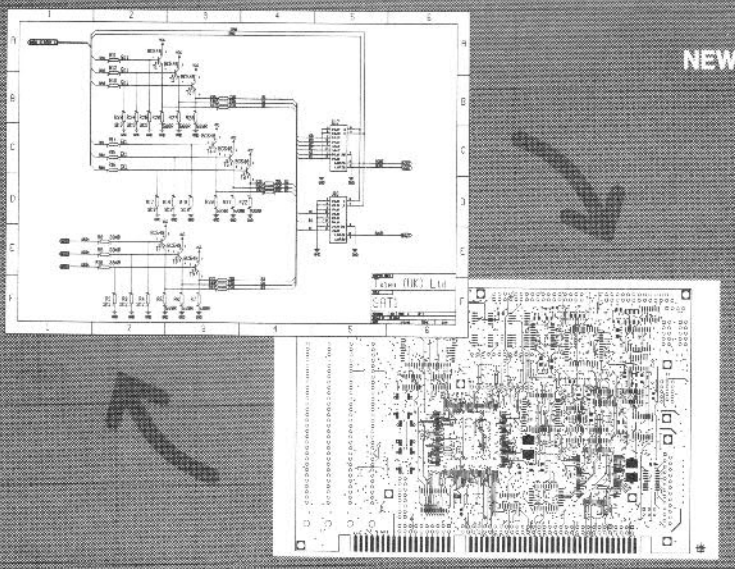

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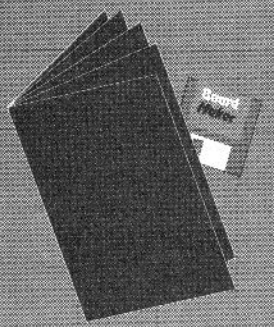

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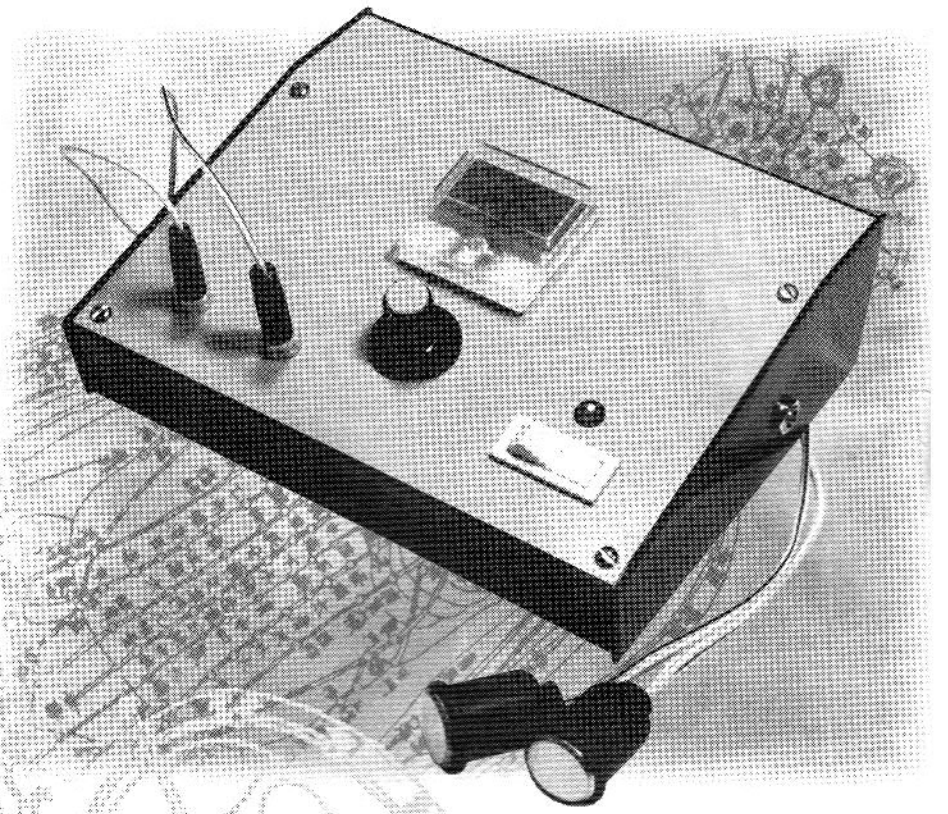


Needles and Pins

G. Lu and P. An help us discover the ancient Chinese art of acupuncture, with a little modern technology

It is well known that acupuncture is a traditional medical cure that originated in China about forty-six centuries ago. In this practice some metal needles were inserted into the patient's body at certain points (called acupuncture points), specifically selected according to a particular disease. It has been found to be very effective, especially for chronical diseases. However, a trained doctor is needed to perform such practice.

The Electronic Acupuncture Device presented here simulates acupuncture. Instead of using needles as with traditional acupuncture, the device uses electric signals to stimulate the acupuncture points by means of two electrodes touching the skin. It can also be used as a massage machine by putting the electrodes in the areas of the body to be massaged. This device is simple and safe to use and can be operated by yourself without special training. It is also economical to construct.

PLEASE NOTE
This device should *not* be used by the following people: People having suffered a heart attack, those with Heart Pacemakers, children and pregnant women. If you are in any doubt, you must consult your doctor.

Principles of Acupuncture and Electric Message

Why can acupuncture cure diseases? There is not a satisfactory explanation yet, however it is well explained according to traditional Chinese medical theory. This theory is based on the philosophy of life energy (which is pronounced '*Chi*' in Chinese) and the interrelationships between '*Yin*' and '*Yang*', the two most fundamental elements of the Universe. *Yin* is the element corresponding to negative, feminine, passive and cold etc. and *Yang* corresponding to positive, masculine, active and hot. They are opposite to each other in nature but together they form the whole world. Chi moves along pathways of the human body called '*Jing Lo*', or meridians, completing a circle every 12 hours. There are 365 acupuncture points on the human body connected by 14 longitudinal and latitudinal paths of *Jing Lo*. A chart showing the acupuncture points and meridians used by the ancients is in Figure 1.

According to this theory, balances between *Yin* and *Yang* are vitally important for the heath of our body. Any imbalances between the two will cause bodily malfunctions and diseases. Acupuncture is the treatment of body malfunctions by inserting needles at acupuncture points of the body to simulate or regulate the flow of *Chi* or to correct any imbalance between *Chi* and other circulatory systems of the body.

The mechanism behind the massaging effect by putting electric currents through the body is also not clear yet. It is suggested that this treatment stimulates the release of body chemicals known as endorphines, which is a sort of naturally produced opiate. Another theory suggests that the relief of pain is due to blocking of the nerve impulses.

The Electronic Acupuncture Device

This device was developed on the basis of similar devices which are popular in

China, Japan and other southeast Asian countries. The device consists a control unit and a pair of electrodes. The control unit generates continuous pseudo-random noise signals and the frequency of the signal is between several hundred Hertz and several thousand Hertz. The amplitude of the signal is controlled by the signal volume control and is monitored by a voltameter. This signal is fed into the two electrodes which touch the skin. As a result, a small oscillating electric current passes through the part of the body between the electrodes and creates massaging effects. Moreover the two electrodes are magnetized and the magnetic field is also believed to have a curing effect.

This device can be used in two ways: The first one is to use it as an acupuncture device to treat certain illnesses. In this mode, the electrodes are put on the acupuncture points which are selected for a particular illness to be treated. The other is to use it as a device to massage muscles or any uncomfortable parts of the body. In this operation the electrodes are placed anywhere in the area of the body to be massaged.

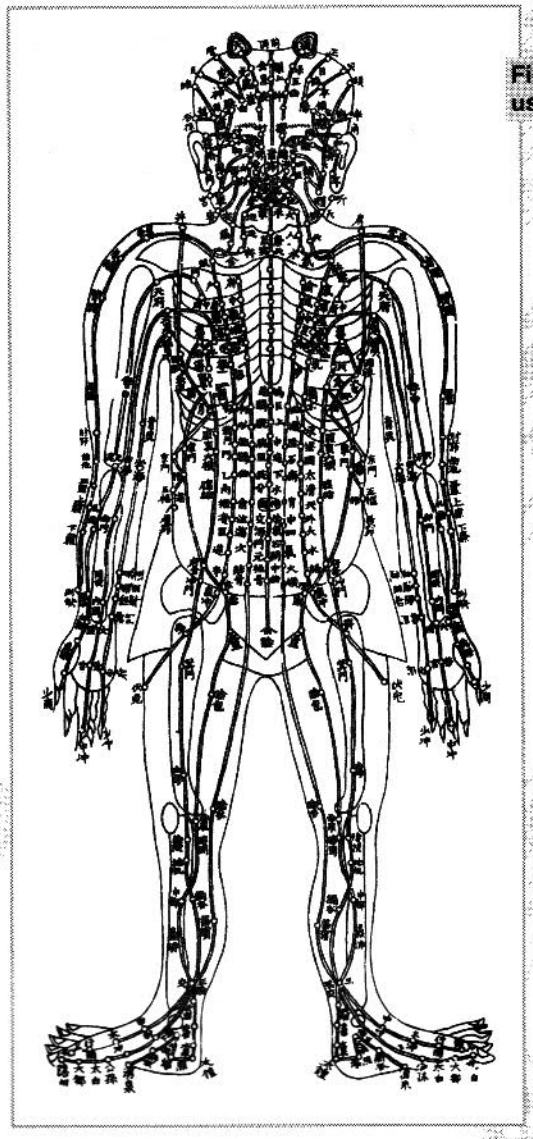


Fig.1 Acupuncture points used by the ancients

Circuit Detail

Figure 2 gives the block diagram of the device. It can be seen that it consists of 6 units, the signal generator unit, amplification unit, voltage step-up unit, voltameter unit, output unit and power supply unit. The signal generator unit generates a low power audio signal which is subsequently amplified by the amplification unit. The amplified signal is fed into the voltage step-up unit to elevate the signal to high voltages. The signal is finally output to the electrodes. The voltameter unit monitors the voltage of the output signal. The power supply unit supplies a constant voltage to all other units.

The circuit diagram is shown in Figure 4. The signal generator unit incorporates a music IC M66T-205 (IC2, available from Maplin Electronics) which produces continuous audio signals. This signal is meaningful to our ears, but is a somewhat random signal when injected into our body. In the developing stage of this device, it has been found that different music tunes have different massaging effects. This particular chip was chosen because the music tunes gave seemingly better massaging effects.

The signal from IC2 is fed to R3 which is a potentiometer. The audio signal pick by the wiper of R3 is fed into the audio amplification unit which is built around the TBA820 IC, IC3. TBA820 is a popular audio power amplifier which requires a power supply from 3 volts to 12 volts and is able to offer an output power up to 2 watts. Pin 2 on IC3 in the inverting input and there is an 6K resistor between the input and output of the IC, Pin 5. This allows the voltage gain to be adjusted by an external resistor R4 and the voltage gain is approximately equal to the value of the internal resistor divided by resistor R4. In the present circuit the voltage gain is set to about 8. C3 and C9 provide DC blocking. C5 decouples the supply to the pre-amplifying stage of IC3. C6, C7 and R6 helps to prevent high frequency instability. R5 and C6 are boostrapping components which give the circuit good power efficiency. The amplified signal is fed into a step-up transformer T (it is an ordinary low-power mains transformer) which has a primary to secondary ratio of 1/40. Thus, the signal obtained from the secondary coil of the transformer is elevated to much higher voltages. This signal is fed to the electrodes and is monitored by the voltameter which consists of an analogue ammeter, R7, R8, D1 and C10.

The power source uses six Alkaline AA batteries (on-board) or an external DC power supply (6-12V). The power to the circuit is regulated by IC1, LM2930, which is a 5V regulator. This IC features a very small dropout voltage of 0.4V typical and can work for an input voltage as low as 6V. C1 and C2 are decoupling capacitors for the power supply lines.

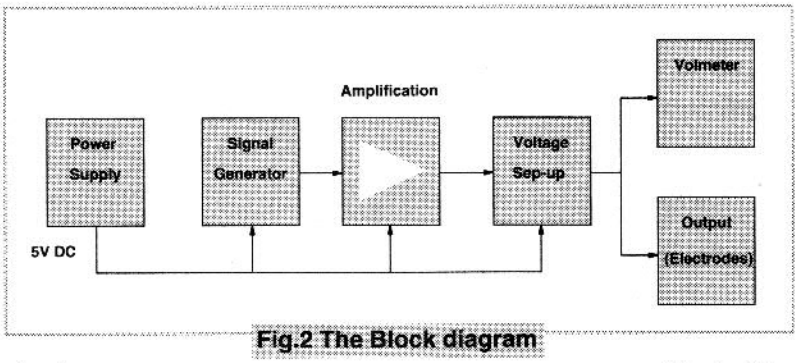


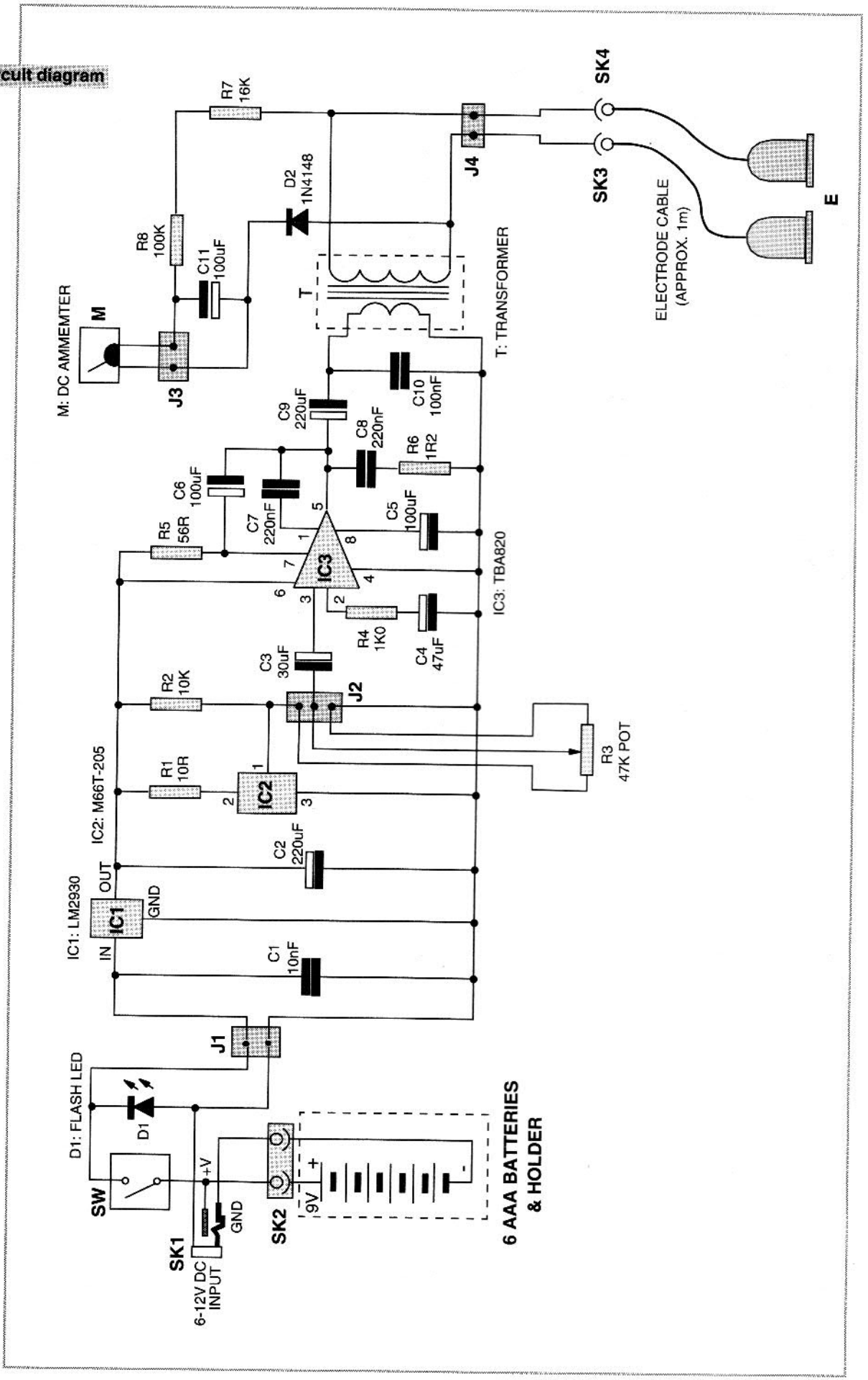
Fig.2 The Block diagram

SUPPLIES FROM MAINS ADAPTORS ARE STRICTLY FORBIDDEN TO BE USED AS THE EXTERNAL POWER SUPPLY. ONLY BATTERIES are allowed to be used.

Construction

Figure 5 and 6 are the copper foil pattern of print circuit board and the component layout. The PCB board is available from the PCB service. The components should be soldered on the PCB board in the following order, the links, resistors, IC sockets, capacitors, PCB connectors and finally the step-up transformer. The PCB, together with the power supply pack, are housed inside a project box.

Fig.3 Circuit diagram



We chose a console-type box (Maplin Electronic, Stock no. LH66W). The control panel consists of a power switch, an indicator, a volume control knob, a voltameter and two plug-in sockets for electrodes. The overall view of the system we produced is shown in Figure 2. Readers can certainly design their own boxes with the style they like.

The electrodes can be made by yourself. A suggested way of making it is illustrated in Figure 7 and is briefly

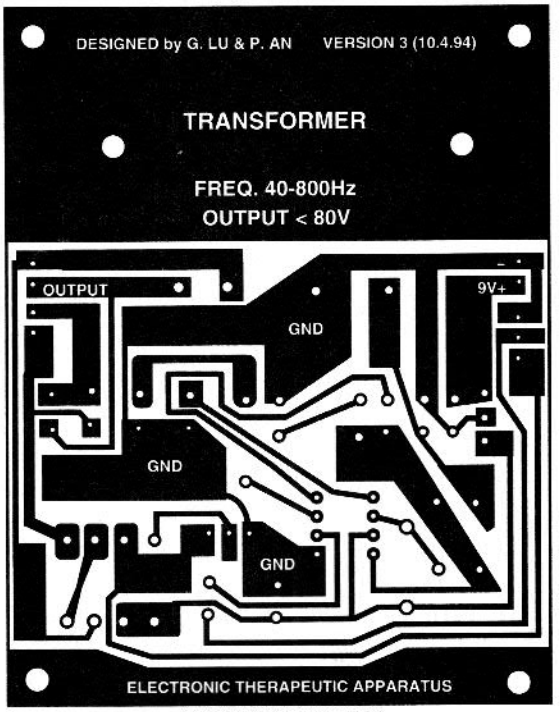


Fig.4 Copper foil

described below. The electrode plate (which contacts the skin) is make from a piece of 0.5mm tin-plated steel sheet. The edge of the plate should be filed to have a smooth finish. A 20mm long and 15mm diameter copper tube is soldered to the electrode plate. A small piece of magnet is glued to the electrode plate inside the tube. The lead of the electrode is made of a well-insulated cable and one end is soldered on the side wall of the tube. The tube and the electrode plate is then covered by a suitable insulation hood. This other end of the electrode cable is connected to a plug which can fit the sockets on the control unit

Testing

After soldering, a careful inspection must be carried out to check all the joints and connectors and to make sure there are no shorts. After this, power can be connected to the device. It is noted that high voltage (about 80 volts) may be present at the output of the secondary coil. Hence to prevent unwanted electric shock, care should be taken not to torch the exposed parts from the secondary coil of the transformer. This high voltage, however, is intrinsically safe.

The following checks can be done. The voltage at the output of regulator (IC1) should be 5V. Now connect a small speaker to the output of IC1, a low level sound should be audible. Connect an AC voltameter to the Pin 3 of IC3 (see Figure 4) and turn the VOLUME control from minimum to maximum, the voltage should change between 0V to 0.3V. Set the VOLUME control to maximum, the voltage across the primary and the secondary coils of the step-up transformer should be about 2.4V and 80V, respectively.

If the circuit works OK, a test on the body can be carried out.

Operations

To use the device on your body, these procedures should be followed:

1 Firstly check that the device is switched off and the volume control is in the minimum position.

2 Wrap the two electrodes in small pieces of soft cloth soaked with water.

3 Switch on the device and turn the volume control to make the meter read about 1/3 of the full deflection.

4 Place the two electrodes in contact with the skin in the area to be treated.

5 Each electrode should be moved around slowly in a small area. Meanwhile the output voltage may be increased gradually, until a sensational and comfortable feeling is obtained.

6 A normal treatment lasts no more than several minutes.

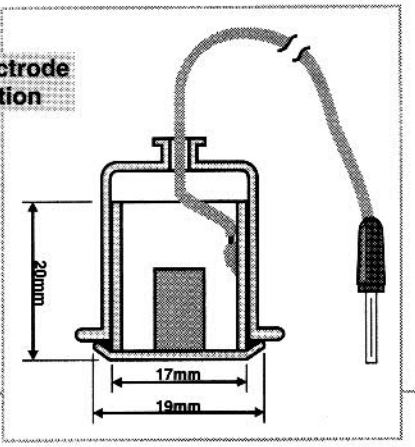


Fig.6 Electrode construction

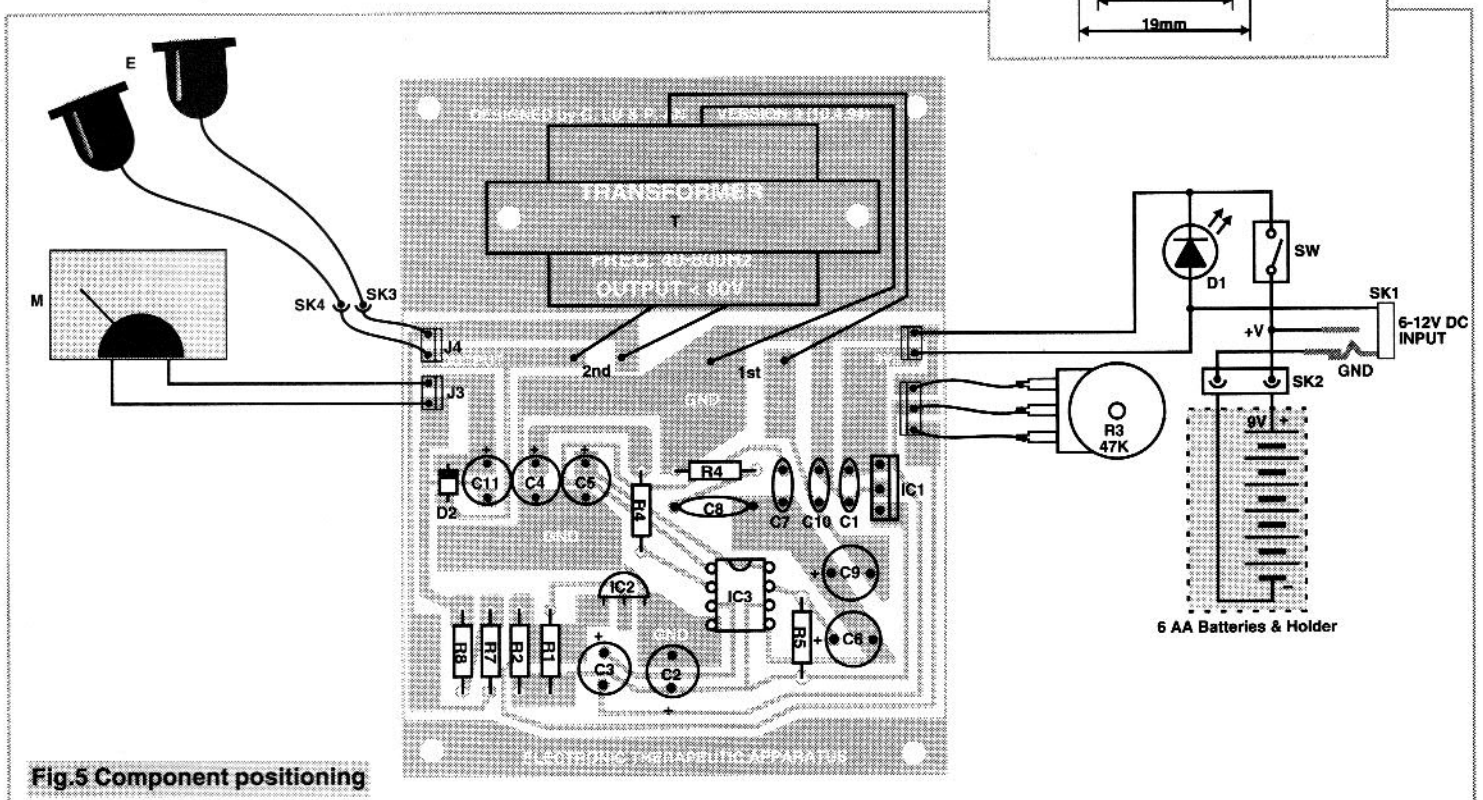


Fig.5 Component positioning

7 After the treatment, the control should be turned down to minimum and the device should be switched off.

Applications

As we already know that there are two applications of the electronic acupuncture device: massage and acupuncture.

To use it as a massager, please follow the operation procedures as described. One electrode is put in the central area of the body to be massaged and the other is moved around the first one in circles. The voltage level of the signal should be increased in step as long as you feel comfortable.

To use it as an acupuncture device, special acupuncture points (see table below) have to be selected according to the disease to be treated. Firstly, follow the procedure detailed in the section 'Operations'. A few examples of common diseases are . The second column in the table shows the pairs acupuncture points to be used in the treatment. During treatment, one electrode is placed at the first point and the other placed on the other. If the two points have the same name, it means that one electrode is placed on the left hand side one and the other on the right hand side one. If any reader is interested in getting more information about treating other diseases please contact us.

If anybody wants to get a complete electronic acupuncture device instead of making it themselves, please write to G Lu, 23 Allerton Walk, Brunswick, Manchester M13 9TG. The cost of a complete device is £40.

Parts

Resistors
(Metal film, 0.25W and 1%)

R1	10R
R2	10K
R3	37K
R4	1K
R5	56R
R6	1R2
R7	16K
R8	100K

Capacitors

C1	10nF
C2	220µF
C3	30µF
C4	47µF
C5	100µF
C6	100µF
C7	220nF
C8	220nF
C9	220µF
C10	100nF
C11	100µF

Semiconductors

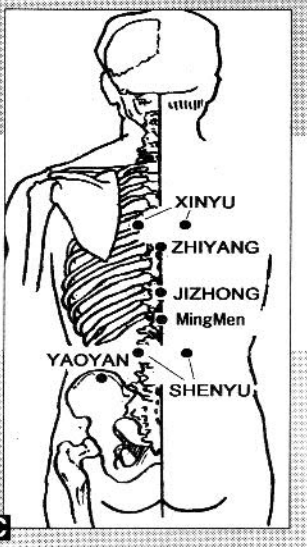
IC1	LM2930
IC2	M66T-205
IC3	TBA820
D1	Flash LED
D2	1N4148

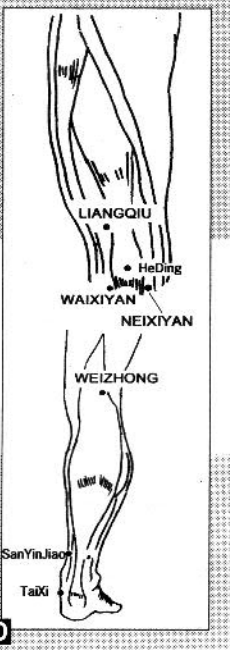
Additional Components

Electrodes
Cable, 2m Hook-up Wire
Insulating Boots x 2
Magnet
Thin iron plate 2 pieces (15mm diameter)
Copper tube x 2 (15 x 25 x 2mm)

J1,J3,J4	2-Way PCB Connector
J2	3-Way PCB Connector
T	Transformer (1:40)
SW1	Toggle Switch
M	DC Ammeter
SK1	2.5mm Power Socket
SK2	Battery Holder Socket and Plug
SK3,4	4mm Sockets and Plugs
B1-6	6×1.5V AA cells

Spacers x 4, Hex Threaded





Disease to be treated	Acupuncture points	Signal level	Period
Knee injury (cartilage)	WeiZhong (D) - pain point	Medium	1 minute per day
Ankle injury (cartilage)	XuanZhong (B)-SanYinJiao (D) KunLun (B) - TaiXi (D)	Medium	1 minute per day
Rheumarthritis on the back	ShenYu - ShenYu (C) XinYu - XinYu (C) ZhiYang(C) - JiZhong (C) WeiZhong - WeiZhong (D)	Medium	5 minutes 1 minute per day
Rheumarthritis in the waist	ShenYu - ShenYu (C) XinYu - XinYu (C) MingMen (C) - YaoYan (C) KunLun (B) - KunLun (B)	Medium	5 minutes 1 minute per day
Rheumarthritis in the waist	ShenYu - ShenYu (C) XinYu - XinYu (C) Nei/Wai XiYan (D) XueHai (A) - LiangQiu (D) WeiZhong (D) - HeDing (D) YangLingQuan (B)-ZhuSanLi(B)	Medium	5 minutes 1 minute per day

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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A Versatile Centronic 24-line I/O Port

I/O Silver

by Dr. Pei An

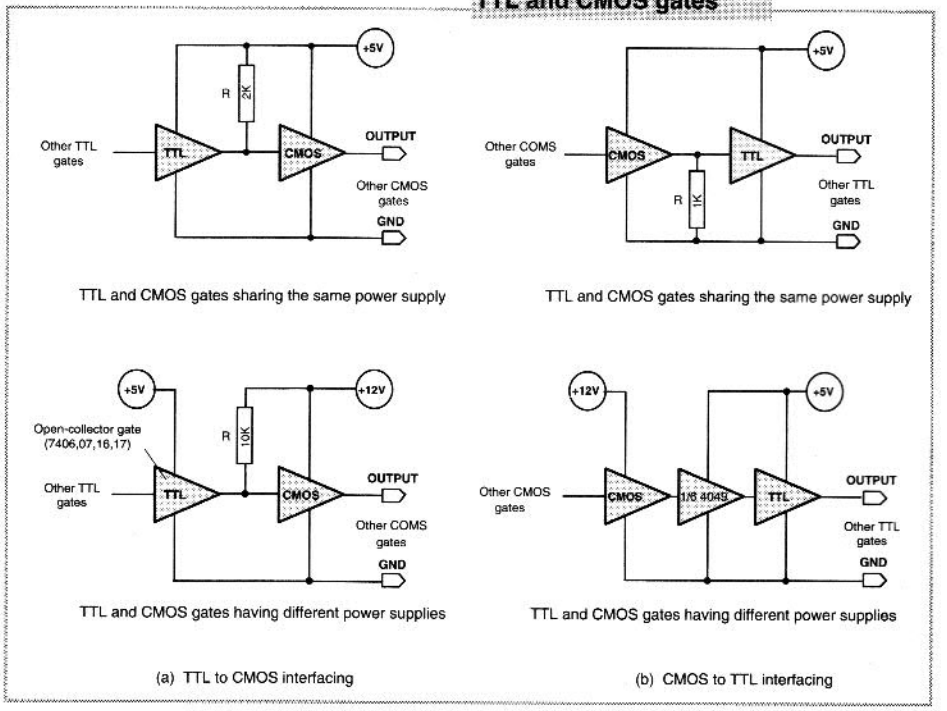
The I/O card control program is written in Turbo Pascal 6 and is based on the LPT1 printer port. The program consists of two operations: writing and reading data from the card. The flow charts of the two operations were shown in Figures 4(a) and 4(b) last month. The sample program is too long to be listed here so readers can obtain a copy of the software on floppy disks at a price of £6 including P&P (The cheque should be payable to X. Qiu and sent to the EIA office).

To use the card, the 8255 PPI should be initialized by writing a suitable control word to the control register. After this, data can be written to or read from peripheral registers according to the port configuration. The procedures of writing and reading are discussed in detail below.

When writing data to an 8255 register, the required data is firstly written to the Data port (Port[888] for LPT1), then the address is written to the Control port (Port[890]) to specify a particular register with the other two lines of the Control port set high. Next a '0' pulse is sent to the 8255 via -WR line of the Control port. This will write the data into the register (see Figure 4(a)). We can only write data to the control register and peripheral registers with their corresponding ports configured as output ports. Because the data lines of the Centronic port are not connected in the same order to that of the 8255 PPI (Figure 2), the actual data sent to the 8255 PPI must be converted before output from the Centronic port. The method of conversion is in a procedure named 'Function convert()' within the program.

To read data from the card, the following procedure is required (see Figure 4(b)). Firstly, an address is written to the Control port with the other two lines of the Control port set high, then a high-to-low pulse is supplied to -RD line. This causes the 8255 PPI to output data to its data bus. Next the first LSB of the Data port is set low (DSL line is low) and the Status port of the LPT1 (Port[889]) reads the first reading. The first LSB of the Data port is then set high (DSL line goes high) and the Status port reads the second reading. Finally the two readings are rearranged and combined into 8-bits of data. The procedure is then completed.

Fig.7 Interfacing between TTL and CMOS gates



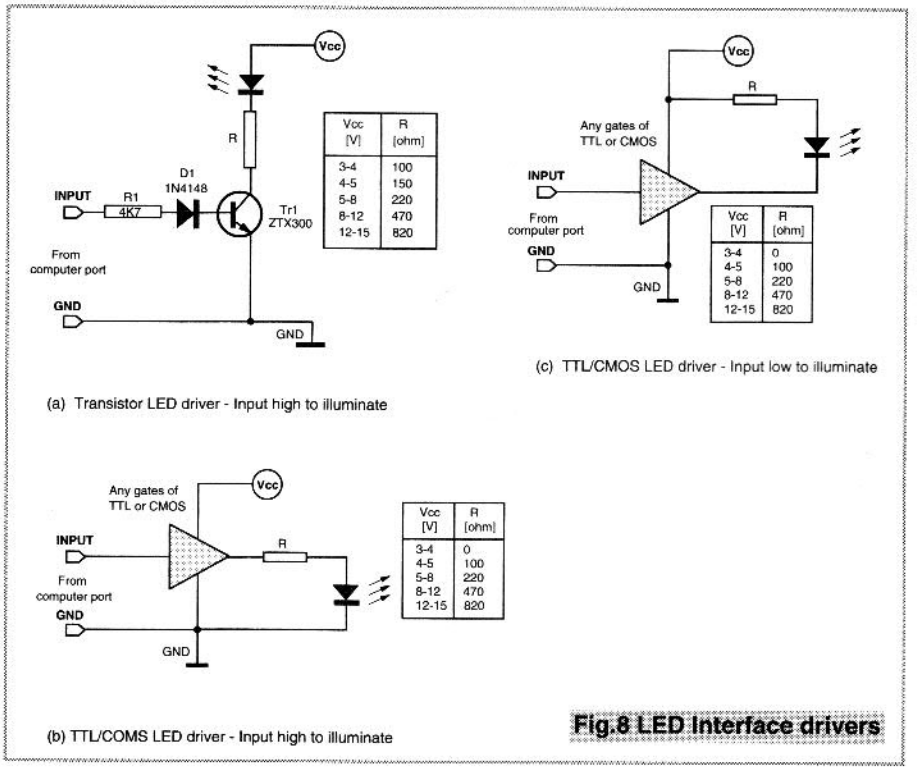


Fig.8 LED Interface drivers

Applications

Building this I/O card is only half of the story of computer interfacing. The other half is to do the actual interfacing with external devices. There are mainly two interfacing schemes. The first one is to use the I/O card to control external

Fig.9 Relay interface drivers

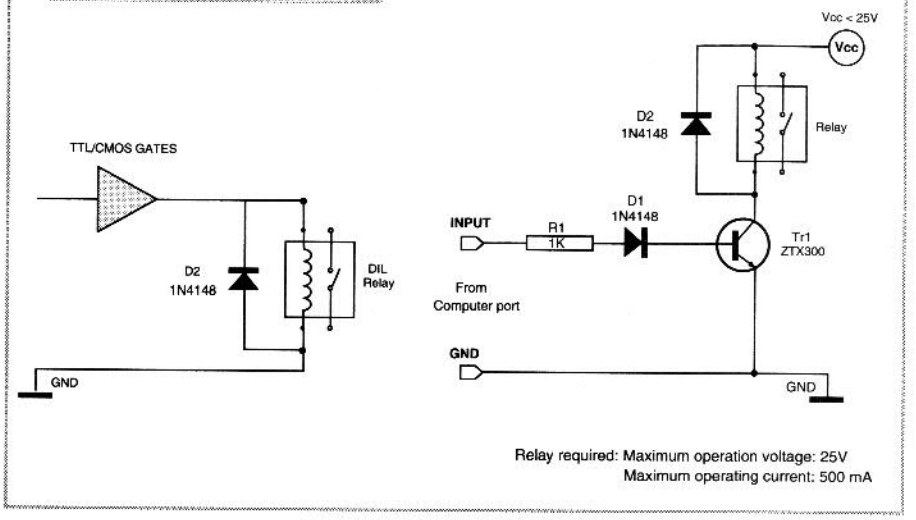
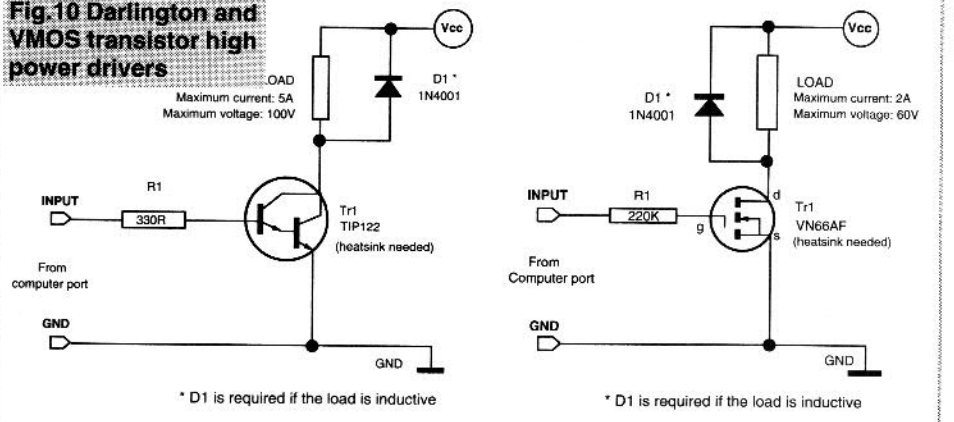


Fig.10 Darlington and VMOS transistor high power drivers



devices such as lights and relays. The other is to use it as an input device to obtain information from the external world. In this section, various ways in which external devices can be interfaced to the I/O card are discussed.

Before this, a brief description is given to show the relationship between logic and voltage levels from TTL outputs and inputs. At logic 0 state, the output will be any voltage between 0V and 0.8V. At logic 1, it will be between 2V and 5V. TTL inputs interpret any voltage between 0V and 0.8V as 'Logic 0' and any voltage between 2V and 5V as 'logic 1'.

Interfacing between TTL and CMOS

Sometimes TTL and CMOS gates have to be connected together. Figures 7(a) show how this is done. The upper figure shows two gates sharing the same power supply and the lower has two gates with different power supplies. Figure 7(b) shows how CMOS and TTL gates are connected .

LED drivers

Using computers to control LEDs is very common in interfacing projects. Several LED drivers are shown in Figure 8. Figure 8(a) shows an LED driver using a transistor, ZTX300. In this circuit, a resistor R has to be used in series with the LED and its value should be chosen according to the voltage applied. LEDs can also be driven by TTL or CMOS gates directly as shown in Figure 8(b) and 8(c). In Figure 8(b), a logic 1 will illuminate the LED. In Figure 8(c), a logic 0 will illuminate the LED. For CMOS gates, R should be chosen according to the voltage of the power supply.

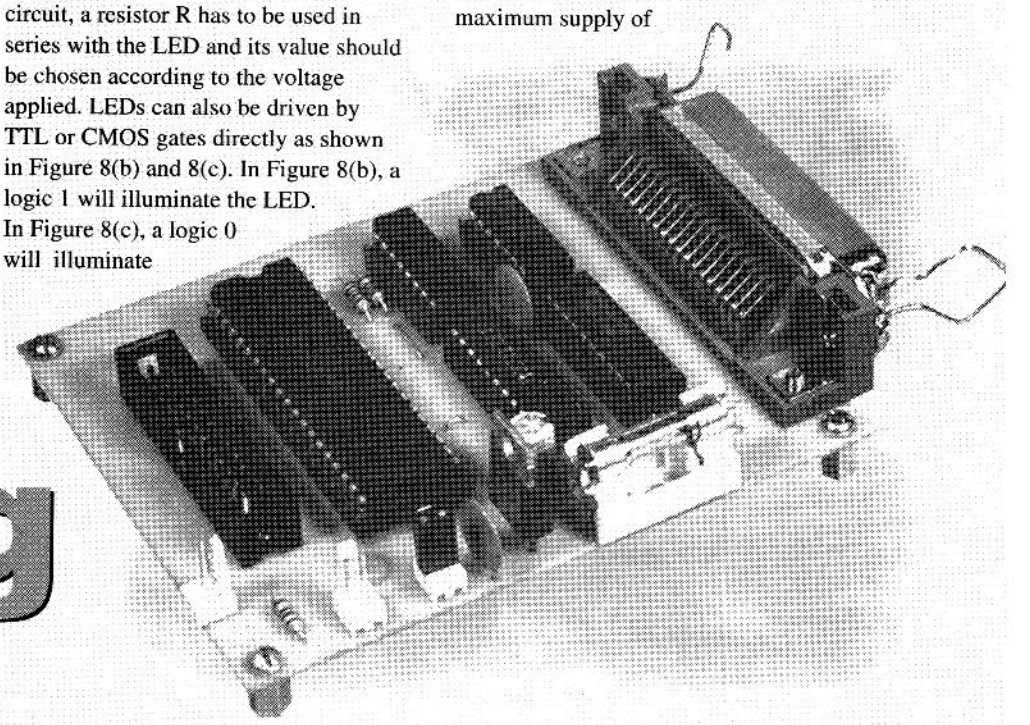
Relay drivers

Low power reed relays, some of which are housed in tall DIL plastic packages, will operate with a coil voltage of about 3.7 volts and a current of 7.4mA. These can be driven directly from TTL gates. A diode is used to protect the TTL output against the reverse voltage generated as the relay switches off. The contact rating of this type of relay is low and the maximum voltage is usually below 100V and maximum power is in the range from 3 to 10 watts. This only enables loads such as low voltage filament bulbs and small electric motors to be controlled, but is far too inadequate for the majority of applications.

Medium and high power relays require relay drivers. Figure 9 shows a relay driver using a ZTX300 transistor. The driver will operate on a maximum supply voltage of 25V and maximum current of 0.5A. This is adequate for most relay applications. The actual voltage of the power supply should be chosen according to the specification of the relay applied. In all cases, the suppressor diode must be used. Other medium power transistors such as BC108C and BC548 can also be used for these applications.

Drivers for high-current loads

Figure 10 shows two driver circuits. The first one uses a Darlington power transistor, TIP122, and can be used with a maximum supply of



Lining

Part 2

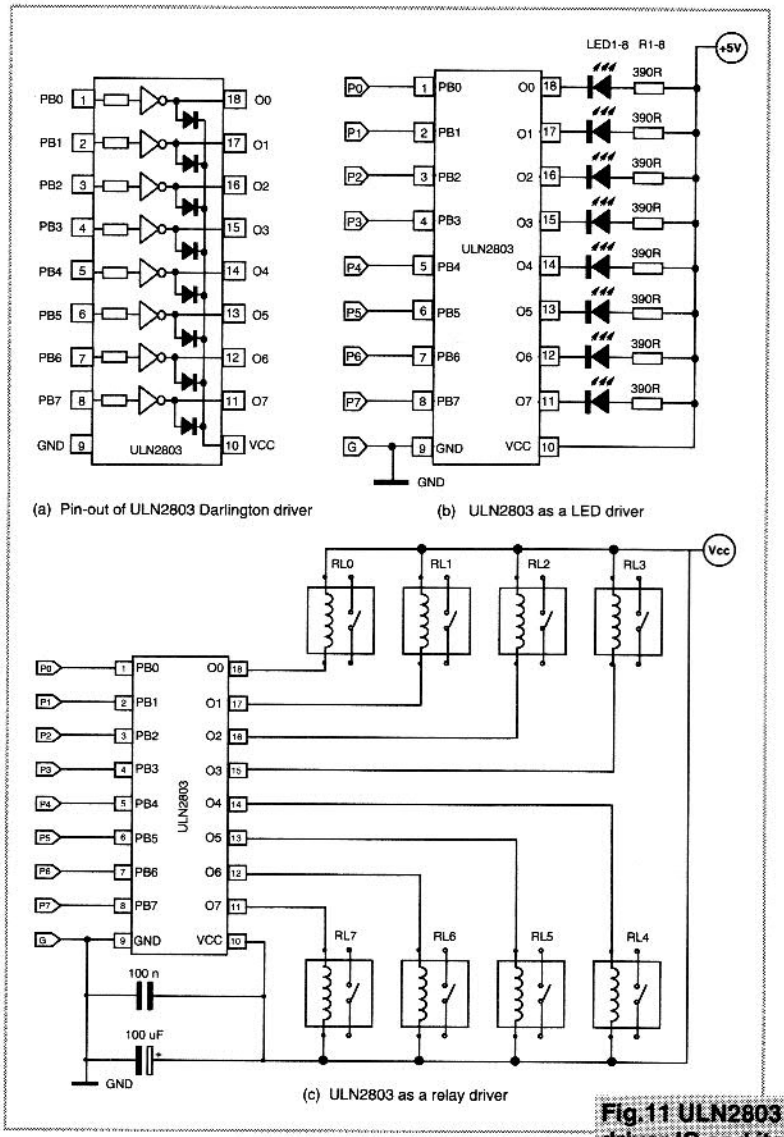


Fig.11 ULN2803 Darlington driver IC and its applications (a) Pin out, (b) LED driver and (c) relay driver

100V and a maximum current of 5A. Darlington transistors start to conduct with a base voltage of 1.2V and have a typical current gain of 5000, therefore a base voltage slightly higher than 1.2V will cause the transistor to saturate in conduction. It can therefore be interfaced directly to TTL gates. The second one uses a VMOS transistor, (VN66AF) which can handle a maximum voltage of 60V and a current of 2A. A VMOS transistor requires an input voltage between 0.8 to 2V to conduct, thus it is possible to directly drive a VMOS transistor from TTL outputs. In both cases, the suppressor diode must be used for highly inductive load such as relays or electric motors and is not necessary if the load is non-inductive such as bulbs or electronic circuits.

Integrated driver ICs

In cases where a number of LEDs, relays or loads are needed, an integrated driver IC such as ULN2803 (or ULN2003) is recommended. This IC has 8 Darlington pair transistor drivers (ULN2003 has 7 pairs) and the pin-out is shown in Figure 11(a). In use Pin 9 is connects to the GND and Pin 10 is connected to the positive power supply. The maximum voltage is 50V and each driver can handle up to 0.5mA current. For currents above 0.1A, heatsinks should be used. Figures 11(b) and 11(c) give the circuit diagrams in which 8 LEDs and 8 relays are controlled by the IC. The former can be used as a logic level indicator for checking the operation of the present I/O card.

Opto-isolator

Opto-isolators are used to electrically isolate the computer from the external devices. This ensures that any fault or mistake in the device side will not lead to damage to the computer. A typical Opto-isolator consists of an infra-red LED and a photo-transistor (Figure 12). In use, the LED is driven from a TTL gate in the normal way. For the photo-transistor, there are two configurations, inverting and non-inverting. In the first case, a logic 1 at the input will result in the output to go low (Figure 12(a)). In the second one, a logic 1 at the input will make the output high (Figure 12(b)).

Opto zero-crossing Triac isolator

The device, such as MOC3041, is used for controlling the mains (Figure 13(a)). It incorporates an infra-red LED, a zero-crossing unit and a Triac. The Triac has a 400V rating and can handle a maximum current of 100mA. Sometimes this is far too inadequate and more powerful Triacs are used. In the circuit shown in Figure 13(b), a power Triac BTA08-600B is used together with the opto triac. This circuit is able to handle a maximum voltage of 600V and current of 8A. ***When dealing with the mains supply, extreme care must be taken.***

Input conditioning interface for TTL gates

In some applications, the signals from certain sensors working with a TTL input are not TTL compatible. So addi-

Fig.12 Opto isolator interfacing circuits

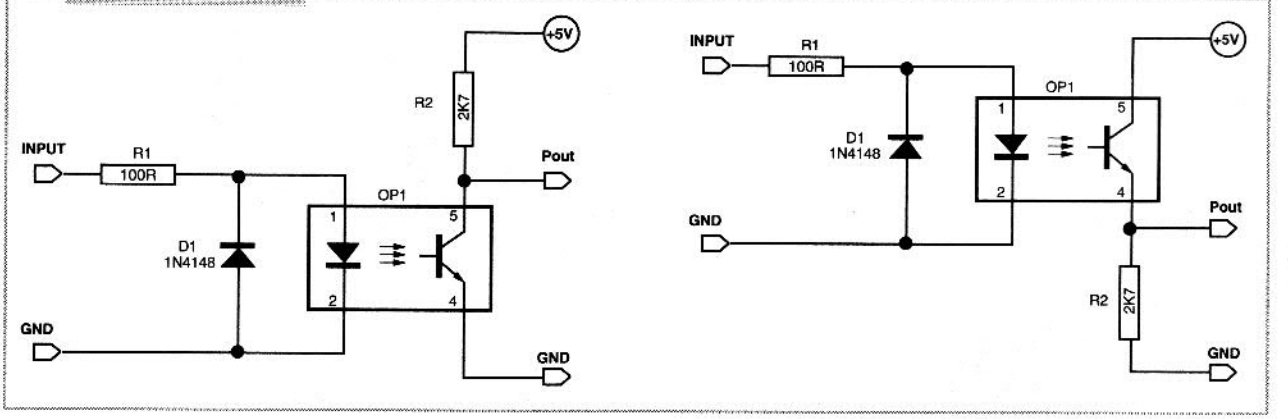
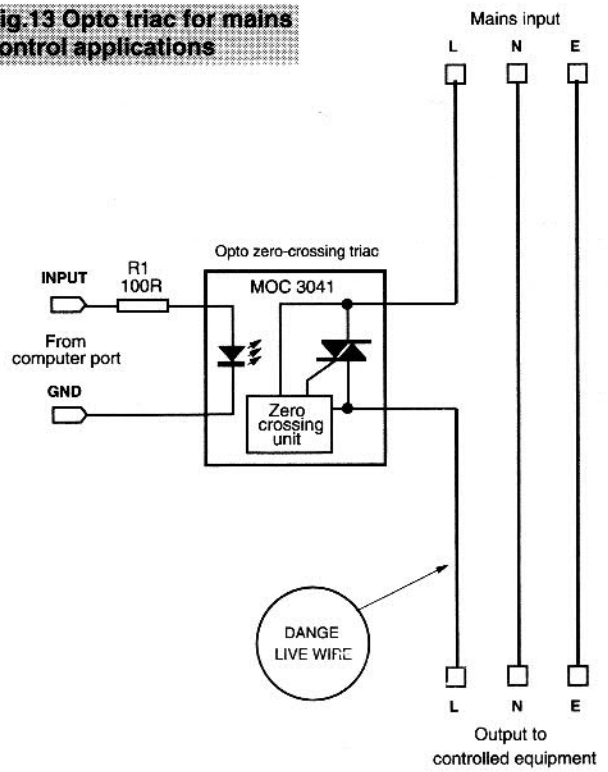
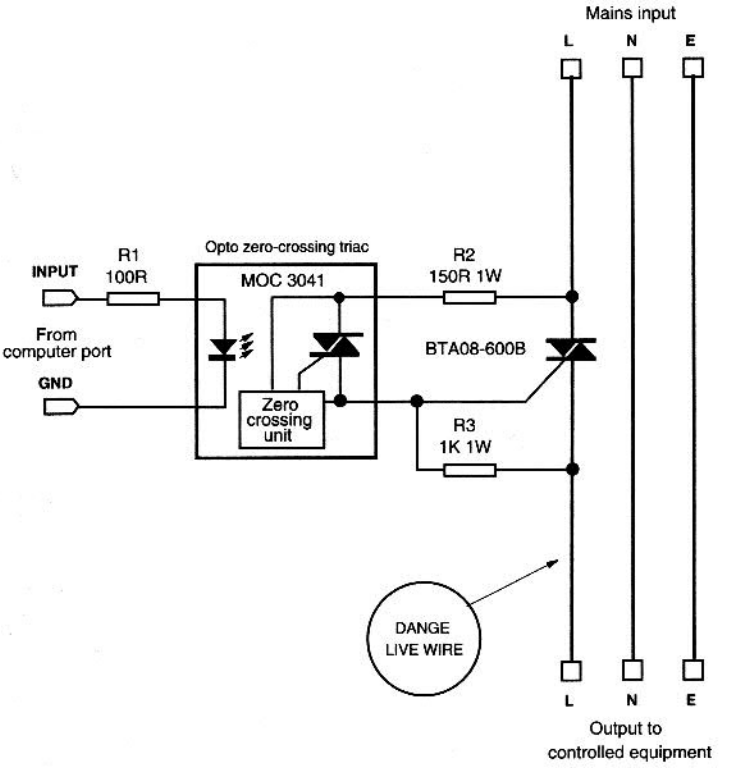


Fig.13 Opto triac for mains control applications



(a) Using an opto zero-crossing triac for controlling the mains



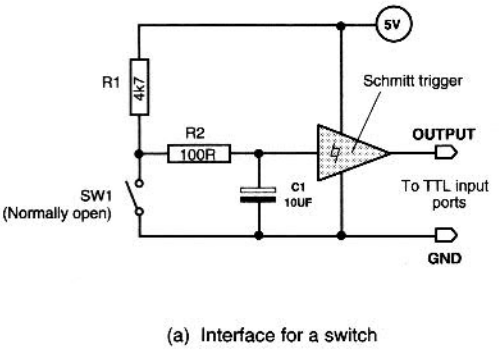
(b) Using an opto zero-crossing triac and a high power triac for controlling the mains (high power version)

tional interfacing circuitry between the sensor and the input port is required. Figure 14(a) shows how a switch is interfaced to the TTL input. Figure 14(b) shows how temperature can be sensed using a temperature sensor. The arrangement generates a logic 0 input whenever the temperature level exceeds the threshold setting and vice versa.

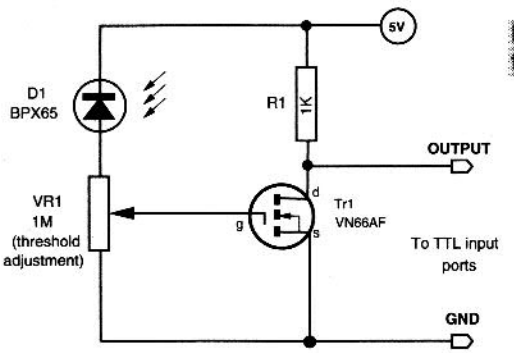
Figures 14(c) shows how light level is sensed using a photodiode sensor. This circuit generates a logic 0 input whenever the light level exceeds the threshold setting and vice versa. Figure 14(d) shows how sound can be sensed using a crystal microphone. In the absence of sound the output from the amplifier is about 2.5V. When sound is detected, the output oscillates above and below this level and the low going voltage change can be detected.

Various interfacing circuits have just been introduced. There are, in fact, a lot more circuits to be interfaced to the I/O card, for example a stepper motor driver, a speech synthesizer driver, etc. Some of these circuits will be introduced in the future.

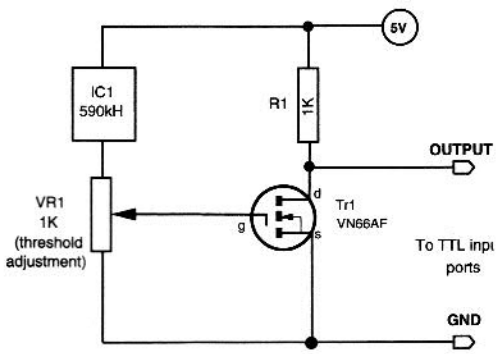
Fig.14 Interface circuits for various sensors



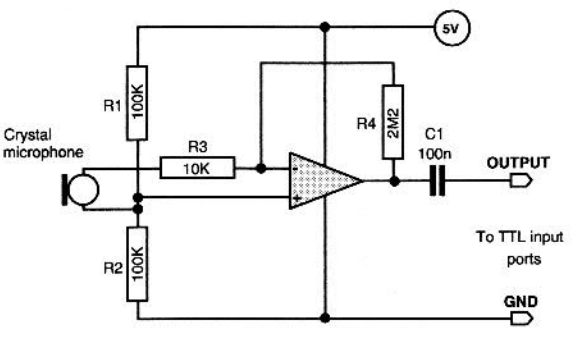
(a) Interface for a switch



(c) Interface for a light level sensor



(b) Interface for a temperature sensor



(d) Interface for a sound level sersor

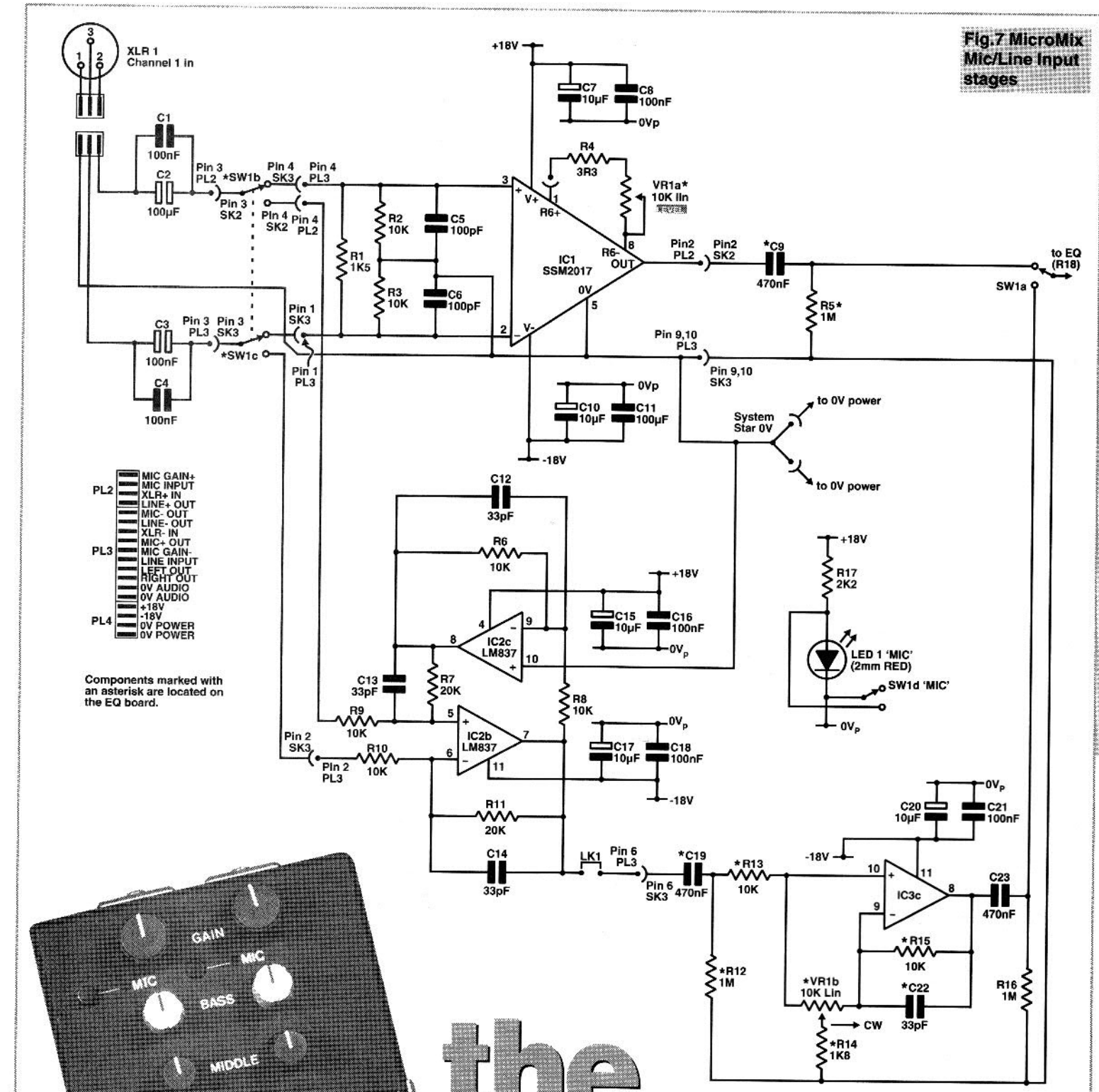


Fig.7 MicroMix Mic/Line Input stages

the MicroMix

Part 2

Mike Meechan moves onto the input stages of his compact mixer project

The Works

The circuit is in four sections, namely Input, EQ, Pan/Level and Output. We'll deal first with the Input stages.

Microphone Input

The Mic. Amp uses the SSM 2017 IC from Analog Devices. This low noise audio preamplifier exhibits a typical voltage noise density of only 950pV/√Hz at 1KHz and 60dB of gain. Gain is provided entirely by the first pair of transistors.

The 2017 has true differential inputs, and while these provide excellent common mode rejection and easily interface to balanced microphone outputs, they can also be connected to single ended devices. The very low noise voltage performance is partially achieved by operating the input transistors at high collector current.

Total noise of the SSM 2017 amplifier system can be calculated as follows;

$E_n = e^2_n + (i_n R_s)^2 + e^2_t$

where

E_n = total input referred noise (EIN)

e_n = amplifier voltage noise

i_n = amplifier current noise

R_S = source resistance

e_t = source resistance thermal noise

In our mic. amp application, where a typical microphone impedance of 200R is likely, the total input referred noise is

e_n = 1nV/ Hz @ 1KHz, *SSM 2017* e_n

i_n = 2pA/√Hz @ 1KHz, *SSM 2017* i_n

R_S = 200R, mic source impedance

e_t = 1.73nV/√Hz @ 1KHz

=2.03nV/√Hz

In a 20Hz-20KHz bandwidth, this is the equivalent to 287nV, (or -128.6dBu). With a best possible (noiseless amplifier) figure of -129.6dBu, when connected to a 200R source, the 2017 yields a noise figure of just 1dB. The mic amplifier is thus virtually transparent to the user.

Gains from 1 to 2000 can be selected via R_G, (in our case, VR1a and R), maximum gain being limited by the minimum resistance of VR1a. Additionally, wide bandwidth and low distortion are retained over the full gain range, with this excellent performance chip. Protection diodes across the base-emitter junctions of the input transistors prevents accidental avalanche breakdown. Feedback is returned directly to the emitters of the input transistors by VR1. Total gain accuracy of the SSM 2017 is determined by the tolerance of the external resistor R_G, together with the gain equation accuracy of the device.

As the devices inputs are fully floating, a DC bias connection for both inputs *must* be maintained where single-ended or pseudo-differential transducers are used. The input therefore remains within a safe common-mode range. R5 and R6 provide DC bias, with their values kept low to retain common-mode performance. Their value is shunted by the impedance of the microphone and so becomes negligible. In this way, neither R5 or R6 compromise noise performance. The reference terminal, pin 5, used for offset correction and level shifting, is connected to a good stable ground since any resistance seen by this terminal will compromise CMR.

Input is via C1//C2 and C3//C4. The large value non-polarised electrolytics will reproduce the low frequencies, whilst the 100n bypass capacitors provide low impedance at HF too. R1 determines the input impedance at around 1K. This resistor can be omitted or altered to suit individual applications. The argument for the omission of R4 is that this kind of 'brute-force' method of determining input impedance has little to recommend it, since impedance, should be a function of the dynamic characteristics of the active stage. Maximum gain is limited only by R4 and the end resistance of the pot. This gain is around 70dB. Capacitors C5 and C6 attenuates unwanted RF and ultrasonic voltages at the input.

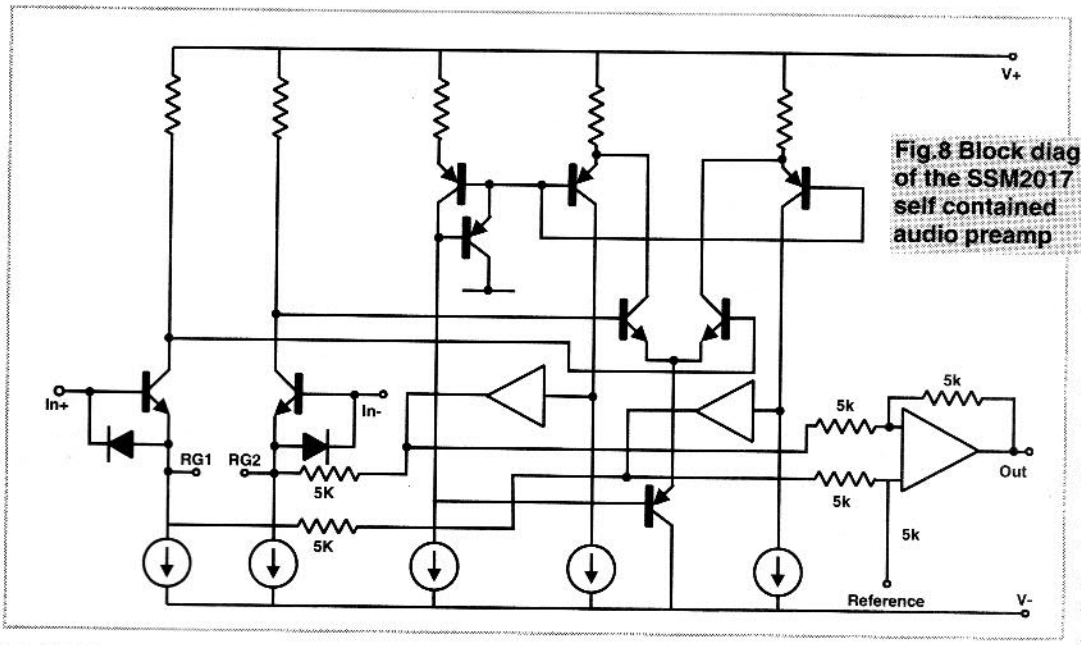


Fig.8 Block diagram of the SSM2017 self contained audio preamp

With such superlative performance *theoretically* attainable from the SS2017 chip in the Mic/Line input stage, we must ensure that such performance isn't degraded by careless choice of any components external to the IC. The most notable place where damage can be done is in the network which provides the 48V Phantom power for capacitor microphones, with CMRR ruined by the fitting of low-tolerance, ill-matched resistances. Also, good quality resistors must be used in the gain setting network, since low quality types, notably carbon composition, can generate significant amounts of distortion and under some conditions, low frequency noise.

Differential amplifiers, unlike most others encountered, operate at high gain when the value of gain setting resistor between the two transistors is lowest. Traditionally, for a good control law, we therefore require an antilog (reverse audio taper) pot, as linear, or worse still, log law, would cramp all of the gain variation into a very small part of the control movement. This type of control is used as the gain controlling network of mic-amps in many mixer input stages, and provides good operational and variable control of gain. These pots yield an almost perfectly linear increase in gain as the pot is rotated clockwise, which is good from an operational point of view. However, I was unable to track down (no pun intended) any readily available supplies of good quality antilog ones, which, as we've said, are a mandatory

requirement if low noise and reliability are to be guaranteed. This pot law just isn't available through the normal commercial retail outlets, and manufacturers and/or distributors want commitment to the tune of a 500 piece minimum order. Furthermore, one control is used to alter gain of both Line and Mic input stages, so that a dual gang pot is called for. To compound the problem, the gain stage of the Line Input requires a linear law type - dual-gang pots split between antilog and linear most definitely aren't available off the shelf. Consequently, a more readily-obtainable dual-gang *linear* law pot has been used in place of the antilog type. The control law isn't quite so linear for equal gain changes but it is workable. The Mic Gain control is likely to be reset only infrequently, so the slight loss of 'user-friendliness' caused by using a linear pot is but a minor operational irritation. Constructors with a secret horde of dual-gang 10K antilog/linear types are of course free to use them if they so desire...

Line Input

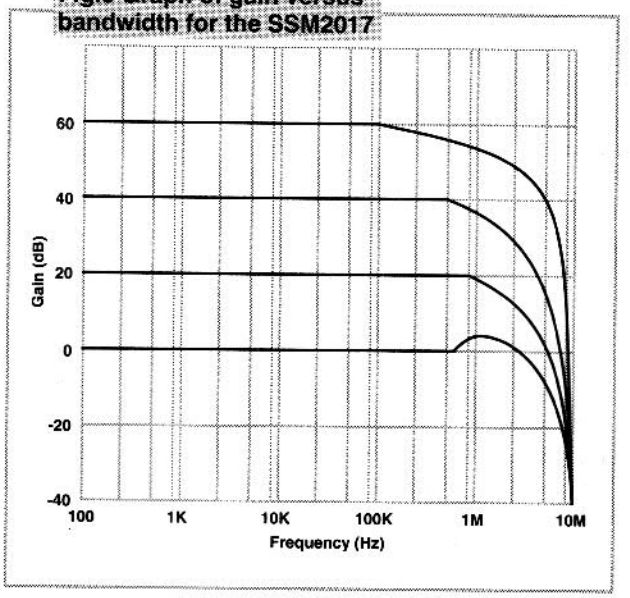
This uses the same XLR or jack socket as the Mic Input so that SW1, whilst determining which of the conditioned outputs is routed to the EQ, must also select which preamplifier stage the input socket feeds. The Superbal Line input circuit is a balanced differential virtual-earth amplifier which is referred to ground at only one op-amp non-inverting input, so providing a symmetrical output from any non-balanced input whilst having quite superb CMR characteristics.

The circuit diagram given in Figure 7 shows resistors values chosen to suit the impedances typically expected for line level inputs ie 20K bridging. A modified version of this, more suited as a DI input for guitars etc, is shown in Figure 16.

The unbalanced output of the Superbal is fed to the gain control stage. The manner adopted to provide this supplementary, second-stage gain control is worthy of note in that it uses no attenuators in series with the input signal path. Many commercial designs use a variable 30 or 40dB pad attenuator, coupled to a fixed gain amplifier. For 15 dB of gain, for example, the input would be attenuated to -30dBu and then amplified by 45dB, with all of the dire aural consequences which this brings. In the circuit offered here, input headroom, signal-to-noise and distortion are optimised for any given input signal magnitude within the range of the amplifier, and there is no unnecessary attenuation of signal. Whenever gain is made up, it is important that any noise is due, in the main, to the gain stage (which, hopefully, has been optimised to reduce noise as much as possible). In this way, all subsequent noise contributions, which, in any case should be small, will thus be masked. At no place in the gain swing should it be necessary to attenuate unwanted gain. This is of particular importance where the gain control is at its minimum setting, since any attenuation, (and hence headroom lost) early in the signal path is effectively lost from that point onwards in the equaliser audio pathway, and can never be recreated. There is little point in having loads of headroom throughout the rest of the system if it's foolishly thrown away by a badly designed gain-controlling stage. It is in just this respect that the circuitry of the Channel Input Trim control scores highly.

The diagram in Figure 15a shows a typical swinging output gain control stage. Here, the gain controlling element is enclosed within the feedback leg of a

Fig.9 Graph of gain versus bandwidth for the SSM2017



Gain Av	dB	Rg
1	0	Not connected
3.2	10	4K7
10	20	1K1
31.6	30	330
100	40	100
316	50	33
1000	60	10
3160	70	3R3

Fig.10 Values for R_G for various gain levels

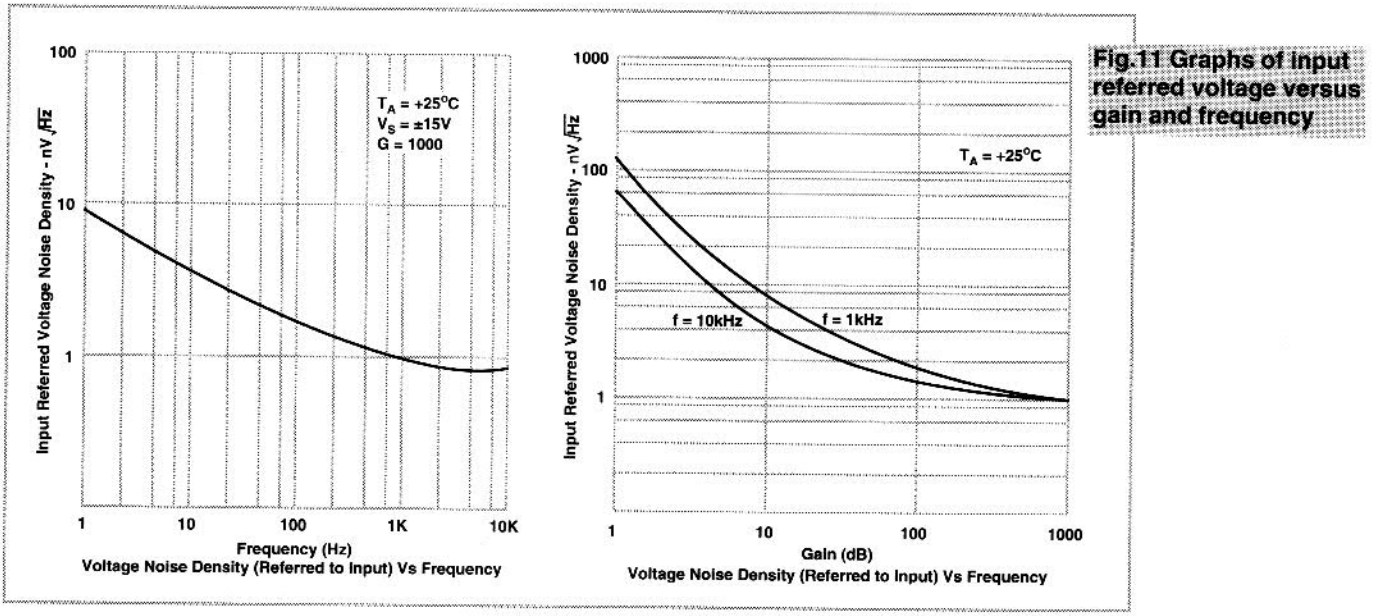
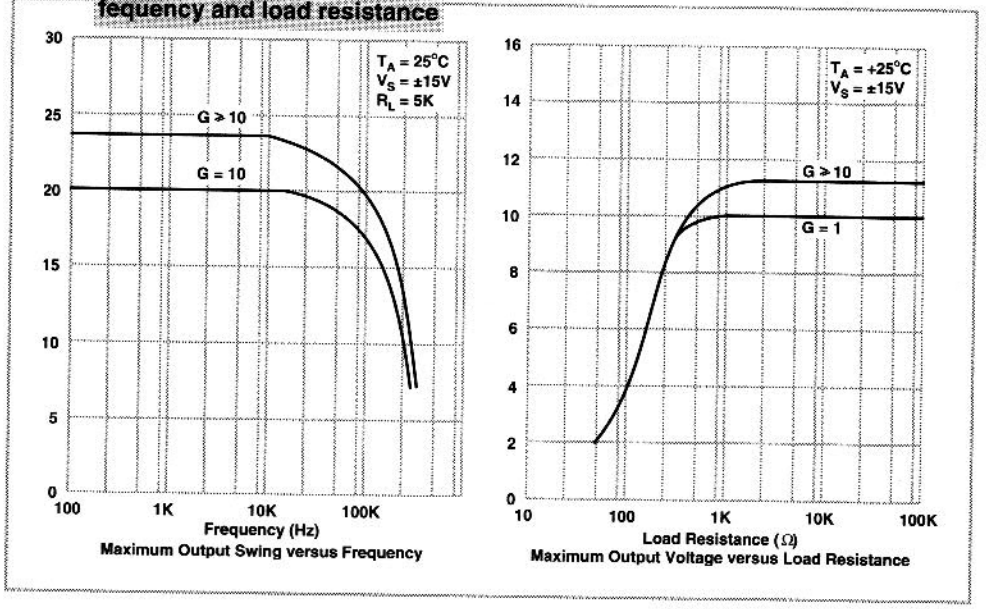


Fig.11 Graphs of input referred voltage versus gain and frequency

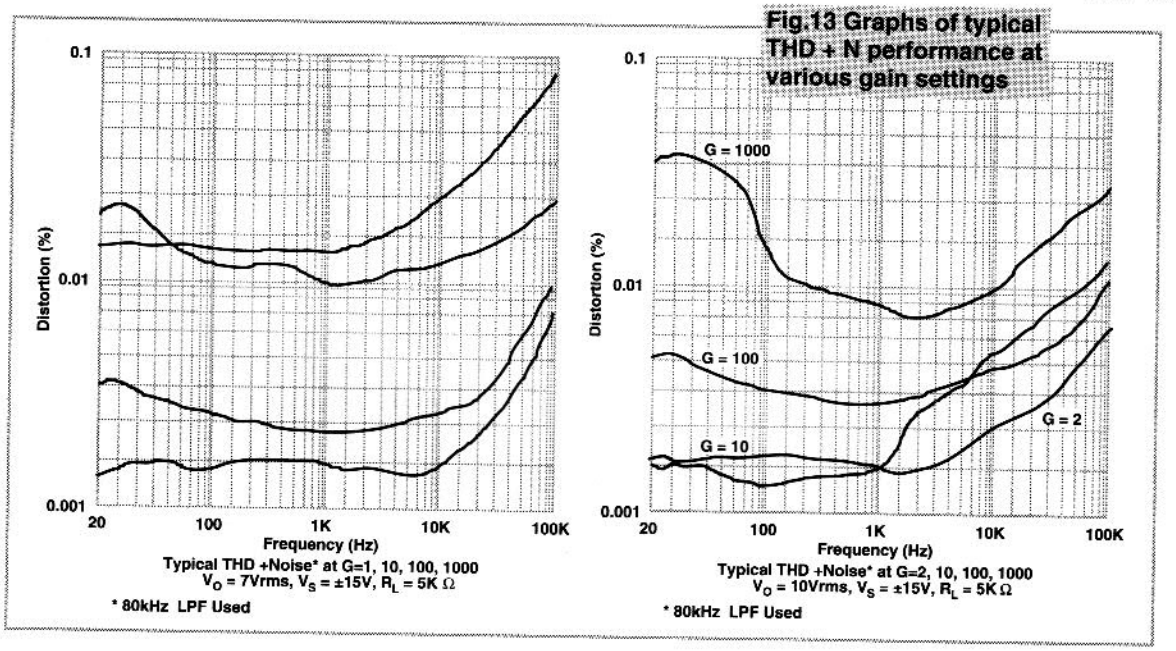
Fig.12 Graphs of output voltage swing versus fequency and load resistance



gain control law.

Unity gain results when attenuation in the output leg is equivalent to that in the feedback leg, since the feedback ratio exactly nulls the effect of the output attenuation. The maximum gain condition results when the feedback leg is shortened with respect to ground, and the output attenuator is lengthened. This means that loop gain of the amplifier is at a maximum, while an almost completely unattenuated signal is available at the network output terminal. At minimum, the feedback resistor is shortened, (reducing loop gain) while the attenuator leg is lengthened, reducing output signal amplitude. A small resistor connected between the pot wiper and ground controls the gain range. Using complex impedances such as capacitors and inductors achieves frequency-conscious boost and cut.

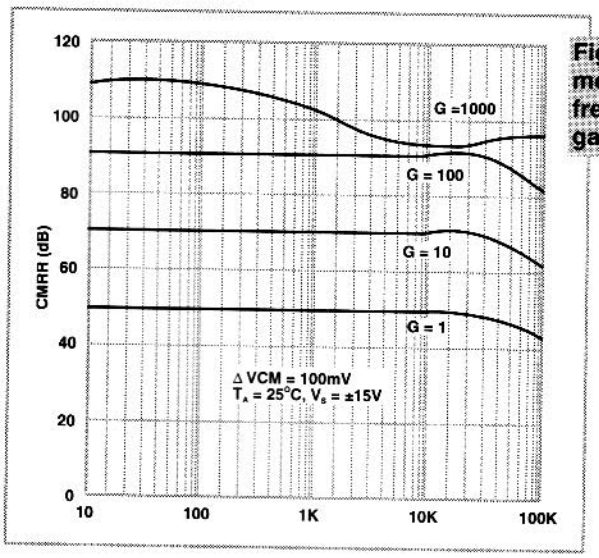
Fig.13 Graphs of typical THD + N performance at various gain settings



The practical upshot of this is that headroom is lost at the output, with figures around 3dB being typical. When we've striven so hard throughout the rest of the design to preserve and optimise system operating levels, it seems foolish to throw so much of this hard-won headroom away by using the swinging-output stage.

There is a way we can improve on it, namely by making it into a swinging input. With this configuration - shown also in Figure 15b - the output attenuation network is transferred to the input, while the feedback network remains as it was in the swinging output type. At the minimum gain setting, the input signal is subjected to maximum attenuation while the amplifier - with its short feedback leg - delivers only a small amount of gain. At maximum boost, these conditions are, of course reversed, with minimum input attenuation and a long feedback component providing high gain.

Fig.14 Graph of common mode rejection versus frequency for various gain settings



non-inverting amplifier. Although this configuration now means that a buffer amp or low impedance source - needed for an inverting configuration - is obviated, unfortunately, the output impedance of this network varies with the setting of the gain control. Consequently, a high subsequent load impedance or output buffer amplifier is necessary if system output impedance is to remain constant. Serious drawbacks arise and can manifest themselves as problems with phase margin and consequent instability, loss of headroom, and departure from, and serious modification of, a workable and useable

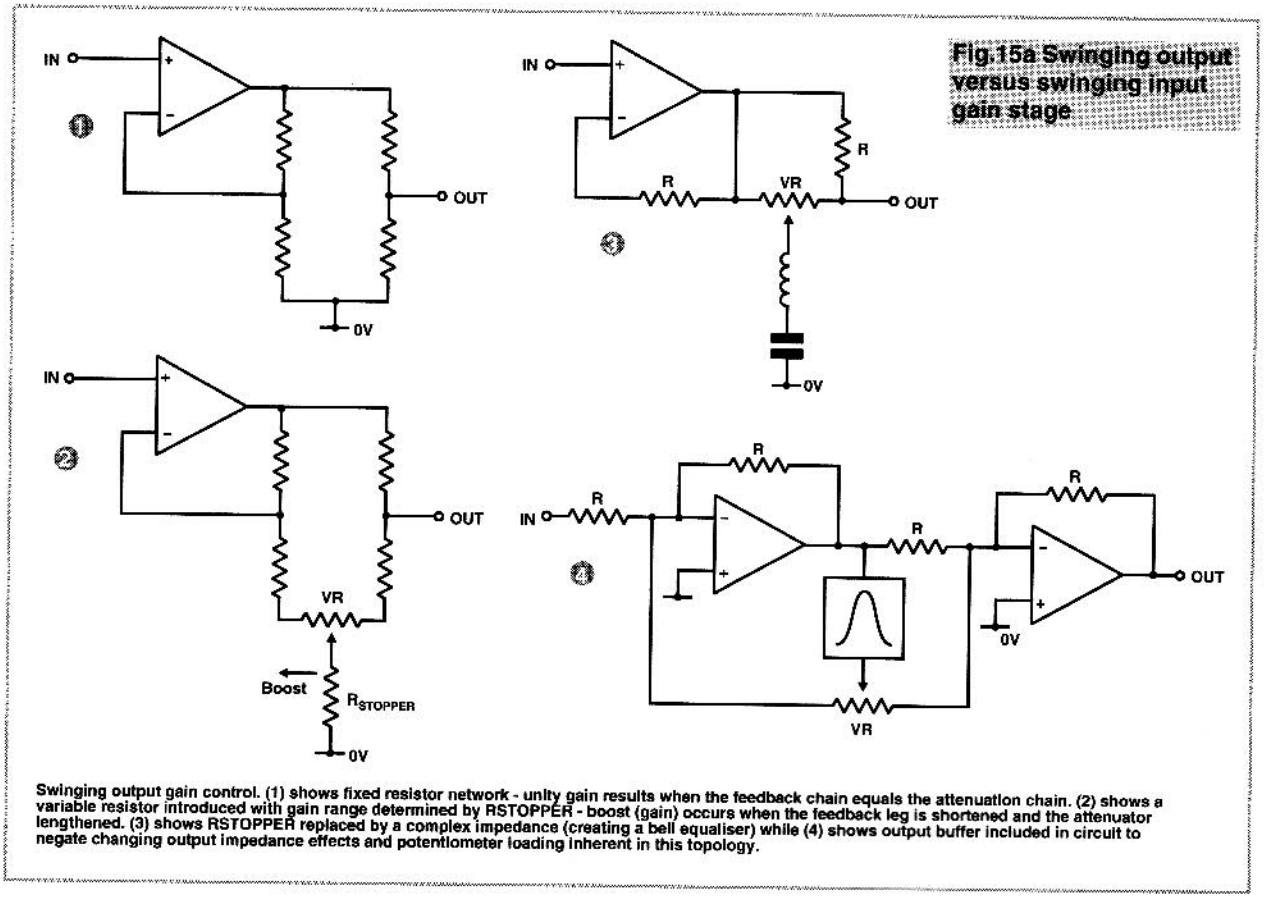


Fig.15a Swinging output versus swinging input gain stage

Swinging output gain control. (1) shows fixed resistor network - unity gain results when the feedback chain equals the attenuation chain. (2) shows a variable resistor introduced with gain range determined by RSTOPPER - boost (gain) occurs when the feedback leg is shortened and the attenuator lengthened. (3) shows RSTOPPER replaced by a complex impedance (creating a bell equaliser) while (4) shows output buffer included in circuit to negate changing output impedance effects and potentiometer loading inherent in this topology.

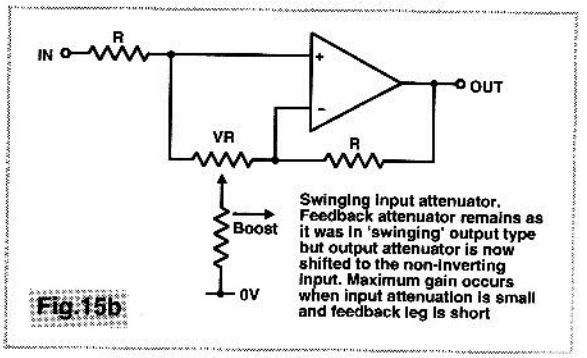


Fig.15b

Swinging input attenuator. Feedback attenuator remains as it was in 'swinging' output type but output attenuator is now shifted to the non-inverting input. Maximum gain occurs when input attenuation is small and feedback leg is short

Further improvements are apparent in the way that the circuit performs with respect to noise. At unity gain, when input attenuation and amplification are exactly nulled, the loop has around 20dB of gain. At first sight this may seem to be somewhat noisier than the corresponding Baxandall type. However, all of the network resistance values can be made lower by an order of magnitude, (about one tenth the typical 100K used with the Baxandall) and so Johnson or thermal noise is significantly reduced. Furthermore, any noise injected into the system (at unity gain) appears in equal quantities at both the inverting and non-inverting inputs ie common-mode noise at a differential input. Ideally, common mode signals should not appear at the output.

Around the centre of the control, where most adjustments will probably be made, the dB change in gain is almost linear with respect to control rotation and the dB change is more cramped at extreme settings of the control, but it is a more than acceptable compromise. It is this type which features here. The output of this is fed through a DC blocking capacitor, referenced to earth and used as an input for the Mic/Line source select switch. Although purists may abhor the number of capacitors in series with the audio signal path, they help to provide click-free switching of sources and symmetrical signal swing about 0V. It has been shown (Ben Duncan or Steve Dove, I forget whom), that the effects of AC-coupling can be devastating to the fidelity of an audio signal. The effects of something of the order of one hundred stages of AC-coupling were analysed. Components were typical 4µ7 electrolytic coupling capacitors/10K ground-referencing resistors, giving a break frequency ostensibly around 4Hz. However, when the cumulative effect of one hundred of these stages (a not-untypical number for an audio mixer) was then analysed, the input waveform bore very little resemblance to the output one. It pays dividends, therefore, to specify AC-coupling components much larger in capacitance than mere calculation might first suggest, particularly where many stages are to be cascaded.

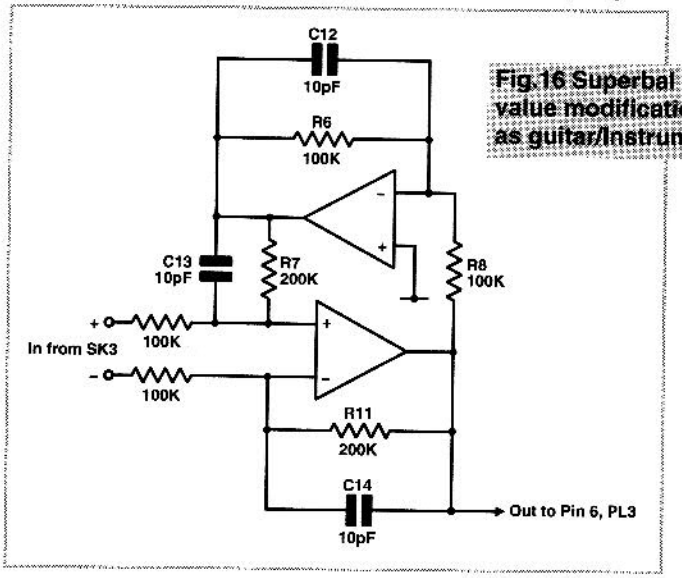


Fig.16 Superbal component value modifications (for use as guitar/instrument DI input)

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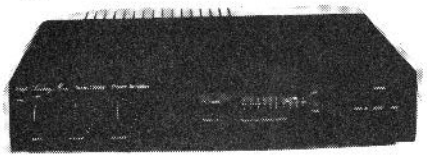
AUDIO DESIGN 80 WATT POWER AMPLIFIER.

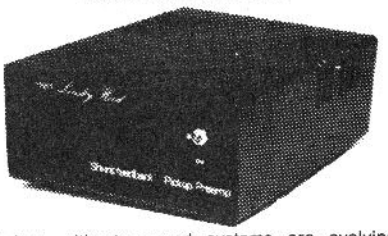


This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance for a few tenths of the cost!. Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic:- "The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout." Options include a stereo LED power meter and a versatile passive front end giving switched inputs using ALPS precision, low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility so that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heatsink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component ident side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre-terminated, ready for instant use!
RLH11 Reprints of latest articles.....£1.80
K1100CM HART Construction Manual.....£5.50

LINSLEY HOOD 1400 SERIES ULTRA HIGH-QUALITY PREAMP

Joining our magnificent 80 Watt power amplifier now is the most advanced preamplifier ever offered on the kit, or indeed made-up marketplace. Facilities include separate tape signal selection to enable you to listen to one programme while recording another, up to 7 inputs, cross recording facilities, class A headphone amplifier, cancellable 3-level tone controls and many other useful functions, all selected by high quality relays. For full details see our list.

LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIERS



Modern, ultimate sound systems are evolving towards built-in preamplifiers within or near the turntable unit. This keeps noise pickup and treble loss to a minimum. We now offer two units, both having the sonically preferred shunt feedback configuration to give an accurate and musical sound, and both having the ability to use both moving magnet and moving coil cartridges.
Kit K1500 uses modern integrated circuits to achieve outstanding sound quality at minimal cost. The very low power requirements enable this unit to be operated from dry batteries and the kit comes with very detailed instructions making it ideal for the beginner. K1500 Complete kit with all components, printed circuit board, full instructions and fully finished case.....£67.99
Instructions only.....£2.80
Kit K1450 is a fully discrete component implementation of the shunt feedback concept and used with the right cartridge offers the discerning user the ultimate in sound quality from vinyl disks. Can be fitted inside our 1400 Preamp, used externally or as a standalone unit. It has a higher power requirement and needs to be powered from our 1400 Series preamplifier or its own dedicated power supply.
K1450 Complete Discrete Component RIAA Phono Preamp.....£109.58
Factory Assembled and Tested.....£159.58
K1565 Matching Audio Grade Power Supply with potted toroidal transformer and limited shift earthing system.....£79.42
Factory Assembled and Tested.....£118.42
U1115 Power Interconnect Cable.....£7.29

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Test Cassette TC1DD.....Our price only **£10.99.**

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Top Quality, Full Digital (DDD) Compact Disks of the great classical favourites.
Like everyone else we didn't like the idea of paying silly prices for CDs. After a long search we have now located a source of top quality classical recordings at prices that make you suspect the quality - until you try them! Send for our list of titles.

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Like music CDs these have overpriced for some time but with low prices of CD ROM drives the multimedia revolution is with us now. Send for our list of titles. Most popular up to now have been "Too Many Typefonts" with 514 TrueType fonts along with 393 ATM and lots of others.
"Shareware Overload" with over 6100 programs extending to 550MB and "Kodak Photo CD Access". The first two are only £12.95, the Kodak only £24.

TECHNICAL BOOKSHELF

Modern Books. Selected to represent the state of the art today.

"THE ART OF LINEAR ELECTRONICS."
J.L. Linsley Hood.
Just Out! Hot off the Press, the definitive electronics and audio book by the renowned John Linsley Hood.
This 300+ page book will give you an unparalleled insight into the workings of all the types of audio circuits. Learn how to read circuit diagrams and understand amplifiers and how they are designed to give the best sound. The virtues and vices of passive and active components are examined and there are separate sections covering power supplies and the sources of noise and hum. As one would expect from this writer the history and derivation of audio amplifier circuitry have an entire chapter, as does test and measurement equipment.
Copiously illustrated this book is incredible value for the amount of information it contains on the much neglected field of linear, as opposed to digital, electronics. Indeed it must be destined to become the standard reference for all who work, or are interested in this field.
SPECIAL OFFER.
With each book purchased you may request a FREE extended index, written by the author, exclusively from HART.
0-7806-0868-4.....**£16.95**
Don't forget most of our kits have reprints of articles by John Linsley Hood that you can purchase separately.

"THE ART OF SOLDERING"
R Brewster.
Absolutely essential reading for anyone who ever picks up a soldering iron. Written from knowledge gained in a lifetime in the field, this is the first book ever solely devoted to this essential and neglected skill for all electronic enthusiasts. Covers everything from the correct choice of soldering iron and solder to the correct procedures to follow with many illustrations and practical exercises.
0-85935-324-3.....**£3.95**

"AUDIO" F.A. Wilson.
320 pages. 178 x 111. Publ. 1985
BP111 "AUDIO" by F.A. Wilson.....**£3.95**

"AN INTRODUCTION TO LOUDSPEAKERS & ENCLOSURE DESIGN" V Capel.
160 pages. 178 x 111. Publ. 1988
BP256.....**£2.95**

"LOUDSPEAKERS FOR MUSICIANS" V Capel.
176 pages. 178 x 111. Publ. 1991.
BP297.....**£3.95**

"HOW TO USE OSCILLOSCOPES & OTHER TEST EQUIPMENT" R. A. Penfold.
112 pages. 178 x 111. Publ. 1989
BP267.....**£3.50**

Classics from the "Golden Age"

"THE WILLIAMSON AMPLIFIER."
D.T.N. Williamson.
In April 1947, Williamson's power amplifier, using excellent quality push-pull output valves, a special output transformer, and a highly filtered power supply, became an overnight success. The author takes the reader deep into his design considerations, offering practical advice on how to build the units plus concise instructions on setting up the new amp. A cult classic.
1947, Reprinted 1990. 40 pages.
0-9624-1918-4.....**£4.95**

LOUDSPEAKERS; THE WHY AND HOW OF GOOD REPRODUCTION.
G.A.Briggs
This easy-to-read classic, last revised in 1949, introduces the reader to concepts such as impedance, phons and decibels, frequency response, response curves, volume and watts, resonance and vibration, cabinets and baffles, horns, room acoustics, transients, crossovers, negative feedback, Doppler and phase effects, and much more. A provocative survey of the right questions about sound reproduction.
1949 reprinted 1990. 88 Pages. 215 x 140
0-9624-1913-3.....**£6.95**

COMPUTER TITLES.

" A CONCISE ADVANCED USERS GUIDE TO MS DOS"
N. Kantaris.
144 pages. 198 x 130. Publ. 1992
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"MAKING MS DOS WORK FOR YOU"
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Please add part cost of carriage and insurance as follows:–**INLAND Orders up to £20 - £1.50, Orders over £20 - £3.50. Express Courier, next working day £10.**
OVERSEAS – Please see the ordering information with our lists.

QUALITY AUDIO KITS

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ALL PRICES INCLUDE UK/EC VAT

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OSWESTRY, SHROPSHIRE
SY10 9AF

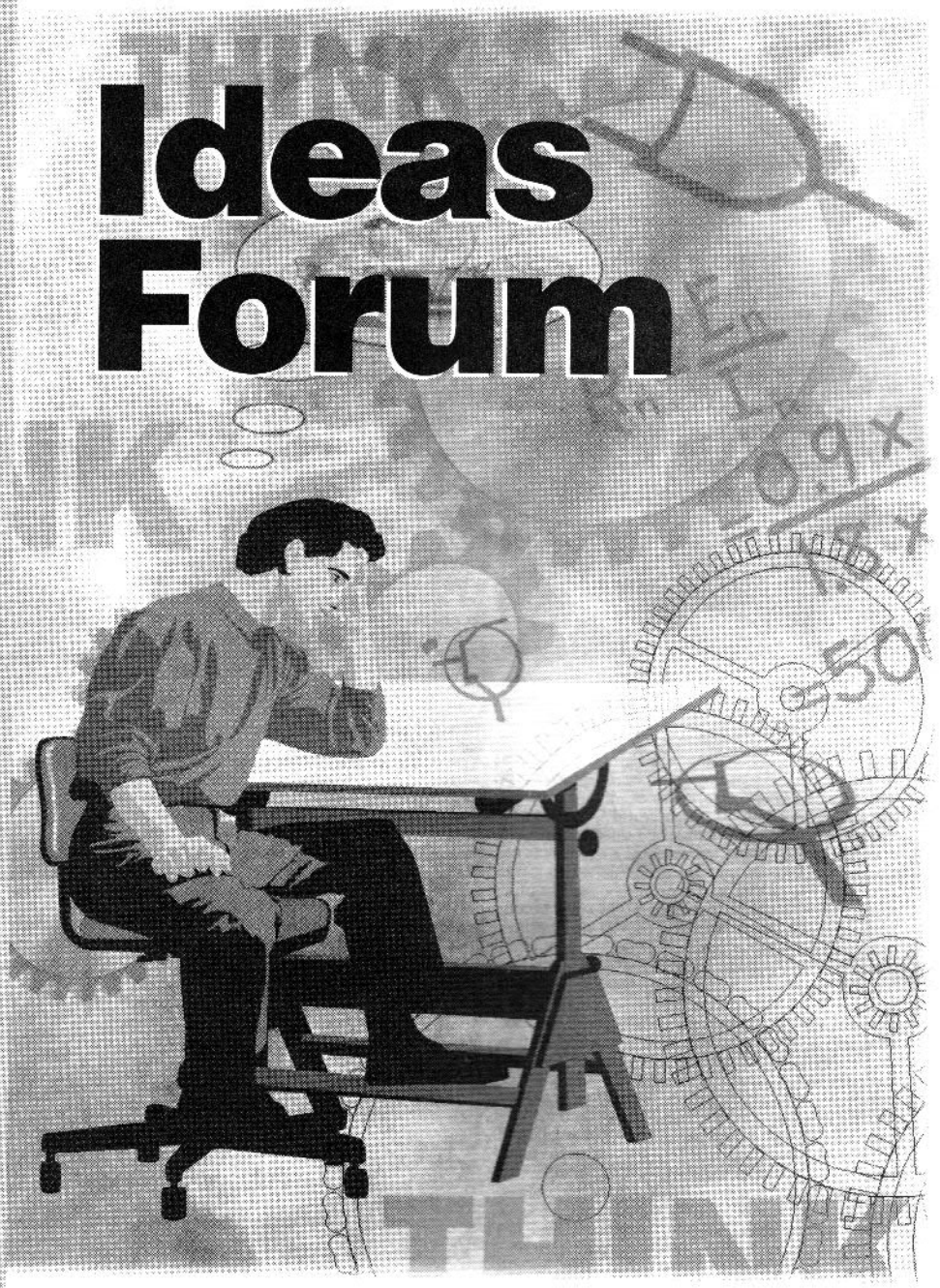
July

Bird Scarer
Just when you've put seed down for a new lawn or your peas are growing nicely on the vegetable patch, the birds decide to make a large dinner out of them. What do you do? How about an inexpensive bird scarer. It must have random or varied sounds so the birds do not become accustomed to the noise. As it monitors a small area, it could work by a proximity sensing arrangement.

Aids for the elderly
When old people live alone, it is not always possible for them to get help quickly if necessary. In many cases they are not always beside a telephone. What is required is an electronic audio version of the HELP, CALL POLICE, AMBULANCE poster. It could operate via a panic button and would always be carried around with them. It would trigger an audio message played through a loudspeaker onto the street to alert passers by.
The circuit could be a simple digital store for a message to be recorded at low bandwidth. The panic button could be a low power transmitter to trigger the prerecorded message.

Hole depth problem
How do you calculate the depth of a deep cylindrical hole in the ground? An old trick is to drop a stone down and time it until a thud is heard and then use the equation $d=\frac{1}{2}gt^2$ What about using sound resonance techniques and treat it like an organ pipe finding its fundamental frequency. Then find the depth from the wavelength calculation arising from the frequency and velocity.

Ideas Forum



Make the most of your brainpower and come up with some brilliant ideas

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.

Even though great inventions come to mind, the tragedy is you may dismiss the idea as worthless. So if you think of a good idea discuss it with a friend to see if they agree with you that what you have to tell the world is brilliant. Then ask yourself, do lots of other people want to hear about it and would you like them to benefit from your idea? Is there a market for it? If there is, who will mass manufacture it? These are some of the questions that have to be thought about. Use the suggestions on this page.

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. It could be the first step along the road to fame.

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

At Your Service

So you don't fancy messing up your best measuring jug with Ferric Chloride, but you still want to make some of our projects properly - with a PCB? This is where we step in. At Electronics in Action we can offer, at very reasonable prices, PCBs for all of our featured projects.

Just select which PCBs you require, fill in the coupon and post it to us with a cheque or postal order (for the full amount) made payable to **Electronics in Action.**

The coupon lists all the projects featured in the last four issues and anything older is listed below. We have left some blank spaces on the coupon should you wish to order an older PCB.

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QH0394-3
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Allow 28 days for delivery

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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.

The Technology Exchange, which was formed in 1985 as a not-for-profit technology sourcing service to industry, holds a biannual 'Technoshop' Technology Transfer Fair at Heathrow Airport and several 'Techmart' Fairs overseas for the United Nations (UNIDO).

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.

If you would like to have an introduction to any of the sources of the offers describes in these profiles, please write to The Technology Exchange quoting the reference number at the head of the entry and giving full contact details for the contact person in your own organisation and your requirements for a new product or process development.

The only cost associated with this process is a simple £10 plus VAT introduction fee for each entry to which you respond. For this we will send you full contact details for the source of the offer and invite them to send you more detailed information about their offer.

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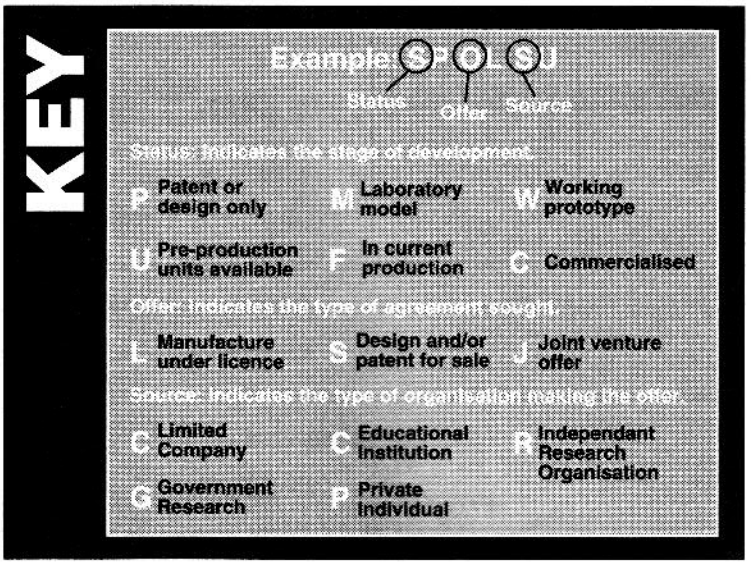

106384
ELECTRONICALLY CONTROLLED SELF-ALIGNING DEVICE

To govern a stepping motor capable of up to 60 speeds.

106385
FULLY AUTOMISED SYSTEM FOR TINNING OF INTEGRATED CIRCUITS

106386
SYSTEM FOR TINNING OF AXIAL AND RADIAL COMPONENTS

In microelectronics.

106391
HIGHLY FLEXIBLE PRODUCTION BOOTHS

For the complete assembly of printed circuit boards in surfaces; SMD and DSM (or combination of both).

106396
ELECTRONIC DRILL HOLE COORDINATE DETECTION SYSTEM

From hand drawn layout to drill hole coordinates for CNC circuit board drilling machines.

506686
MACHINE FOR AUTOMIZED SETTING AND PACKAGING

of various sheet metal parts into plate packets, especially rotor and stator plates for small electric motors. Microprocessor control ensures technical parameters of the packs and enable incorporation of the process into automized production lines.

6397
CIRCUIT BOARD PROTOTYPE DETECTION SYSTEM

From hand drawn layout to mechanically manufactured circuit board prototype.

106499
CONTROLLED ASSEMBLY LINE FOR MANUAL ASSEMBLY OF PRINTED CIRCUIT BOARDS

and small mechanical devices, intermediate stations as soldering machine, post assembly stations, solder frame retrieval and full equipment of single stations.

506588
SYSTEMS FOR THE PRETREATMENT OF PRINTED CIRCUITS

with the aid of an electrolytic system. New electrolytes.

106684
MACHINE FOR AUTOMIZED BANDAGING OF WINDINGS

For stators of small electric appliances, featuring new procedures for tying and knotting to achieve a compact coil winding head.

106699
HANGING ILLUMINATION DEVICE

with adjustable height for installation, maintenance and repair of illuminations systems. Saving on maintenance systems, scaffolding, personnel and storage space Considerable saving of energy by regular maintenance.

706685
BANDAGING MACHINE FOR ALL COIL WINDINGS
in medium-to-large-sized electrical appliances. Automatic operation, adaptable to all types of coils without problems.

706697
LOW-VOLTAGE HALOGEN TABLE
and standard lamp with patented lateral and height adjustment capability.

706764
INDUCTIVE PROXIMITY SENSOR AND PROXIMITY SWITCH
measurement of inductance and field loss resistance with 4-conductor measurement and evaluation of reactive and active power in the sensor coil; any frequency, infinitely low temperature sensitivity, extended range. long feed cables

6779
THIN FILM BATTERY
based on vitreous solid electolytes

706782
PRODUCTION OF THIN-FILM HYBRID MODULES
intelligent sensors with integrated signal processing and micro-systems-technology products. Also: circuit design, module design, testing and production

206783
THIN-FILM TECHNIQUES FOR PRODUCTION OF SENSORS
resistors and conductor strips with structural width over 20m. Sputter plants can produce the following films: Cu, Au, Pt, Al,CrNi, CrSiWN, SiO_2, $CrSiO_2$, Ta_2O_5, Si_3N_4. (Other films on request)

6790
CORONA ELECTRODES
made of non-metallic electrically conductive materials. Main uses: paper and film production, printing and copying technologies

706791
CERAMIC HIGH TEMPERATURE SUPERCONDUCTORS
method for manufacturing and characterising ceramic high-temperature superconductors

206792
ELECTRODE AND CONTACT SURFACE COATING (MATERIAL)
developed and tested which comprises a mechanically resistant material exhibiting good electrical conductivity. For use in the fields of thin-film and measurement technology

406794
SEMICONDUCTOR COMPONENTS
and basic circuits especially for analog integrated circuits

906795
TIMER FOR LIGHT BULBS
energy saving since bulbs are prevented from burning unnecessarily. Application areas: household and industrial use

906700
12V-DC LUMINESCENT LAMPS
for solar technology, emergency light, interior light for vehicles, boats; consumption 5 to 13W for light output of 75W with 80% efficiency; very low heat dissipation; GS and VDE tested.

606701
EXTREMELY ECONOMICAL LIGHT
as bright as a 75W bulb. 13W power consumption from car battery (12V). Can be used in mobile homes, boats, households, etc., perfected electronics.

706728
ELECTRONIC COUNTER
mains-independent, low-cost with digital display. Operation on optoelectronic or electromechanical basis. For counting persons or items in production or packaging

806784
PRODUCTION OF PRINTED CIRCUIT BOARD SMD and COB
(bare chips on board); also: circuit design, module design, testing and production

406785
SAFETY SWITCH
comprising two components (separable), operating selectively; activated by proximity

506787
SAFETY SWITCH
capable of actuating any type of switching process without touching the actual switch

606789
FRANKING MACHINE
using the TEMEX Post Office service, mechanically perfected design; completely new machine intended for the amrket segement sending up to 30 letters per day

406796
GATE AND BARRIER CONTROL SYSTEM
on microcomputer basis; suitable for rugged environments, can be configured through hardware and software to meet customer requirements, also suitable for high-security lock systems, codable access authorisation, interface for superposed monitoring possible

106799
WIND DYNAMOS
for low power applications (10 100 watts) for low consumption systems in yachts, electric fence, beach cabins etc.

906802
STRIPPING TOOL
for high frequency coaxial cable; for assembling plugs and jacks

805020 P L U
SUBMERSIBLE TELEVISION EXPLORATORY VEHICLE
This invention describes a remotely controlled device for exploring and mapping submerged geological cavities. It provides a means for exploring flooded underground cavities where the floor is silty or the passages is too narrow too use manual exploration. The device is sufficiently small and inexpensive.

505037 F S/L C
MULTIPLEXING SIGNAL CONDITIONERS
For instrumentation, automatic test equipment and process control applications. Novel output multiplexing capability allows many transducers to be measured by few A to D convertors. Very small size, plastic moulded DIN rail mounted with finger proof terminals. 1000V isolated and low cost, non-isolated ranges cover temperature, pressure, voltage, current.

805138 W L G
MAGNETIC VALVE-TYPE REACTOR
is a high power inductive reactance, smoothly regulated in its value by magnetic biasing of magnetic circuit with direct current. The reactor magnetic circuit is of a special transformer type design which cores operate in high saturation conditions. The cores incorporate mains, control and the converter transformer windings in one.

505158 W J G
MINIATURE FIBRE OPTIC GYROSCOPE
includes a multiturn coil of the single mode, small diameter fibre with maintained polarisation; phase modulator; two fused tapered couplers; fibre crystal polariser; super luminescent diode;

photo diode and electronic circuit card. All optic elements are formed in series on a continuous strand of fibre. Fibre crystal polariser is fabricated under unique technology.

105277 F J G
UNIVERSAL POSITIVE-NEGATIVE PHOTORESIST. PRODUCTION FORMS PHSN3 AND PHSN-3PV

A new photosensitive composition which includes polymer components (phenol formaldehyde and/or epoxy resins), a light sensitive component and a mixture of organic solvents. Production forms make it possible to prepare photoresist layers of 0.3-3.0mm thickness. This adds new possible applications of the photoresist, in particular, in the lift off lithography.

105436 C L/J C
NOVEL PRIME MOVER

converts DC electrical energy into mechanical work by electrochemically compressing and decompressing hydrogen and oxygen or air. It has several advantages compared with conventional DC motors. Applications include: pumps, actuators, robot sensors, control devices, energy conversion.

305077 G
ELECTROMAGNETIC RADIATION TRANSDUCER

Transducers transform invisible electromagnetic radiation into the visible one. They can be used in opto and microelectronics for the laser system and electron microscope tuning, for visual evaluation of light spot uniformity and as gamma - radiation dose meters. Luminescent composition, operating in clearance and reflection mode is the base of visualisers.

105469 P L
PRINTED CIRCUIT MANUFACTURING PROCESS INVOLVING RAISED CONTACTS

enables electrodeposition of contacts at any desired location, and provides simple protective coating operations. It can be applied to any rack, including card carrying baskets. Advantages include reduced cost and higher reliability.

105136 F J G
SWITCHING GERMANIUM TUNNEL DIODES

Switching tunnel diodes are extremely fast, p-type germanium diodes with peak current of 50mA. These devices fabricated with KVARZ's new sandwich pellet and are housed in a sub-minitature epoxy package. Designed for use in ps switching circuits for voltage sharp change shaping with an edge of picosecond duration. They are key elements in wideband pulse-oscilloscopic radiomeasuring equipment.

405179 P L G
ELECTROINSULATING COMPOSITION

The composition is put on the surface of the protected insulated construction via a pulveriser and in 1520 minutes it becomes dry, forming a stable film, which closely covers the insulators body, preventing it from contact with moisture, acid and other aggressive media. Surface electric strength - 14 kw/cm. The composition is chemically strong, heat resistant.

105470 P L
SYSTEM FOR THE ATTACHMENT OF PLUGS ON A RECTANGULAR, MULTI CONTACT ELECTRICAL CONNECTOR

prevents the occurrence of connecting errors and key system rejection. Many codes are possible. This process is especially relevant to the data processing and aeronautical industries.

605243 W G
MAGNETOHYDRODYNAMIC RELAYS FOR AC

High strength hermetically scaled case filled up with electrically conducting liquid, inert gas. Relays are supplemented with magnetic system. Liquid switches the output circuits being the only moving element which is controlled by magnetic field. The value of the movement is the function of the input signal.

405251 W L/J G
ELECTRONIC DEVICES BASED ON MONOCRYSTALLINE THIN FILMS OF INDIUM ANTIMONIDE ON SAPPHIRE

All kinds of devices were formed by way of mesastructure formation by application of chemical or plasma etching. The main types of devices developed:
1) single photoconductive elements with sensitive area from 500 x 500m to 30 x 30m.
2) multielement linear array with a number of pixels 1 x 32, which have detectivity D in x degree =5.10 in 10 degree cm.

505265 P L G
AUTOMATIC SYSTEM OF HEAT MOISTURE TREATMENT CONTROL FOR CONCRETE PRODUCTS

A multichannel temperature controller RTM-3 is a digital regulator on microschemes of H 561 series with programmes generation. RTM3 is aimed for the control of reinforced concrete products heat treatment in various technological units; steam curing chambers, thermoforms, printed circuit boards etc.

5267P L G
ELECTRONIC STRESSES MEASURING INSTRUMENT EIN-3 AND EIN-4M

These instruments are based on frequency method, have us original multistep system of the tone variation treatment satisfying high precision requirements. It is a small jamming stable adaptive periods indicator with molten crystals indication.

205437 C L/S C
STARODYNE: SYNCHRONOUS ELECTRIC MOTOR

includes an oscillating core, which does not rotate but causes a high speed spindle to rotate. Advantages: very low response time, compactness, robustness, easy to service, adaptable, no power limit. Applications: mechanisms, automation, handling, electrical systems.

905922 M J C
ELECTRICAL POWERLINE SIGNALLING SYSTEMS

A patented system allows for data transmission over considerable distances via electrical power distribution lines. The principle of the new system has been proved to work and investment is now required in order to develop and build a series of prototype systems. The technology will allow remote reading and tariff programming of domestic/business electricity meters through existing cables.

905994 W L G
GROUND BASED RADIO EQUIPMENT

The basic modification intended for landing in ICAO's category I weather conditions comprises the following subsystems: azimuth fixing aids for guidance in a horizontal plane; elevation fixing aids for guidance in a vertical plane; range finding aids; air traffic control tower equipment for remote control, additional data input and signalling. The expanded modification intended for landing ensuring in ICAO's category III weather conditions includes the addition of back azimuth fixing aids for guidance in a horizontal plane during go around procedure and take off.

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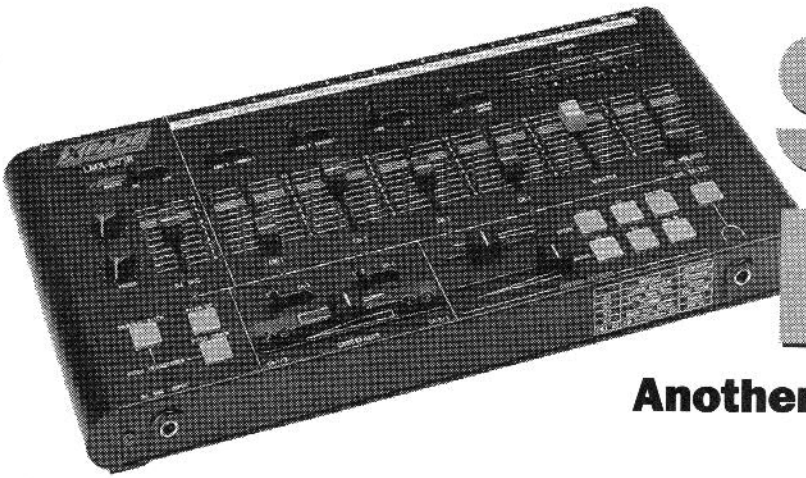

Stereo Mixers

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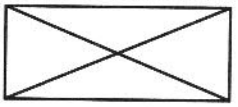


LMX907 STEREO MIXER

A five channel stereo mixer allowing maximum flexibility in audio signal processing. Features include: 5-band graphic equaliser, analog echo, DJ mix channel with pitch changer and auto talkover, assignable/removable cross fader, six built-in sound effects and LED bargraph monitoring of output. The cross fader circuit controls levels of various sources for smooth mixing between channels. A special 'auto-talk' circuit lowers all music signals by 12dB for better microphone clarity during announcements. The flexible monitoring system allows any channel to be heard individually through stereo headphones, so channels can be cued-up while others are playing through the main output. Repeat and delay circuits can produce effects ranging from rapid 'slapbacks' to reverberation and discrete echoes. The echo function can be switched in or out at any time.

specifications:

Input sensitivity/overload,input impedance:	
DJ mic:	1.5mV/10mV,10kΩ
Mic:	1.5mV/50mV,10kΩ
Phono(at 1kHz):	3mV/120mV,47kΩ
Line(CD/tape/aux):	150mV/7.2V,27kΩ
Output:	
Typical:	1V(0dB)
Frequency response:	
Mic:	20 to 20kHz (±3dB)
Phono inputs:	30 to 20kHz (±3dB)
THD:	
DJ mic:	1.6%
Mic:	0.5%,
Phono:	0.2%
Line inputs:	0.05%
Stereo crosstalk:	
Phono:	>60dB
Line:	>66dB
Signal-to-noise ratio:	
DJ Mic:	60dB
Mic:	53dB
Phono:	62dB
Line:	69dB
Headphone output Impedance:	5mW/4Ω
	10mW/8Ω
	16mW/16Ω
	24mW/32Ω
Echo/delay:	100ms(max)
Equaliser:	60,250,1k,4k,12kHz (±12dB)
Power (AC adaptor inc):	12 Vac
Dimensions(WxDxH):	482 x 190 x 37mm
Weight:	1.6kg

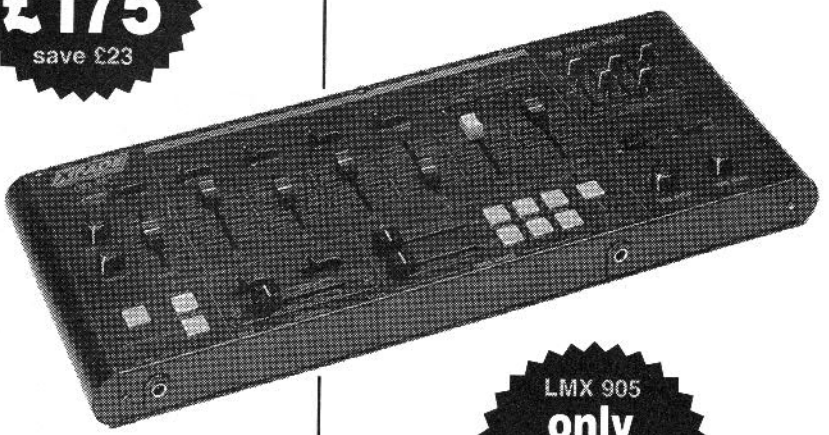
LMX 907 only £175 save £23

LMX905 STEREO MIXER

A five channel stereo mixer similar to the LMX907 but without the 5-band graphic equaliser and the analog echo circuit. Features include: DJ mix channel with pitch change and auto talkover, assignable/removable cross fader, six built-in sound effects and led bargraph monitoring of the output. Crossfader, special 'auto-talk' and monitor systems are the same as the LMX907 mixer.

specifications: as LMX907 except:

Mic 'Auto-talk' reduction:	12dB
Dimensions (WxDxH):	383 x 190 x 37mm
Weight:	1.4kg



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Future View

Victor B. Jipson, Optical Products Manager from IBM-Storage Systems Division in Arizona takes a look new directions for optical storage.

The consumer success of 'read-only' audio compact disk players has greatly reduced the cost and increased the availability of components and technologies central to optical data storage systems. As a result, optical data storage has proven in recent years to be an attractive alternative to magnetic technologies in automated libraries and as multifunction removable-media disk drives for workstation applications. But with the cost of magnetic disk storage decreasing by more than 30% a year, optical technologies must match or exceed this rate of improvement to remain a viable alternative. This requires doubling a disk's capacity every two years while maintaining fixed hardware and media cost, or combining more modest capacity gains with cost reductions.

Kurt Rubin of IBM's Almaden Research Center (San Jose, California) holds billions of bytes in his hands as each disk has two or more layers

In current 'write-once' and 'erasable' optical storage systems, bits are written when high-intensity infrared light from a pulsed laser beam is focused to a 1 micrometer diameter spot on a coated, spinning disk in a way that alters the medium's optical properties. The information can be read by noting the change in either intensity or polarization of the reflections of a lower intensity laser beam, one not powerful enough to write over the bit being read.

Once a master disk is prepared, high density 'read-only' optical disks can also be reproduced very inexpensively by simple plastic-stamping technology. This capability is leading to the very wide dissemination of vast amounts of readily accessible information, especially encyclopedias, periodicals, manuals, catalogues and other reference works via CD-ROM disks.

Optical data storage today has several distinct advantages over magnetic storage. Foremost of these is 'removability'. Removing an optical disk from the drive unit is just as easy as taking an audio compact disk from a home player. This can be a significant advantage if, for reasons of security or convenience, one wants to keep the large amounts of information on an optical disk separate from the computer or use the information on a series of units. Removability is possible because the optical head is about a millimetre away from the actual optical disk surface. By comparison, it is virtually impossible for a user to remove and reinstall the stack of magnetic disks from a disk drive and is very inconvenient to remove the entire hard-disk drive unit itself. Removability also permits the same optical drive unit to be used for all three types of optical disks - read-only, write-once and erasable (or rewritable).

Optical Advantages

There is a real density advantage in optical storage compared to magnetic technology because a sophisticated servo system can position the laser beam very accurately, permitting very narrow data tracks to be set atop ridges between very closely spaced (1-2 micrometers apart) grooves.

The future success of optical storage will depend on the pace of improvement in the technology that reduces the cost per byte of information stored and improves device performance while maintaining removability and other functional advantages.

For business applications requiring access to very large amounts of data, automated optical libraries (also known as jukeboxes because the stacks of disks and robot-like pickers resemble those record-playing machines) are more convenient than magnetic tape and microfilm due to their faster access capability. But to be successful, optical systems must be more than 10 times

cheaper than online magnetic storage alternatives, such as disk drives, which can be accessed much more quickly. If one can tolerate the rather long serial access time, magnetic tape often provides a lower cost solution. Due to its very high areal density and low cost, optical tape (coated with optically sensitive material) may also become popular in some applications.

In the workstation arena, a single multifunction optical disk drive can initially replace three types of peripherals: 'backup' tape drives, low-performance hard disk drives and high-capacity floppy disk drives. Furthermore, future optical disk drives that are compatible with the low-power requirements of portable computers should become very popular due to their multifunction capability.

Capacity per disk is an important factor in the increased use of optical storage in both libraries and workstations.

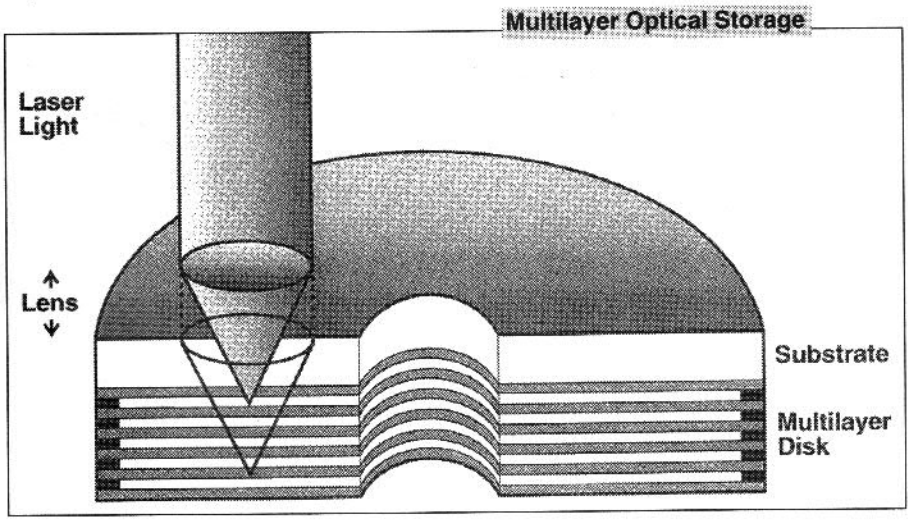
Using Blue Light

Reducing laser wavelength is a high-leverage item for improving capacity. Current units use infrared light because compact, reliable and inexpensive semiconductor lasers emit light of that colour. Shorter-wavelength light can be focused into smaller spots, which, in turn, results in higher storage density. Within a few years, red lasers will begin to replace current infrared lasers, resulting in a 50 percent capacity improvement. A compact, efficient blue-light source that we developed has given a factor of five improvement in data density in tests at our Aimaden Research Center in San Jose, California. The first use of such blue lasers will likely be in optical libraries, where such a large density increase would reduce dramatically the cost of storing data. But today's designs are probably still too bulky and expensive to find wide use in personal computers or workstations. Low-power blue/green sources based on non-linear waveguide and semiconductor technologies are likely to show up first in some consumer high-density read-only applications.

An increase in the focusing power, or numerical aperture," of the final focusing lens in the optical disk drive could permit smaller spot sizes and, ultimately, a nearly two-fold increase in capacity. However, this would require stringent optical tolerances and servo control that may prove expensive.

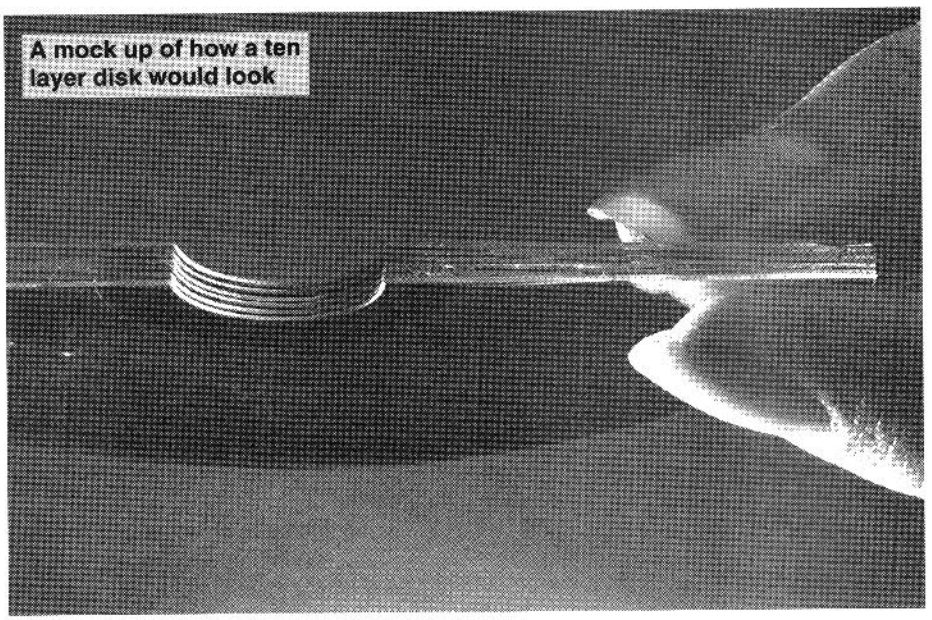
More sophisticated recording 'channel' electronics will soon increase capacity by up to two times, but will also require better control of the recording media and recording process.

Finally, using three or more parallel light beams can permit another doubling of a disk's capacity by packing data tracks much closer together. The outer laser beams would electronically suppress any interference from adjacent data tracks.



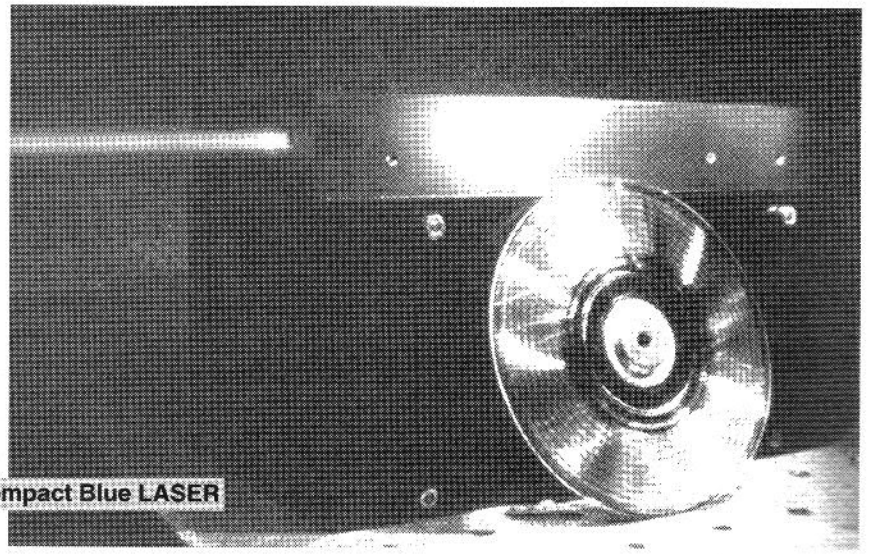
Multilayer Disks

In a development announced this May, scientists at our Almaden lab have demonstrated that new multilevel optical disks are capable of huge gains in disk capacities. The new disks are made by gluing individual layers together into a stack with spacers to provide a gap between the disks. Data is contained on any disk surface within the stack. Moving the optical disk drive's focusing lens up and down selects the surface on which data is read or written.



Our scientists have shown that data can be both read on 2, 4 and 6-layer read-only disks and also written and read on 2 and 4-layer write-once disks with essentially product-level signal-to-noise quality. There seem to be no technical barriers to 10 or 20-layer CDs or writable disks with up to eight layers.

Unlike today's single-layer disks, these multilevel disks must be partially transparent to permit the optical drive's laser beam to penetrate to all of the layers. At the same time, each surface must also have sufficient reflectivity to direct enough light back to the disk-drive's detectors so the data can be read accurately. Ultimately, the maximum number of surfaces in a disk stack is limited by the power of the laser, the transparency of the layers and the cost of making multilevel disks compared with their single-surface competitors. For a given laser power, the maximum number of layers in a writable disk would typically



be less than in a CD-ROM because the writing process also requires that the disk materials absorb some of the laser light, thus reducing the transparency of each layer.

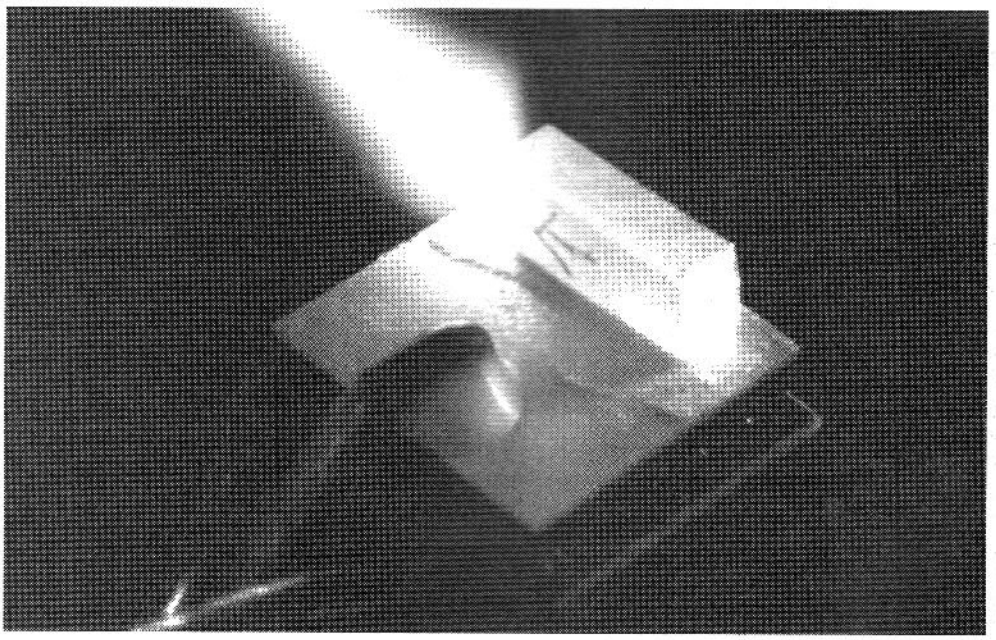
At today's optical data storage densities, a 10-layer disk would store some 6.5 billion bytes (or gigabytes) of information — equivalent to more than a million pages of printed text. This would permit feature-length movies to be stored as high-resolution digital video on a single compact disk. Since the multilevel design does not interfere with other data-density increases, optical disks are likely to have even greater capacities in time.

What about the access time?

Should all these advancements be achieved, optical disks would have about 100 times the data storage capacity of today's products. But sheer capacity is not the only area ripe for improvement. The speed with which the stored information is accessed and processed is also very important. It is also the area in which magnetic storage devices now hold a substantial advantage.

As in magnetic recording, the key performance parameters in optical disk drives are the access time and data rate. Access time is defined as the sum of the time required for a drive's read/write head to move between tracks ('seek time') and the time for the desired disk sector to rotate to a position beneath the head ('latency'). Seek time is typically improved by making the moveable parts of the head lighter and finding ways to move the head faster while maintaining the ability to position it accurately over the desired data track. Latency, which averages one-half the time of a disk revolution, is reduced by spinning the disk faster. Data rate is the speed with which information is stored and retrieved.

Modelling results of typical personal computer environments clearly indicate that reduced latency is the key to improved optical disk drive performance.



These improvements will require better media mechanical properties, larger servo bandwidths and higher write-laser power. Today's optical drives typically have average seek times that are two to five times longer than magnetic hard drives, but recent results indicate that this difference will narrow as split optical head designs, lower-mass fine actuators, improved coarse actuators, and optimized seek algorithms are introduced.

In the area of data rate, magneto-optic rewritable devices suffer from the need to erase on one disk revolution before writing. Many devices also include a third 'read-verify' revolution, which can result in a total 'write-latency' that is five times greater than that of magnetic disk drives. The keys to improving this performance are the use of Direct Read After Write (DRAW) and Direct OverWrite (DOW). DRAW optical heads use multiple laser beams to verify the data immediately after it is written. DOW typically employs improved media or magnetic field modulation techniques capable of single-pass overwrite. Combining DRAW and DOW can reduce the write latency five-fold in the workstation arena and increase the write data rate by a factor of three in backup applications.

In Conclusion

Finally, for applications that require very high data rates, parallel recording can lead to significant read and write data rate improvements. The application of parallelism in both reading and writing exploits an intrinsic advantage of optical recording and can greatly improve both the capacity and performance of an optical data storage system.

Many of the technologies to support the improvements I've described have already been individually demonstrated. As these advances are incorporated into products, the performance of optical disk drives will continue to improve, making them evermore appealing alternatives where their multifunction capability provides a more cost-effective overall way for businesses and individuals to store computer data.

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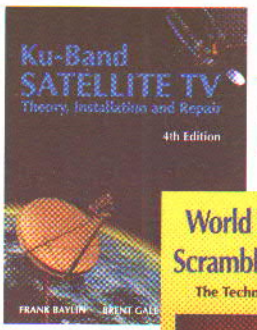

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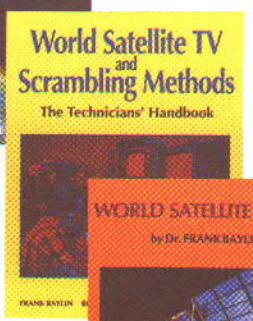

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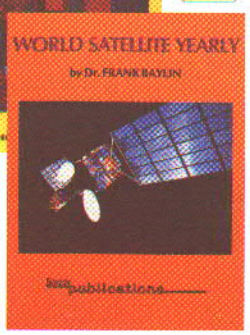

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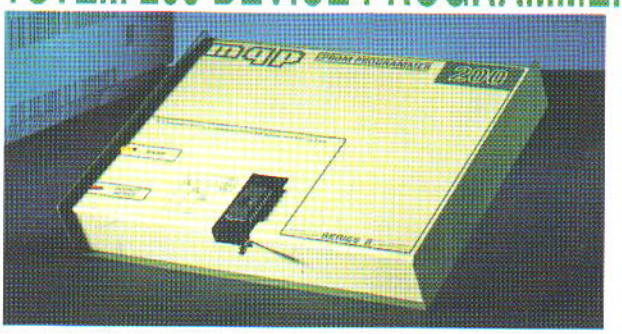

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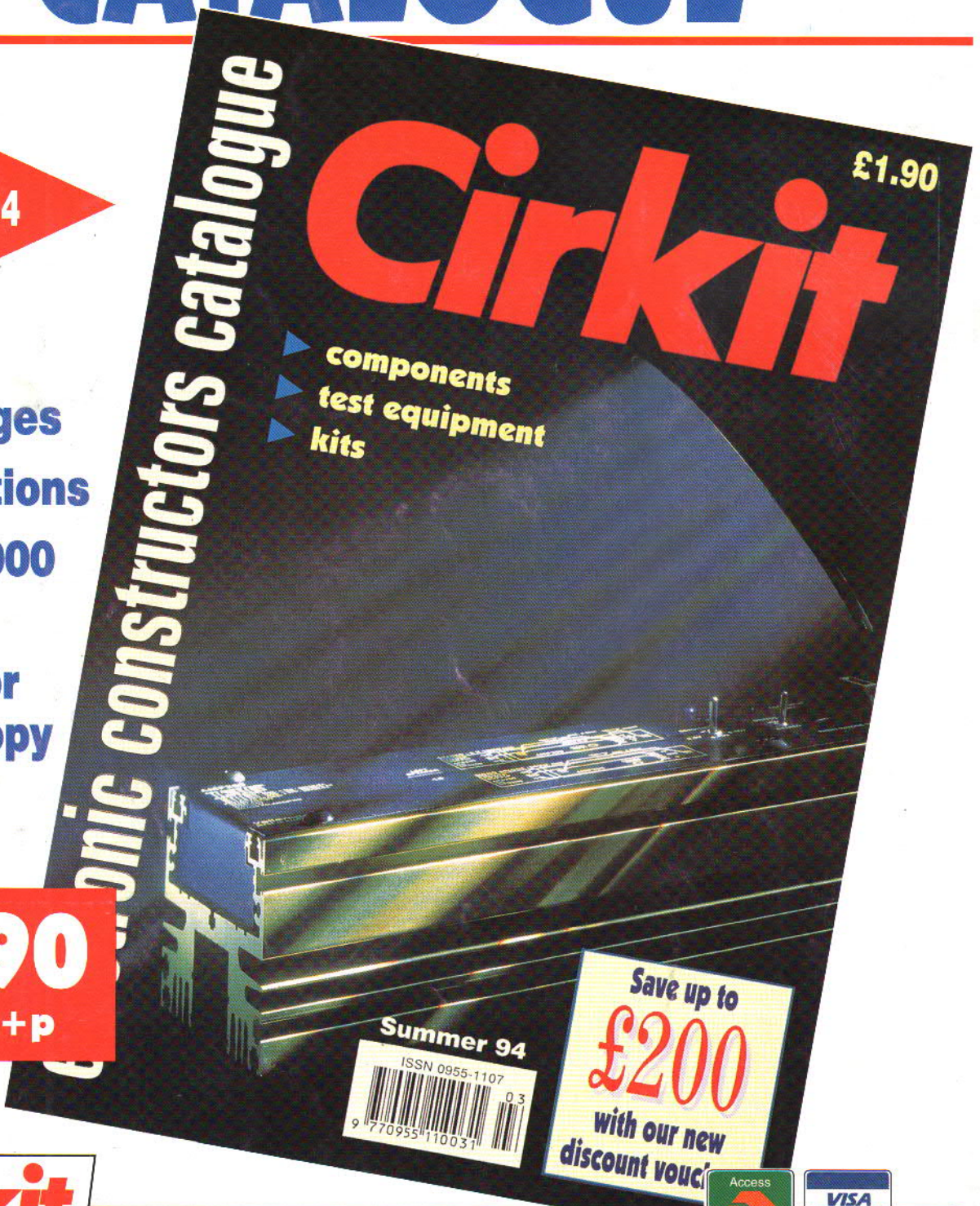

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