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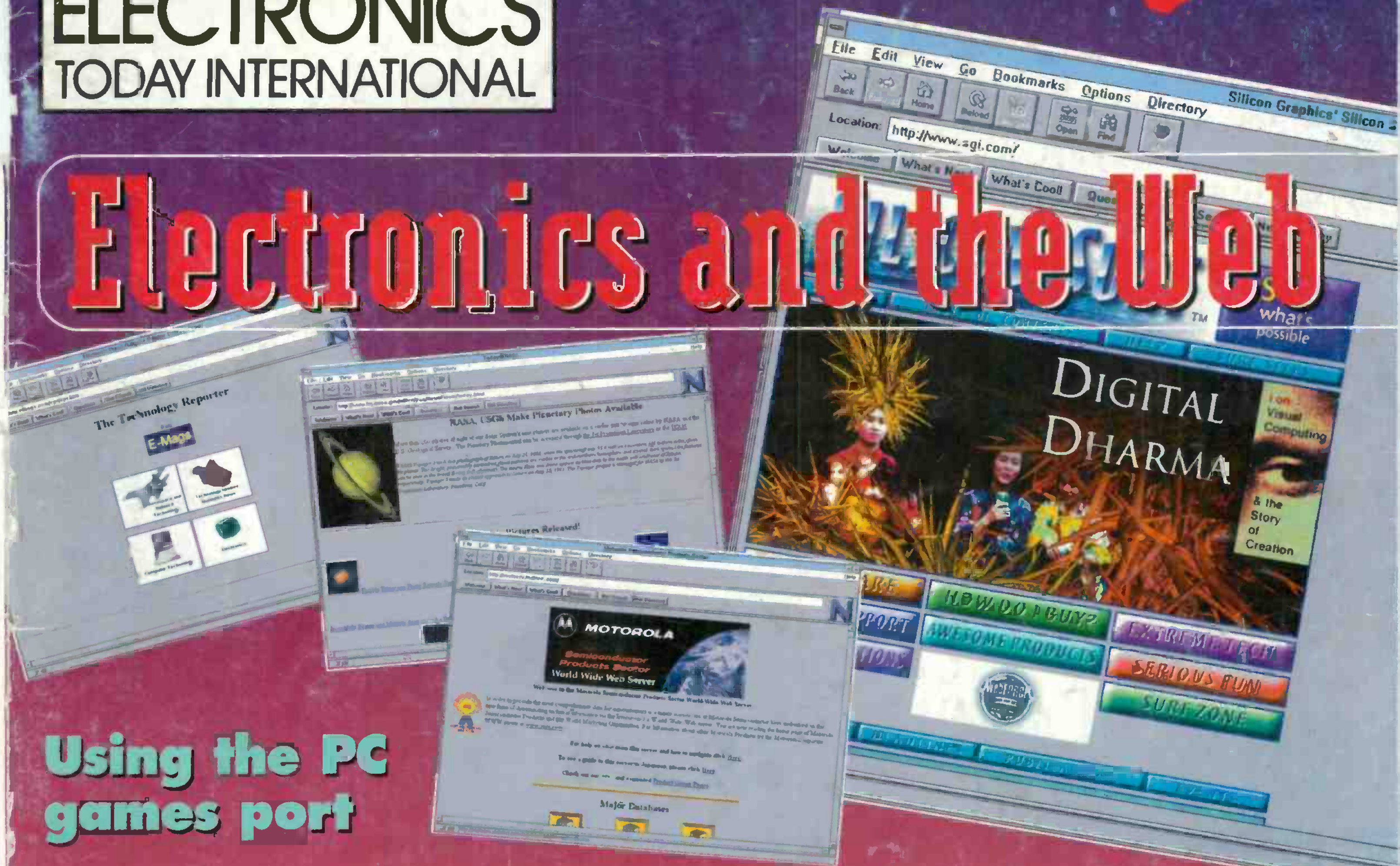
Electronics and the Web



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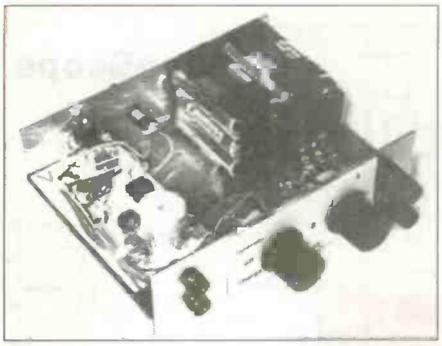
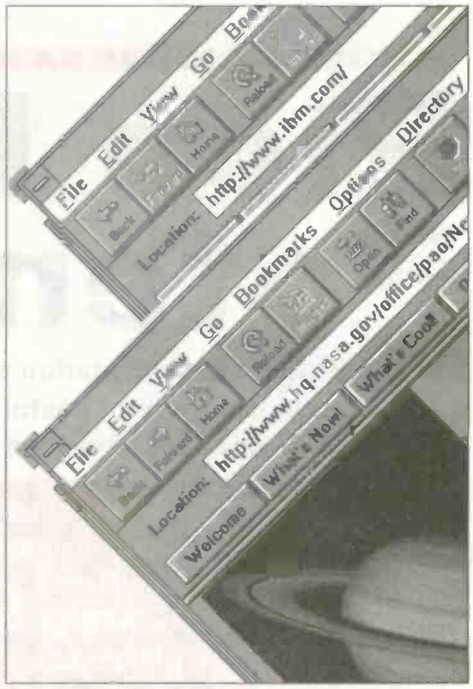




Volume 25 No.5

& Features Projects

Regulars

ETI ELECTRONICS TODAY INTERNATIONAL News...

Mitsubishi Launches High Performance Embedded Development Kit

Mitsubishi Electric, in conjunction with IAR Systems, has announced the introduction of the new DK16 embedded development kit for the M37700 family of 1Gbit microcontrollers. The new kit provides C source level debugging and costs £549 plus VAT. It comes complete with development board, IAR's Professional ROM Monitor Debugger and Macro Assembler. It is only available from Mitsubishi and IAR distributors Gothic Crellon and Micromark.

Mitsubishi's already successful DK16 development kit has now been upgraded and personalised to function with the IAR Rom Monitor. The low cost system also includes free technical support for IAR's ROM Monitor and Assembler, together with a discount voucher for IAR's C Compiler for Mitsubishi M37700 microcontrollers. Also included are a 5V power supply, 9-25 way adaptor and full documentation.

IAR's Assembler generates relocatable code and during the design process provides an extensive set of directives which allow total control of the code and data segmentation. Multiple modules are easily created within a file as are macro definitions and variable declarations. The Assembler also includes Xlink, the high speed memory based linker, locator and format generator, to produce 7700 prommable code.

IAR's Assembler is designed to interface fully with the company's 7700 C Compiler and also includes Xlib, the highly efficient and fast library manager.

In operation, IAR's Rom Monitor Debugger can be interfaced to provide source and command windows or alternatively user selectable windows. The source code execution lines are highlighted and break points can be placed directly on the source line. Registers can display all the contents at any point in time and enable alterations to the contents to carried out using point and modify routines or specific commands.

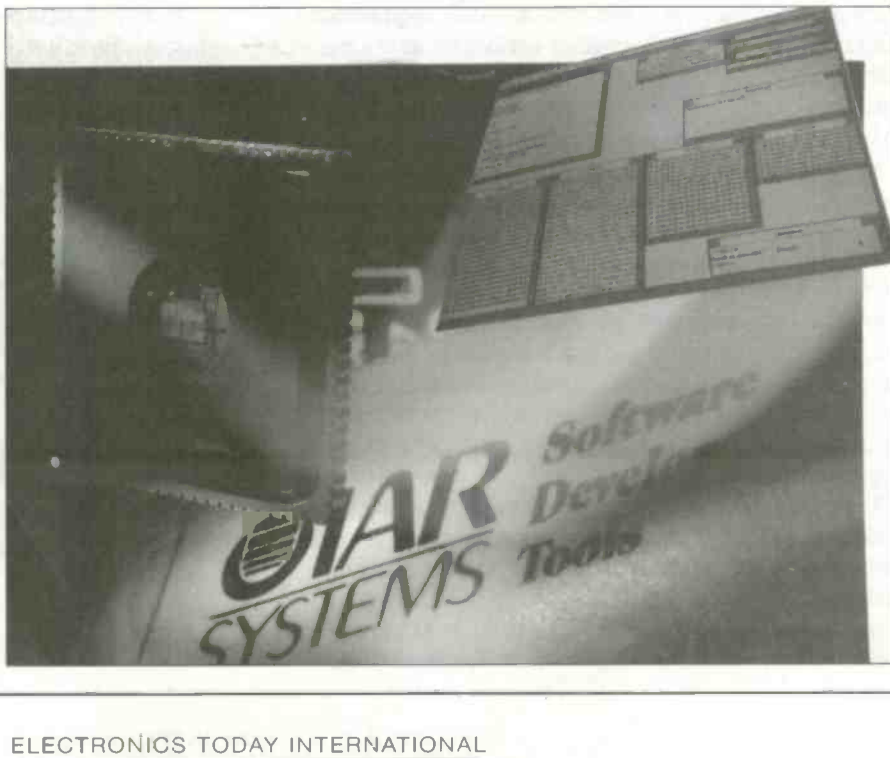
The Monitor Debugger is designed to operate with IAR's Assembler and C Compiler and therefore enables full debugging of high and low level language. Its memory simulates the device memory space. Multiple memory windows can be opened simultaneously and again contents alterations can be carried out using point and modify routines or specific commands. A Watchpoint displays the contents of the system variables and globals, locals, structures and arrays are all supported ,with specific commands used for modifications,

A unique feature of the Monitor Debugger is the Terminal I/O which enables the monitor screen to act as the system output and the keyboard to act as the system input. The powerful command set contains mouse click or keyboard function key triggers for frequently used commands.

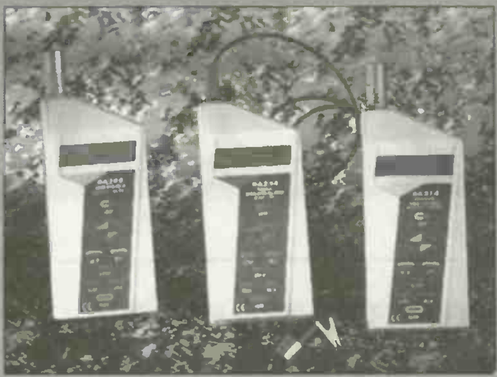
A built-in assembler disassembler is provided with the Monitor Debugger which also features a very high level of functionality to provide full symbolic debugging operations. Breakpoints and Watchpoints can be complex and unlimited. The IAR Linker generates Aubrof Formats providing the debugger with all the necessary information to perform register tracking of all dynamically allocated registers variables.

Notably the breakpoints are totally unlimited, whether they are the result of either complex conditions using macros or alternatively, simple line numbers.

For further information contact Mitsubishi Electric UK Ltd, Semiconductor Division, Hatfield. Tel: 01707-276 100.



Castle Sound Level Meters



Consisting of an Impulse SLM, an Integrating Leq meter and a Dosemeter, the range will enable companies who have been otherwise put off by cost or complexity to comply with the Health & Safety Regulations and meet their obligations to measure noise.

The new Castle Popular range employs the latest electronic technology and is micro-controller based providing powerful operation combined with long battery life. They are built to the demanding IEC 651 Sound Level Meter Standards. Designed to cover three dimensions of industrial noise measurement there are three models, the GA208 for simple, instantaneous SPL and Peak measurements, the GA255 Noise Dosemeter and the GA214 Integrating meter with time weighted averages (Leq) plus much more. Each model features a touch keypad for all major functions and an 8 digit LCD. Their tough, lightweight bodies are small enough to fit in any pocket for maximum portability, a real advantage for industrial users.

They comply with all the requirements of the European Noise at Work Regulations and come with comprehensive instructions and a complimentary book on noise measurement.

For further information contact: Castle Group Ltd, Scarborough. Tel: 01723 584250.

New Hitachi 16-bit microcontrollers

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Mitsubishi Fibre Optic Amplifier

Mitsubishi Electric has announced the introduction of the innovative FG-602S-T01 erbium doped fibre amplifier which provides single mode direct amplification for optical fibre signals for 1550nm window applications. The amplifier is optimally designed to provide flat gain particularly over 1535 to 1565nm and features alarm signal monitoring and automatic shutdown when transmissions cease.

Notably, the amplifier will amplify all channels operating in the window and is designed to accommodate simultaneously a high number of channels with very high data rates. The unit can amplify 60Gbits/s in a single pass, making it ideal for amplifying traffic between System X exchanges at large distances apart as well as for local loops in fan-out applications and spur highways.

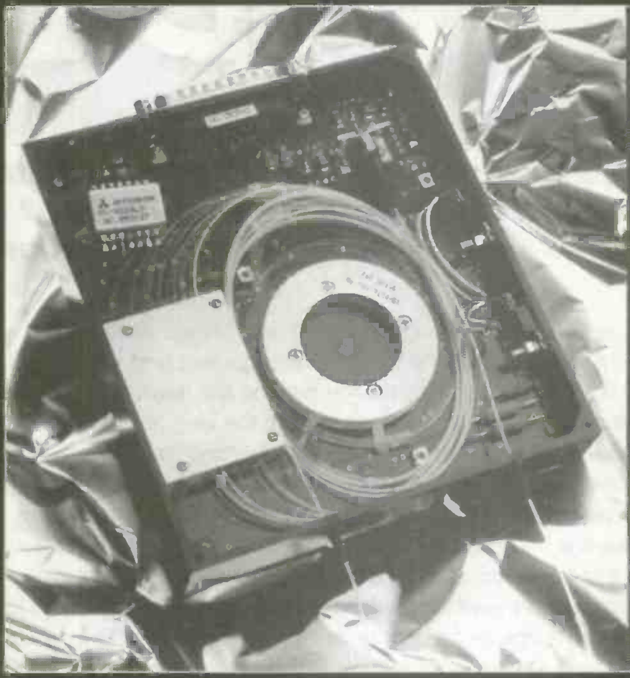
The advanced amplifier design comprises an erbium doped fibre optic coil to provide the gain, with the optical signals travelling through the amplifying erbium doped fibre, bi-directionally pumped by 1480nm isolated laser diodes. Full temperature control for the pump lasers is electronically controlled within the amplifier housing and fibreoptic couplers combine the pumped signals into the doped optical fibre. The control circuitry generates TTL signals for pump bias and temperature alarms as well as for pump shutdown.

In operation, both input and output optical interfaces provide sufficient isolation to prevent signal reflection back to the system transmitter and to the internal laser oscillators. The amplifier is supplied in a compact, static safe casing measuring 152x122x25mm, with heat sink mounting facilities and interface and monitor connector sockets.

Minimum large signal inputs of -5.5dBm power are amplified by the unit to at least 15dBm. Small signal input power is 30dBm and gain is a minimum 28dBm, with a typical noise figure of 6dB. The erbium doped amplifier operates from maximum supplies of +6V and -6V. Typical supply operation is from +4.75 - +5.25V1 at 3A for the positive supply and -5.46 - -4.94 at 3.6A for the negative supply. Operating case temperature is typically 250C and 600C maximum, with a storage temperature range of -40 to +70C.

The optical interface is provided by two Coming MFD cladded, single mode 9/125um fibre optic links with AT&T ST type connectors. The electrical interface is via two 12pin male connectors for power supplies, alarm and disable functions, with a 14pin female connector for monitoring functions.

For further information contact Mitsubishi Electric UK Ltd, Semiconductor Division, Hatfield. Tel: 01707-276 100.



PC-104 for Embedded Control

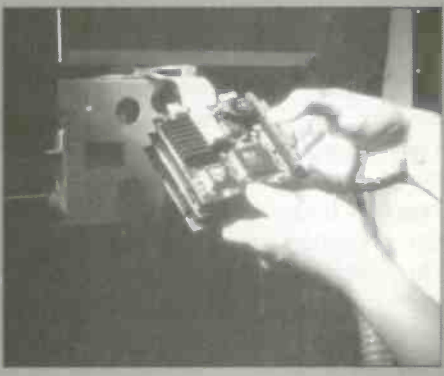
IMS have expanded their range of PC-104 modules for embedded PC applications. The PC-104 modules offer the benefit of the standard PC-Bus architecture but on a miniature form size, measuring only 3.6" x 3.8" and with exceptionally low power consumption. PC-104 is therefore ideal for embedded applications where PC architecture is desired, but current PC Motherboard/Plug-in cards technology is too bulky and powerhungry.

The current range offered by IMS includes a diverse mix of products, including such modules as CPUs, Peripheral Interfaces (Hard/Floppy Disk), Serial & Parallel I/O, SVGA & Flat Panel Display Controllers, PCMCIA, Ethernet Network, RS422/485 Communications, Solid State Disks, Digital I/O and Analogue A/D & D/A.

The PC-104 modules can be used as 'Lego' style building blocks, by interconnecting them in a stack, enabling a wide variety of configurations to be implemented thereby offering the versatility and flexibility required in many diverse embedded applications. Because of the miniature size, developers can now embed PC-Based control in a variety of machines and equipment, retaining the development investment based on PC technology as well as benefiting from the enormous development support products available on the PC.

Since its implementation in 1992 the PC-104 standard has rapidly become an emerging international standard for modular miniaturised PC Architecture based technology, finding applications in a diversity of markets from medical, communications, industrial, office equipment and many more.

For further information contact: IMS Ltd, Southampton. Tel: (0703) 771143



Entering the WORLD WIDE WEB

We have all heard of the Internet and the World Wide Web, but are they of any real practical use to us in our working lives? Nick Hampshire takes a look at this question, as well as looking at how developments in the technology will affect all of us

To most people the terms 'Internet' and 'World Wide Web' simply imply something to do with computers and telephones. Something that is faintly subversive and the realm of obsessive technofreaks who pass the time untill the wee hours of the morning 'surfing the net'. But is it something that 'serious' professional people such as engineers, scientists and business people will find useful, or as the popular press would have us beleive is it totally given over to the weird and the wacky?

It is rather amusing that the popular image of both the Internet and the World Wide Web should be so firmly linked to such an image since both technologies were born from decidedly serious applications. The Internet arose from the US Department of Defence's need to create a global computer network to link supercomputers with defence establishments, defence contractors and universities. The World Wide Web was developed at the CERN atomic research establishment in Switzerland as a means of transferring research documents over the Internet.

So both the Internet and the World Wide Web were developed with very serious applications in mind, and they are still very widely used for serious applications. It is just a pity that in the mind of the general populus, and the media in particular, they have become firmly associated with an alternative youth culture. An image projection which has undoubtedly led to neither being taken that seriously by Government, business and the professions.

However, such people are ignoring the development of these two technologies at their peril. They are undoubtedly the basis of a future information transfer and communication technology based revolution which within a decade will sweep the entire world, through both the developed and underdeveloped nations. It will sweep aside many established concepts and ideas, will topple whole areas of industry, and create whole new areas. It is a revolution waiting in the wings.

To understand why this revolution will have such an impact we only need to look at some of the trends which are already developing in a technology which is still very much in its infancy. We also need to look at some of the technologies which are being incorporated into it.

What is the Internet?

The proper starting place for our examination of these technologies will develop is to examine exactly what they are, and what form they take today. Since the Web is reliant upon the Internet it is proper that we start there.

The Internet is, in very simple terms, a very large loosely structured computer network which extends across the entire surface of the globe and connects together an estimated 30 to 40 million computers. The connections between these computers being composed of a wide range of different links, from conventional copper wire voice telephone lines, to dedicated very high capacity optical fibre links, and even in some cases radio links.

Indeed the primary reason for the success of the Internet is that it uses existing communication links, this has allowed it to expand very rapidly without a great deal of costly capital expenditure. The Internet as a public communications system relies upon a combination of commercial phone lines and a few very high capacity, long distance data links that have been built for military, commercial or academic applications.

Because of the way in which it is designed the Internet can make use of the 'spare' capacity on these lines thus permitting communications between computers on the other side of the world to each other but with only local or short distance phone charges. It can do this because the data that is being transferred between the two systems is transferred in small 'packets'.

Each data packet has added to it the address of both the system it is going to and that from which it has come. Since the packet is small it can easily be slotted into very small periods when a line is not being used. The origin and destination addresses then allow the packet to be independently routed in the best way as it is passed from one computer system to another. This accounts for the frequently very noticeable delay in response which will be familiar to any user of either the Internet or the Web.

This packaging of data into small addressed packets and its transmission through the network relies upon the development and use of a common communications protocol known as TCP/IP (this stands in fact for two protocols, the Transmission Control Protocol and the Internet Protocol). These protocols are designed to run on any type of hardware with any type of operating system. It is the TCP part which controls the data transport and ensures that the data reaches its proper destination.

All the computers that are permanently attached to the Internet are differentiated by giving them unique names, the IP address. These addresses are in the form of a sequence of four numbers separated by periods, and are translated into the more familar address, such as -

www.emags.com

by the Domain Name System, or DNS. It should be noted that most users will not have either a domain name or an address since they will be accessing the system on a casual basis via an Internet Service Provider or ISP. However, the ISP's computer will have a domain name and address.

This means that with the TCP/IP protocols and the combination of Internet addresses and domain names it is possible to send data from any computer of any type attached to the Internet to any other computer of the same or different type attached to the Internet. The basic form in which such data is transmitted is the e-mail message.

We can thus say that the Internet is primarily a global computer network which allows the transmission between named computers of data in the form of e-mail messages

The birth of the Web

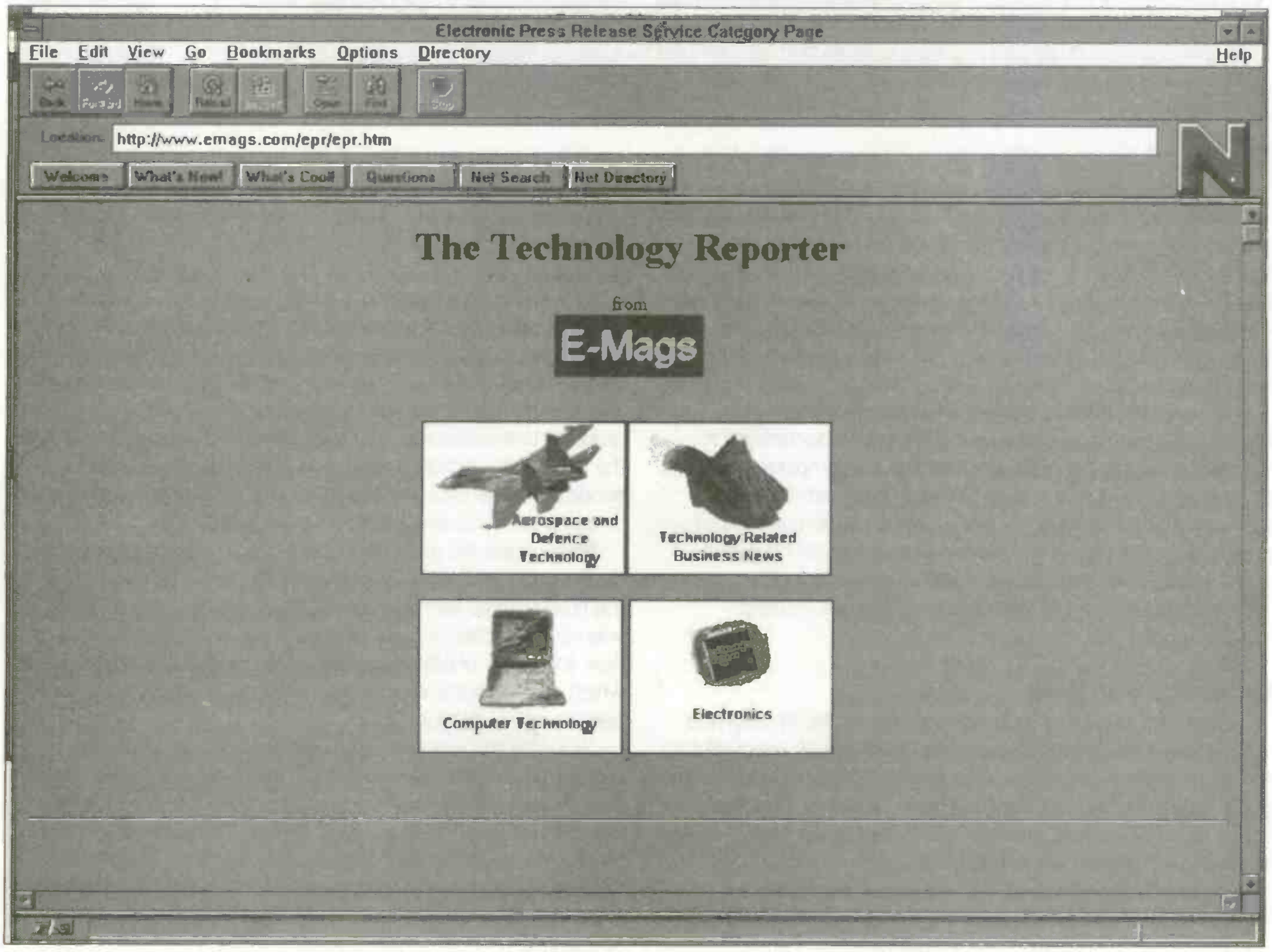
Based upon the existing Internet network the World Wide Web was first proposed in 1989 by physicists at CERN in Switzerland as a means of allowing scientists anywhere in the world to share text and graphical information. To do this they developed another protocol on top of TCP/IP, this protocol is known as the HyperText Transfer Protocol, or HTTP. This allowed users to remotely access documents stored on other systems, basically in the form of e-mail messages, and then display them on their own computer.

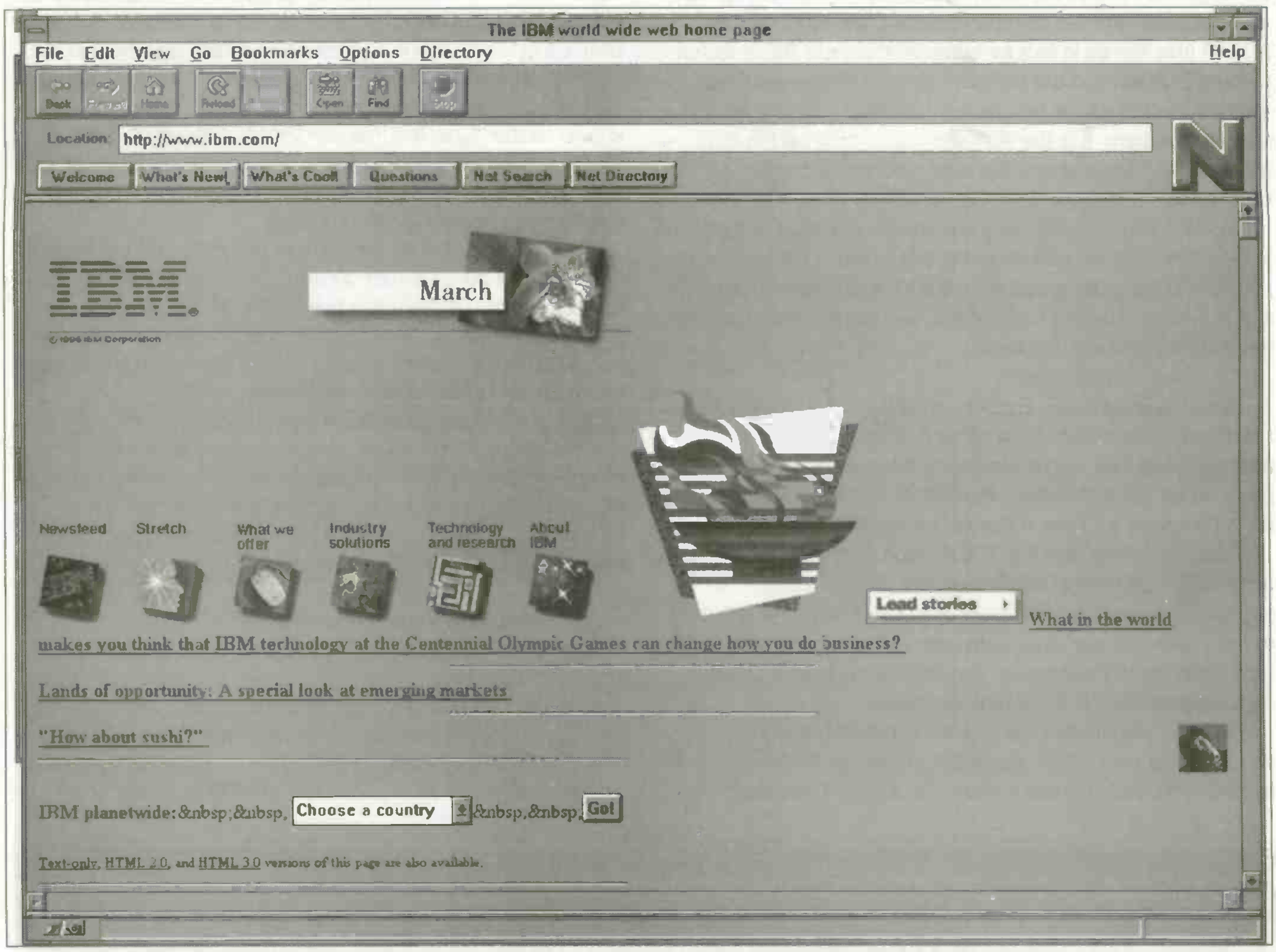
The information is accessed from named computer systems using the standard Internet domain name system. However, the Web naming system has been extended to allow the accessing of specific files stored in specific directories on the target computer system. This location is done with an address known as an Uniform Resource Locator, or URL.

The URL incorporates the domain name , plus the appropriate path and file name in a standard format which is recognised by any piece of software which accesses and displays Web information (such programmes are known as browsers, and for PC users the best known are Netscape and Mosaic). Thus for E-Mags Technology Reporter starting page the URL is:

http://www.emags.com/epr.htm

Note that the starting HTTP defines the transfer format, which is then separated from the domain name by :// the domain name is then separated from the path or file name by another / In this example the file is stored in the system root directory. The file name for any Web file, or page as they are usually refered to, has an extension of HTM or HTML, this





indicates that it is a HyperText Mark-up Language file which can be interpreted and displayed by the browser software.

With the Internet, the Web and the HTTP protocol, you can use an URL to access a file stored on another computer, perhaps located on the other side of the world, and display the graphical or text contents of that file on your own system, very much as if it were stored on your own hard disk. The Web has thus converted the Internet into an extremely powerful data storage and retrieval system.

However, the Web designers were inspired originally by Ted Nelson's pioneering work on linked Hypertext documents for structuring and using information stored on computer. The use of HyperText links, in the form of URLs, is an extremely powerful feature of the Web since it allows large numbers of pages, perhaps stored on different computers, to be pulled together into a single document with a coherent logical structure that is a highly efficient way of communicating information.

Entering the Web

In 1991 there were just 300 pages stored on the World Wide Web, today, less than five years later, there are an estimated 30 million pages that are accessable over the Web, a figure that could easily double over the next twelve months. This is an awful lot of information, most of it fairly low grade, but scattered amongst it some real gems.

Perhaps the best way of thinking about the Web is to compare it to a conventional library, a library which at the moment has the equivalent of about a quarter of a million books. That is a pretty big library by any standards. It would occupy about fifteen to twenty thousand feet of shelf space, and even for a fast reader that is a few lifetimes' worth of reading.

With so much information, there is a very serious problem associated with finding the specific information that you are looking for. In a conventional library this is, to a degree, solved by the use of a standard cataloging and classification system. This means that all the books are divided and physically grouped into categories and sub categories in accordance with the main subject matter. Each title is then given a code according to its category which can be crossreferenced in card or computer indexes of titles, authors, etc.

Web pages are grouped in clusters, or 'web sites' around a 'home page' on individual computer servers, and to this extent the home pages can be viewed, and classified, in the same way as book titles. It is therefore not surprising that there are now a number of classified catalogues of web site home pages which make it somewhat easier for the Web user to find the necessary information.

Probably the most widely used catalogue of web sites, or as they are sometimes referred to - metasite - is Yahoo which now indexes several hundred thousand web sites around the world covering a whole range of different subjects. In addition there are a large number of specialist metasites, thus E-Mag's Technology Reporter incorporates a comprehensive classified index of web sites in each of its technology areas, in particular electronics and computing.

Such classification systems are fine when dealing with books, and Web site home pages. However, information stored on the Web is not as easily classified as books, since it is in the form of millions of individual pages. Indeed with the increasingly extensive use of hypertext links we can almost regard the entire Web as comprising a single volume with thirty million pages.

Creating an index for thirty million, soon to be forty, fifty, sixty million, pages of constantly changing information is virtually impossible, but engineers have come up with another solution, the intelligent agent. This is still a very new concept but is one which will ensure that the Web remains a practical information source. In essence an intelligent agent is a small piece of software that is designed to search through all the web sites looking for pages which match certain search criteria which it has been given.

Intelligent agents are very much a feature of the Webs future development. For the moment the best way to find useful information stored on the Web is via one of the metasites, in particular one of the specialist metasites.

What is on the Web?

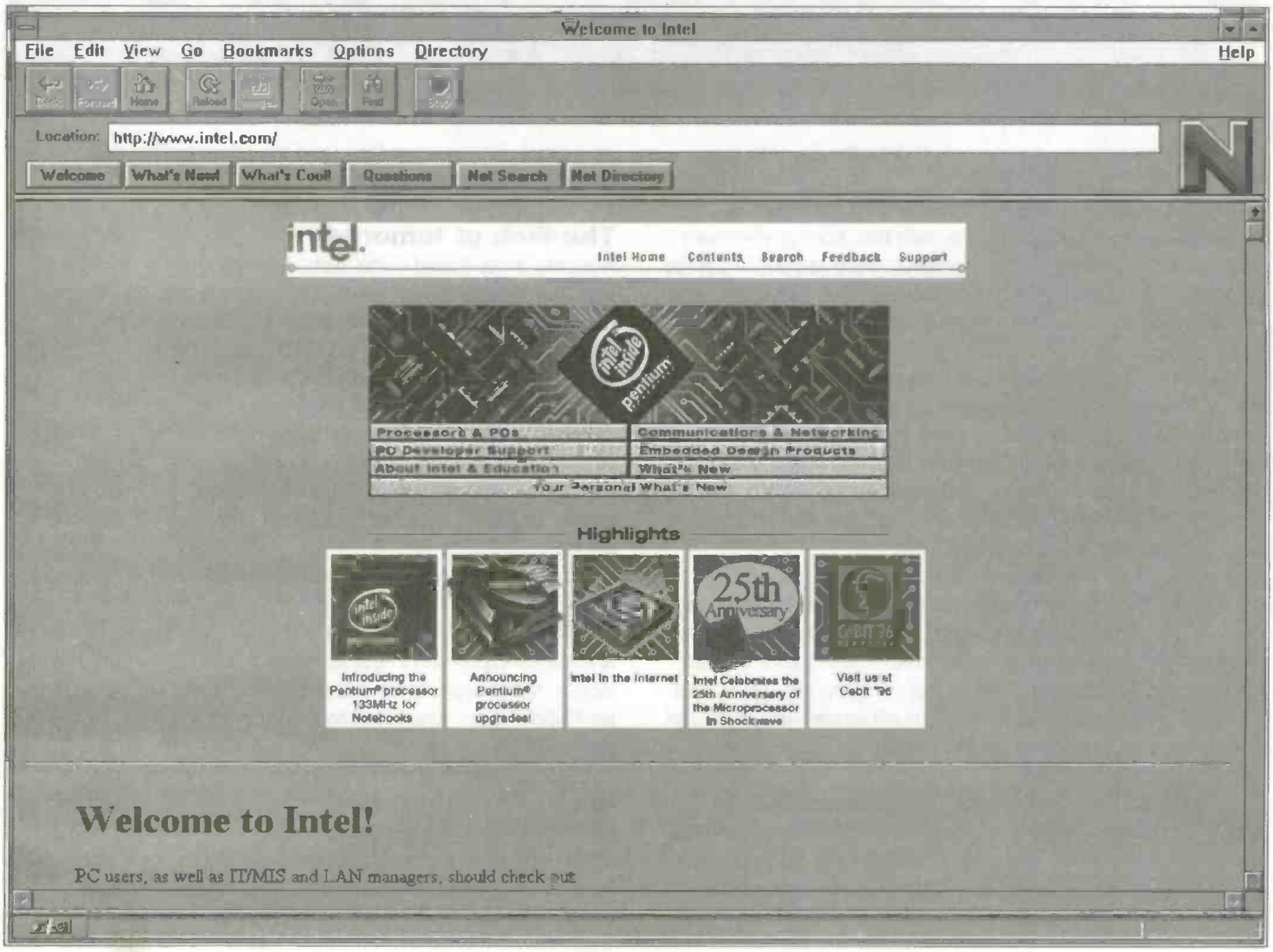
It is estimated that there are at the moment over a million different Web sites, a great many consisting of just a single page, a few consisting of thousands of pages. Some sites have been created and run on large corporate budgets, others on a shoestring by private individuals. As for subject matter, there are now Web sites covering every subject that mankind has ever thought of, and fortunately for us over 98% of all sites are in English.

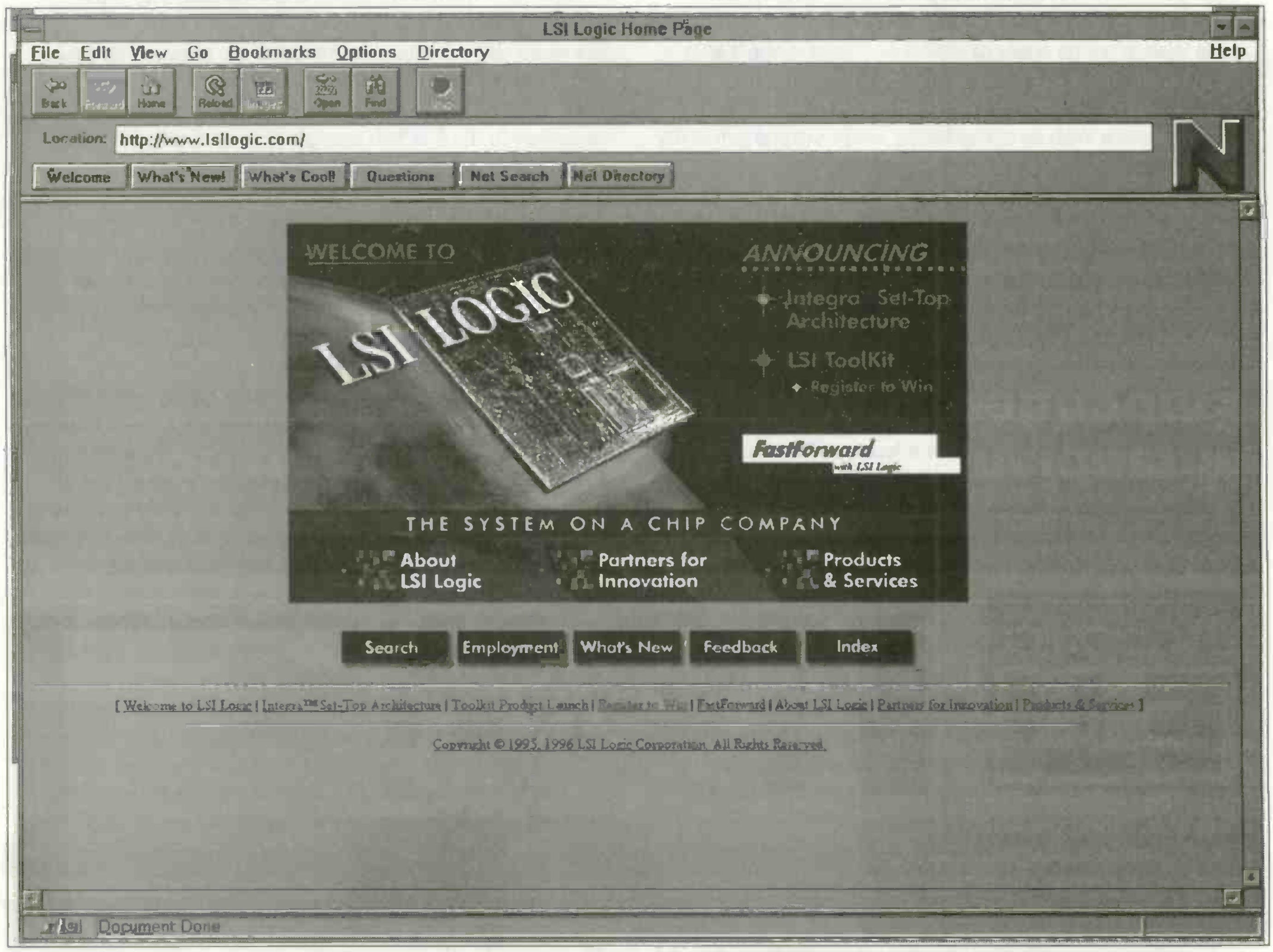
Broadly, however, we can divide Web sites into three distinct categories, the fairly large corporate sites, the academic and government sites, and the sites run by private individuals. For the businessman, scientist or engineer the main sources of useful information will be found almost exclusively in the first two categories of site. Indeed the vast majority of useful information stored on the Web is contained in fewer than ten thousand sites.

The first Web users were of course the academic and government Web sites, primarily US but increasingly from other parts of the world. These are probably the most information rich sites since they are primarily being used to disseminate information about particular research projects to other individuals working in similar areas.

Typical examples are the sites maintained by some of the big US government research establishments such as Sandia Labs, the Oak Ridge Labs, and of course the biggest of them all, NASA. The range and scope of research carried out at these labs is enormous and certainly not confined to military, atomic energy, and aerospace related subjects. They are a very good source of information about future trends in the development of technology and are well worth a visit.

An increasing number of companies, primarily in the USA, now run Web sites as a valuable aid to their sales, marketing, and product support departments. They are using their Web sites to give customers and potential customers information about the company and its products. They are also being used to disseminate product support information, such as software bug fixes, or new applications data. Some are even putting





their entire catalogues and technical data sheets onto their Web sites.

The information contained in these corporate sites is obviously of more immediate use than that from government and academic research labs. However, many large companies with their own research facilities, such as IBM, AT&T, etc., also maintain special Web sites for these labs; these too are well worth visiting.

Scientists and engineers can thus use the Web to find out information about new developments from both commercial and academic/government sources. In addition there are sites with more general information, such as those maintained by the Times/Sunday Times, FT, Telegraph and Guardian, the New Scientist, and a host of other magazines and information providers on both sides of the Atlantic.

The Web can also be used to locate information about otherwise unknown companies and products, in fact it is an ideal way of locating the specialist products and services that are often provided by small companies whose existance can be very hard to discover. Finding them may require quite a lot of Web searching but this is made much easier with the aid of a metasite or a site with a specialist catalog, such as the Technology Reporter site.

Another source of information offered by sites such as E-Mag's Technology Reporter is the publication of press releases, the raw material which technical journalists rely upon to keep themselves up to date, and as a source of news and new product reports. These can provide a lot of information about new products, new services, and the latest technical developments, from companies big and small.

The Web of tomorrow

Not only is the World Wide Web expanding at an enormous rate, the technology on which it is based is also developing very rapidly. Text based Web browsers have given way to graphics based browsers, the Web page description language HTML is now under assault from a new more interactive system called Java. Neither does it stop here, for two dimensional graphics are now being replaced by 3-D VRML virtual reality graphics, and the user base is set for rapid expansion with the iminent launch of several low cost, high power, hardware systems developed exclusively for Internet users.

All these, and many other, developments underline several important trends in the development of both the Internet and the World Wide Web. The first is that we can expect to see an enormous expansion in the number of users around the world, indeed some experts are estimating that there will be as many as 1billion users connected to the Internet and Web by the year 2000.

Secondly as data transmission speeds increase thanks to optical cables and high speed modems we can expect to see the Internet increasingly becoming a real time, high quality, multimedia data transmission system. People are already using Internet phones to make low cost long distance calls. A handful of radio stations are already broadcasting over the

Looking for information on the Web

Looking for specific information on the Web is not really that hard. The first stop is to access one of the big metasites such as Yahoo, or a specialist technology index site such as Technology Reporter.

the URL for Technology Reporter: -
http://www.emags.com/epr.htm

If you use Technology Reporter you will find that the home page gives you a selection of icons relating to different categories of information. Simply use the mouse to click on the desired icon, and a menu page for that subject will be displayed. This menu allows you to look at press releases stored in that section, or look at the various indexes of press releases. It also allows you to go to a hierarchically organised index of Web sites.

With a hierarchically organised index it is possible to narrow down a search for information to narrow down the search for particular information to a handful of sites rather than the tens of thousands that are stored on the system. Finding your way around the hierarchical index is simply a matter of using the indexes and navigation icons to go up and down the branches of the hierarchical index.

Technology Reporter also has a collection of company profiles and associated with many of these are lists of web site entry points, and the latest press releases from the company. All of which can be a veritable mine of useful information about the company and its products.

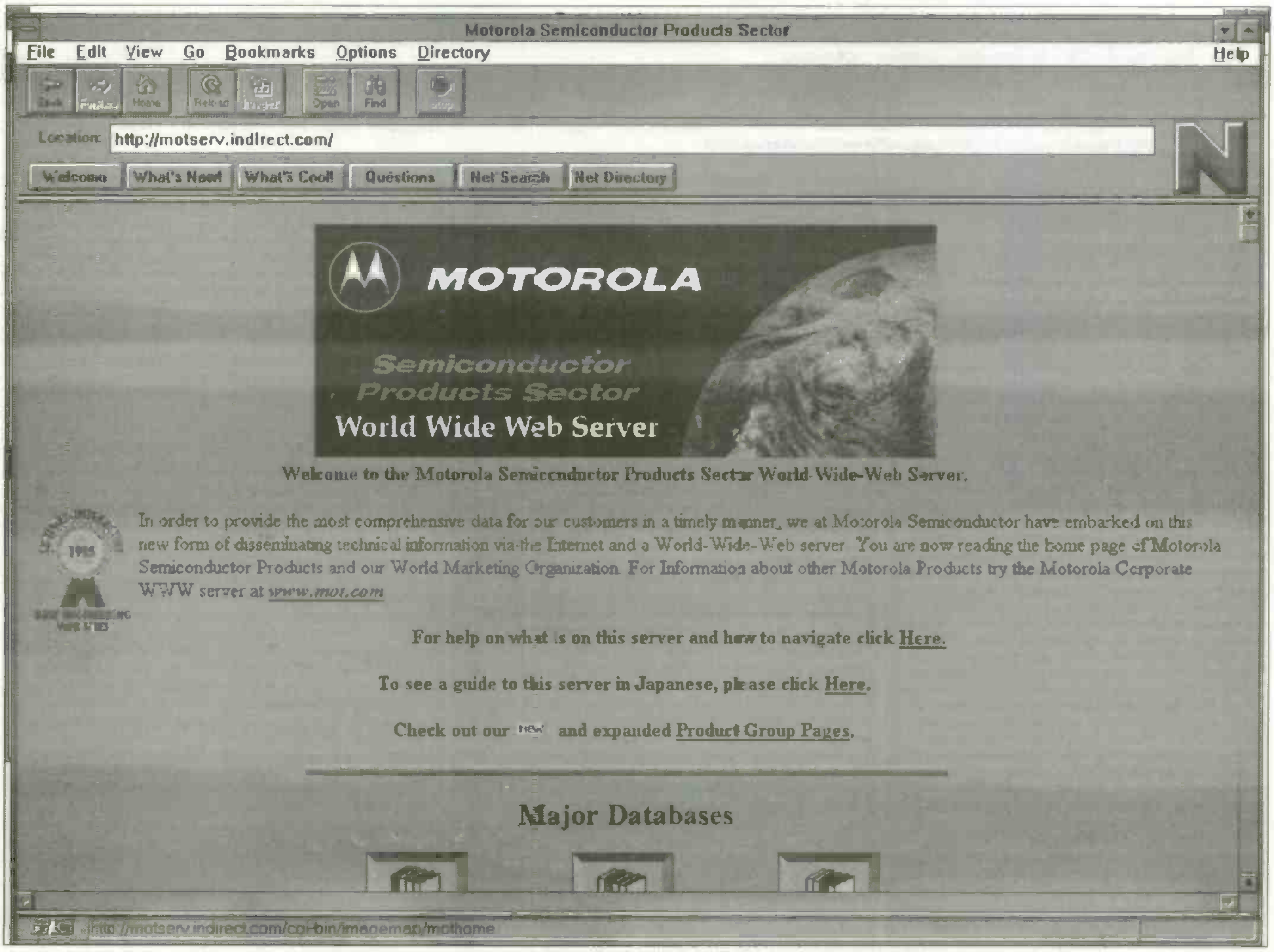
Internet, and there are even a few experimental net based TV broadcasts.

In fact it is very much on the cards that Internet based broadcasting of sound and 2-D/3-D video will be the next explosive development to hit us all. Once again experts are predicting the demise of much of wireless based broadcasting and its replacement with an 'on demand' system delivered by optical fibre networks.

A more highly developed version of the Internet could also make the much touted concept of telecommuting a lot more viable, and will certainly revolutionise education. For a start there is no reason why all the books in the greatest libraries of the world should not be accessible to anyone with a computer attached to the network. Similarly it should be possible for everyone to have access to the finest teachers in the world.

The fact that robots can be remotely controlled over the Internet using virtual reality systems is opening up yet more avenues of development. People operating remotely located machines from an office thousands of miles away, surgeons operating on a patient living on the other side of the world, and virtual reality tourists visiting the deep oceans or driving across the surface of the moon.

Without a doubt Internet based technology is not the preserve of the computer freak, and the wacky proponent of alternative lifestyles, it is a key component of the future for all of us.



Doing business on the Web

The Web started off as an academic network, and quickly acquired a lot of individual users who were attracted by the anarchic structure of the system. There is no organisation which controls the Web, just the domain naming committees, so individuals found themselves free to say what they wanted to say without let or hindrance. Hence the current image of Internet and Web users as wacky odd-ball characters.

These individuals have helped to pioneer the Internet and Web, they further developed the technologies and experimented with what was possible and in so doing pushed the technology boundaries to where they are today. But the use of the Web as an alternative lifestyle network was bound to be limited, for as soon as it reached a certain size it began to attract the attention of businesses around the world.

The first businesses to use the Web were either in computer technology, especially Web related technology, or in businesses which sold to the kind of individuals who pioneered the use of the Web. These were music companies, alternative lifestyle and pop culture magazines, and companies like Coca-Cola.

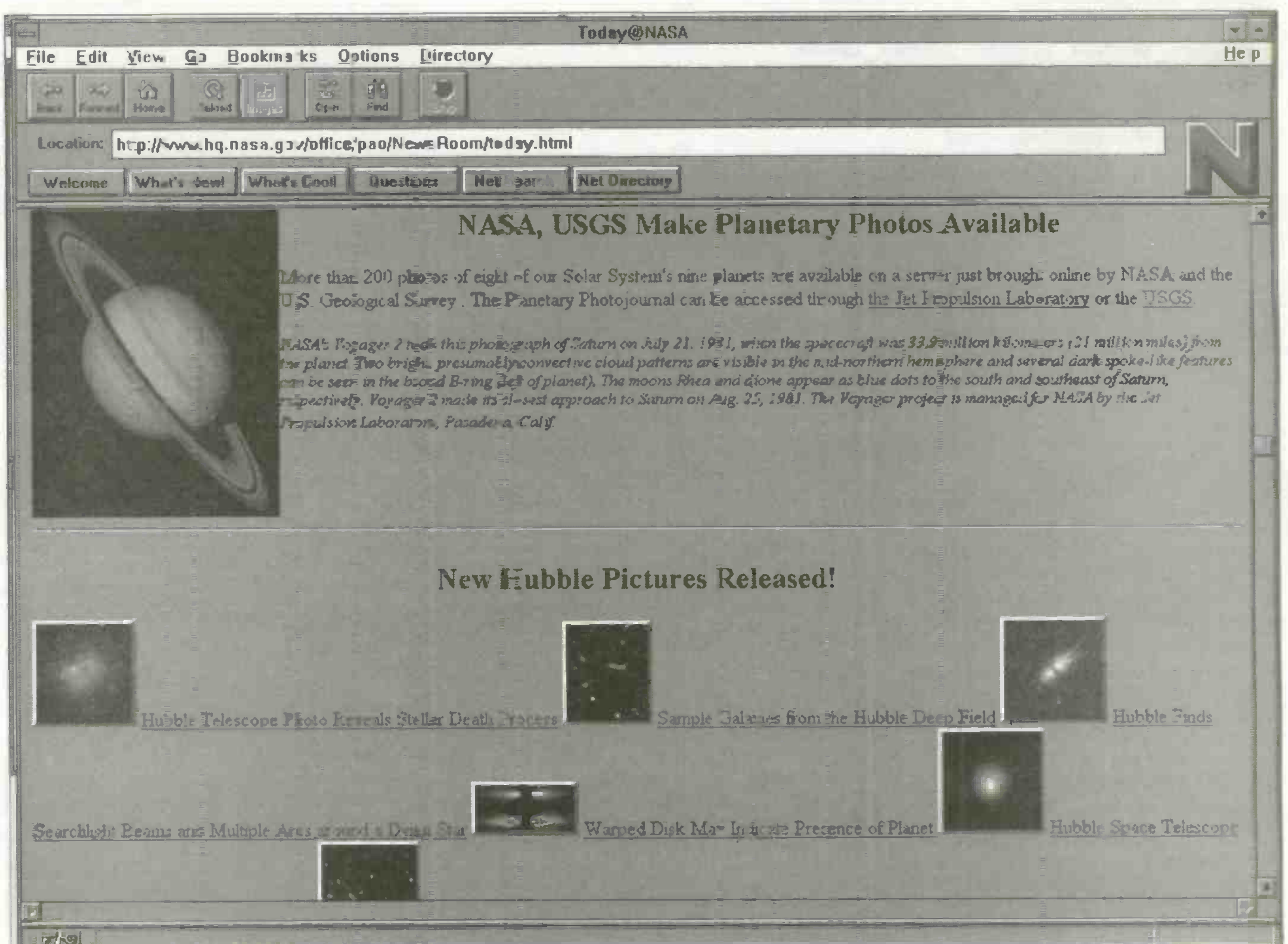
High technology companies, primarily in the US, also started to use the Web to provide initially customer support information, then sales support, and more recently investor support. These large high technology companies have been followed by a host of smaller companies, mostly in technology, who see the Web as a means of advertising their products and services on a global basis (unfortunately UK companies seem remarkably slow in investigating this oportunity for widening sales).

Advertising on the Web is something which has only started to appear over the last six months, and is still primarily confined to a few metasites such as Yahoo. This is probably because most companies see having a Web site of their own or renting a page from one of the companies which offer such a service as being the better option. After all a page can be rented for a year on a site like the Technology Reporter for just £50, compared with $5000 for a small banner on one of the metasites.

Not surprisingly one area of Web development which has been the subject of a lot of work, and will continue to be for some time, is the technology for doing business over the Web. This basically means making the Web secure enough so that users can confidently use it to transfer money to or from another Web user, business, or Web based bank.

The initial developers of both the Internet and the Web were not trying to hide anything, indeed the exact oposite, so no consideration was given to methods of preventing anyone from 'listening in' to the data that was being transmitted. However financial information needs to be kept private which means that if users are to be able to pay for goods and services ordered over the net then that information has to be encrypted in such a way that nobody else can intercept it.

First generation secure server systems have now been developed which means that we will start to see the rise of organisations selling information, and entertainment over the Web. In fact this year should see the start of the Web's use as a proper commercial tool, and will mark a departure from the current main feature of the Web, the fact that the information on it is free.



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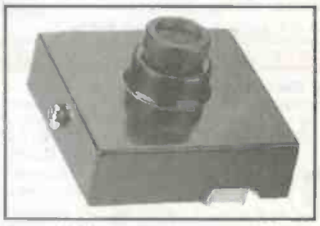

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Rechargeable PSU

Terry Balbirnie's handy bench power supply

This device differs from the usual type of amateur power supply unit because it is battery operated. This allows total freedom of use and completely safe operation. Power is obtained from a set of nickel cadmium cells and recharging is effected by plugging the unit into a car cigar lighter socket. The output is switchable from 3V to 12V in 1V steps and the current output limited to about 800mA. There is also an audible warning when the batteries need to be changed.

The prototype unit used standard (500mAh) "AA" size batteries and these were found to be adequate for most purposes. Using this type of cell keeps the size and cost down. Most "hobby" purposes need only a small current - 100mA or less. When drawing 100mA, 5 hours' service will be obtained before the need to re-charge. It is suggested that, in normal use, no more than 500mA is used and this will provide about 1 hour of operation. At a higher current, it may be difficult obtaining a full 12V output. Also, the period of service becomes rather short.

It would be a simple (but more expensive) matter to use high capacity "AA" cells. The 850mAh version would provide a 70% increase in capacity - that is, 8 hours' service at 100mA. It would also be possible to use physically larger cells such as "C" size with a corresponding increase in capacity. Charging standard "AA" batteries from "flat" takes 15 hours although the unit may be left connected for longer than that without harm. Higher capacity batteries will, of course, take correspondingly greater times. While charging, the total requirement of the circuit is 125mA approximately and this will impose negligible drain on a well-charged car battery.

Left in charge

Having a 12V output available poses a problem when charging the batteries from the 12V car system. This is because the source needs to have a higher voltage than the batteries being charged. The problem is overcome by dividing the cells into two groups of six. This gives sets having a voltage of about 7.5V each (regarding the nominal voltage of a single cell as 1.25V). The half-sets are then charged individually and since the voltage of each is less than 12V, the car battery is sufficient. When the supply is in use, the half-sets are connected in series to provide a nominal 15V output which is then regulated to the voltage required. When the cells are freshly-charged, the voltage of the pack will be about 17V. When almost discharged, it will fall below 14.5V and the "re-charge" buzzer will sound - quietly at first then more urgently.

The unit is controlled by two rotary switches on the front panel. The first (selector switch) has three positions: "off", "charge" and "operate". The other (output switch) has ten positions and selects a voltage from 3V to 12V as required. There are output terminals and LED indicators on the front and a socket on the back to which the charging lead is connected. When the switch is set to "charge", a red LED operates. While operating, a green one lights.

How it works

The complete circuit diagram for the Re-chargeable PSU is shown in figure 1. SW1 is the selector switch shown in the "charge" position. This switch consists of four independent sections (poles) labelled "SW1a", "SW1b" and "SW1c" (pole d is not used). The numbers correspond with those marked on the switch itself and it may be helpful to refer to these during

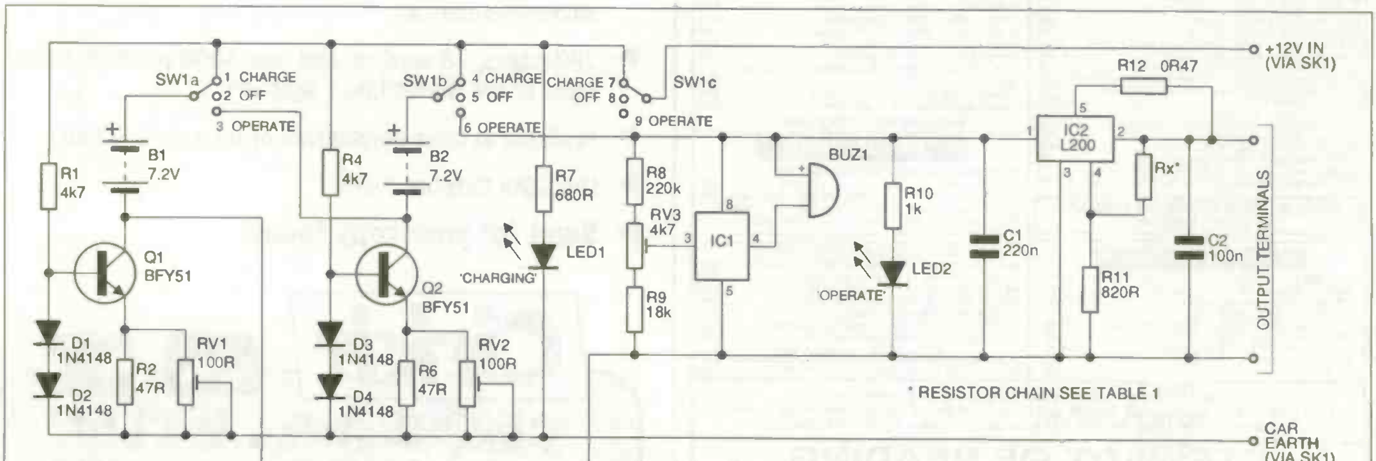


Fig.1. Rechargeable PSU - circuit diagram

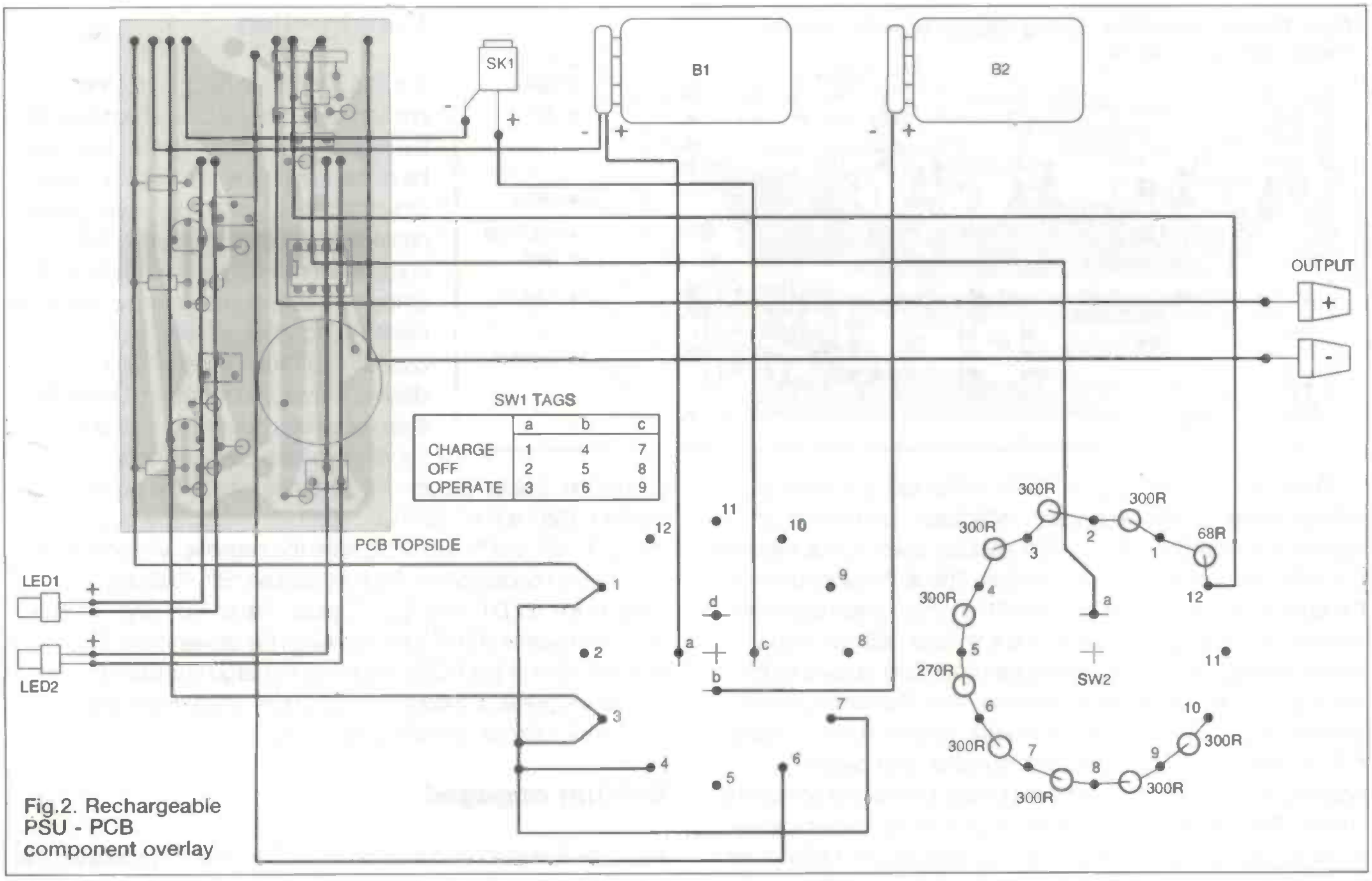


Fig.2. Rechargeable PSU - PCB component overlay

construction. Pole c directs current from the +12V car feed to the rest of the circuit. Red "charging" indicator, LED1, lights with current limited by resistor, R7. Poles a and b send current to the twin circuits based on transistors Q1 and Q2 which are responsible for charging the cell half-sets, B1 and B2 respectively.

Nickel cadmium cells must be charged from a constant current source. This is provided in the following way. It is only necessary to consider the charging of one set - say, B1 - since the other operates in identical manner. Current flows through resistor R1 and the two diodes, D1 and D2, in series. Since a silicon diode develops 0.7V approximately between its ends while conducting (i.e. in forward bias), there will be about 1.4V across the pair. Current enters transistor Q1 base via R1 and collector current flows through the cells so charging them. There will be about 0.7V developed between base and emitter (since this junction is equivalent to a forward-biased silicon diode). It follows that 0.7V approximately will exist across the emitter resistor network, R2, R3 and RV1. Virtually the same current as that in the collector will flow through this network (ignoring the very small contribution made by the base current). Also, as stated above, the voltage across it will be 0.7 V. By choosing the appropriate emitter resistance, the charging current may therefore be controlled. A value of 50mA is recommended for charging "AA" cells. The emitter resistance needed to achieve this may be calculated using Ohm's Law thus:

$R = V/I = 0.7/0.05 = 14W$

The voltage between Q1 collector and emitter adjusts automatically to maintain the charging current as set. This happens as the battery voltage rises in the course of charging.The purpose of RV1 is to adjust the charging current since the 0.7V levels mentioned above are not exact. Ideally, a value of about 30 ohms would be necessary but these are not available. To overcome the problem, a 100 ohm preset is used with a 47 ohm fixed resistor connected between its outer tags. This provides an adjustment between zero and about 33 ohms. The response is no longer linear but this does not matter. Resistor R2 limits the current if RV1 were to be adjusted to zero.

Discharge

Suppose switch SW1 is now set to "operate". Pole c disconnects the car supply (in case the unit has been left plugged in), Pole a connects the positive terminal of battery half-set B1 to the negative terminal of half-set B2 so they now appear in series. Pole b connects the positive terminal of what is now a nominal 15V supply to regulator IC2 input, pin 1. The negative terminal of the set is connected direct to the 0V ("negative") output line. Green "operate" indicator, LED2, lights with current limited by resistor, R10. Ignore the section of the circuit centred on IC1 for the moment.

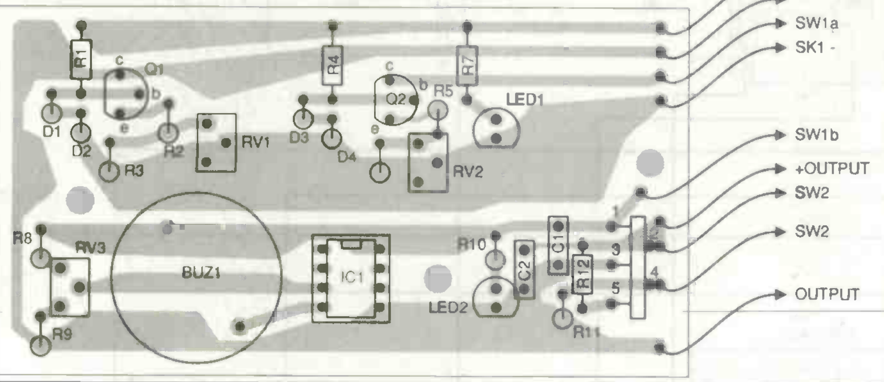
The regulator accepts the basic input and delivers a controlled voltage output. Its value will depend on resistors, R11 and Rx. R11 is fixed in value but Rx (referred to as the chain) is selected by rotary switch, SW2 (shown in figure 3 but not in figure 1) to provide the required voltages. Table 1 shows the resistors needed. The current limit is set by resistor R12 connected between pins 1 and 5 according to the formula:

$I = 0.45/R.$

With a value of 0.47 ohms as specified the current will, in theory, be limited to about 960mA. Due to additional stray resistance, it is likely to be less than this - 830mA in the prototype.

The regulator can only function correctly if the input voltage is at least 1.5V to 2V higher than the output. When 12V is selected, the batteries must therefore be capable of supplying at least 14V. The difference between supply and output voltages appears across the device. In the "worst" case, the input voltage will be 17V and the output 3V. If 800mA is drawn, there will be a power dissipation of over 11W. A heat sink is therefore needed and this is provided by the metal case.

Fig.3. Rechargeable PSU - wiring diagram showing batteries, and voltage selection switch.



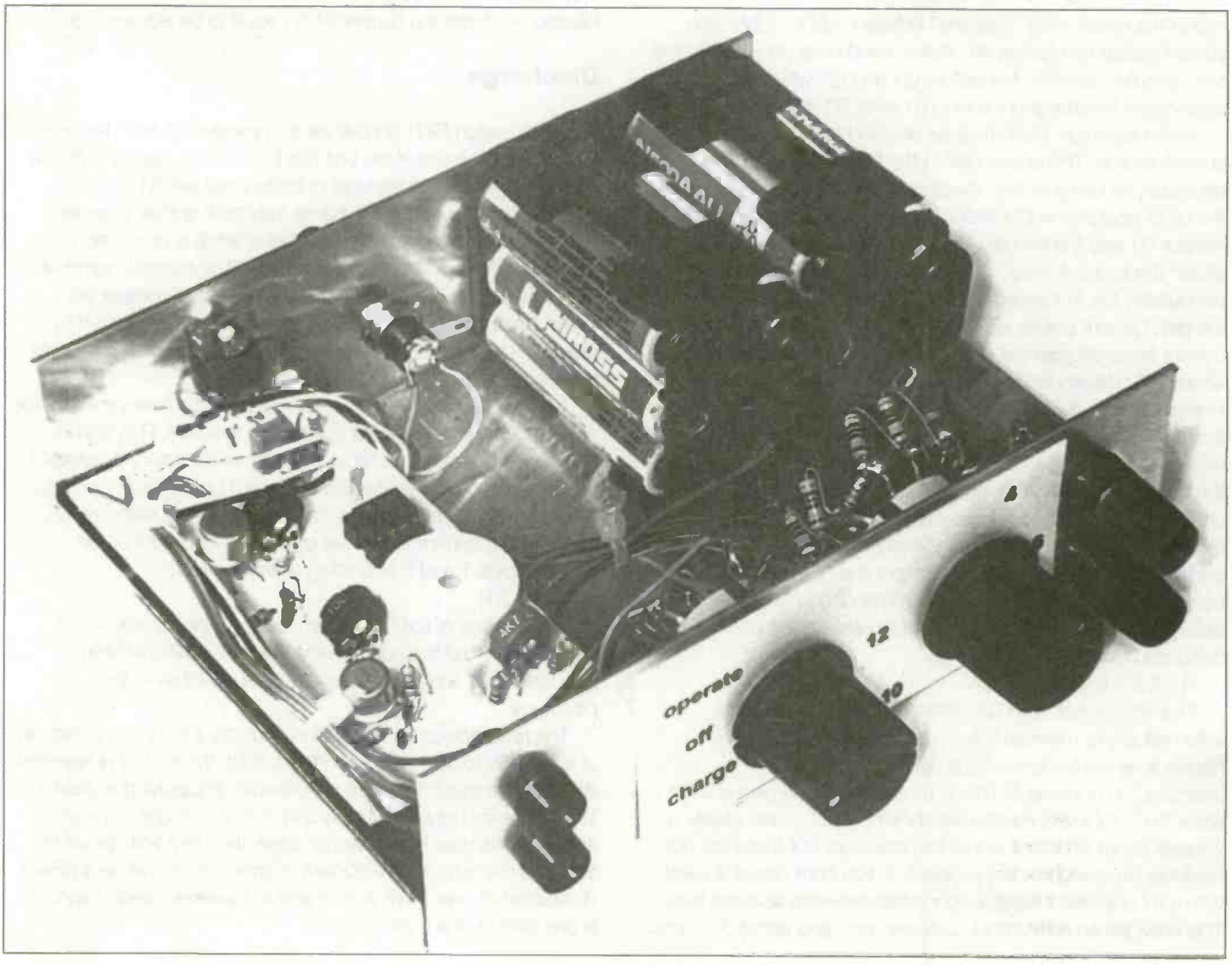
When the battery charge is nearly exhausted, the terminal voltage will fall quickly - especially under load - and will fail to operate the regulator. This will first happen when 12V is selected but will quickly follow at lower voltages. This is the point at which the buzzer will sound. The section of the circuit which does this operates in the following way. IC1 is a voltage detector chip. When a voltage less than a reference of 1.15V is applied to the input (pin 3) the output (pin 4) becomes low. This sinks current through buzzer, BUZ1, from the positive supply rail, so sounding it. Fixed resistors, R8 and R9, in conjunction with preset potentiometer RV3 form a potential divider connected across the supply. RV3 will be adjusted at the end of construction to apply 1.15V to pin 3 when the supply is just falling below 14.5V or for best effect.

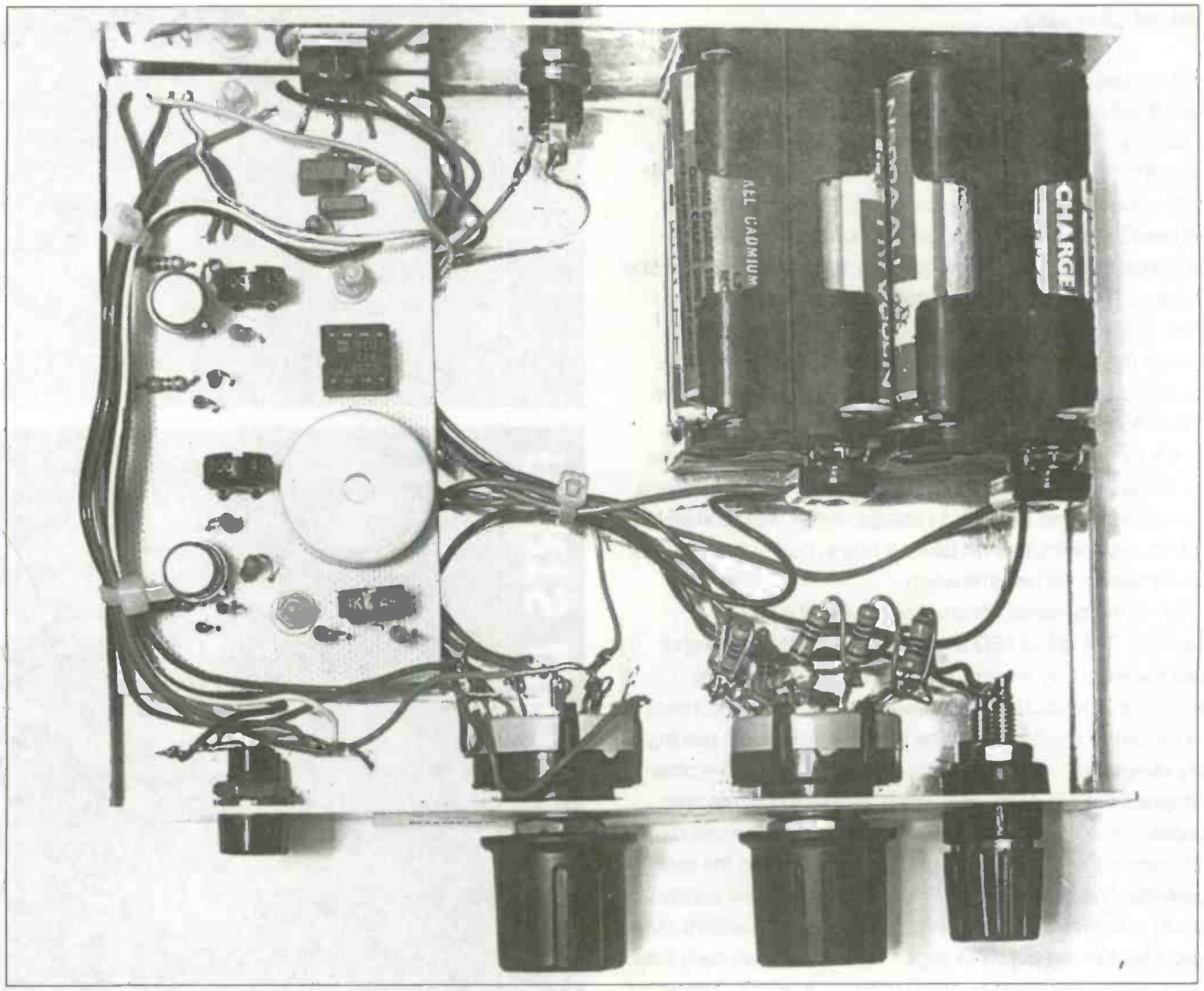
Construction

A metal case must be used for this project since it is used as a heat sink for the regulator. The cigar lighter plug must be of the fused type carrying a 1A fuse. Construction is based on a single-sided printed circuit board (PCB) and the component overlay is shown in figure 2. Solder IC1 socket in position as well as all resistors (including presets) and capacitors. Follow with transistors, diodes, buzzer and regulator. Note that these latter components are polarity-sensitive so take care over their orientation. Solder pieces of connecting wire to the points labelled "SW1 a b c", "SW1a ", "SK1 -", "SW1b", "+ output", "SW2" (2 off) and "- output". Solder the negative wire of one of the battery connectors to the pad marked "B1 -". Solder four wires to the "LED1" and "LED2" pads. Adjust RV1 and RV2 fully anti-clockwise and RV3 fully clockwise (as viewed from the regulator end of the PCB). In view of the large number of connecting wires, it would be wise to use different colours to reduce the chance of making a mistake.

Getting engaged

Adjust switch SW2 end stop so that it has only 10 positions. This is done by removing the brass nut and tab washer beneath. It will





be seen that there is a ring of holes and the tab may be engaged into any one of these to provide the number of positions required. Rotate the spindle fully anti-clockwise and locate the tab in the tenth hole. Replace the brass nut and check that the switch operates correctly with the required ten positions.

Refer to Table 1 and solder the chain resistors around SW2 tags as shown in figure 3. These are used cumulatively - the values add up as the switch is rotated. Note that the first member - 68 ohms - is mounted with one end connected to tag 12. This is permissible because the moving contact never reaches this position - it is simply used as a take-off point. The other resistors should, in theory, all have a value of 296 ohms. Since this is not a standard value, 300 ohms is used. This would result in a slightly high voltage output. The single 270 ohm resistor almost entirely corrects this and the theoretical off-load voltages all lie within 1%. The actual voltages will depend on the tolerance of the resistors used - 1% is advised. Output switch, SW2, must be of the "make before break" type. This will result in the voltages rising regularly as the spindle is rotated. However, selector switch, SW1, should be of the usual "break before make" type.

Nice kit

Prepare the box by drilling the three holes in the base to correspond with those in the PCB. Drill the holes in the front panel for the rotary switches, LED indicators and output terminals. Drill the hole in the rear for the socket to which the input lead will be connected. Mount the circuit panel on short stand-off insulators and mark the position of the hole in the regulator tab on the rear panel. Remove the PCB again and drill this hole. Re-mount the PCB attaching the regulator using a mounting kit (which consists of a thin mica washer and a plastic bush) to electrically isolate it from the metalwork. Check using a multitester set to "ohms" with one probe touched on the metal tab and the other on the box. Infinite resistance should be indicated.

Refer to figure 3, mount all remaining components and complete the wiring, shortening any wires as necessary. Use a red terminal for the positive output and a black one for the negative. The "power-in" connector used for the input must have its outer (sleeve) terminal wired as the negative one. Observe the polarity of the LED indicators or they will not work - the shorter lead is the negative one. This connects to the large "land" area on the PCB in each case. With the specified box, the battery holders will be held tightly by the lid when this is in position and no further support is needed. A bracket may be made if a different box is used. Check that there are no protruding metal parts such as rivets on the battery holders (which could cause short-circuits to the case) and provide insulation if necessary.

Prepare a piece of twin wire for the input lead by soldering the cigar lighter plug to one end and the "power-in" plug to the other. The outer connection in each case is the negative one. Fit a 1A fuse in the plug. Make sure that the positive supply wire will end up connected to SW1 pole c. Check that the cigar lighter socket is live with the ignition key removed. If not, it will need to be re-wired so that it is.

Out of the way

It is now necessary to adjust the charging current and to check the voltage output. Insert the cells in their holders taking care to observe the orientation of each. Push on one terminal of each PP3-type connector swivelling the other connection out of the way. With the selector switch off, connect the supply then switch to "charge". The red LED should light. Set the multitester to a current range covering 100mA and clip a probe on one of the unconnected battery snap terminals and the other on the battery. The charging current will then flow through the meter. This is likely to be in the region of 20mA. Adjust the corresponding preset so that 50mA flows - within 2mA is acceptable. Do not leave it drawing a much higher current than this for a long time or the transistor will become hot. Repeat with the other battery. Connect the battery snaps correctly and leave the cells to charge. If they were completely "flat" to begin with, this will take 15 hours. During this process, the transistors will become warm.

When the batteries are charged, switch the unit to "operate". The green LED should come on. Turn the output switch spindle fully anti-clockwise - i.e. to 3V. Adjust the multitester to a voltage range covering 12V d.c. and connect the probes to the terminals. The meter should give a reading very close to 3V - say, within 5%. Proceed through the other voltages checking each one. If there is anything amiss here, suspect the soldering at one of SW2 tags. With the unit set to 12V, connect a 12V 5W lamp (car sidelight bulb) to the output terminals. This draws 420mA approximately and the supply should maintain this for more than 1 hour using standard "AA" cells. Measure the output voltage - under load it will have fallen a little. Measure it again every 10 minutes. It will be clear when it begins to fall more rapidly to, say, 11V indicating that the regulator is unable to maintain the supply. Adjust RV3 at this point so that the buzzer just begins to sound. It may be necessary to re-adjust it slightly over a few days of trial to achieve the best effect.

If all is well, assemble the case checking for trapped wires and short-circuits. Drill a few holes in the top section above BUZ1 position to allow the sound to emerge if it proves to be too quiet. Attach self-adhesive plastic feet to the bottom of the case. It now only remains to label the switches and put the unit into service.

Final points

Note that the switching current of SW1 is only 150mA although it can carry 5A. It is, therefore, important not to switch the unit on or off using SW1 when a higher load than this is connected. This precaution does not apply to SW2 which carries only a small current. When a large current is drawn and a low voltage is selected, the case will become warm in use - this is normal. Also, at a high current, there may be difficulty maintaining a 12V supply. The red LED is not a signal that the batteries are actually charging - only that the switch is in the "charge" position. Do not leave it like that with no supply connected or the LED will drain the batteries.

TABLE 1

Voltage	Resistor value (ohms)
3	68
4	300
5	300
6	300
7	300
8	270
9	300
10	300
11	300
12	300

PARTS LIST

Resistors

R1, R4	4k7
R2, R5	4R7
R3, R6	47R
R7	680R
R8	220k
R9	18k
R10	1k
R11	820R
Rx	Chain resistors: 68R (one off), 300R (8 off), 270R (1 off). See Table 1. All 1% metal film.

Capacitors

C1	220n min. metalised polyester 5 mm pin spacing
C2	100n min. metalised polyester 5 mm pin spacing

Semiconductors

Q1, 2	BFY51
IC1	ICL8211CPA voltage detector
IC2	L200CV voltage and current regulator
LED1	Red LED indicator
LED2	Green LED indicator

Miscellaneous

B1, B2 12 off "AA" nickel cadmium cells - see text. Cell holders for 6 "AA" cells with PP3-type connectors - 2 required.
SW1 4-pole 3 way rotary switch - break before make action.
SW2 1-pole 12 way rotary switch - make before break action.
BUZ1 PCB mounting buzzer - 12V d.c. 5mA operation
4 mm. terminal posts - 1 red, one black
2.5mm "power-in" plug and socket
TO66 mounting kit for regulator
PP3 battery connectors (2 required)
Fused cigar lighter plug and 1A fuse to fit. Control knobs
Aluminium case (152 x 114 x 44 mm)

Buy Lines

Most of the components for the Rechargeable PSU are freely available. Check the prices of "AA" nickel cadmium cells with several mail order suppliers - you should not pay more than £1 each. Maplin supply the semiconductors, buzzer, switches, enclosure, etc.

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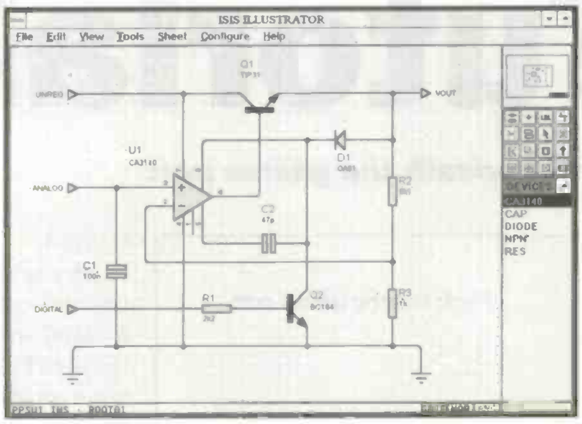

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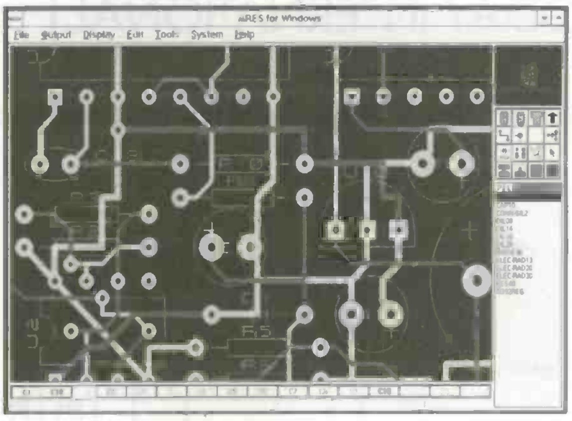

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ELECTRONICS TODAY INTERNATIONAL

Games Port Tutorial

Stephen Smith looks at the unexplored world beneath the games port

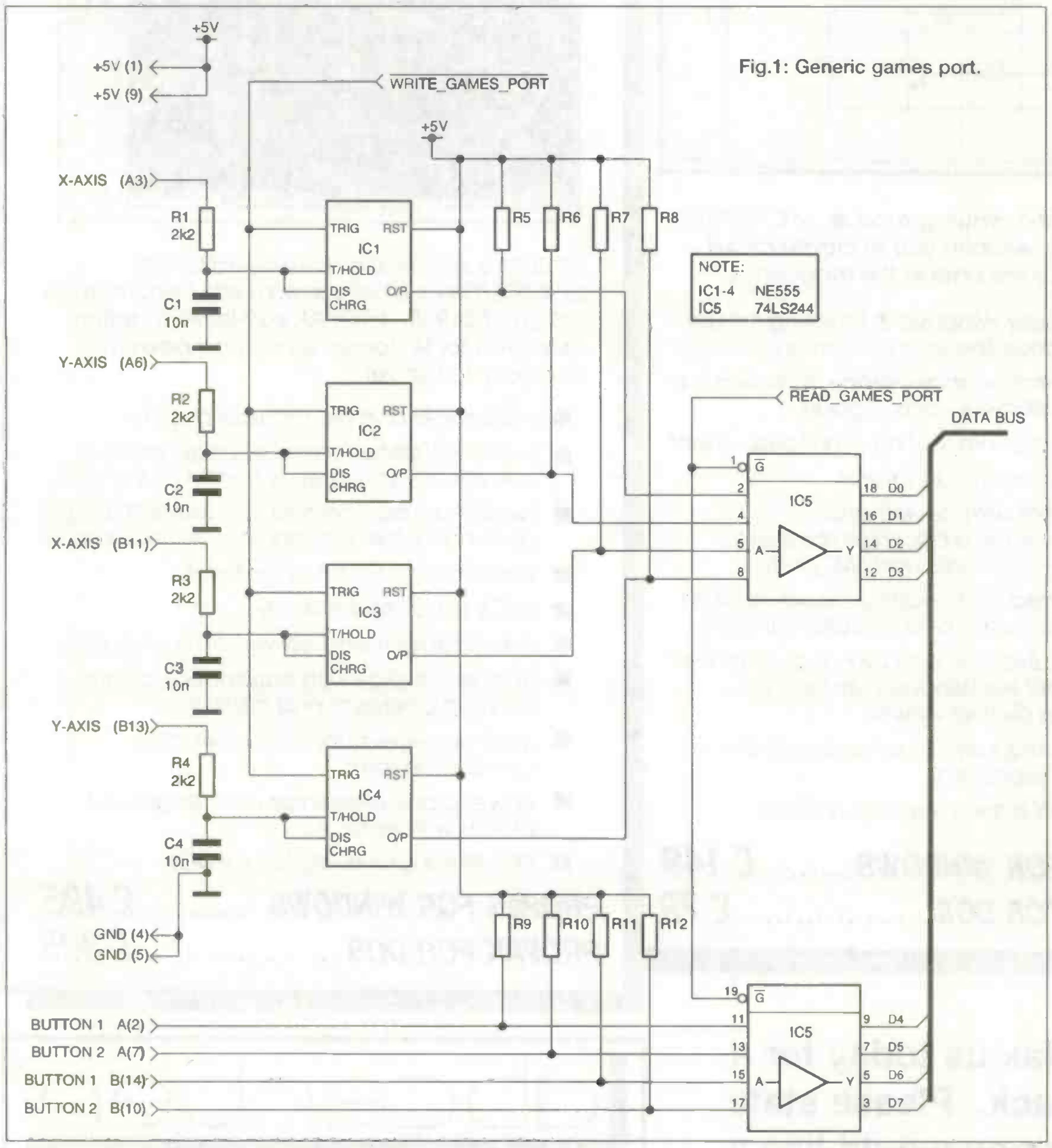


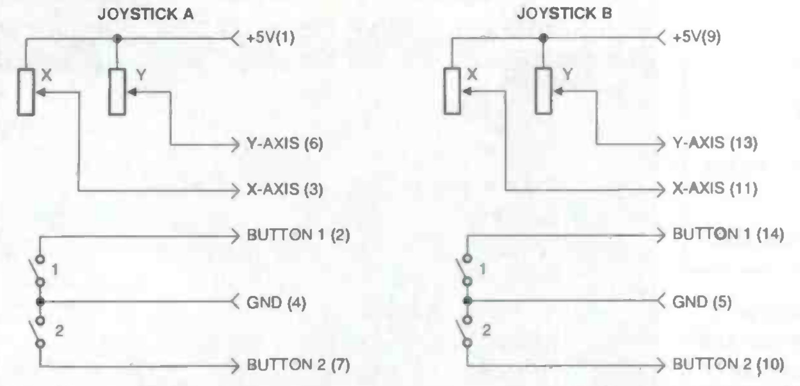
Fig.1: Generic games port.

If you are anything like myself, the first thing you do when you get a new computer is play games. Lost in this twilight world, we never usually give a second thought to the games port; its only obvious use is to plug in the joystick. But beneath the innocent exterior of the games port lurks an unexplored world to the hobbyist.

When you look at the input/output available on a standard PC, you see a parallel printer port (see making use of the PC parallel port, ETI, June '95) two COM ports (standard RS232 ports) and a games port. The games port may seem a strange addition to a primarily business computer, but the cost it adds to the highly integrated multi-I/O controller is so small that many computers have them, essentially, for free. Using this port to interface your own projects to your PC is easy and, potentially, very powerful. To use the games port for other tasks, you first need to understand its intended use.

The PC games port is designed to interface to two analogue joysticks, each with two buttons. These analogue joysticks consist of two potentiometers at right angles (the x and y axis) that are linked to the joystick, so that the amount of movement in either direction is converted into a resistance across the potentiometer. The games port allows the PC to evaluate this resistance to assess the joysticks' position.

Fig.2: Dual joystick.



A conventional method of reading such an analogue joystick is to put a constant DC voltage across the potentiometers and measure the voltage at the wipers of the potentiometers. This involves using an ADC to measure this value (as used in the BBC Micro). ADCs cost money and people want cheap games ports, so IBM designed a much simpler method of assessing the joystick's position. If a capacitor is placed in series with the potentiometer's resistance to be measured, the RC time constant can be used to read the joystick's position.

The IBM joystick port is located at I/O address 201Hex; writing anything to this location triggers a set of four one-shots that are used to measure the x and y positions of the two joysticks supported. Table 1 shows the bit allocations of the games port. Once the one-shots have been triggered the games port is continuously read until all of the one-shots have decayed. The number of times the location is read before the one-shots have decayed is counted by the controlling software and interpreted as a joystick position. The time of the one-shot is given by:

24.2 + (0.011 * resistance) micro-seconds

but stray capacitance and lead resistance can, in practice, make this equation useless. When reading a joystick, however, it is the movement thus variation in this time that matters, so the absolute time and resistance does not matter. Using a software counter to time the one-shots does, however, make the process more complex as the original 4.77MHz PC counts a lot slower than your modern 486. This means that calibration of the joystick is essential. Measuring the joystick's readings at top left and bottom right allows the full travel of a joystick to be known.

Figure 1 shows a circuit diagram for a typical games port. The buttons pull the appropriate inputs to the buffer to ground whereas the position inputs are fed to a 555 configured as a monostable. The 2K2 input resistor allows any resistance to be measured, even down to a short circuit. The time of a 555 one-shot is given by 1.1RC; here the time equals:

$$1.1(2K2+R_{POT})10^{-8}.$$

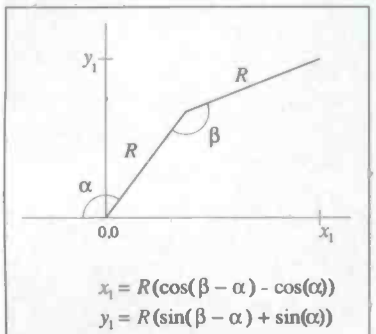


Fig. 3: Geometry of a Pantograph

Address decoding on the games port expansion card generates one of two signals when reading from, or writing to, I/O location 201Hex. These are shown as Read_Games_Port and Write_Games_Port in figure 1. The action of writing to the games port location triggers the 555.

The 10nF capacitor charges via the 2K2 resistor and the resistance being measured. Once the threshold voltage of 2/3Vcc has been reached, the output of the 555 rises and the software counter can stop.

You can use the BIOS INT 15Hex, sub-function 84Hex to read the joystick in all PCs except the very early ones. To read the buttons set DX=0 and the status of the buttons will be returned in bits 4-7 of AL. To read the position set DX=1 and the positions of the joysticks will be returned in AX, BX, CX and DX (corresponding to bits 0-3 of the games port). For the people that use high level languages QBasic has two functions for reading joysticks. STICK to read the position and STRIG to read the status of the buttons. (Look at listing 2 and in the on-line help if you want more assistance.) Listing 1 gives an example Turbo C program to read the position and button status of a joystick. This code counts the length of the one-shot for each joystick potentiometer until all time out or the counter reaches MAXINT. (This is in case only one joystick is attached.) Reading the status of the buttons is a simple case of masking the appropriate bits.

Table 2 gives the pinout of the 15way D type that is used for the games port. The potentiometers go between +5V and the appropriate pin goes to the wiper. The buttons simply pull the appropriate pin down to ground. This is simply illustrated in figure 2. The +5V from the games port is usually unfused and, as such, great care should be taken when using it. The obvious uses for the games port include sensing any switches or resistances that vary up to 150K. These could include temperature measurement using a thermistor or even a pantograph. A pantograph is a mechanical instrument for copying drawings made up of a series of jointed beams that is fixed at one point, has a pen at another and has a pointer to trace the original drawing. When I was a child I had a pantograph that could copy drawings at a scale of 1:1, 2:1 or 1:2 depending upon the configuration of the pointer, pen and fixed base. Electronic versions of the pantograph allow drawings to be digitised by simply tracing the outline of the drawing. A geometric representation of an electronic pantograph is shown in figure 3. Two beams of length R are jointed with a pair of potentiometers. Therefore the angles that the joints make are represented by the resistance of the linear potentiometers. From these two values and a known beam length, the co-ordinates of the pointer can be found. To convert the joystick positions from the games port into an angle for the trigonometric equations, the system needs to be calibrated. Defining each angle to be zero by placing the pointer at the origin and having the beams horizontal to the left and at maximum when the beams are fully extended horizontally to the right, allows the coefficients for calibration to be calculated. (i.e. the zeroed figures are the offsets to be removed by the software and the fully extended readings correspond to 180o or p radians.)

Figure 4 shows a very simple ADC based upon the PC games port. The op-amp buffers the input signal into a current mirror. The current being defined by the output voltage of the op-amp and the 20K resistor. Thus the capacitor in the one-shot is charged by a constant current defined by the input voltage. The pulse generated by the one-shot has a duration of $\frac{2}{3(4.3-V_{in})}$ mS. Unfortunately, this time is inversely proportional to the input voltage which means that the resolution at low input voltages is very poor, so try and keep the input voltage between 2.5V and 3.5V to improve the accuracy (although the circuit will work on input voltages as low as 1V, they are acquired with a very poor accuracy).

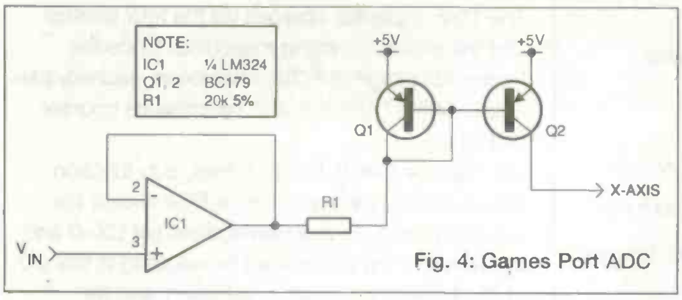


Fig. 4: Games Port ADC

Listing 2 gives a short QBasic program to read in a voltage from such a converter. The diagram shows only one channel; four such channels can be implemented on the four position inputs of the games port, using the four op-amps in the LM324. This ADC is very crude, giving only about 6 bits resolution, but as the component cost is less than £2 for four inputs you cannot really complain. Replacing the 20K resistor with a larger value, such as 200K, gives a greater resolution but cannot be read by the STICK QBasic command. If the position inputs of the games port are driven by a logic level (0V or 5V) these inputs could be used to read in a digital signal. If 0V is present at an input the capacitor in the one-shot will not charge and the games port will read this as a logic 0. If 5V is present at an input the one-shot will run just off the 2K2 inherent resistance, which will create a pulse of approximately 24.2uS. Therefore, to read a logic level input the port needs to be left for a time greater than this after being triggered, before a valid reading is possible. Thus all the inputs of the games port are essentially digital and they could be used to input 8 bits of digital data.

WARNING

The +5V supply available on the games port is usually directly connected to the PC's main +5V supply. This supply is capable of delivering up to 20A that can blow a fuse on the games port, if you are lucky, or vaporise tracks on the games port's PCB. Either form of destruction leads to a dead games port or computer. Also, do not connect any externally powered circuit to your games port unless you have checked and double checked your work. It is important to note that modern PCs have their games ports on the same small piece of silicon as the serial ports, printer port, floppy and hard disk controllers. So, electrically, the games port is very close to expensive parts of your system, like the motherboard and hard disk. Damage to the games port puts these expensive parts in danger of devastation. Please do not let this deter you, just be careful.

The circuits and systems presented here are not intended to be full projects and as such no PCB or other support is available. These have been devised only as examples and ideas to inform you and invoke your imagination. The games port is an easy way of getting data into your PC, so have fun experimenting.

Bit	Use
0	Joystick a, x axis
1	Joystick a, y axis
2	Joystick b, x axis
3	Joystick b, y axis
4	Joystick a, button 1
5	Joystick a, button 2
6	Joystick b, button 1
7	Joystick b, button 2

The axis bits are 1 when the one-shot is active.
The buttons are 0 when pressed

Table 1. Games Port Register Bit Allocation.

Pin	Use
1	Joystick a, 5V
2	Joystick a, Button1
3	Joystick a, x axis
4	Ground
5	Ground
6	Joystick a, y axis
7	Joystick a, Button 2
8	No Connection *
9	Joystick b, 5V
10	Joystick b, Button 2
11	Joystick b, x axis
12	No Connection *
13	Joystick b, y axis
14	Joystick b, Button 1
15	No Connection *

* The pins identified as 'No Connection' may be used by some cards for other functions, e.g. a MIDI interface on a Sound Blaster card.

Table 2. Games Port Pin Allocations

```
/*  Listing1.
    Joystick reading example program.
*/
#include stdio.h
#include values.h
#include dos.h
      const  int    MASKXA=1;
      const  int    MASKYA=2;
      const  int    MASKXB=4;
      const  int    MASKYB=8;
      const  int    GAMES_PORT=0x201;
void   joy(int *xa,int *ya,int *xb,int *yb)
{
      int State,Count;

      outportb(GAMES_PORT,0); /* Dummy Write to
Trigger one-shots */

      State=inportb(GAMES_PORT);

      for(Count=0;(State&0x0f) !=0 && (Count 999
MAXINT);Count++)
      {
      if ((State & MASKXA) != 0) *xa=Count;
      if ((State & MASKYA) != 0) *ya=Count;
      if ((State & MASKXB) != 0) *xb=Count;
      if ((State & MASKYB) != 0) *yb=Count;

      State=inportb(GAMES_PORT);
};
};
main()
{
      int    xa,ya,xb,yb;

      for(;;)
{
      joy(&xa,&ya,&xb,&yb);
      printf("The Joysticks read:
      %d,%d,%d,%d\n",xa,ya,xb,yb);
      };
      return(0);
      };
REM Listing2
CLS
Start:
      V1 = 4.5 - 100 / STICK(0)
      V2 = 4.5 - 100 / STICK(1)
      V3 = 4.5 - 100 / STICK(2)
      V4 = 4.5 - 100 / STICK(3)
LOCATE 10, 5, 0
PRINT V1, V2, V3, V4

GOTO Start
```

valve radio SERVICING AND RESTORATION PART 2

Paul Stenning continues his exploration of 'antique electronics'

Last month we took a general look at the restoration and repair of 'antique electronics', in particular old valve radio sets. This month we delve further into the practical aspects starting with a look at the circuit diagrams of two receivers. Circuit 1 is the Ekco U245. This is a small transportable bakelite set made in 1955. It is designed for use on AC or DC mains, and covers the MW and LW wavebands only. The circuitry is reasonably standard, apart from the biasing of the output stage. Circuit 2 is the Bush VHF61. This is a larger bakelite table set made in 1956. It is designed for use on AC mains only, and covers MW, LW and VHF. The circuit is fairly typical of a higher quality receiver, and features a tone control, gramophone input, 'Piano Key' waveband selection switches, and a 'Magic Eye' tuning indicator. These circuit diagrams were kindly supplied by Anode Electronics.


An American set from the mid 1940s, of unknown manufacture. Possibly imported during or shortly after the Second World War, it covers MW and two SW bands.


The Ferguson 621U. A three waveband VHF/MW/LW set from the late 1950s, constructed on a PCB.

Applying a Test HT supply

Before the set is connected to the mains, apply a test supply to the HT rail. This will show up some leaky capacitors, and will hopefully reform the electrolytics. It is not necessary to fit the valves at this stage. My High Voltage Capacitor Reformer unit is ideal for this purpose. Switch it to the 240V setting and connect a meter to the appropriate terminals to monitor the current.

Connect the negative lead to a convenient point on the chassis and the positive lead to the positive terminal of the electrolytic capacitor that is connected directly to the cathode of the rectifier valve. This is often the red tag on the main smoothing can. On our example circuits, this is the positive terminal of C32 on the Ekco and the positive terminal of C58 on the Bush.

Switch the HT supply on, and watch the current reading. It will probably start high (maybe 30mA), and will hopefully drop after a few seconds as the smoothing capacitors charge up. If you are lucky it will drop to maybe 1mA, which is acceptable leakage for the electrolytics. However it is more likely to remain at a higher level, and there can be several reasons for this.

Check for potential divider circuits across the HT supply. Most sets do not have one, but our example Ekco does - R15 and R16. For this test to be meaningful the lower one (R16 in this case) should be temporarily disconnected.

If the current reading is still over 1mA once the potential dividers have been accounted for, we need to establish where it is going. The most likely explanation is leaky capacitors.

Leaky capacitors

Elderly electrolytics often have high leakage currents. These will


A group of the above sets.

sometimes improve if they are left powered by the capacitor reformer for a few hours.

I prefer to remove the electrolytics from the chassis for reforming if it is likely to take more than a few minutes. This allows each section of a can to be reformed separately, without the effects of other components. If the leakage is fairly bad the electrolytic could get warm after a while, in which case switch off the power and allow it to cool down again. The maximum acceptable leakage current is about 1mA for each 30uF.

Look for signs of resistors or capacitors getting warm (such as molten wax). But don't poke your fingers into the chassis with the power on! Any capacitors that are getting warm will need to be replaced. If a resistor is getting warm, work out which capacitor(s) it is supplying. Thus on our sample Ekco, if R9 was getting warm, C24 would be suspect.

Even if nothing is getting warm we can use the same logic to establish the cause of the current consumption. Measure the voltage drop across any resistor (or resistive component such as a transformer winding) that is feeding one or more capacitors. If the capacitor is OK there will be no voltage drop.

You can also check other potentially leaky capacitors by this method. In particular I would urge you to check the coupling capacitor to the grid of the output valve. Measure the voltage between the grid and the chassis. If it is even slightly positive, change the coupling capacitor (C27 on the Ekco).

If there are several leaky capacitors in a set, the chances are that other components of the same type will be in a similar state. In this case I would change all of that type, to save problems later.

Capacitor types

The capacitors in question here are those values from about 0.001uF (1nF) to 0.47uF (470nF). The smaller value capacitors do not seem to give any trouble. There are various types of capacitor used, and some are worse than others.

Probably the most common - and the most trouble - are the wax coated paper types. These are tubular components, with a distinctive sticky yellow wax coating. Most of these capacitors will be found to be leaky, and I usually replace them all as a matter of course. Many later sets use Hunts Moldseal capacitors. These are small brown or black tubular plastic components which are fairly unreliable. If the case is cracked or fractured it should be replaced, otherwise it may be OK.

Many Philips sets use black capacitors coated with pitch. These are usually fairly reliable, but when they do fail they tend to go short circuit.

Some later sets use small tubular capacitors, which have the appearance of a piece of thin tube with two wires wrapped around it. From my experience these are reliable.

Replacement capacitors

Any replacement must be of similar shape and size as the original, and must have a suitable voltage rating. Valve component suppliers such as Anode electronics stock suitable capacitors, often at favorable prices. You may be able to obtain a mixed pack of 50 or 100 components, containing the more useful values.

The replacement capacitors may not be available in the same capacitance values as the original components. This is not normally a problem, simply fit the closest available. For example a new 0.047uF component could be used to replace a faulty 0.04uF or 0.05uF capacitor.

Electrolytic capacitors

The cans are not readily available now, although valve radio dealers often stock something suitable. The usual approach is to fit a replacement modern axial capacitor below the chassis and leave the

The Philips B2G81U. A small AC/DC set released in 1959, constructed on a printed circuit board.

The Bush VHF61. One of our example sets.

can, disconnected, on the chassis so it looks correct. Some restorers remove the innards from the original cans and fit the modern replacement capacitors inside.

Anode Electronics stock a range of 450V axial electrolytics in values from 1uF to 47uF which should cover most eventualities.

Fitting replacement components

Any replacement components must follow (as close as possible) the path and position of the originals. In particular this applies to those close to the chassis and those in the RF stages. Connections to the chassis should be made to the original point if possible. The original layout would have been planned and optimised to avoid instability, so it is best not to deviate from this.

Any lead that is close to another component or the chassis should be sleeved with PVC sleeving (or a bit or wire insulation) to avoid any risk of short circuits.

Preparing to apply the mains

The mains flex must be replaced with modern cable. The only exception to this is if the cable contains ballast resistance (this cable is thicker than normal).

If the set is an AC/DC type, one side of the mains will be connected directly to the chassis, or via a low resistance (as in our example Ekco). This should be connected to neutral (blue wire) for safety.

Check that the mains on/off switch works. If is a single pole type it should ideally be replaced with a double pole switch. Failing that, make sure it is switching the live side of the mains, and rewire it if necessary.

Make sure the dial lamps are the correct types and functional. Check the mains voltage setting matches the supply voltage in your area.

Reconnect the output transformer and speaker. Make sure any speaker switching arrangements are set so that the internal speaker is connected. Finally fit the valves, making sure they are in the correct positions.

Applying the mains

Connect a test meter between the positive terminal of the main HT smoothing capacitor and the chassis. Set this to a DC voltage range of at least 300V.

Arrange some sort of safe mains connection that you can switch on and off easily. Always keep your finger near the mains switch when the set is on - so it can be switched off quickly.

Switch the power on for just a few seconds. Hopefully all the valve heaters will start to glow, and the dial lamps should illuminate. If any valves heaters do not glow, or some are brighter than others, the reason should be investigated. Valves are fairly robust, but the heaters must not be overrun for any period of time or the cathode will be damaged.

If all the heaters seem OK, leave the set on for a little longer and watch the HT voltage reading. After maybe five to ten seconds this should start to rise, and will reach a maximum of perhaps 250V to 300V after a further five or ten seconds. The voltage will then begin to drop again, by between ten and forty volts, as the output valve warms up.

Check the service information for the correct voltage on the cathode of the rectifier valve. In the case of our sample Ekco it is 190V, and on the Bush it is 252V. The actual voltage can vary by perhaps 15V either way, but greater discrepancies should be investigated.

If you have a digital meter with a high input impedance you should measure the voltage directly across the control grid resistor of the output valve. It should be virtually zero. If there is a positive voltage here, the coupling capacitor is leaky.

Quick Checks

If the set does not show signs of life, all is not lost. A few simple tests and observations may help to narrow down the faulty section.

Listen closely to the speaker for signs of life. If you can hear some sort of hum or noise the power supply and amplifier are probably doing something. If it is completely silent, check the connections between the output transformer and speaker, in particular the switch or whatever is used to disable the internal speaker. The primary of the output transformer may be open-circuit.

Turn the volume up and touch your finger on the centre tag of the volume control pot. If the amplifier is working you will hear a loud buzzing from the speaker. This would confirm that the amplifier and power supply are alive.

With the volume turned up, operate the wavechange switch. If there are healthy crackles from the speaker, the IF and detector sections are probably alive.

If the IF seems OK, try connecting an aerial or a length of wire to the control grid of the mixer-oscillator valve (pin 2 of V2 on the Bush). If this produces some sort of noise or even stations, the connections and components between the valve and the aerial socket or ferrite rod aerial may be suspect.

Confirm that the set is dead on all wavebands. If some wavebands are working, the fault is narrowed down to those components or circuits that are used only on the faulty bands.

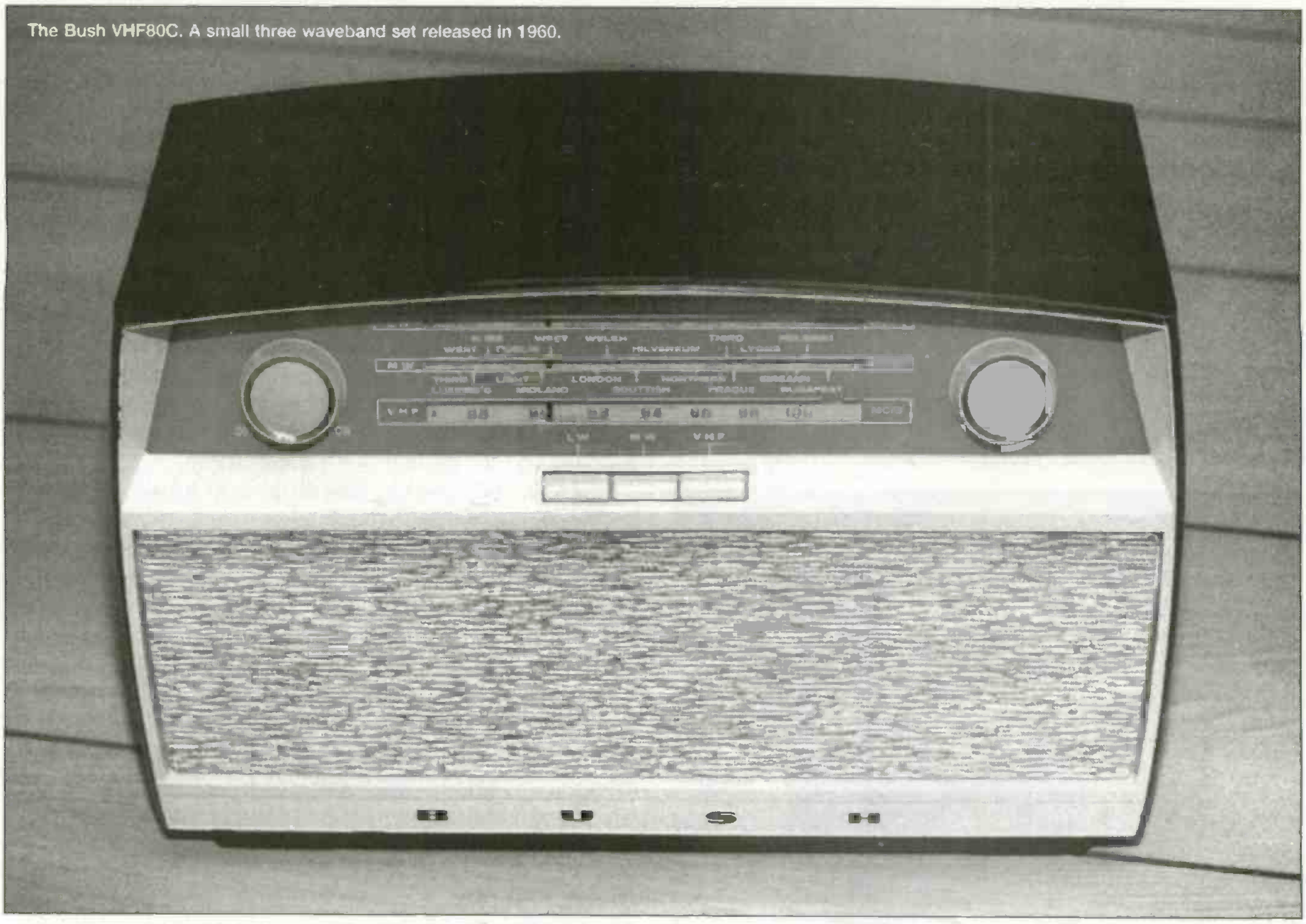
Detailed circuit operation

The following descriptions only cover the more common arrangements. I have not attempted to explain the operation of the circuit, except where valve techniques differ widely from transistor arrangements.

Power supply circuit arrangements

There are two basic arrangements, depending on whether the set is designed for use on AC and DC mains, or AC mains only.

The Bush is an AC only set. The transformer T2 supplies the valve



The Bush VHF80C. A small three waveband set released in 1960.

heaters, which are connected in parallel, from a low voltage (in this case 6.3V) winding. On some sets the rectifier heater is powered from a separate transformer winding to reduce the stress on the heater-cathode insulation. The dial lamps are powered from the main heater winding.

The mains transformer often has two or more tappings on the primary, for different mains supply voltages. To avoid damaging the valves, it is important to check that the setting is correct for the local supply voltage in your area.

A separate centre-tapped secondary winding, typically 250-0-250V, is used for the HT supply. This is full wave rectified by V8 (EZ80). If the HT supply is absent, check that the AC supply is reaching both anodes of the rectifier valve. Mains transformers occasionally fail, but this is often caused by a fault elsewhere.

A few specialist companies offer a transformer rewinding service, but this can be expensive. RS stock a modern HT transformer (196-072) for £24.85, which may be a suitable replacement in some cases. Anode Electronics and a few other dealers may have a suitable second hand component which would be somewhat cheaper and more in keeping with the age of the set. If the requirements are unusual, the best approach may be one of the transformer winding kits. A 50VA kit is normally suitable, and costs about £11.

If the AC is present but the DC HT supply is absent, the rectifier valve is probably faulty. Check first that the heater is being driven.

If there is sparking and fireworks inside the rectifier valve, there is probably a short circuit or heavy current demand on the HT supply. This is probably due to a faulty smoothing capacitor or maybe a fault in the output stage. Do not leave the set in this state for any time as the risk of destroying the mains transformer is very high. You will definitely need a new rectifier valve, even if the transformer survives. Sparking inside the rectifier valve can also be caused by the valve itself being faulty, but this is less common.

AC/DC sets

The main drawback of AC only sets, as far as manufacturers were concerned, was the cost and weight of the mains transformers. This could explain the popularity of AC/DC sets in the 50's, even though DC mains was becoming less common.

In AC/DC sets (such as the Ekco) the valve heaters are connected in series. The current ratings are the same (often 100mA) and the voltages differ. If one valve heater should become open circuit, the circuit will be broken and none of the heaters will glow.

The total voltage of the heater chain is normally lower than the mains supply voltage, and the remainder is dropped by a resistor. In the Ekco R21 is the dropper resistor, which drops about 93V and dissipates 9.3 Watts. Sometimes the dropper resistor is replaced or supplemented by a thermistor to keep the heater current more constant.

Mains supply voltage selection is arranged by additional series resistors. In the Ekco, R22 is included in the circuit when the voltage is set to the 225-250V position.

If one valve does not glow it has probably lost its vacuum. If some valves do not glow and others are excessively bright, one of the valves may have a heater to cathode short circuit.

If you need to check the heater current, the easiest method is to measure the voltage across one of the valve heaters and compare this to the value in the valve data book. Alternatively measure the voltage across the dropper resistor and calculate the current using ohms law. If the difference is greater than about 5% either way, the reason should be investigated.

Dial lamps

Dial lights are sometimes connected into the heater chain. There may be a thermistor or resistor in parallel with them, to enable the set to keep working if one of the lamps fails. The dial lamps may alternatively be in series with the supply to the whole set, possibly shunted by a resistor or thermistor.

The dial lamps will probably not be running at maximum brightness when the set is warmed up and working normally. During the initial warming up process the lamps will vary in brightness, and may be very dim or very bright depending on the circuit arrangement.

Dropper resistor

The dropper resistor and voltage selection resistor are often contained in one component. This is often a green (or sometimes grey) tubular component with several tags, mounted on the top of the chassis. These high power resistors run very hot, and often fail by going open circuit.

You may be able to obtain a suitable second-hand component from a valve component dealer. Failing that, the normal solution is to bridge the faulty section with a new resistor of suitable power rating. The resistors often have odd values, in the Ekco the main section is 930R. A suitable replacement would be a 1K0 11W ceramic resistor.

AC/DC HT supply arrangements

The mains is half-wave rectified, to produce the HT supply. This is carried out by V5 (UY41) in the Ekco set. R20 is a surge limiting component. If the HT supply is missing, check that the AC supply is reaching the anode of the rectifier. The surge limiting resistor is prone to failure, resulting in no HT. If the AC is present but the HT supply is absent the rectifier valve is probably faulty.

C34 in the Ekco is a suppression component, which prevents modulation buzz when the set is tuned to a strong signal. This capacitor often fails by blowing itself to pieces. The replacement MUST be suitable for direct connection across the mains.

Faulty valve holders

A fairly common problem, particularly on cheaper sets, is poor contact between the valve and the valve holder. This is not limited to the power supply, and can occur anywhere in the set.

The problem is often caused by the contacts in the holder losing some of their spring tension. They can often be tightened by pushing a small jewelers screwdriver between the contact and the body to close the contact slightly. This must be done with great care to avoid breaking the contact or body.

Sometimes the valve holder contacts will be broken, or weakened by corrosion. There are various "techniques" used by service engineers for overcoming valve holder problems, but these are more appropriate to quick repairs than serious restoration.

With some types of valve holder it is possible to extract the contacts from above once the connections have been desoldered and the tags straightened.

It is often easier to replace the defective contacts with those from another valve holder, than to replace the complete holder.

Before disconnecting anything, make a note of the connections. The solder should be removed from the tags with a desoldering tool. If the existing solder does not melt and flow very well, apply some new solder before removing the lot with the desoldering tool.

Valve holders are often fixed to the chassis by rivets, which need to be drilled out. The new holder can be fixed in place with small screws and nuts.

Smoothing circuits

On earlier sets chokes were often used for decoupling, with comparatively low value electrolytic smoothing capacitors (8uF or 16uF). As higher value capacitors became available (32uF to 50uF), the chokes were replaced with power resistors which were much cheaper and less bulky. Some earlier sets use an energised speaker, the field winding being used as a smoothing choke.

Other power supply arrangements

Some AC/DC sets have the dropper resistor incorporated in the line cord. This can be identified by the mains cable being thicker than normal. The length affects the resistance, so it must never be shortened. If you suspect it has been, check with the service sheet or measure the heater current as described previously.

This line cord is no longer available so you may have no choice but to fit a suitable resistor inside the case of the set, but this could cause problems with heat dissipation. Some imported sets from countries with lower mains supplies (such as the USA) were fitted with long line cord resistors to drop the excess voltage.

Some continental AC/DC sets are designed for use on either 220V or 117V supplies. The heater chain is divided into two sections with their own dropper resistors. On the lower voltage setting they are connected in parallel, and on the higher voltage setting they are in series.

A few sets use a combination of AC and AC/DC circuit techniques. I have seen a Bush set using a series heater chain driven by the mains transformer. I have also seen a Ferranti set that uses a small transformer to drive the 6.3V heaters, the HT being derived by rectifying the mains.

The HT rectifier may be a metal or selenium rectifier. Either of these could be replaced with a 1N5404 silicon rectifier diode in the event of failure. If there is no surge limiting resistor or thermistor in series with the original rectifier, add a 120R 2.5W resistor in series with the silicon replacement.

Foreign sets

Continental 220V sets can be modified by adding a resistor in series with the supply to the set to drop about 25V. A 18R 5W resistor is often suitable, and can be positioned inside the set (it will dissipate about 3.5W).

110V sets from the USA are more of a problem. Many of these will have been modified by adding a large dropper resistor internally, to drop the extra 130V.

Some American AC/DC sets use a 300mA heater chain, so the total mains current consumption is about 350mA. The dropper resistor would be about 370R and would dissipate some 45 Watts, causing serious overheating. The best approach with 110V sets is to use an external 240V-110V transformer.

Battery valve sets

Batteries for battery sets are no longer available. The normal supply required is 90V at about 20mA for the HT and 1.5V at about 300mA for the LT (Heaters).

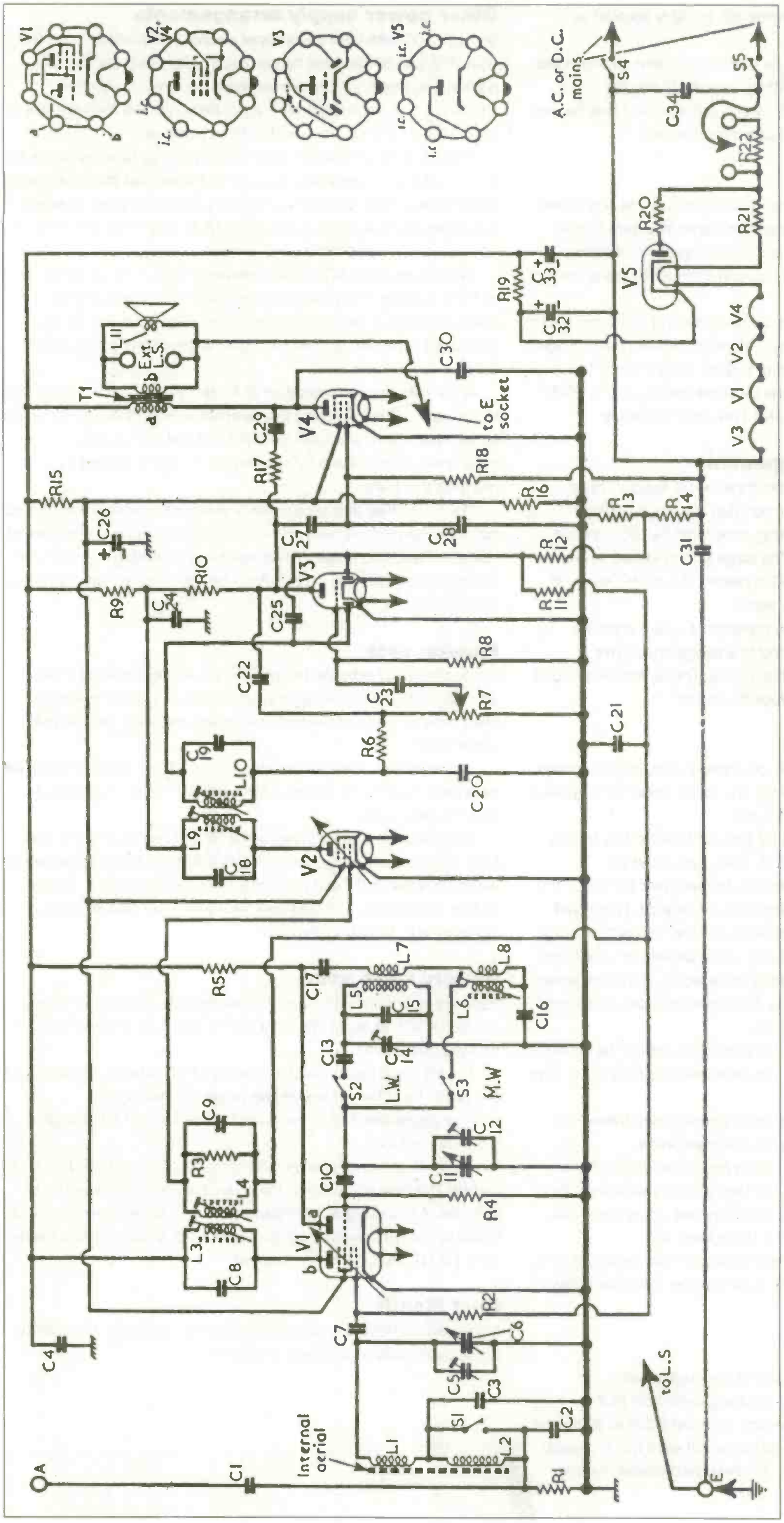
The HT could be obtained from ten 9V PP3 batteries in series, but this would be rather expensive and would not last for long.

A single alkaline 1.5V D cell would suffice for the LT, but again it would not last long.

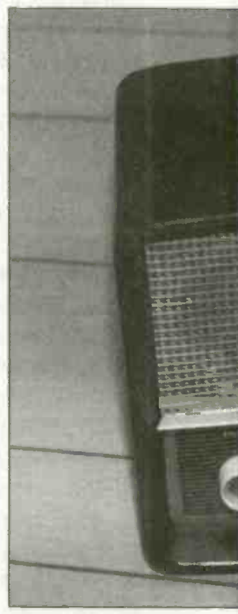
The best approach is some sort of mains power supply. This could be built in a case that will fit in the space previously occupied by the batteries. A unit designed jointly by myself and Nigel Rogerson will be available from Anode Electronics in early 1996. When ordering please state the HT and LT voltages required.

Next Month

In the next part of this series we will continue our detailed look at the circuit configurations and likely problems.



Circuit diagram of the Ekco U245. A.G.C. delay bias and grid bias for V4 is developed across **R13** and **R14**. Valve base connections, as seen from the underside of the chassis, are inset on the right of the main part of the diagram.



CIRCUIT 1-EKCO U245 - COMPONENT LIST

Valves		C15	200pF	**Resistors**		R21	930R
V1	UCH42	C16	421pF	R1	22K	R22	200R
V2	UF41	C17	0.001uF	R2	470K		
V3	UBC41	C18	100pF	R3	680K	**Coils** *	
V4	UL41	C19	100pF	R4	47K	L1	1.4
V5	UY41	C20	50pF	R5	47K	L2	3.5
		C21	0.1uF	R6	47K	L3	11.5
Capacitors		C22	50pF	R7	500K	L4	11.5
C1	0.01uF	C23	0.01uF	R8	10M	L5	6.3
C2	2600pF	C24	0.1uF	R9	1K	L6	3.4
C3	47pF	C25	15pF	R10	220K	L7	3.2
C5	-	C26	2uF	R11	1M	L8	1.5
C6	-	C27	0.002uF	R12	1M	L9	11.5
C7	300pF	C28	0.002uF	R13	39R	L10	11.5
C8	100pF	C29	0.002uF	R14	47R	L11	2.5
C9	100pF	C30	0.02uF	R15	10K	**Other Components** *	
C10	100pF	C31	0.05uF	R16	33K	T1a	430
C11	-	C32	50uF	R17	1M	T1b	-
C12	-	C33	50uF	R18	1M	S1-S3	-
C13	345pF	C34	0.05uF	R19	470R	S4,S5	-
C14	40pF			R20	160R		

* approximate DC resistance in Ohms

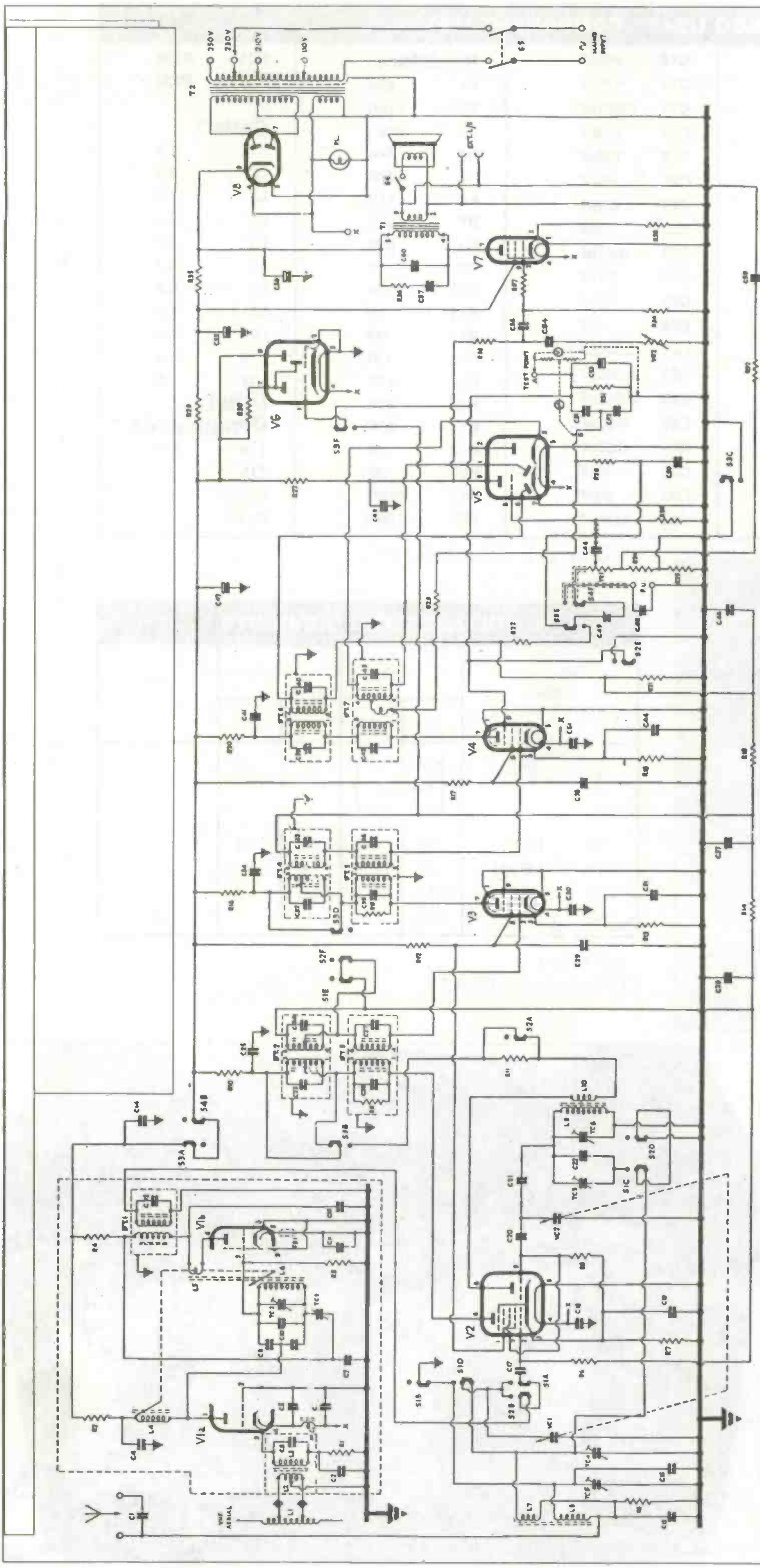
Above: The Ekco U245. One of our example circuits.

VOLTAGES AND CURRENTS

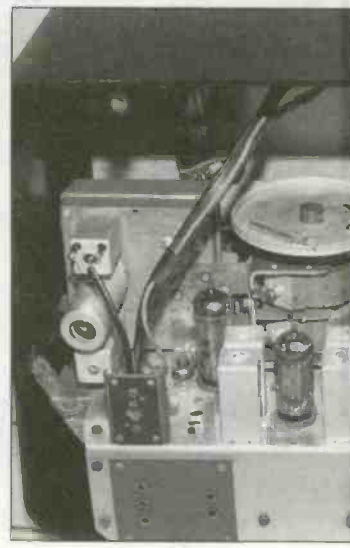
Valve		Anode		Screen		Cath. (V)
		V	mA	V	mA	
V1	UCH42	170 / Oscillator 55	1.7 / Oscillator 2.3	72	2.9	—
V2	UF41	165	3.8	72	1.1	—
V3	UBC41	78	0.4	—	—	—
V4	UL41	157	27.0	72	3.7	—
V5	UY41	205[1]	—	—	—	190[2]

[1] *AC Reading*
[2] *Cathode Current 45mA*

Right: An internal view of the Ekco U245 (one of our example sets). Note the additional resistors connected across the faulty dropper resistor to the right of the set.



Circuit diagram of the Bush VH61 receiver, drawn with the set switched to the v.h.f. position.



The Bush DAC10. This set covers MW
preset tuning. It was released in 1950

BELOW: An internal view of the Bush VHF61 (one of our example sets). The VHF tuner assembly is visible at the left of the chassis, next to the tuning capacitor. The mains transformer and voltage selector are on the right side. Below this on the rear of the chassis is the internal speaker switching screw and external speaker sockets. The tuning indicator is just visible on the speaker board to the left. Note that the output transformer (centre) is the RS replacement type suggested in the text.

The tetrode solves the capacitance problem allowing operation at high frequencies. If it were connected directly to 0V it would act as another control grid and greatly reduce the anode current. It is therefore often connected to the HT rail via a resistor to drop some voltage, and decoupled to 0V with a suitable capacitor.

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and is very popular with collectors

CIRCUIT 2 - BUSH VHF61 - COMPONENT LIST

Valves

V1	ECC85
V2	ECH81
V3	EF89
V4	EF89
V5	EABC80
V6	EM81
V7	EL84
V8	EZ80

Resistors

R1	150R
R2	2.2K
R3	100K
R4	6.8K
R5	10K
R6	680K
R7	150R
R8	47K
R9	22K
R10	10K 0.5W
R11	2.2K
R12	12K
R13	150R
R14	1M
R15	22K
R16	1K
R17	10K
R18	150R
R19	1M
R20	1K
R21	330K
R22	47K
R23	100R
R24	470R
R25	1K
R26	15M
R27	180K
R28	100K
R29	1K 6W
R30	470K
R31	22K
R32	4.7K
R33	120K
R34	470K
R35	1K 6W
R36	10K
R37	47K
R38	180R 0.5W
VR1	1M
VR2	1M

All resistors 0.25W unless otherwise stated.

Capacitors

C1	47pF
C2	560pF
C3	10pF
C4	560pF
C5	560pF
C6	560pF
C7	47pF
C8	22pF
C9	22pF
C10	5.6pF
C11	560pF
C12	47pF
C13	10pF
C14	0.01uF
C15	0.0075uF
C16	90pF
C17	270pF
C18	0.01uF
C19	0.02uF
C20	68pF
C21	515pF
C22	450pF
C23	110pF
C24	110pF
C25	0.01uF
C26	47pF
C27	47pF
C28	0.04uF
C29	0.04uF
C30	0.01uF
C31	0.02uF
C32	110pF
C33	110pF
C34	0.01uF
C35	47pF
C36	47pF
C37	0.04uF
C38	0.04uF
C39	110pF
C40	110pF
C41	0.01u
C42	10pF
C43	47pF
C44	0.02uF
C45	0.01uF
C46	100pF
C47	40uF 350V
C48	0.01uF
C49	270pF
C50	270pF
C51	470pF
C52	470pF
C53	5uF 50V
C54	0.005uF
C55	20uF 350V
C56	0.01uF
C57	0.01uF
C58	40uF 350V
C59	0.1uF
C60	0.03uF
C61	0.02uF
C62	0.001uF
TC1	3-15pF
TC2	3-15pF
TC3	3-40pF
TC4	3-40pF
TC5	3-40pF
TC6	3-40pF
VC1	528pF
VC2	528pF

Inductors (approximate DC resistances)

L8	13R
L9	4R
L10	1R
IFT2 pri	14R
IFT2sec	14R
IFT4 pri	14R
IFT4sec	14R
IFT6 pri	14R
IFT6sec	14R
T1 pri	380R
T2 pri	20R
T2sec	220R

VOLTAGES AND CURRENTS

		Anode V	Screen V	Cath. V	Cath. mA
V1A	ECC85	150	—	1	6.7
V1B	ECC85	127	—	—	6.3
V2A	ECH81	105	85	1.7	11.3
V3	EF89	168	85	1.3	8.7
V4	EF89	165	135	2.3	15.3
V5	EABC80	70	—	—	—
V6	EM81	170	—	—	—
V7	EL84	245	210	6.5	36
V8	EZ80	—	—	252	—

All readings except, those for V1, obtained with receiver switched to medium wave, usunf Model 7 Avometer. Limited variations may occur without imparing the performance of the receiver

PORTABLE MIXER

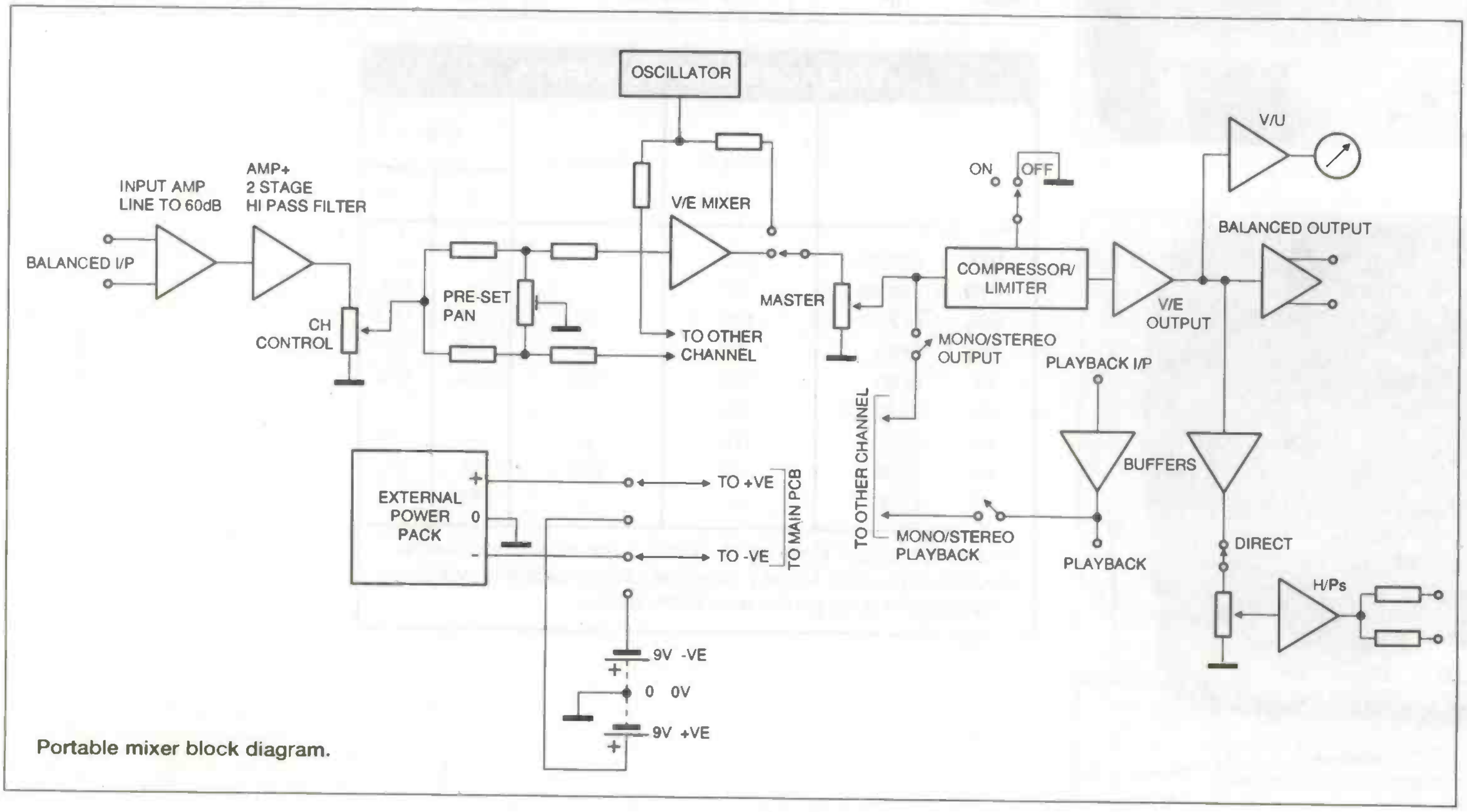
PART 2

Tony Sercombe concludes his portable audio mixer project

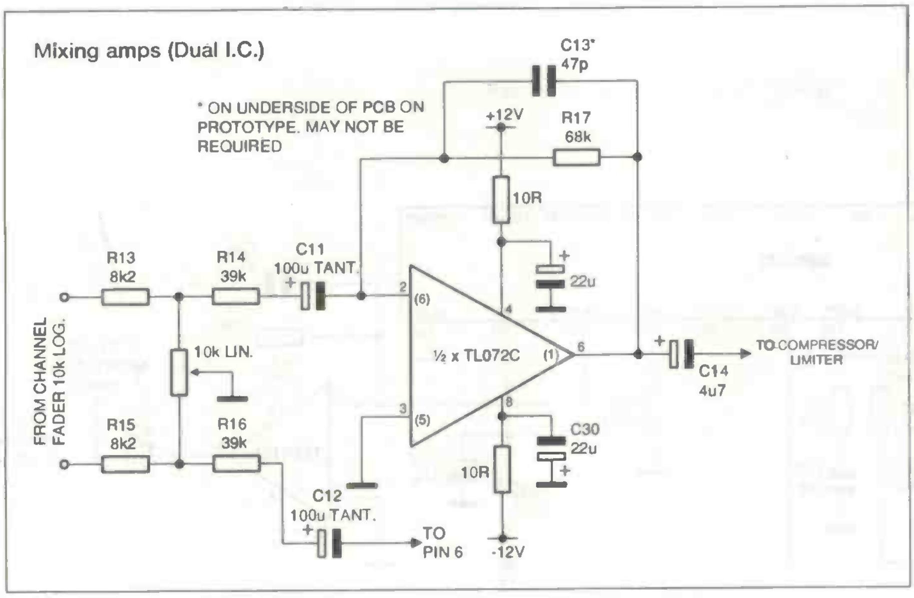
Testing and Use

When construction of the board is complete, it is a fairly easy matter to test the individual amplifiers. This Is best done before the controls are connected and the major part before fitting into the case. Although a DVM will suffice, the availability of an oscilloscope and AF generator is very useful.

First, check the printed side of the board for whiskers of solder, accidental bridges etc. Then apply voltage and check it is correct before fitting the ICs into their sockets, taking the measurements at the actual socket pins. Insert one input IC at first. Always disconnect the supply when fitting or removing ICs. Now check the signal out for gain and, if possible, look at the waveform in case of any distortion. Insert the TLE 2027 IC and repeat, feeding the signal from the input as before. The LF roll-off checks are best left until the switches are fitted; in any case listening through a microphone is a good subjective check if no 'scope is available. Do the same thing with the two virtual earth amps and the compressor IC. I normally use test links made up from 6 to 8 inches of connecting wire, terminated at each end with a crocodile clip. Use one of these to supply an earth link so that the IC has a flat response in terms of compressing or limiting. If more links are supplied for the channel level and the output master control, this test may be carried right through from input 1 to output. Check the overall response and the noise level, which will be rather 'hissy' at full gain with no input connected, but at position 1 and 2, it should be undetectable. In my case, I found an inherently noisy SSM 2017. Now go to the other channels and repeat the same thing. This time, it is simply the two channels' ICs that are being checked. Since the output amplifiers drive at 5 ohms, a



Portable mixer block diagram.



standard level. At this point the other output may be checked, and it should lie within a few millivolts of the first one, allowing for component tolerances.

The next task is to align the VU meters. Normally, the point '4' on a PPM is set at 1 Mw or 0.775 volt in 60 ohms. In this circuit, it is necessary to compromise somewhat. I chose -7 on the VU scale to represent 0.775 volt output, since there is no '8', with '0' or 100% representing absolute peak. On a PPM this would be shown as '6' on the scale. So, with the master control as before and the output at 0.775 volt, adjust both VU presets to read -7.

To set up the compressor/limiter, back off the threshold fully, and connect the circuit board links to the 'compress' connections. With the oscillator on, open the master control fully, and advance the pre-set until the meters show a large drop in level, about 2/3 of scale. The compressor should be switched to 'on', of course. The ratio, as already mentioned, is 2:1, so the compress and limit action is fairly modest, but I find it sufficient for normal outdoor use. When connected as a limiter, it simply holds back on any large peaks that may occur.

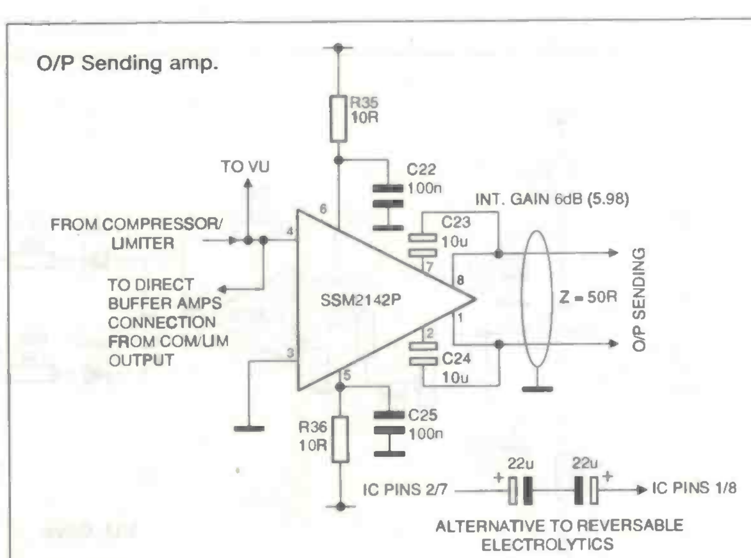
The setting up procedure is now complete. It is worth noting here that any standard output level may be adopted and, indeed, 0.775 volt will be too high in cases where domestic equipment is to be connected. The oscillator, compressor and VU meters may all be set up at any point within the control setting range, making the design very flexible. Exact readings are not required. Components, meters etc have tolerances, as does the test equipment. Stereo potentiometers are usually of 20%. Therefore, as long as readings are the same, this should be accepted, and will not be noticed in practice. Adjust the pre-set in the power supply to 9 or 12 volts output.

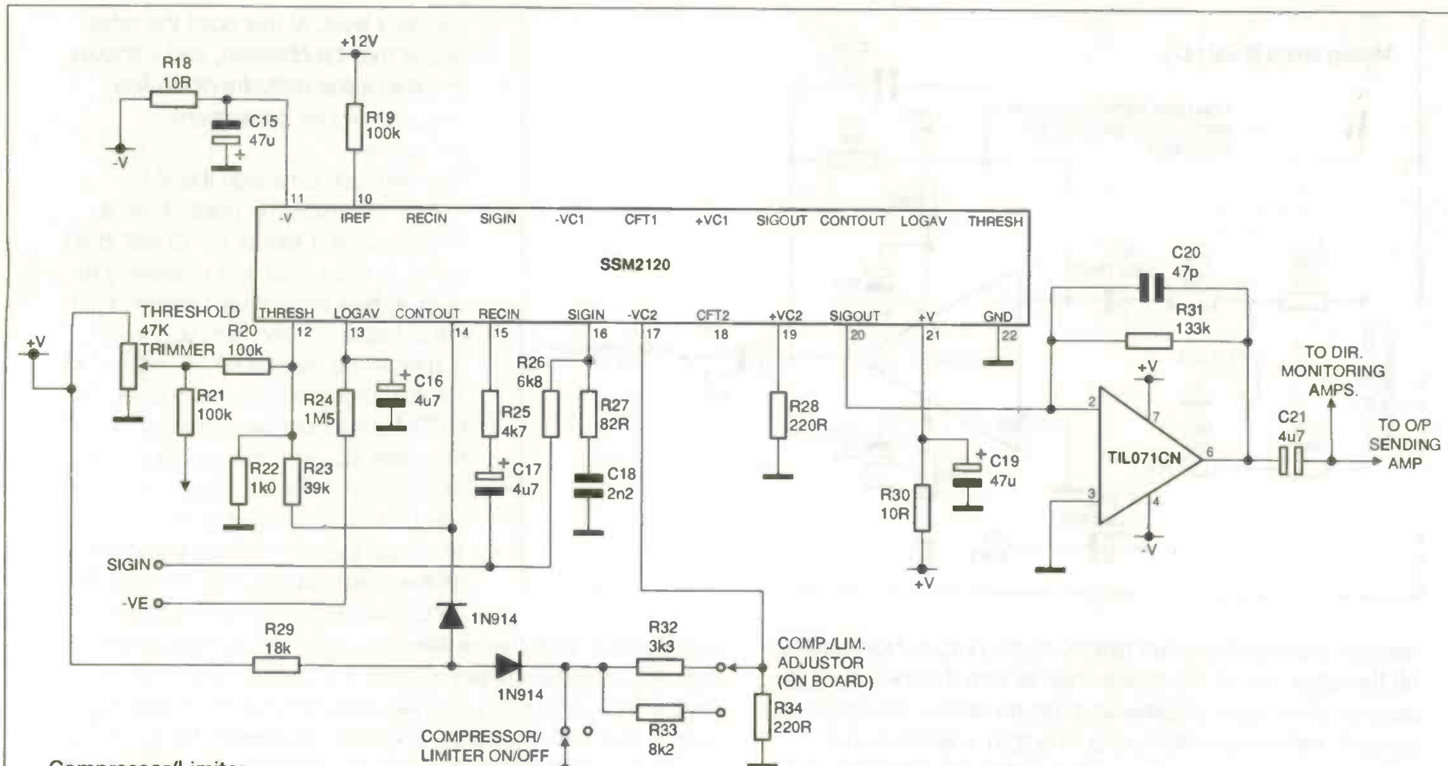
The p.s.u. is, in fact, based on a unit which appeared in Practical Electronics, January 1995. As previously stated, the mixer can be added to or reconfigured in almost any way required for a particular application.

headset can be connected directly to the output. Now connect up the other side of the stereo channel with the links, from the second virtual earth amplifier and test as before. The same can be said of all the amplifier's checking gain, response and distortion. So far as possible, make certain the oscillator works by connecting a link to ground from the oscillator ground point. If it does not at first, adjust the value of the 2K7 resistor. Hook up a couple of LEDs to the battery indicator and, if possible, reduce both sides of the supply in tandem, and note the changeover point. This should be at, or just before, 6-0-6 volts. When you are generally satisfied that everything is working correctly, the board may be fitted into the case. It is best to fit the top panel controls and VU meters first. The side plugs and sockets etc may be left until later. If veropins have been used at the off-board connection point - and I suggest this is the best method - it is an easy matter to connect up the circuit points with the appropriate controls. Ordinary, light connecting wire may be used for this purpose, except that a screened balanced cable should be used to connect the inputs. I used three-pin XLR chassis mounting sockets for the input. The pin numbers as shown are standard, and a chassis mounting male for the auxiliary headphone output, the main operator output being the standard stereo jack socket. The mixer output can be contained within a multiway chassis mounting socket, and cable mounted plug to suit (the other end of the cable having connectors to suit).

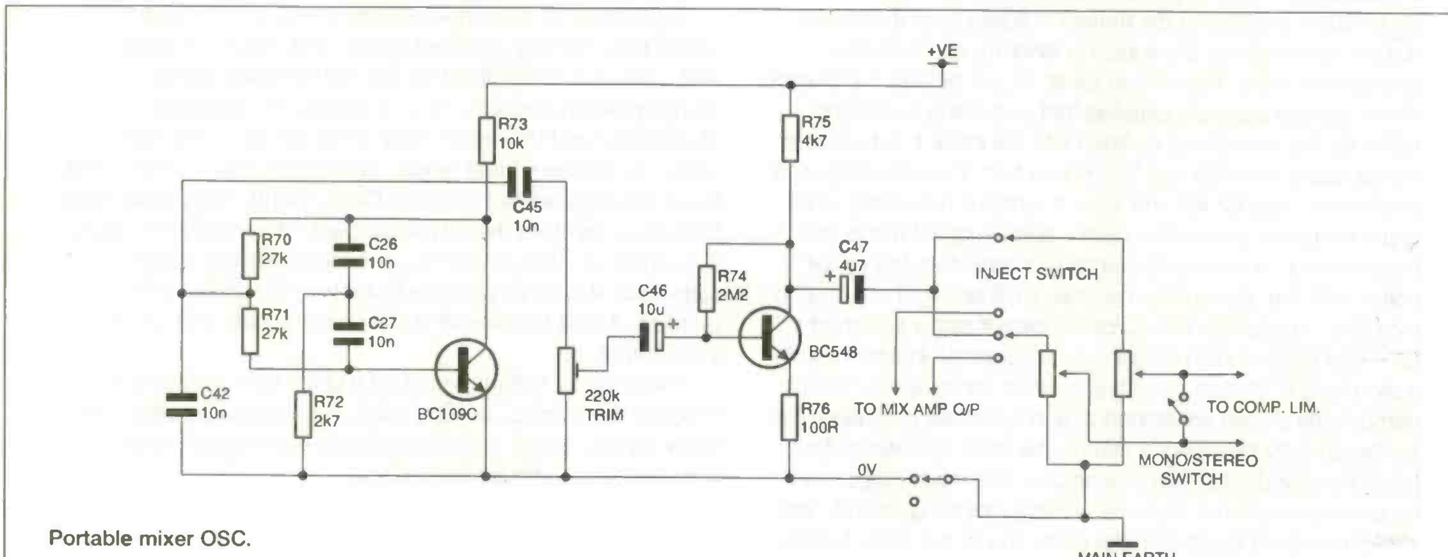
When the circuit board has been fitted into the case, and the connections to the controls made, it is time for the final setting up.

Start with the oscillator. With the master control at 2/3 rotation, and the compressor/limiter switched off, connect a DVM or AC millivoltmeter to one of the mixer outputs, with its range setting to 1 volt or more. Switch the oscillator on. If an oscilloscope is available, connect this across the oscillator output (across the master fader). First check the waveform shape - visual inspection is quite adequate. At this point, if frequency can be measured, this too can be checked. Otherwise, a fair check may be made aurally, with a headset connected across the output. But, remember to remove the headset for the next check, if it is connected across the same output. Now adjust the output level of the oscillator so that the output from the mixer is 0.775 volt. This is the

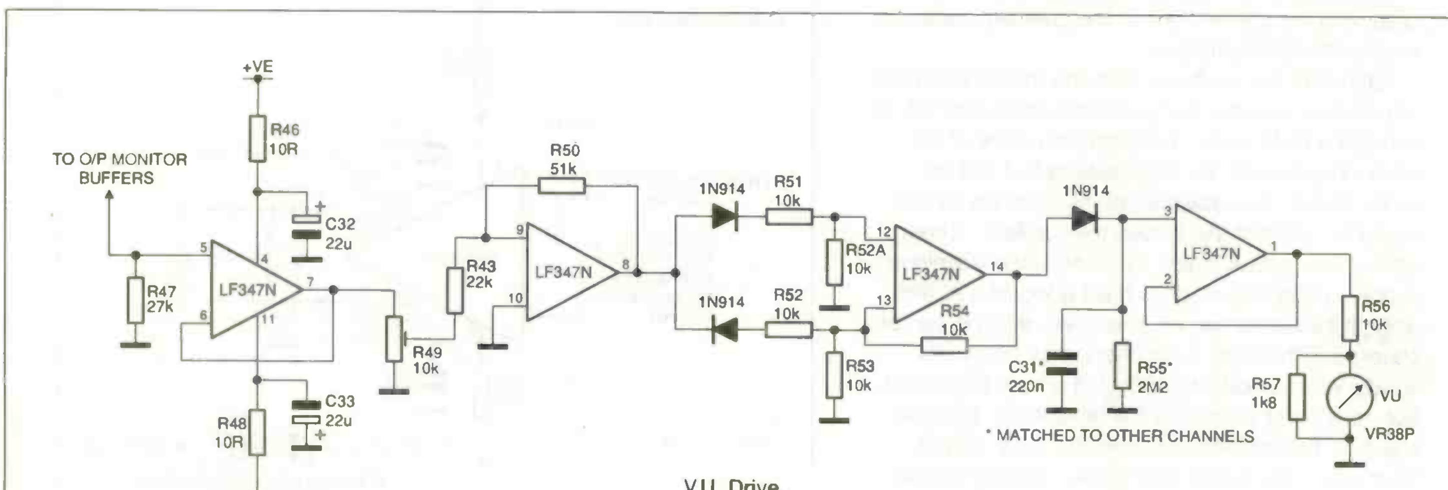




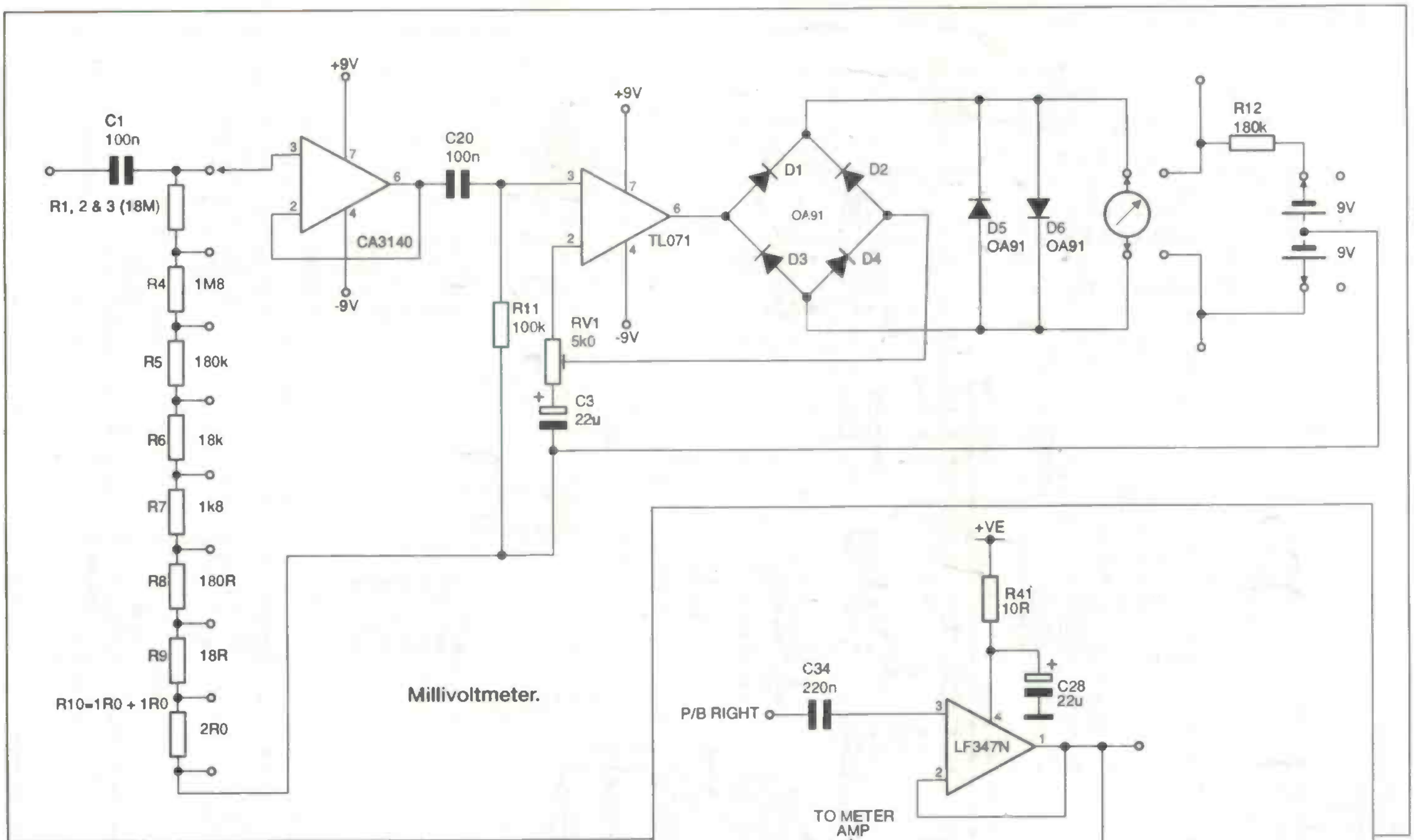
Compressor/Limiter.



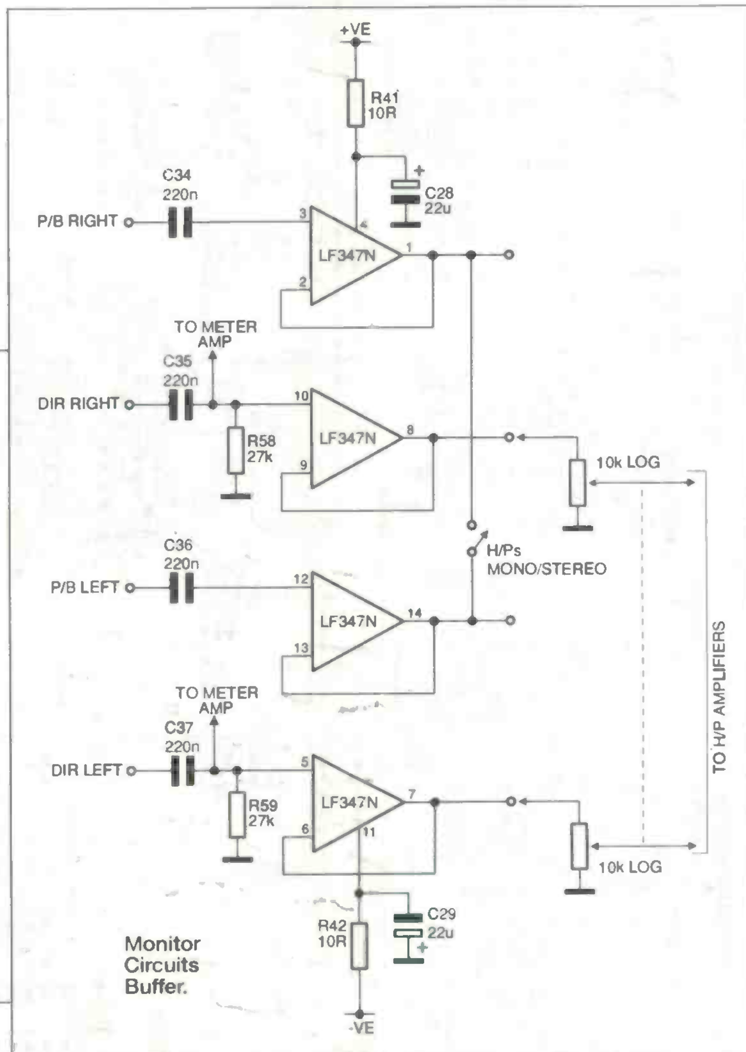
Portable mixer OSC.



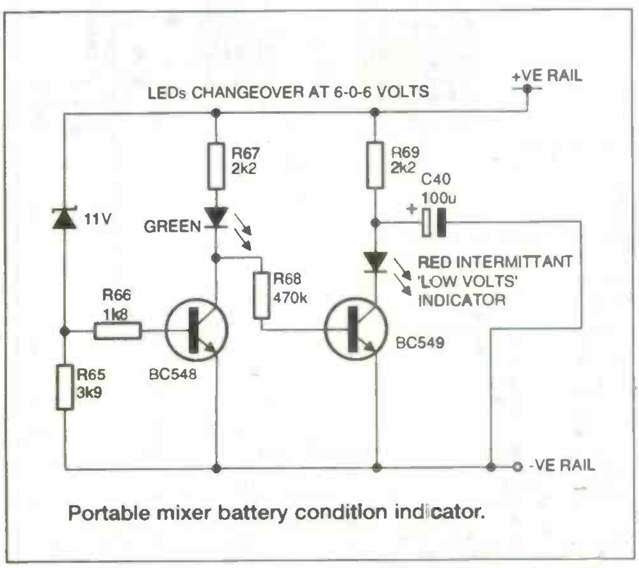
V.U. Drive.



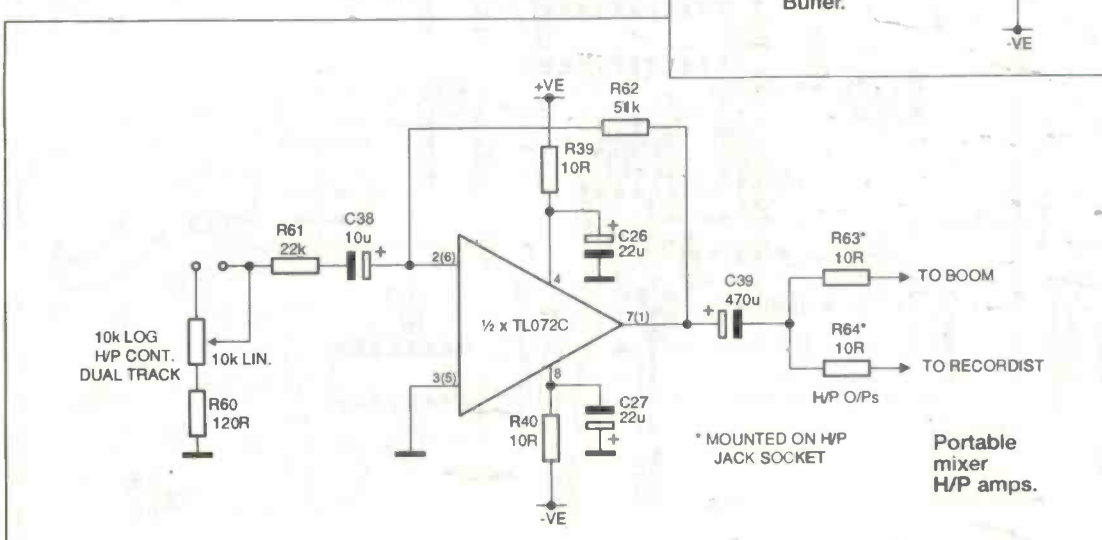
Millivoltmeter.



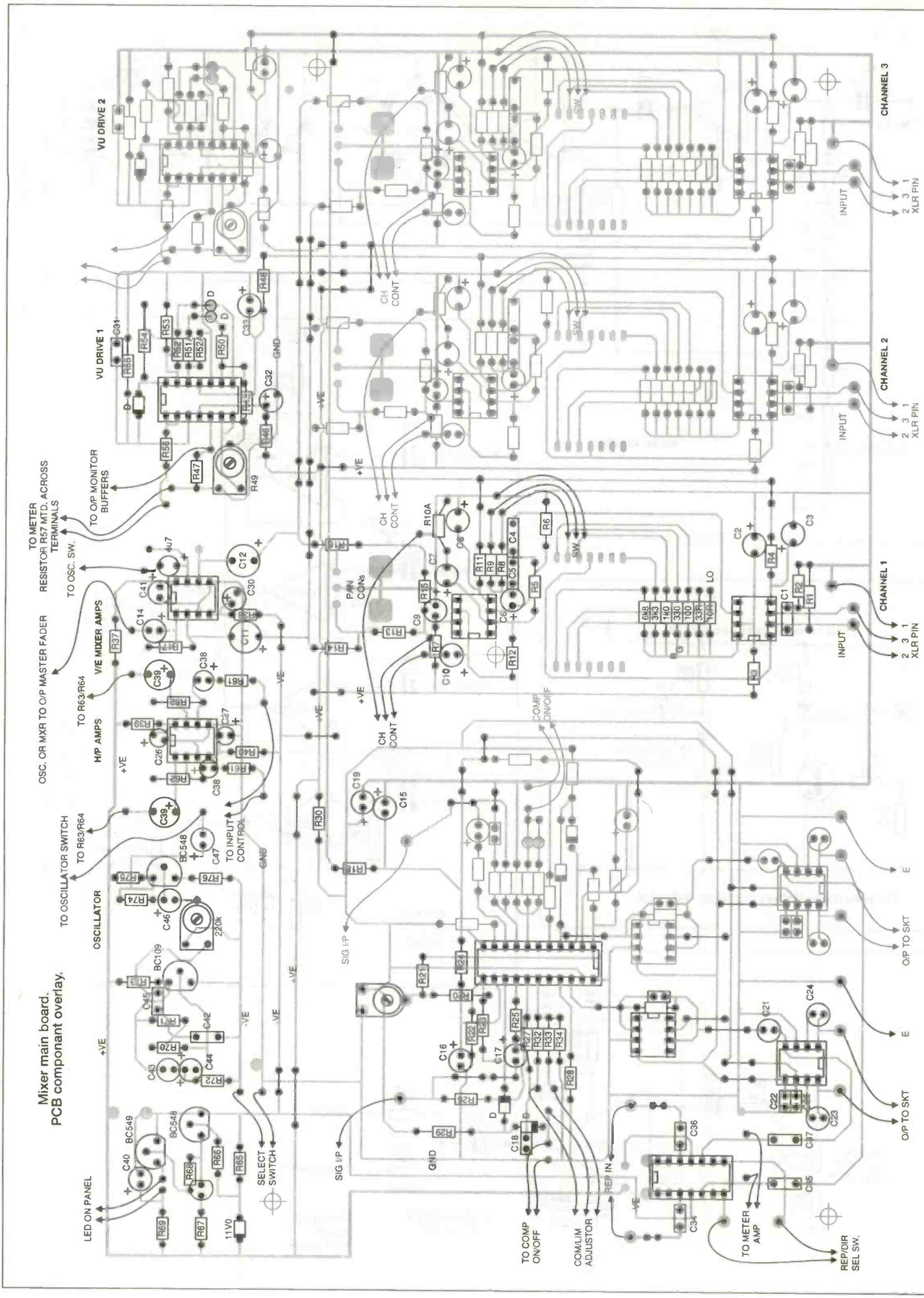
Monitor Circuits Buffer.



Portable mixer battery condition indicator.

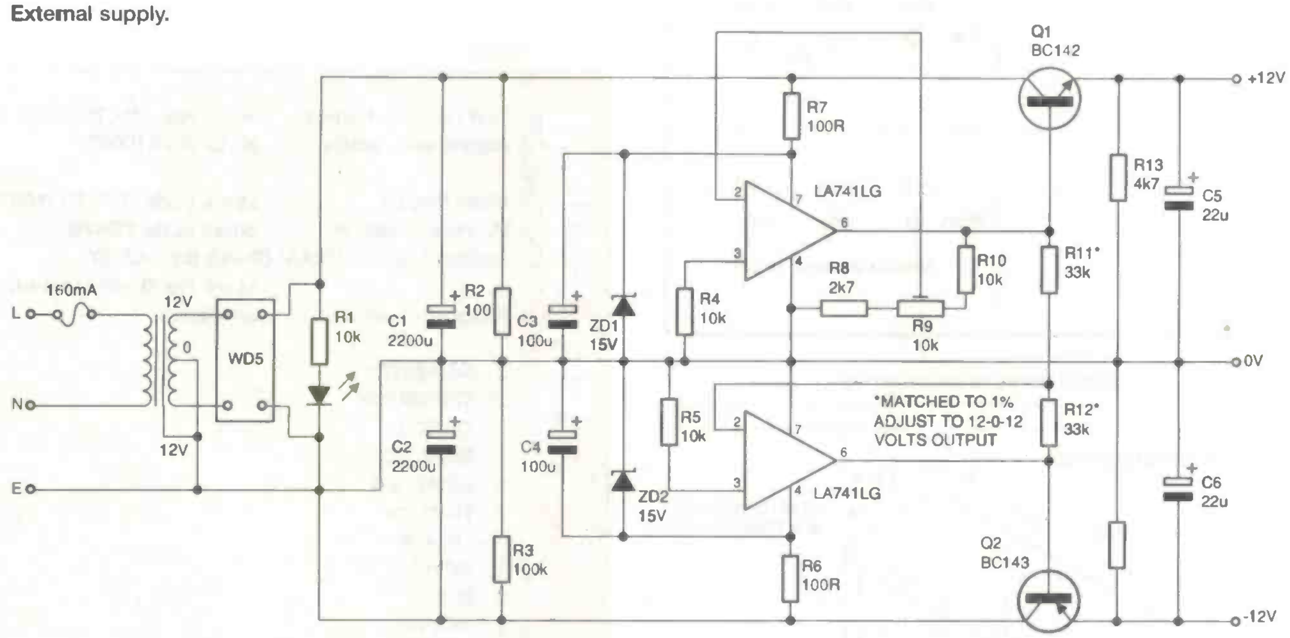


Portable mixer H/P amps.

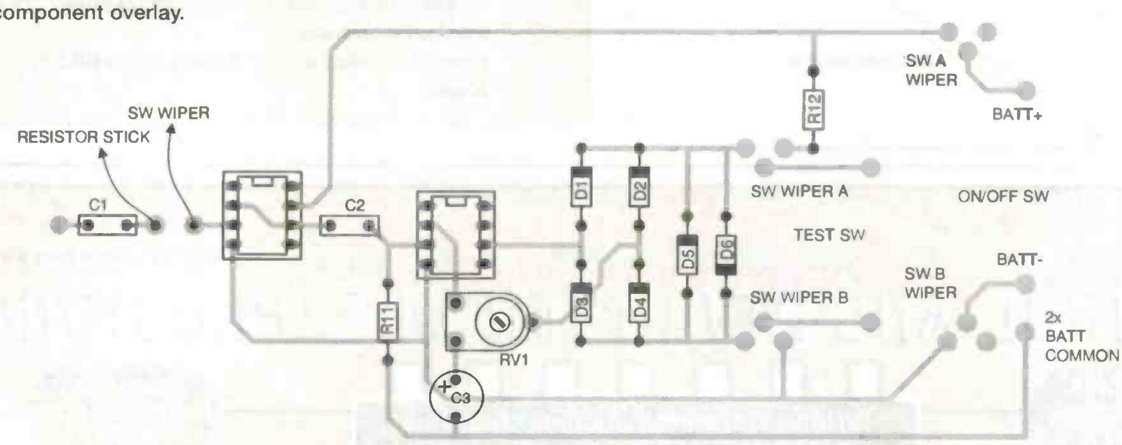


Mixer main board.
PCB componant overlay.

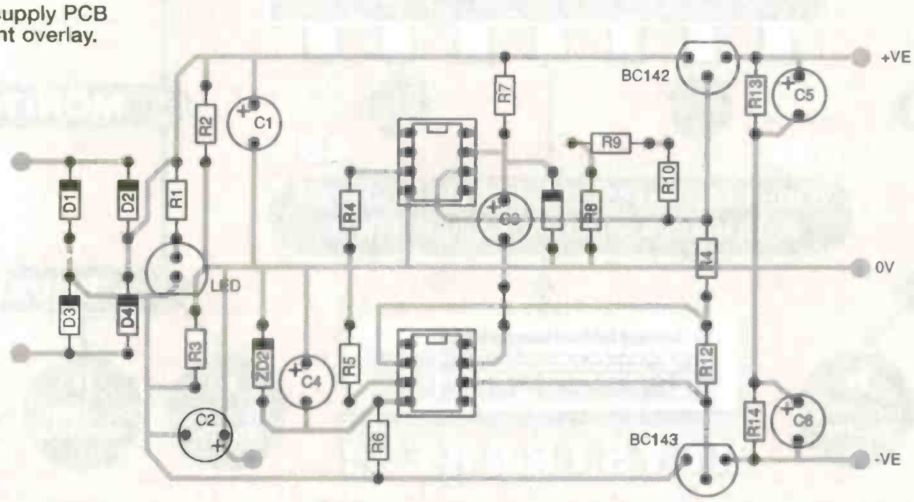
External supply.

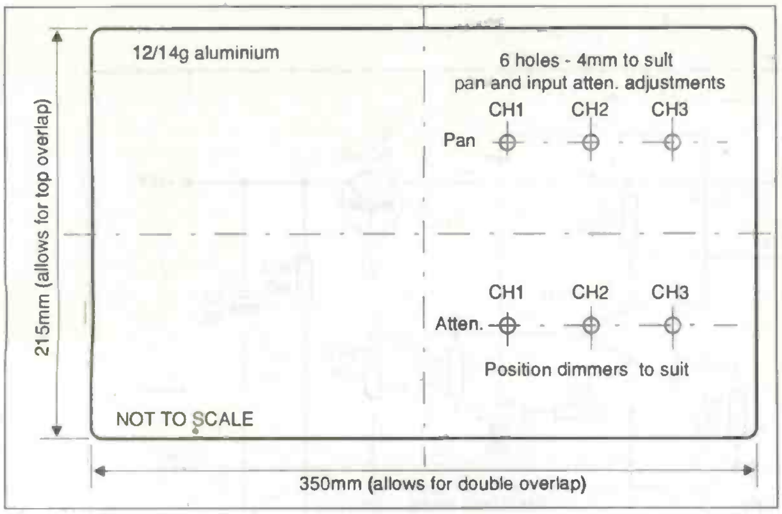


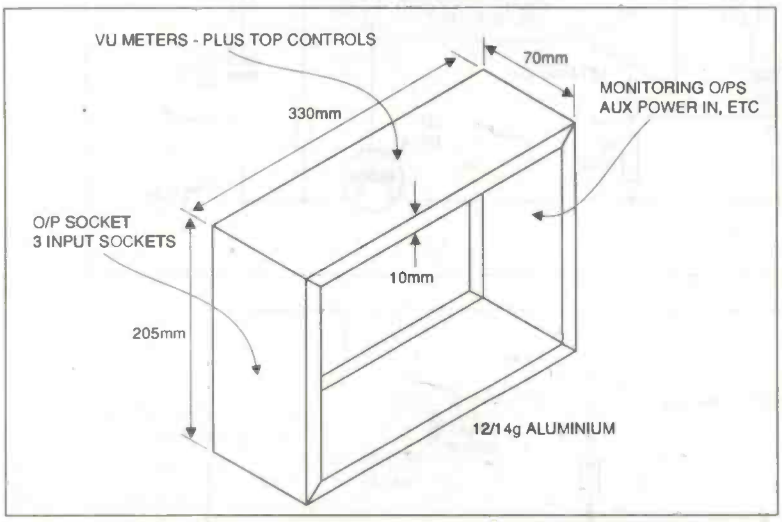
Millivoltmeter PCB component overlay.



External supply PCB component overlay.







Left: Case construction.

PARTS LIST

Pan presets, Farnell	stock No. 410072X (10k 1in)
Adjustment shafts	stock No 410082F
Citec Maplin	stock code UHO3D (10K 1in)
VU meters Maplin	stock code YO47B
Battery holders (12AA) Cir-Kit Bo BX0027	stock No. 01-00811 4 off
Integrated circuits	all Maplin

3 - SSM2017P
3 - TLE2027CP
2 - TL072C
1 - SSM2120
2 - SSM2142P
2 - TIL71CN
3 - LF347N
1 - BC109C
2 - BC548
1 - BC549

Any similar devices will be suitable for these positions.
All resistors are 'M' series. Capacitors and toggle switches from Maplin.
All other components, except where noted, from Maplin Electronics.
Input attenuator switch if used. Code DK85G - Maplin

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Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are *BRAND NEW* or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3½" supported on your PC).

3½" **Panasonic** JU363/4 720K or equivalent RFE	£24.95(B)
3½" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only	£25.95(B)
3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£18.95(B)
5¼" Teac FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5¼" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£22.95(B)
5¼" **BRAND NEW Mitsubishi** MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5¼" Flopp or HD	£29.95(B)
8" **Shugart** 800/801 8" SS refurbished & tested	£195.00(E)
8" **Shugart** 810 8" SS HH *Brand New*	£195.00(E)
8" **Shugart** 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided *NEW*	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

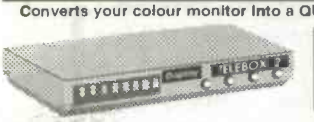
HARD DISK DRIVES

End of line purchase scoop! Brand new **NEC D2246** 8" 85 Mbyte drive with **industry standard SMD interface**. Ultra hi speed data transfer and access times, replaces Fujitsu equivalent model. Complete with full manual. Only £299.00 or 2 for £525.00 (E)

3½" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£59.95(C)
3½" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£69.00(C)
3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£99.00(C)
3½" **WESTERN DIGITAL** 850mb IDE I/F *Brand New*	£185.00(C)
5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00(E)
Hard disc controllers for MFM , IDE, SCSI, RLL etc. from	£16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER
CABLE COMPATIBLE

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD** etc. The composite video output will also plug directly into most video recorders, allowing reception of **TV channels not normally receivable** on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND** as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX STL as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

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

DC POWER SUPPLIES

Virtually every type of power supply you can imagine. Over 10,000 Power Supplies Ex Stock Call for info / list.

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

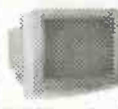
6,000,000 items EX STOCK

For *MAJOR SAVINGS* - CALL FOR SEMICONDUCTOR HOTLIST

VIDEO MONITOR SPECIALS

One of the highest specification monitors you will *ever* see - At this price - Don't miss it!!

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



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

5000 Monitors from stock !!!
HERCULES, EGA, CGA, VGA, SVGA - 6 to 26"
+ Many special items - CALL with your needs !

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

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with **both RGB and standard composite 15.625 Khz video inputs** via **SCART** socket and separate phono jacks. **Integral audio power amp and speaker for all audio visual uses.** Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security** applications with **direct connection to most colour cameras**. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £95** (E)

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

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

20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & *optional* sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc.In EXCELLENT little used condition with full 90 day guarantee.

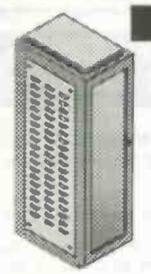
20"....£135 22"....£155 26"....£185 (F)

SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
2kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
Broadcast Electronics Inc FX30 FM exciter 80-108 MHz	£750
Stanelco STA15 15kW RF Induction heater system	£POA
IBM 8230 Type 1, Token ring base unit driver	£950
IBM 53F5501 Token Ring ICS 20 port lobe modules	£750
IBM MAU Token ring distribution panel 8228-23-5050N	£95
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE	£550
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
HP APOLLO RX700 system units	£950
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP7580A A1 8 pen HPGL high speed drum plotter	£1850
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
EG-NG Brookdeal 95035C Precision lock in amp	£650
OTC Ltd 1550 SM Stabilised IR laser calibration source	£2250
Ling Dynamics 2kW programmable vibration test system	£POA
Computar 16mm CCTV auto iris lenses 'C' mount - NEW	£125
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Roken 80-250 240v single phase flow solder machine	£1200
ICI R5030UV34 Cleanline ultrasonic cleaning system	£POA
Mann Tally MT645 High speed line printer	£2200
INTEL SBC 486/133SE Multibus 486 system. 8Mb Ram	£1200
Zeta 3220-05 A0 4 pen **HPGL** *fast* drum plotters	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 2998 Infrared spectrophotometer	£POA
VG Electronics 1035 **TELETEXT** Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
Thurlby LA 160B logic analyser	£375
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
Densei MUD 0185AH 1KVa UPS system with batts NEW	£575
System Video 1152 PAL waveform monitor	£485
Test Lab - 2 mtr square quietised acoustic test cabinets	£300
Kenwood 9601 PAL Vectorscope - NEW	£650

Please call for further details on the above items

19" RACK CABINETS



Superb quality 6 foot 40U Virtually New, Ultra Smart

Less than Half Price!

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

OPT Rack 1 Complete with removable side panels.	**£335.00 (G)**
OPT Rack 2 Rack, Less side panels	**£225.00 (G)**

32U - High Quality - All steel RakCab

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

Sold at LESS than a third of makers price !!

A superb buy at only £195.00 (G)

Over 1000 racks - 19" 22" & 24" wide
3 to 44 U high. Available from stock !!
Call with your requirements.

TOUCH SCREEN SYSTEM

The ultimate in **'Touch Screen Technology'** made by the experts - ***MicroTouch*** - but sold at a **price below cost !!** System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a **standard serial RS232** or **TTL** output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an **incredible matrix resolution of 1024 x 1024** positions over the entire screen size !! A host of available translation software enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available !) ***The applications for this amazing product are only limited by your imagination!!*** Complete system including Controller, Power Supply and Data supplied at an incredible price of only: **£145.00** (B)
Full MICROTOUCH software support pack and manuals for IBM compatible PC's £29.95 RFE - Tested

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with **2 Mbytes** of memory on board. Card is fully selectable for **Expanded** or **Extended** (286 processor and above) memory. **Full data and driver disks supplied.** RFE. Fully tested and guaranteed. Windows compatible. **£59.95**(A1)
Half length 8 bit memory upgrade cards for **PC AT XT** expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.
Order as: XT RAM UG. 256k. £34.95 *or* **512k £39.95** (A1)

SIMM SPECIALS

1 MB x 9 SIMM 9 chip 120ns Only	**£19.50** (A1)
1 MB x 9 SIMM 3 chip 80 ns **£23.50** or 70ns	**£24.95** (A1)
1 MB x 9 SIMM 9 chip 80 ns **£22.50** or 70ns	**£24.00** (A1)
4 MB 70 ns 72 pin SIMM *-with parity-* Only	**£95.00** (A1)
8 MB 70 ns 72 pin SIMM - no parity	**£159.00** (A1)
INTEL 486-DX33 CPU £55.00 INTEL 486-DX66 CPU	**£69.00** (A1)

FANS & BLOWERS

EPSON DO412 40x40x20 mm 12v DC	£7.95 10 / £65
PAPST TYPE 612 60x60x25 mm 12v DC	£8.95 10 / £75
MITSUBISHI MMF-D6D12DL 60x60x25 mm 12v DC	£4.95 10 / £42
MITSUBISHI MMF-08C12DM 80x80x25 mm 12v DC	£5.25 10 / £49
MITSUBISHI MMF-09B12DH 92x92x25 mm 12v DC	£5.95 10 / £53
PANCAKE 12-3.5 92x92x18 mm 12v DC	£7.95 10 / £69

EX-EQUIP AC fans. ALL TESTED 120 x 120 x 38 mm specify 110 or 240 v £6.95. 80 x 80 x 38 mm - specify 110 or 240 v £5.95
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW **£79.95**
Shipping on all fans (A). Blowers (B). ***50,000 Fans Ex Stock CALL***

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£1 BARGAIN PACKS - List 5

If you would like to receive the other four £1 lists and a lot of other lists, request these when you order or send SAE.

TEST PRODS FOR MULTIMETERS with 4mm sockets. Good length very flexible lead, Ref: D86.
8 OHM PM SPEAKERS, size 8" x 4", pack of two. These may be lightly rusty and that is why they are so cheap but are electrically OK, Ref:D102.
PAXOLIN PANELS, size 6" x 6", approximately 1/16' thick, pack of two, Ref: D103.
13A SOCKET, Virtually unbreakable, ideal for trailing lead, Ref: D95.
PIEZO BUZZER with electronic sounder circuit, 3V to 9V D.C. operated, Ref: D76.
DITTO but without internal electronics, pack of two, Ref:D75.
LUMINOUS ROCKER SWITCH, approximately 30mm sq, pack of two, Ref: D64.
ROTARY SWITCH, 9-pole 6-way, small size and 1/4" spindle, pack of two, Ref: D54.
FERRITE RODS, 7" with coils for Long and Medium waves, pack of two, Ref: D52.
DITTO but without the coils, pack of three, Ref D:52
SLIDE SWITCHES, SPDT, pack of 20, Ref: D50.
MAINS DP ROTARY SWITCH with 1/4" control spindle, pack of five, Ref: D49.
ELECTROLYTIC CAP, 800µF at 6.4V, pack of 20, Ref:D48.
ELECTROLYTIC CAP, 1000µF + 100µF 12V, pack of 10. Ref: D47.
MINI RELAY with 5V coil, size only 26mm x 19mm x 1mm, has two sets of changeover contacts, Ref: D42.
MAINS SUPRESSOR CAPS 0.1µf 250V A.C., pack of 10, Ref: 1050.
TELESCOPIC AERIAL, chrome plated, extendable and folds over for improved F,M, reception, Ref:1051.
MES LAMP HOLDERS, slide on to 1/4" tag, pack of 10, Ref: 1054.
PAXOLIN TUBING, 1/4" internal diameter, pack of two, 12" lengths, Ref: 1056.
ULTRA THIN DRILLS, 0.4mm, pack of 10, Ref: 1042.
20A TOGGLE SWITCHES, centre off, part spring controlled will stay on when pushed up but will spring back when pushed down, pack of two, Ref: 1043.
HALL EFFECT DVICES, mounted on small heatsink, pack of two, Ref: 1022.
12V POLARISED RELAY, two changeover contacts, Ref: 1032.
PAXOLIN PANEL, 12" x 12" 1/16" thick, Ref: 1033.
MINI POTTED TRANSFORMER, only 1.5VA 15V-0V-15V or30V, Ref: 964.
ELECTROLYTIC CAP, 32µF at 350V and 50µF section at 25V, in aluminium can for upright mounting, pack of two, Ref: 995.
PRE-SET POTS, one megohm, pack of five, Ref: 998.
WHITE PROJECT BOX with rocker switch in top left-hand side, size 78mm x 115mm x 35mm, unprinted, Ref: 1006.
6V SOLENOID, good strong pull but quite small, pack oftwo, Ref: 1012.
FIGURE-8 MAINS FLEX, also makes good speaker lead, 15m, Ref: 1014.
HIGH CURRENT RELAY, 24V A.C. or 12V D.C., three changeover contacts, Ref: 1016.
LOUDSPEAKER, 8 Ohm 5W, 3.7" round, Ref: 962.
NEON PILOT LIGHTS, oblong for front panel mounting, with internal resistor for normal mains operation, pack of four, Ref: 970.
3.5MM JACK PLUGS, pack of 10, Ref:975.
WANDER PLUGS, pack of 10, Ref: 986.
PSU, mains operated, two outputs, one 9.5V at 550mA and the other 15V at 150m A, Ref: 988.
ANOTHER PSU, mains operated, output 15V A.C. at 320mA, Ref: 989.
PHOTOCELLS, silicon chip type, pack of four, Ref: 939.
LOUDSPEAKER, 5" 4 Ohm 5W rating, Ref:946.
230V ROD ELEMENTS, 500W terminal-ended, 10" long, pack of two, Ref: 943.
LOUDSPEAKER, 7" x 5" 4 Ohm 5W, Ref: 949.
LOUDSPEAKER, 4" circular 6 Ohm 3W, pack of 2, Ref:951.
FERRITE POT CORES, 30mm x 15mm x 25mm, matching pair, Ref: 901.
PAXOLIN PANEL, 8 1/2" x 3 1/2" with electrolytics 250µF and100µF, Ref: 905.
CAR SOCKET PLUG with P.C.B. compartment, Ref: 917.
FOUR-CORE FLEX suitable for telephone extensions, 10m, Ref: 918.
VERO OFF-CUTS, approximately 30 square inches of use-ful sizes, Ref: 927.
PROJECT CASE, 95mm x 66mm x 23mm with removable lid, held by four screws, pack of two, Ref: 876.
SOLENOIDS, 12V to 24V, will push or pull, pack of two, Ref: 877.
2M MAINS LEAD, 3-core with instrument plug moulded on, Ref: 879.
TELESCOPIC AERIAL, chrome plated, extendable, pack of two, Ref: 884.
MICROPHONE, dynamic with normal body for hand hold-ing. Ref: 885.
CROCODILE CLIPS, superior quality flex, can be attached with-out soldering, five each red and black, Ref:886.
BATTERY CONNECTOR FOR TP3, superior quality, pack of four, Ref: 887.
LIGHTWEIGHT STEREO HEADPHONES, Ref: 898.
PRESETS, 470 Ohm and 220 kilohm, mounted on single panel, pack of 10, Ref:849.
THERMOSTAT for ovens with 1/4" spindle to take control knob, Ref: 857.
12V-)V-12V 10W MAINS TRANSFORMER, Ref: 811.
18V-OV-18V 10W MAINS TRANSFORMER Ref: 813.
AIR SPACED TRIMMER CAPS, 2pF to 20pF, pack of two, Ref: 818.
AMPLIFIER, 9V or 12V operated Mullard 1153, Ref: 823.
2 CIRCUIT MICROSWITCHES, licon, pack of 4, Ref: 825.
LARGE SIZE MICROSWITCHES (20mm x 6mm x 10mm) changeover contacts, pack of two, ref: 826.
MAINS VOLTAGE PUSHSWITCH with white dolly, through panel mounting by hexagonal nut, Ref: 829.
POINTER KNOB for spindle which is just under 1/4", like most thermostats, pack of four, ref: 833.

MAINTENANCE FREE BATTERIES

The **YUASA** batteries are sealed lead-acid types and they can be used in any position and are virtually maintenance free. We have two popular ones in stock at bargain prices, the 12V 15AH will cost you only £10 if you collect or £12.50 including carriage if we have to send, Order Ref: 12.5P2. This battery would also stand in as a car battery in an emergency.
The other one we have is much smaller, it is a 12V 2.3AH, regualr price £14, yours for **£5**, Order Ref: 5P258. These batteries are in tip top condition, virtually unused and fully guaranteed.
DRY BATTERIES All high wattage, heavy duty type. Four popular types in stock:-
1 1/2V HP7, sometimes known as the penlight battery, four for **60p**, Order Ref: GT10.
1 1/2V HP2, sometimes known as the big torch battery, two for **60p**, Order ref: GT11.
1 1/2V HP11, also a popular torch battery, two for **50p**, Order Ref: GT12.
9V, ever popular PP3, 2 for **£1**, Order Ref: GT13.
35mm PANORAMIC CAMERA. Has super wide lens, ideal for holiday viewing, is focus free and has an extra bright and clear view finder. Brand new and guaranteed, individually boxed, **£6.50**, Order Ref: 6.5P2.
OV-20V D.C. PANEL METER. This is a nice size, 65mm sq. It is ideal if you are making a voltage variable instrument or battery charger. price **£3**, Order Ref: 3P188.
FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a XENON tube and has an amber coloured dome. Seperate fixing base is included so unit can be put away if desirable. **Price £7.50.** Order Ref: 7.5P13.

BIG BUYER

Please note if you order 10 of an item you may deduct 10%. If you order 25, then deduct 25% but add VAT. If you need 100 or more, you can usually deduct 40% but please ring to confirm.

12V 2A TRANSFORMER , £2, Order Ref: 2P337.
12V-OV-12V TRANSFORMER, 35VA, **£2.50,** Order Ref: 2.5P13.
HIGH RESOLUTION MONITOR. 9" by Phillips, in metal frame for easy mounting. Brand new, offered at less than the price of the tube alone, £15,Order Ref: 15P1.
15W 8" OHM SPEAKER AND 3" TWEETER Amstrad, made for their high quality music centre, **£4** per pair, Order Ref: 4P57.
INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enables you to read Insulation directly in Megohms. The multimeter has four ranges: A.C./D.C. volts; 3 ranges milliamps; 3 ranges resistance and 5 amp range. Ex-British Telecom, tested and guaranteed OK, yours for only **£7.50** with leads, carrying case **£2** extra, Order Ref: 7.5P4.
We have some of the above testers not working on all ranges, should be repairable, we supply diagram **£3**, Order Ref: 3P176.
LCD 31/2 DIGIT PANEL METER. This is a multi-range volt meter/ammeter using the A-D converter chip 7106 to provide five ranges each of volts and amps. Supplied with **full** data sheet. Special snip price of **£11.50** Order Ref: 11.5P2.
MINI BLOW HEATER. 1KW, IDEAL FOR UNDER DESK OR AIRING CUPBOARD, ETC. Needs only a simple mounting frame, **£5**, Order Ref: 5P23.
MEDICINE CUPBOARD ALARM. Or it could be used to warn when any cupboard door is opened. the light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery, £3. Order Ref: 3P155.
DON'T LET IT OVERFLOW! Be it bath, sink, celar, sump or any other thing that could flood. This device will tell you when the water has risen to the pre-set level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, **£3.** Order Ref: 3P156.

£1.50 BARGAIN PACKS

NICad BATTERY 3.6V with P.C.B. mounting prongs, Order Ref: 1.5P2.
6-DIGIT COUNTER 12V, Order Ref: 1.5P3.
PAIR OF ULTRASONIC MODULES, one sender, one receiver, Order Ref: 1.5P4.
100-CORE CABLE, any length, Order Ref: 1.5P6 per metre.
KEY SWITCH, two-position, complete with two Yale type keys, Order Ref:1.5P12.
CASSETTE MOTOR, 9V brushless, Order Ref: 1.5P14.
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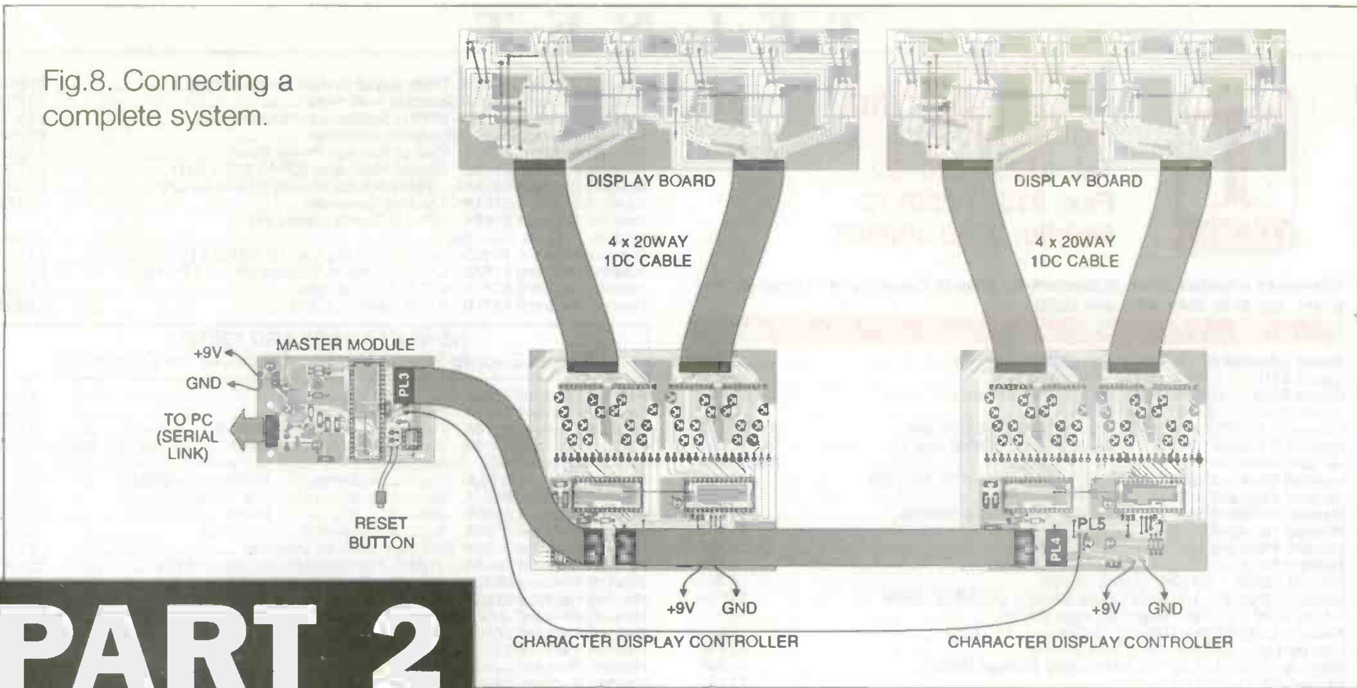


Fig.8. Connecting a complete system.

PART 2

Matrix display message driver

In last month's article we looked at the circuit diagrams and the operation of the matrix LED display message system. In this article Robin Abbott takes a look at the construction, testing and operation of the system

As we saw last month there are three PCBs in the message display system, the master controller module, the character display controller card, and the display board. An oscilloscope is not essential for testing, but is useful particularly if the system cannot be made to work.

Master control card

This card is straightforward to construct. There are two links to install first, followed in order with the IC sockets, resistors, capacitors transistors and remaining components. The position for IC3 is drilled for a 78L05, or a 7805. If a large number of display controller cards are to be driven then a 7805 should be used. However, a heat sink is probably unnecessary even in this case. Make sure none of the ICs are inserted. Connect the board to a power supply of greater than 9V, and check the voltage on the power supply pins of IC1 and IC2. Now connect to a PC using a serial cable made up as shown in figure 7 and short out pins 25 and 26 of IC1. Connect to a terminal emulator and check that characters are echoed back to the PC. If not, check out the serial circuitry.

Now power down and insert IC1 and IC2. Install the PC control software. Use a terminal emulator on the PC, (such as Winterm.exe) and set the emulator to 9600 BPS, 1 stop bit, no parity and XON/XOFF signalling. Now check that when power is applied then a 'Z' is displayed on the terminal emulator (the OK diagnostic). Download the file called "send8c.txt" which is supplied with the PC control software to the module. This may be done in Winterm.exe by using the Transfer I Send Text file menu option. This file commands the master module to enter a diagnostic mode where all received characters are looped back to the PC. Use the same technique to send any text file on the PC to the module and check that it is successfully received without error. This confirms operation of the 16C74, the serial circuitry (and XON/XOFF system) and the interrupt routines.

Now power the module down and up again and start the main control program, chardisp.exe. Use the Module I Communications menu option to set up the serial port to be used at 9600bps. The control program will check that the module is present and report on the result. The first action that must be undertaken is to download the font to the module without which no operations can take place. Use the Module I Download Font menu option, and select the font "normal.fon". The font will be downloaded, but this may take a few seconds. If all is well the program will report that the font has been verified OK.

Finally if you have an oscilloscope then check that the reset signal goes high for approximately 1 second after power up, and that the change and row drive signals look correct as shown in figure 3 of the first article. For almost all oscilloscope testing it is useful to connect channel 1 to row 1 drive, and trigger from this row. All other signals can then be referenced to row 1. The left and right communications signals should also show transmissions in some rows. However, with no connections to display controller modules with pull up resistors, the location of these signals in rows may not be defined.

Display board and IDC cables

The display board has 21 links which were necessary to achieve a single sided PCB. These should be inserted first. The PCB may be modified according to the pitch of the display block pins. However, the basic layout should remain the same as most of the devices I have seen have the same pinout. The displays should be socketed to raise them off the board, and to allow easy replacement in case of LED failure. Use SIL sockets for this. The IDC connectors are soldered in last.

The IDC cables for the display boards and for the headers used between display controller cards are chosen for their ease of construction. Some amateur constructors are put off by the high price of special IDC connector insertion systems. However, in practice, a small vice or a mole wrench may be used to gently squeeze the connector halves onto the cable For the Bib headers a 14 pin DIL socket should be soldered into a piece of scarp veroboard. The header should be plugged into this socket, and the top half of the header connector squeezed on with the vice (bearing on the top of the connector and the bottom of the veroboard).

Display controller card

Insert all the links first - there are eight of these including one long link from underneath IC1 to underneath IC2. Next insert all the resistors. It is easiest to solder in the 30 vertically mounted base resistors in groups of 10 at a time. The four SIL resistors can be soldered next. However, if you are using very high drive currents (greater than 30mA), then it is recommended to use 9 pin SIL sockets, and to start with higher value resistors, and insert the correct values when operation is confirmed. This is because if the multiplexing circuitry fails (due, for instance, to a short) then the LEDs will certainly be blown if the drive current is set to 80mA! In the prototype, discrete resistors were used instead of SIL networks. Follow up with the IC sockets and finally the other components. IC3 will almost certainly need a heatsink if it is used to power the displays.

There are two veropins in the middle of the transistors for each PIC. These are used to supply the LEDs with power. If drive currents of 30mA or less are to be used then these veropins can be connected together and soldered to any component connected to +5V near the regulator, one end of Resistors R1, 2 or 3 is suitable. If drive currents of more than 30mA are to be used then the veropins must be connected to an external power supply of 5V of sufficient drive current. DO NOT be tempted to use a higher supply voltage with greater emitter resistor values, as the transistors will be turned on permanently by the static protection diodes to Vdd on the PIC 46C57 devices. A supply based on the SGS-Thomson L4975A can provide up to 5A at 5V. Maplin sell this device and can supply data sheets with example circuits.

To test the module build the display board as detailed above and connect it to the controller card using 20 way IDC cable. Do not insert IC1 or IC2 yet. It is possible to test all the connections at this stage, although this is laborious, and alternatively there is a lamp test function provided in the message control program. Check the power supply to 1C1 and IC2, and then short the row drives on pins 1 to 7 of PL3 to Vdd (short each turn), and for each row connect the column drives on the port B and C pins of IC1 and IC2 to ground, one

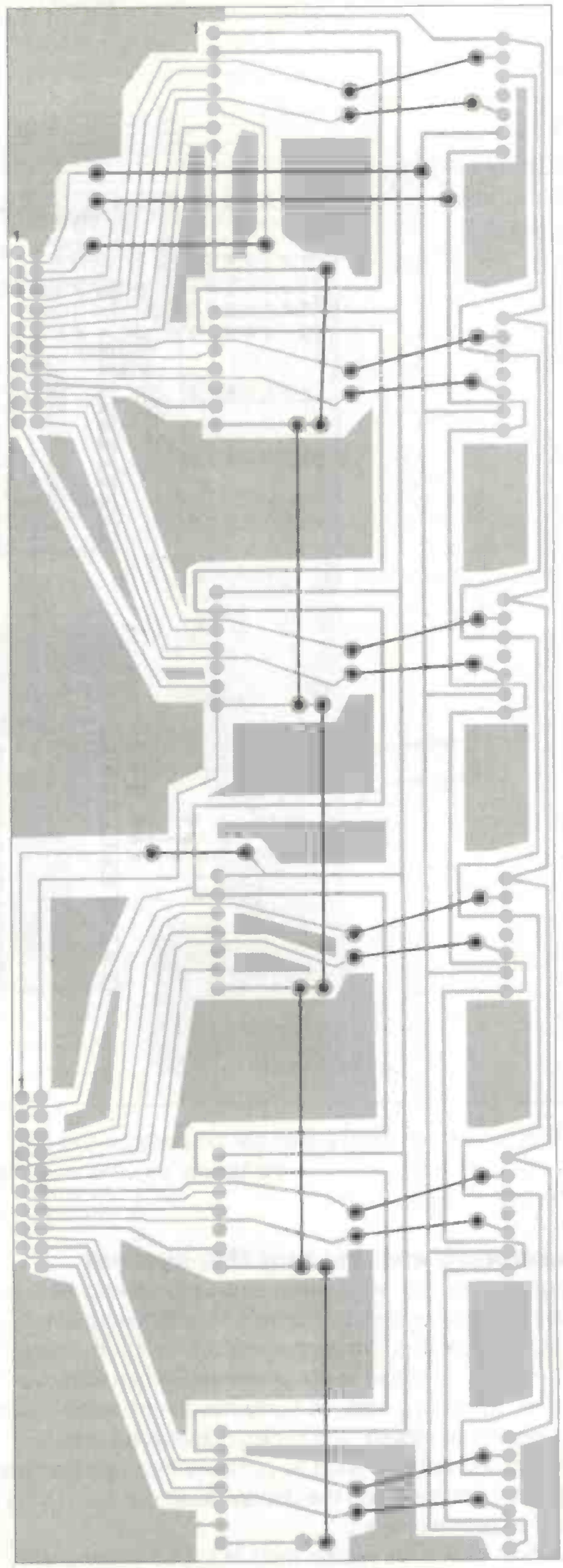
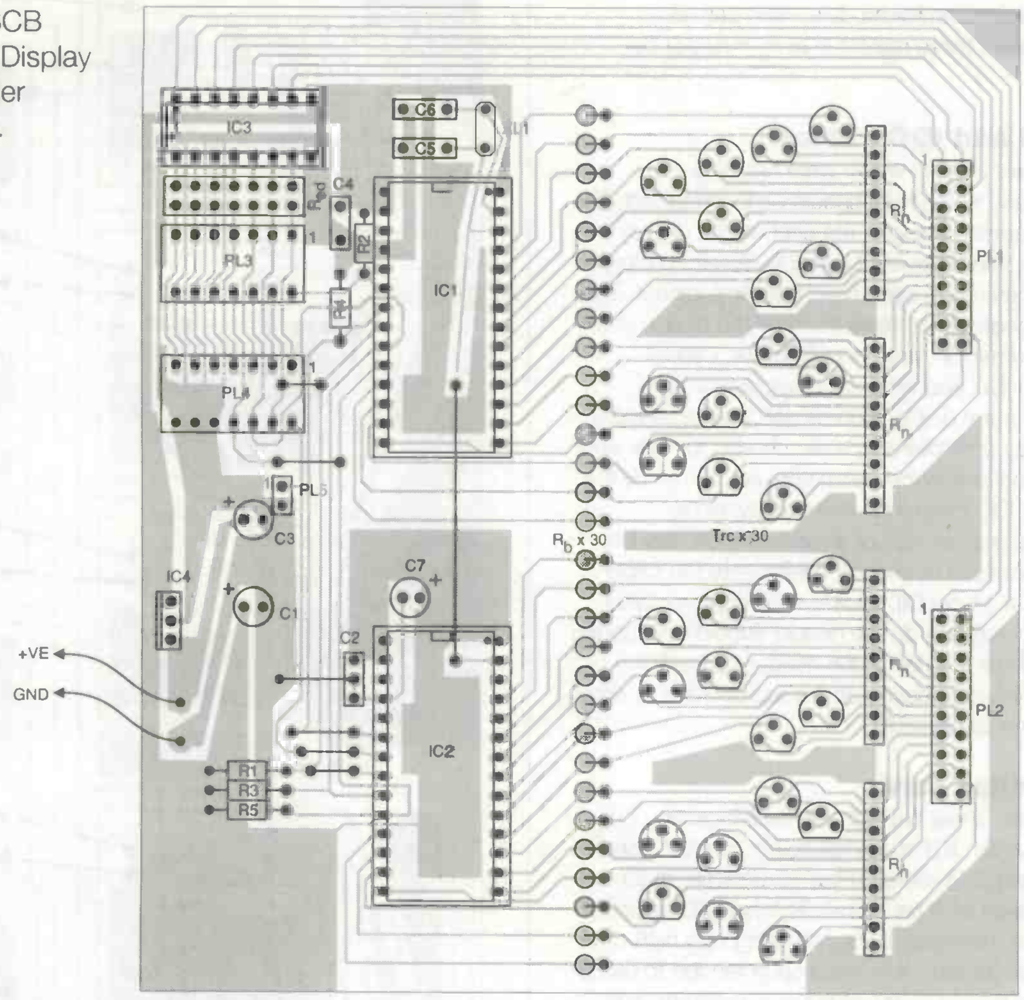


Fig.6. PCB overlay Display Board.

at a time; it is possible to check out every LED in this fashion. In case of failure check the signal path from the pin in error through the drive resistor, transistor, SIL resistor and IDC connectors. In the prototype three column drivers and one row driver had failures on initial checkout.

Power down, insert IC1 and IC2 and power up. At this stage IC1 and IC2 will be held in the reset state by the pull up resistor R5. Check that all column drive outputs are at +5V, and that the oscillator is operating on pin 26 of each PIC at 4MHz using a scope, or a frequency meter (with a voltmeter pin 26 will show about 2.5V +/- 1V if the oscillator is operating).

Fig.5. BCB overlay Display Controller Module.



There is little more testing that can be performed at this stage, the next action is to wire the boards together and check out the system as a whole.

Assembling and testing the system

Having tested out the individual boards, it is now possible to check the complete system. Figure 8 shows how to wire together the modules. Although figure 8 shows two display controllers it is advisable to check out the system with one display controller at a time, and only wire the whole lot together when they are all proven. The cables between the display controllers should be as short as possible; the cables between the display controllers and the display board can be as long as convenient (within reason).

Connect PL3 of the master module to PL3 of the display controller board, and the controller board to the display board. Wire the bottom pin of PL4 on the master module to the left hand pin of PL5 on the controller board. Connect to the PC, start the terminal emulator, and (provided that a font has been downloaded), then as characters are typed they should scroll across the display. If this is OK, then quit the emulator and start the character display controller application. The lamp test menu option will turn on all LEDs for one second to test the display and its connections. Now send the file test.txt (supplied with the controller) to the module by using the Module I Send File menu option. This will demonstrate variable speed scrolling, display dimming, flashing, inverse effects and scroll directions.

If the system does not work then there are a number of areas to investigate. Check that the reset signal, and the change signals are correct at the PIC16C57's. The fundamental communications link is the global transmission link from the master module. If the lamp test works then this link is OK, and the next link to investigate is the link to PL5 from the master module which is the left output from the master.

Once it is operating successfully the system can be mounted into a suitable case. Construction details are not given here, as the mechanical construction will depend on application, the power supply, and the number of display boards used in the system. When mounting the master module then link 1 should be connected to an external reset button.

Using the PC controller software

The PC controller software runs under Windows 3.1, 3.11, or Windows '95. It is installed by running the program INSTALL.EXE on the disk, and running the program using the icon CHARDISP.EXE. The software is very straightforward to use, and is not essential for the use of the controller. The serial link protocol is described below to enable further applications to be developed.

The application contains a simple text editor, and the controls to enable messages to be sent to the module, to loop on the module, and also enables messages to be downloaded to the module to enable it to operate autonomously. Autonomous operation allows messages to be looped, and so to regain control it is necessary to undertake a special procedure. Connect the PC, power the system down, press the reset button (shorting the link on the master module), and power up, keep the reset button pressed for at least 2 seconds after power up. Now the character display controller application can be used to disable the message using the Module | Clear Message menu option. Finally reset the module using the Module | Reset Module menu option to regain control.

Simple text files are sent to the module "as is". As a default all messages are sent at maximum brightness, with no flashing, no inverse text, and are scrolled from right to left. Line breaks are ignored. To control the messages and to provide effects a simple control system is employed. To use this, then a # character is embedded followed by a control character. Thus to clear the display then use #C, and to pause for about 1 second then use #P150. Figure 9 shows all the control codes that can be embedded together with their effects. The example file test.txt included with the software demonstrates all the control codes. The control codes work fine in messages downloaded into EEPROM store. If the message is to loop forever then place the code #A followed by a space at the end of the message file.

The following example will send the message "Display module" to the display, then cause it to flash for 2 seconds, and finally will scroll it slowly upwards off the top of the display. If it is downloaded to EEPROM then the message will loop forever.

```
#CDisplay Module
#F1 #P300 #F0 #DU #Z20
SSSSSSS
#DL #Z4 #A
```

The S characters are not displayed because the scroll direction has been set to upwards, and a scroll upwards (or downwards) clears the display. Each S character simply causes one scroll.

Serial protocol operation

For those who wish to develop their own software, details of the serial protocol and the operation of the EEPROM is given in this section. A knowledge of these protocols is not essential for construction and use of the project.

At the lowest level the module operates using the XON/XOFF protocol, and any application software must provide support for this - probably using interrupt driven software. Windows provides direct support for this protocol. To send the codes for XON (11H), XOFF (13H), and ESCAPE (1BH) then send an escape character followed by the code with bit 7 set. Thus to send XOFF, then send the bytes 1 BH followed by 93H. The master module operates the same protocol. The serial buffer sizes for the application software should be set to be of comparable size to the master module (the PC control software uses 64 bytes), this prevents large amounts of information being sent even though a transfer has been cancelled.

To send an ASCII character then simply send the code for that character to the master module. There are a number of control codes concerned with setting scroll direction, display clearing and programming the EEPROM; these are shown in figure 10. All of these codes have bit 7 of the byte set. Note that all commands return a 'Z' character to the PC when they have been successfully executed. Where a 2 byte parameter is provided then the low byte of the parameter should be sent first, followed by the high byte. Commands can be stored in EEPROM and will have the same effect as if sent from the PC. The only commands which cannot be executed from EEPROM are the EEPROM read and write commands (for obvious reasons).

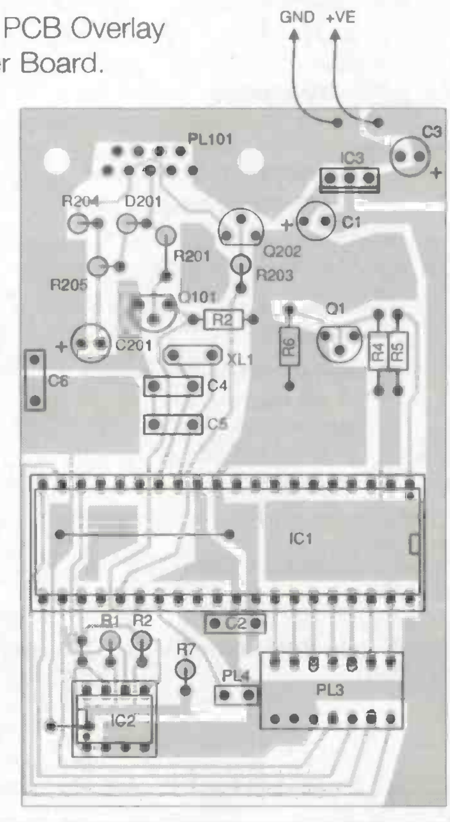
The final information which may be required by an application program is the use of the EEPROM. To write information to the EEPROM the write command is used as shown in figure 10. This is followed by a 2 byte address, and the byte to be written. Thus to write the byte 67H to address 1234H, then the bytes 89H,34H,12H and 67H should be sent to the master module, When the byte has been written (which takes about 10mS) then the master module will return the 'Z' character. To read the EEPROM (for verification purposes) then the command 8A# is sent which returns the byte at address 0, subsequent bytes can be read by giving the 8BH command.

The address map of the EEPROM is as follows:

```
00H-01H     Start address of message
02H         Magic number 1, B6H
03H         Magic number 2, 49H
04H         Width of character font
020H        Start of font
            Followed by the message
```

The font holds 128 characters for each ASCII code from OOH to 7FH. Each character occupies a number of bytes in the EEPROM. The default font is normal.fon, and this holds 5 bytes per character, so the size of the font is 5x128, or 640 bytes. To find the start of character number 33, then multiply 33 by 5, and add 20H, this gives address 197 (in decimal). Each character is formed by up to five bytes which contain the character pattern in bits 6 to bit 0 (bit O is the top row of the display). The last byte in the character has bit 7 set, and this informs the master module that it must send a space between the characters. As the characters can have less than 5 bytes in width then the font can be proportional - character 'I' takes less width on the display than 'W' for example. The font width must be written to address 04H in the EEPROM. Details on creation of fonts are included with the application software.

Fig.4. PCB Overlay Master Board.



Following the font, the message can be written. If a message is in EEPROM, then the first two bytes of EEPROM should give the message address. Then address 02H should contain the byte B6H, and address 03H should contain byte 49H. These "magic" numbers cause the master module to start reading data and commands from EEPROM when it is reset. To stop the master module doing this when it is reset then the bytes at address 02H and 03H can be set to O.

Following the message then the end of the message must be indicated to the master module. This can be achieved with command byte 94H which returns control to the serial port, or command byte 95H which causes the master module to start reading from the start of the message again.

Obtaining components and software

All of the components are fairly standard with the exception of the 16C74 which is available from Farnell on 0113-263-6311. The displays for the prototype were obtained as surplus from Greenweld, but other compatible displays are widely available. The 24LC65 is available from Maplin on 01702554161.

The PC software and a programming service is available from Forest Electronic Developments, 10 Holmhurst Avenue, Christchurch, Dorset, BH23 5PQ. (01425) 275962. Send a blank 16C74, and as many blank 16C57XT/P devices as you would like programmed together with a cheque for £20.00. They will be programmed and returned with the PC software. Alternatively the 16C74 can be supplied for £9.50, and 16C57 devices for £5.50 in addition to the programming charge. (All VAT inclusive). The PC software is only available for Windows 3.1, 3.11, or Windows '95 on 3.5" disk.

Figure 7 - serial interface wiring

Master module	PC connectortype:			
Serial Skt	*9 way Female*	*9 way Male*	*25 way Female*	*25way Male*
2	3	2	3	2
3	2	3	2	3
5	5	5	7	7

PARTS LIST

Master card

Resistors, 5% metal film

R1,2,201,203	22K
R4,5	1M
R6	220K
R7	1K
R202	10K
R204	2K7
R205	300R

Capacitors

C1	10uF, 10V
C2,6	100n
C3	47uF, 16V
C4,5	22pF
C201	100uF, 16V
XL1	4MHz crystal

Semiconductors

IC1	PIC16C74XT-P
IC2	24LC65 or compatible
IC3	78L05 or 7805
TR1,202	BC559
TR202	BC548
D201	1N4148 etc.

Other

PCB	
PL101	9way, right angle mount D connector
PL1	Veropins
PL3	14pin DIL socket
PL4,Link 1	2pin header
IC Sockets	40 pin, and 8 pin
IDC cable	14 way
IDC headers	2 off, 14 pin DIL

Character display controller card

Resistors, 5% metal film

R1,2,3,4,5	10K
Red (7 off)	4k7
Rb (30 off)	4k7
Rn (4 off)	SIL resistor network (see text)

Capacitors

C1,7	10uF, 10V
C2,4	100n
C3	47uF, 16V
C5,6	22pF
XLI	4MHz crystal

Semiconductors

IC1,2	PIC16C57XT/P-04
IC3	UL2001A (see text)
IC4	7805
Trc (30 off)	BC559

Other

PCB	
PL1,2	20 way locking IDC connector
PL3,4	14 pin DIL socket
PL5	2 pin header
IC Sockets	28 pin (2 off)
IDC cable	14 way, 20 way
IDC headers	2 off, 20 way
Veropins	

Display Card

Semiconductors

Display 1-6 Any 5x7 LED matrix block, row cathodes e.g. TFB3X58 etc.

Other

PCB	
PL1,2	20 way locking IDC connector, Right angle

Figure 9, embedded control characters in text files

Control codes	Effect
#A	Only has an effect in messages which have been downloaded to EEPROM. It should be placed at the end of the message and causes the message to loop back to the start
#Bn	Set brightness of display to n. If n is O then display is maximum brightness, if n is from 1 to 3 then display is dimmed (n=3 is the dimmest)
#C	Clear the display - turn off all LED's
#Dd	Set scroll direction. d is L,R,U or D for left, right, up, or down. Thus #DL sets the scroll direction to Left.
#Fn	Set flash mode. If n is O then flashing is turned off, if n is 1 then flashing is turned on
#In	Set inverse mode. If n is O then text is printed normally, if n is 1 then all text is printed in reverse
#M	Returns to the monitor in messages downloaded to the EEPROM. This is not required normally, but is used to
	return control to the PC whilst developing messages, and removed when they operate correctly.
#Pnnn	This causes the message to pause. nnn is a number from 1 to 30000. if nnn is 150 then the message will pause for about 1 second, so for example to pause for 10 seconds then use #P1500
#R	Return the copyright message and software date
#S	Turn on all the LED's in the system
#Znn	Set speed of display shifting to nn. If n is 2 then the shift speed is maximum. The default speed is 4, a
	reasonable speed for scrolling messages up and down off the display is 20

Figure 10 - Control codes used for the master module

Command bytes from PC	Parameters	Description
80H	None	Return module count (not currently implemented)
81H	None	Clear complete display
82H	2 byte count, Lo-Hi format	Pause for count multiplexing cycles. Each multiplexing cycle is 7.168mS, so there are 140 cycles per second
83H	None	Forces the module to return a 'Z' character to confirm that it is present
84H	None	Set scroll direction to Left
85H	None	Set scroll direction to Right
86H	None	Set scroll direction to Up
87M	None	Set scroll direction to Down
88H	None	Set all outputs to on -lamp test function
89H	2 byte address in Lo-Hi format followed by a data byte	Write the data byte to the supplied address in EEPROM. On completion return a 'Z' character (takes around 10mS)
8AH	None	Read byte at address 0 and return it, follow with a 'Z' character
8BH	None	Read the byte from the next address in EEPROM, follow it with a 'Z' character
8CH	None	Loopround test. Transmit all characters received from the serial port straight back to the port. Stop when an escape character (1BH) is received.
8DH	None	Reset the system, start the PIC16(=74 program at address 0
8EH	1 byte speed	Set shift speed to supplied number, 2 is faster, FFH is slowest
8FH	None	Set flash mode to ON
90H	None	Set flash mode to OFF
91H	1 byte brightness	Set brightness of the display to the following 1 byte number, this should be 0 for maximum brightness, and 4 for minimum brightness (higher numbers will be dimmer on a static display, but will cause unpleasant flickering effects when the display shifts)
92H	None	Set inverse mode to ON
93H	None	Set inverse mode to OFF
94H	None	Stop reading characters from EEPROM, and return to reading information from the serial port
95H	None	When read from EEPROM this causes the master module to start reading the message from its start

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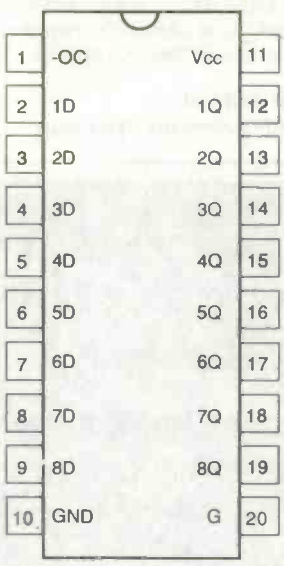
8031 & 80535 Single Board Computer

PART 2

Dr Pei Ann continues the construction of the single board computer, starting with a look at the operation of the 8155 PIO

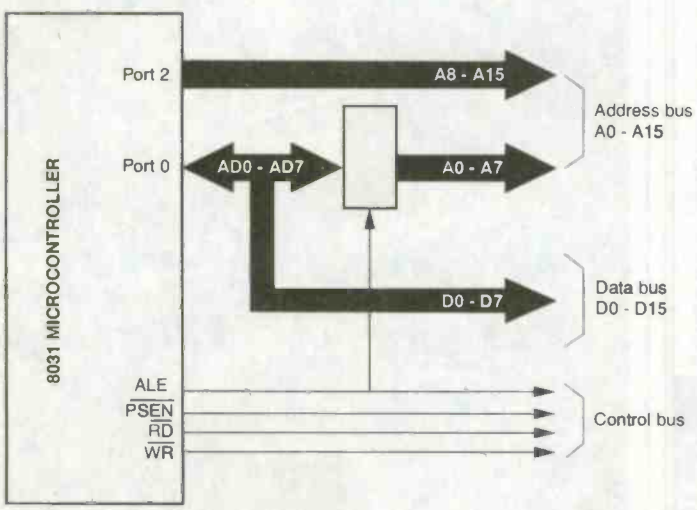


(a) Pin-out of 74LS573

INPUTS			OUTPUTS
-OC	G	D	Q
L	H	H	H
L	H	L	L
L	L	X	Q0
H	X	X	Z

X Don't care
Q0 Initial value
H,L High or low state

(b) Logic function table



There are 4 registers associated with I/O operations of the 8155 chip. They are the C/S (command/status) register, Port A register, Port B register and Port C register. It also includes a 14-bit timer. These registers are selected by address lines A0, A1 and A2. A4 to A7 are ignored. The addresses are shown in the following table. Note that only when IO/-M is held high (to enable I/O operation) can the registers be accessed.

Figure 8. 8155 internal registers

Address A2	A1	A0	Register
0	0	0	Internal command/status register (C/S)
0	0	1	Port A register
0	1	0	Port B register
0	1	1	Port C register
1	0	0	Low 8 bits of the timer
1	0	1	High 6 bits and two bits of function controls

C/S register has an address of 000B.

When writing data into the register, it becomes a control register. When reading data from it, it acts as

(a) Pin-out of 74LS138

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

G2=G2A + G2B

(b) Function table

Figure 9 Bit functions of the control register

B7	B6	B5	B4	B3	B2	B1	B0
TM2	TM1	IEB	IEA	PC2	PC1	PB	PA
Timer mode: 00= NOP 01= Stop 10= Stop after the present operation. 11= Start, after loading modes and counts		Port B interrupt	Port A interrupt	00=MODE1 01=MODE2 10=MODE3 11=MODE4		Port B 1=output 0=input	Port A 1=output 0=input

Bit functions of the status register

B7	B6	B5	B4	B3	B2	B1	B0
	TIME R	INTE B	B BF	INTR B	INTR A	A BF	INTRA A
	Counter interrupt	Port B interrupt enable	Port B buffer full/ empty	Port B interrupt request	Port A interrupt enable	Port B buffer full/ empty	Port A interrupt request

a status register. The bit functions of the control register are shown in Table 8.

The bit function of the status register is shown in Table 9. Port A and Port B can be configured as input or output ports by setting bits 0 and 1 in the C/S register. Port C has 6 bits. The port can be configured as an input or an output by bits 2 and 3 of the C/S register.

The 6 bits can be also configured as handshake lines for Ports A and B. In this case, PC0 to PC2 lines will be allocated for Port A and PC3 to PC5 for Port B. The 4 modes of the Port C is shown in the following table:

@B1:The timer is a 14-bit count-down counter. For every pulse at the timer input (TIME IN), the content in the timer/counter will be decreased by 1. After the content becomes zero, a signal is given at the timer output pin (TIME OUT). This signal may be a single square pulse or a series of pulses depending on the configured operation mode. To program the timer, write to bit 0 to bit 13 of the timer registers (total number of bits is 14. The value to be written is in the range from 0002H to 3FFFH). Bits 14 and 15 select the time-out output modes:

Figure 11. 8155 timer/counter registers (upper and lower registers)

(Upper register)

D7	D6	D5	D4	D3	D2	D1	D0
M2	M1	T13	T12	T11	T10	T9	T8

high bits of the timer counts

(Lower register)

D7	D6	D5	D4	D3	D2	D1	D0
T7	T6	T5	T4	T3	T2	T1	T0

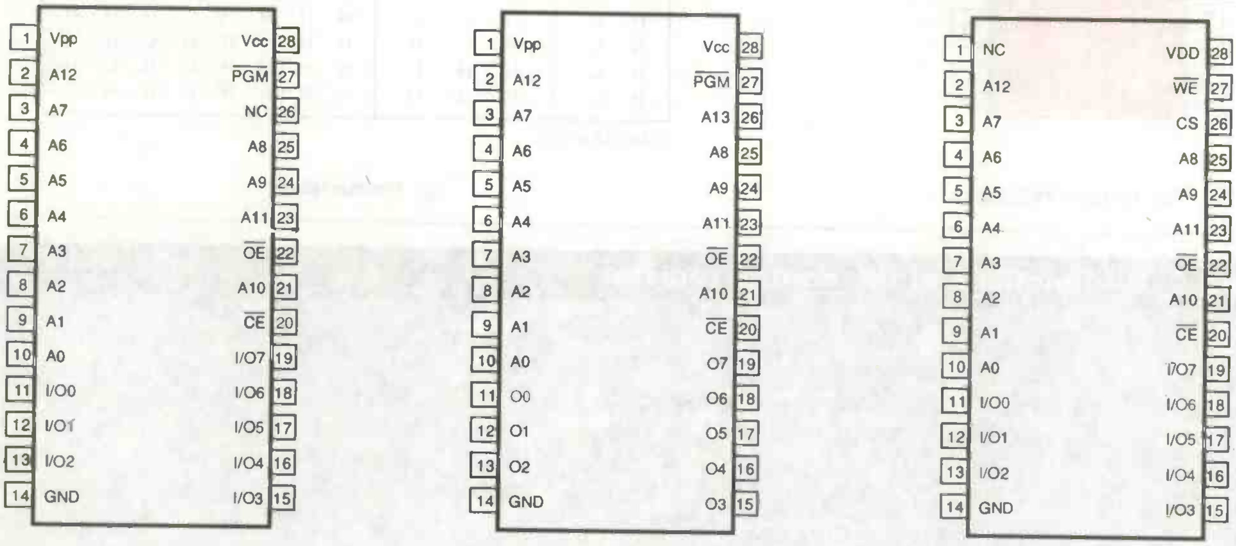
low bits of the timer counts

(Bit 14 and 15 of the counter register)

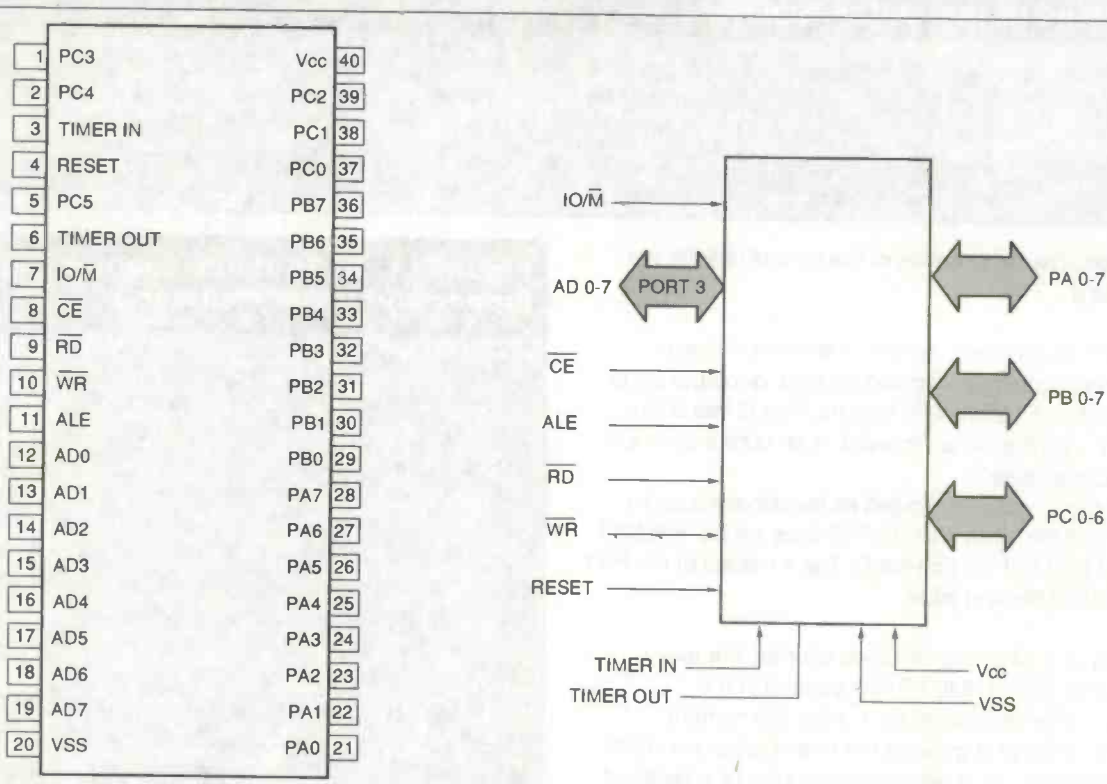
M2	M1	Time-cut signal shape
0	0	Single square (High-low-then-high)
0	1	Each time-out changes the voltage status of the output (Continuous square wave)
1	0	Single narrow low-going pulse
1	1	Continuous narrow low-going pulses

Figure 10 Modes of PC0, PC1, PC2 and PC3

Bit	Mode 1	Mode 2	Mode 3	Mode 4
PC0	Input	Output	Port A INTR	Port A INTR
PC1	Input	Output	Port A buffer full (A BF)	Port A buffer full (A BF)
PC2	Input	Output	Port A strobe (A -STB)	Port A strobe (A -STB)
PC3	Input	Output	Output	Port B INTR
PC4	Input	Output	Output	Port B buffer full (B BF)
PC5	Input	Output	Output	Port B strobe (B -STB)

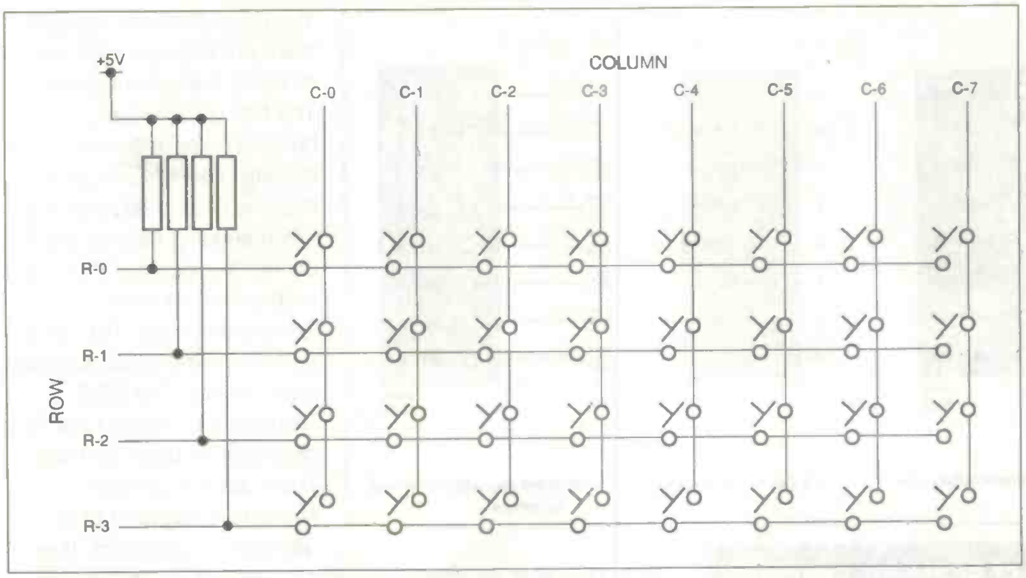


(a) 2764 8k byte EPROM (b) 27128 16k byte EPROM (c) 6264 8k byte CMOS RAM



(a) Pin-out of 8155 (b) Logic symbol of the 8155

New values can be written to the timer register even if the timer is counting. However, to use the new value, a start command must be issued to the C/S register.



that four resistors are used for pulling up the lines to +5V). If there is a key pressed and the column corresponding the key is also at low state, the row line is at low state. Knowing the column and row numbers, the position of the pressed key can be obtained (Figure 14). There are two keyboard scanning schemes. The first one utilizes polling. The microcontroller scans the keyboard when it is free of doing other things. This method makes the better use of the CPU; however, the scanning interval is not regular. The other utilizes CPU interrupt. For every fixed time interval (20 ms, for instance) an interrupt is generated which causes the microcontroller to respond to the interrupt - to scan the keyboard.

In this SBC, the 32 key functions are accomplished by a 16-key keypad plus a numerical/function selection key (selection key, in short). When the selection key is not pressed, the keypad is for inputting numerical digits. When it is pressed, the keypad is for inputting functions. This arrangement is achieved using a simple circuit as shown in Figure 3c. The two rows from the keypad are connected to the inputs of four tri-state buffers of a 74LS241 IC (see Figure 3c). Enable pins of the buffers are connected together to form a selection line. It is normally high because of the pull-up resistor. It can be pulled down to GND if the selection key is pressed. When the selection line is high, the lefthand side buffers 1 and 2 are enabled. When it is low, the buffers 3 and 4 are enabled. This allows the two rows of the keypad to be connected to PC0 and PC1, which are for numerical inputs, if the key is not pressed and the two rows are connected to PC2 and PC3, which are for function inputs, if the key is pressed. A selection of numerical digits and functions is therefore achieved.

How the 8155 is used in the present SBC

The circuit showing how the 8155 is used in the SBC is given in Figure 3b. AD0-AD7 of the 8155 is connected to Port 0 of 8031. -RD, -WR, ALE are all connected to the corresponding pins of 8031. IO/-M is connected to A9 of 8031. If A9 is low, internal memory of 8155 can be accessed. If it is high, I/O registers can be accessed. Chip enable (-CE) is connected to Y0 of the second 74LS138 (IC6) decoder. The enables of IC6, -G2A and -G2B are connected to Y3 of the first 74LS138 (IC3). This combination allocates a 256 byte address range from 6000H to 60FFH to the internal RAM of the 8155. This RAM is reserved by the monitor program of the SBC. Users should not access this memory area, if the SBC operates under the control of the monitor program. Locations from 6100H to 6105H are the addresses for C/S register, PA, PB, PC and timer registers.

The ports of the 8155 can be used as general purpose input/output ports. In the present SBC, they are specially used for driving the LED display, keyboards and a piezo-electric sounder. When it is used with the display and keyboard, Ports A and B are both configured as outputs. Port C is configured as an input port. If the display and keyboard is not used, Port C can be configured as an output port, which will be used to drive the sounder.

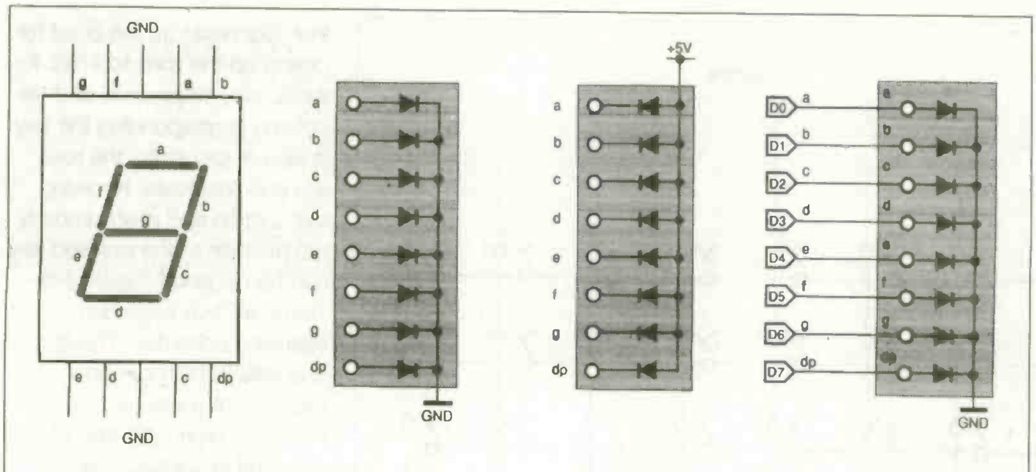
Keyboard, display and others

The keyboard is an important device in this SBC. It allows users to input the program code (machine code) directly into the SBC. There are, in total, 32 key functions on the keyboard, which are supported by the keyboard monitor software. The first 16 functions are for digits input (0 to F) and the others are for controls. From the circuit diagram, it can be seen that those 32 functions are detected by an 8x4 scanning key matrix circuit. The 8 columns (Column-1 to Column-8), which supply the scan signal, are connected to Port A of the 8155. The 4 rows (Row-1 to Row-8), which receive the signal from the keyboard are wired to the lower four bits of Port C, which is configured as an input port. The four rows are pulled to +5V by four pull-up resistors.

A schematic of the principle of a scanning matrix keyboard is shown in Figure 14. The 8 scan lines in the column are normally high. Each of the column lines is brought low for a short period of time in turns. When one of the lines is in low state, the status of the four rows are monitored by the 8031. If there is not a key pressed, these four lines will be high (note

7-segment display circuit

7-segment LED displays are used in this SBC. The pin-out, functions and types of the display is shown in Figures 15a to d. There are two types of displays. One is the common-anode type in which the anodes of the 7 LEDs are connected together (Figure 15c). In use, the common is connected to +5V of the power supply. An LED lights when its corresponding pin is brought to low state. The other type is the common-cathode type. In this case, the cathode of LEDs are connected together (Figure 15b). In use, the common is connected to GND of the power and an LED is enabled by pulling its anode to high state. Special code has to be sent to the display in order to display certain numerical digits or characters. The relation between some display symbols and their binary codes is shown in the following table:



(a) 7 segment LED display (b) Common cathode type (c) Common anode type (d) Typical connection for common cathod type

In a microcontroller system, there are two common ways of using 7-segment displays. The first one involves hardware decoder and driver circuits. The advantage is that the CPU is required only when sending data to the circuit. It is obvious that this method needs extra hardware circuits. The other method is known as software display drive. The SBC employs this method and it is described in detail as follows. There are six common cathode 7-segment LED displays. In operation, they are lit one after another in turns. At a time, there is only one display which lights. However, due to the effect of residual vision of our eyes, we see as if all displays are showing messages in the same time. The electronic circuit achieving such a display sequence is shown in Figure 3c. It can be seen that display data is output from Port B of the 8155. This data is supplied to the 7-segment LEDs via a 74LS245 (IC1) driver to boost the output current. The common cathode of the six LED displays, which are connected to Port A of the 8155 via TTL drivers of the 7806, are normally high and all the LEDs are unlit. By pulling one of the common cathode to GND, that 7-segment LED display will light, showing the display data.

Next month, the details of the construction of the SBC will be described.

Figure 12. Binary codes of digits for common-anode and common-cathode displays

Symbol	Common -anode	Common -cathode	Symbol	Common -anode	Common -cathode
0	C0H	3FH	9	90H	6FH
1	F9H	06H	A	88H	77H
2	A4H	5BH	b	83H	7CH
3	B0H	4FH	C	C6H	39H
4	99H	66H	d	A1H	5EH
5	92H	6DH	E	86H	79H
6	82H	7DH	F	84H	71H
7	F8H	07H	blank	FFH	00H
8	80H	7FH			

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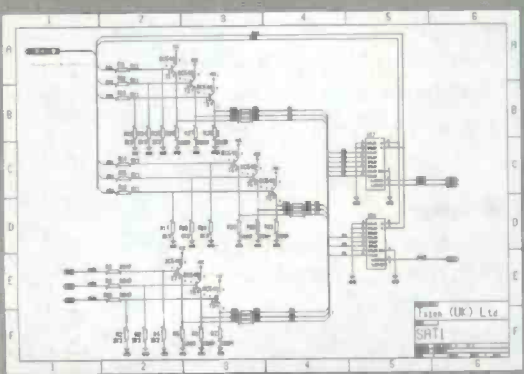

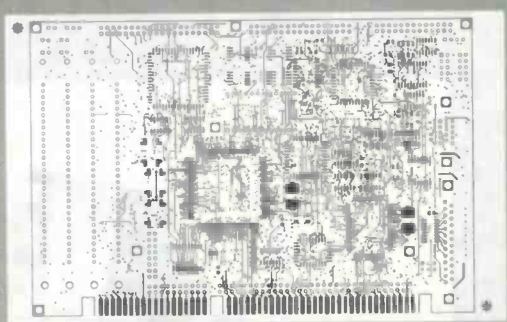

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Practically Speaking

BY TERRY BALBIRNIE

This month we shall continue looking at construction technique. This follows from my observations of GCSE examination projects over several years. It should help amateur constructors or those preparing for technology and electronics examinations.

Many circuits work even though they have been constructed badly. However, faults are more likely to develop and it sometimes happens that these only appear after a period of use. Poor construction often results in intermittent operation where the circuit might work when shaken or the circuit panel bent slightly. Another result of poor construction is that faults, once developed, are more difficult to find.

Any old iron

Poor soldering technique probably accounts for most circuits failing to work or for working intermittently. Soldering is an art which is only developed by practice and beginners should use scrap materials to make joints until they are satisfied with the result. Many examination candidates have had too little practice.

Amateur soldering irons often become so bad that even an expert would find difficulty making a good joint using them. After a short period of use, burnt flux collects on the bit and this must be regularly removed, using a damp sponge. After a long period of use, pitting tends to occur. Small pits do not matter but large ones make for difficult work. Plain copper bits may be filed to re-shape them and to remove the pitting. However, iron clad bits should be renewed. Note that soldering technique was looked at in detail in Practically Speaking December 1994 and January 1995.

When attaching wires to off-board components, it helps to make a mechanical connection before soldering - hooking wires around component tags or through any hole which might exist. The photograph shows a rotary switch with a wire hooked through the tag before soldering. This will stand up to vibration or pulling better than a joint made direct to the tag. Of course, for experimental work it is better to solder the wire without hooking it so that it is easier to remove again.

Cor, blimey

Constructors often give little thought as to the choice of connecting wire they use. It's often the case that they grab whatever happens to be lying around on the bench. If the mains supply is involved, it is essential to use the correct type of mains-rated wire and it is extremely dangerous to do otherwise. However, beginners' projects and school-type circuits will be battery-operated or powered from a commercial mains supply unit.

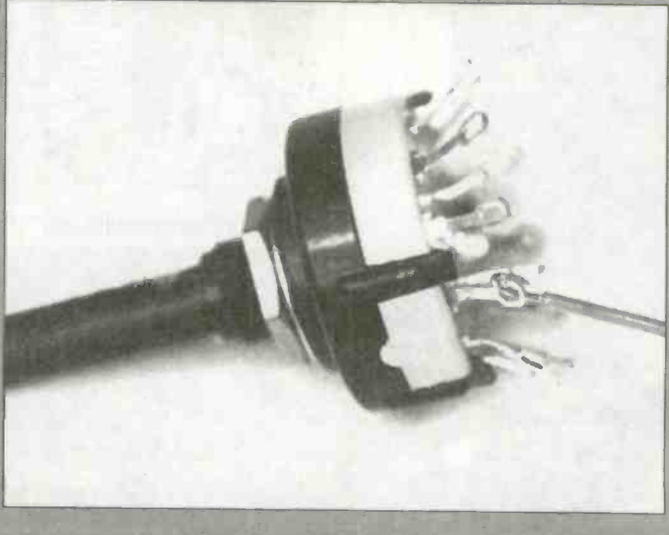
For point-to-point wiring, there are two types of wire commonly used - single (solid) core and stranded core. These are described in catalogues as "X/Y" where X is the number of strands and Y the diameter of each strand in millimetres. For example, general-purpose single core wire may be listed as "1//0.6" i.e. one core of diameter 0.6mm. A general-purpose stranded wire would be described as "7/0.2" - a core consisting of 7 conductors, each 0.2mm diameter. The total cross-section area of the copper core determines the maximum current it can carry and this point will be looked at in a later Practically Speaking column.

Under strain

Single-core wire should never be used where it will be subjected to repeated bending since it will soon break. Suppose a switch is mounted on the lid of the case so that its connecting wires bend each time the lid is removed. Single-core wire should not be used for this purpose. This type of wire should be used where its ability to stay bent in one position means that it produces a neat layout. Stranded core wire will withstand bending much better and so must be used wherever repeated movement takes place. There is an extra-flexible wire (55/0.1) which will withstand this type of treatment for a long time. It is used for meter probes and similar purposes. Candidates rarely think ahead and mount switches and potentiometers on the same section of the box as the circuit panel so that, when the lid is removed, the wiring is not put under any strain.

The end of the tale

Wires may be neatly grouped using cable ties. These are placed around the wires, one end pushed into the other and the tail pulled tightly. This locks it in position. The excess tail is then cut off. Where many wires of similar type are connected to a component such as a rotary switch, it will help if they are colour-coded. This will avoid wiring errors. "Rainbow" ribbon cable is excellent for this purpose.



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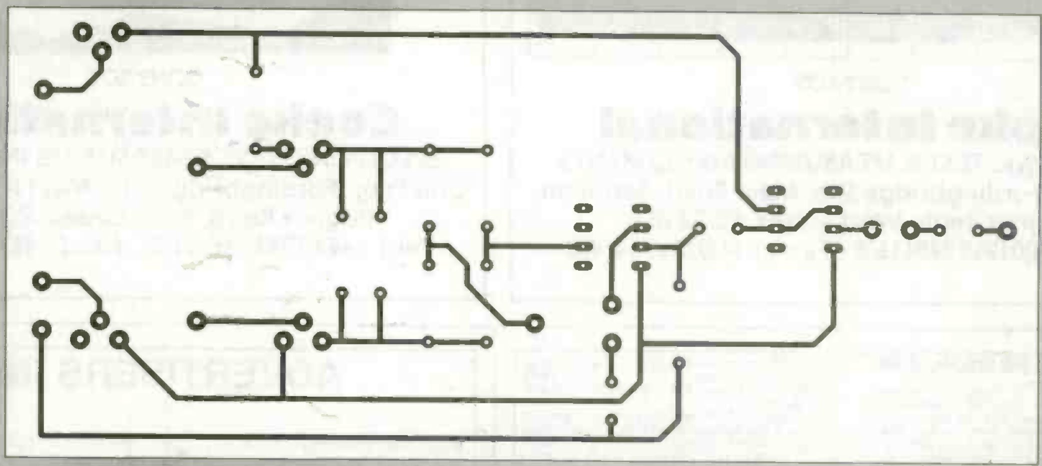

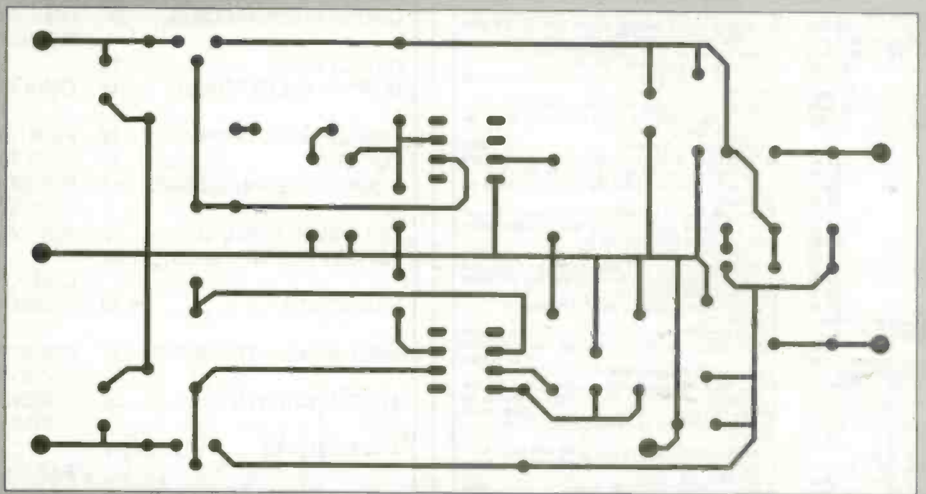

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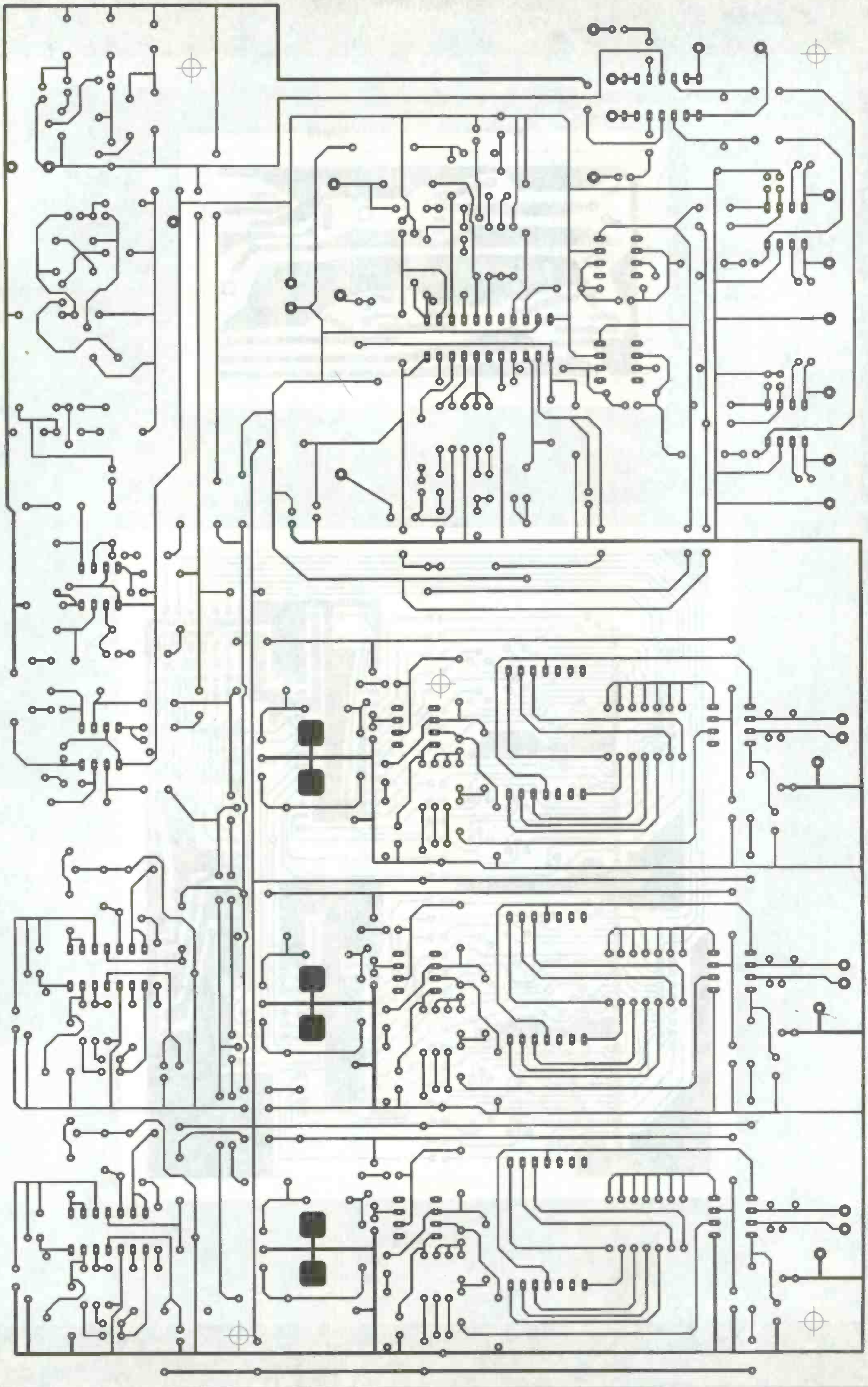

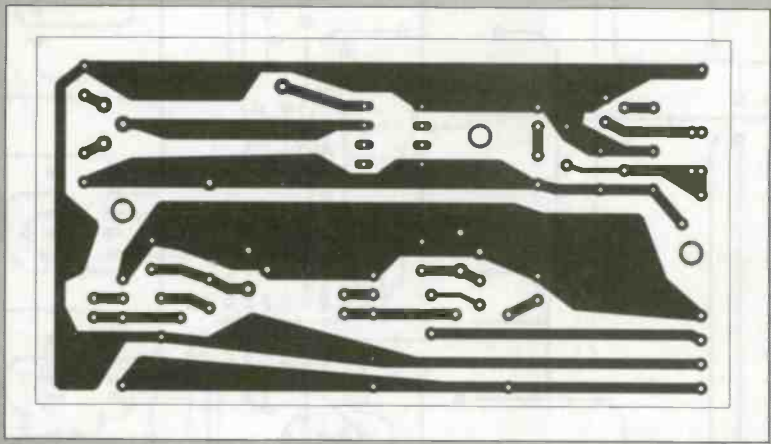

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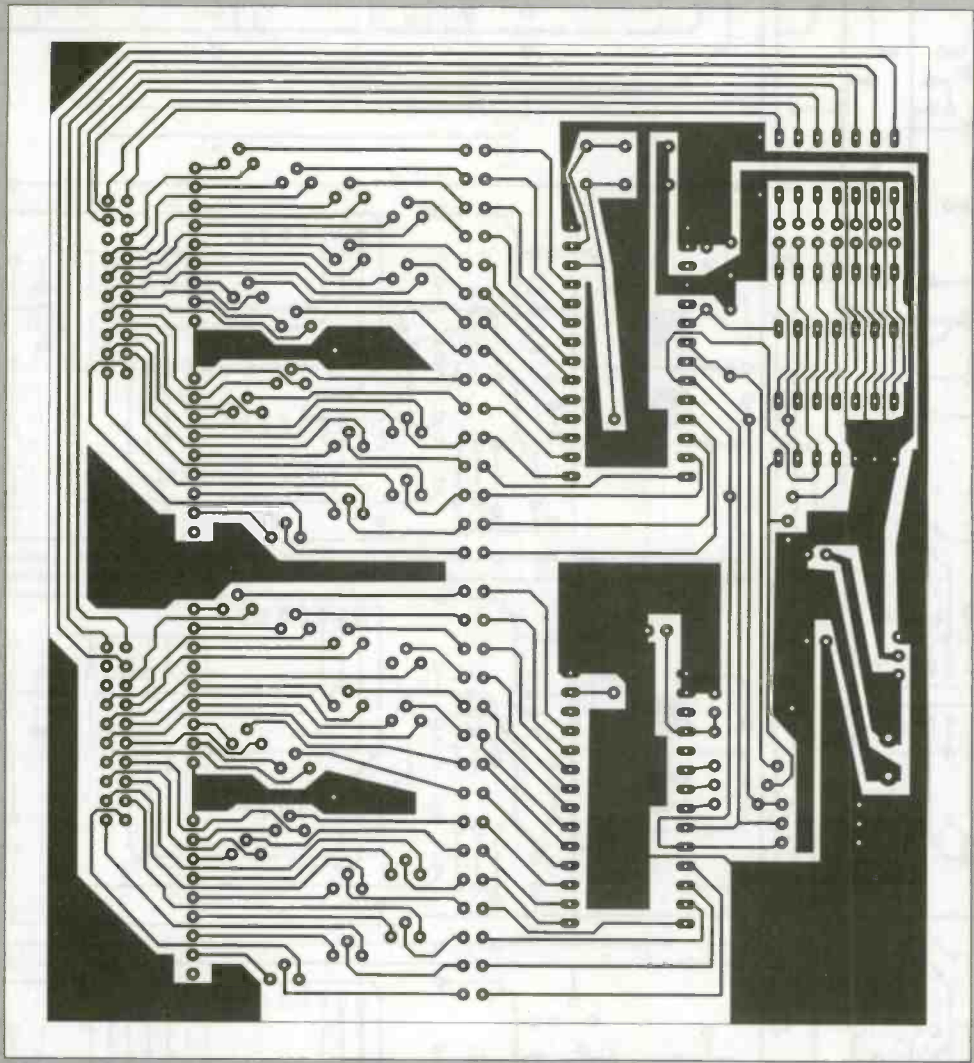

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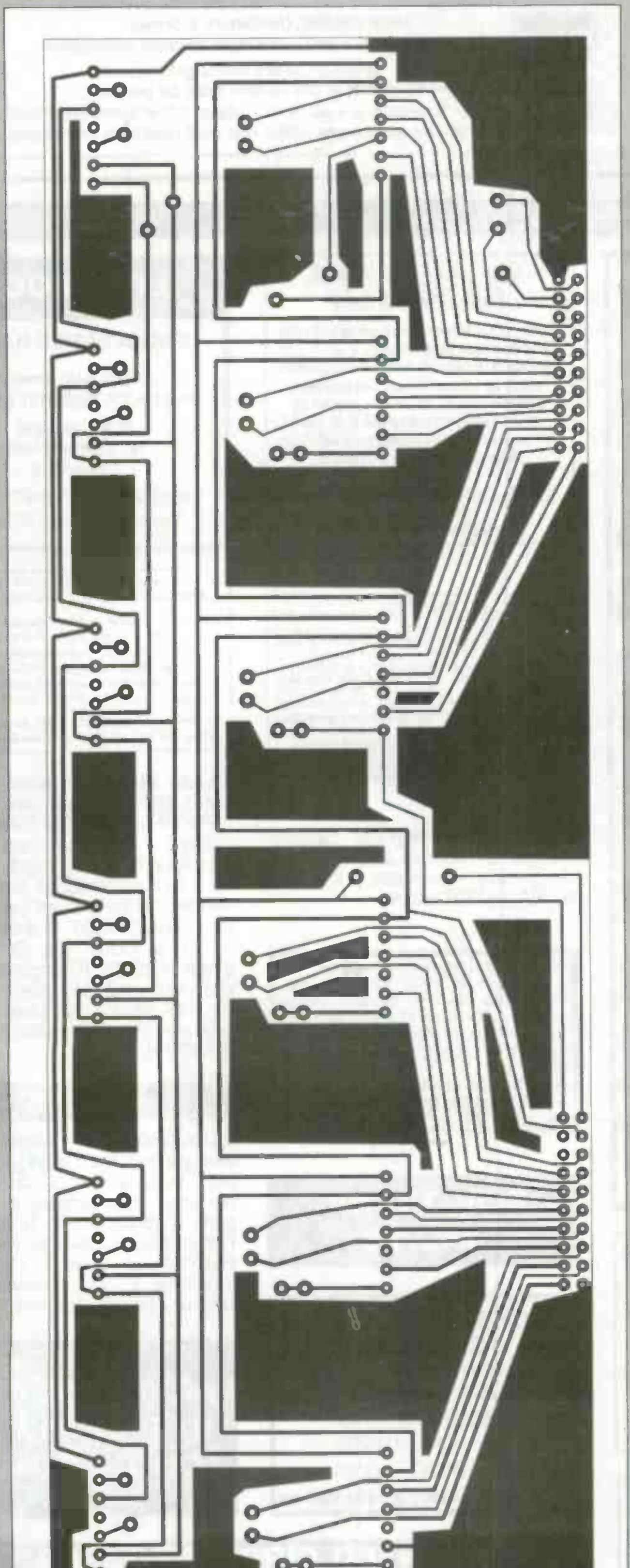

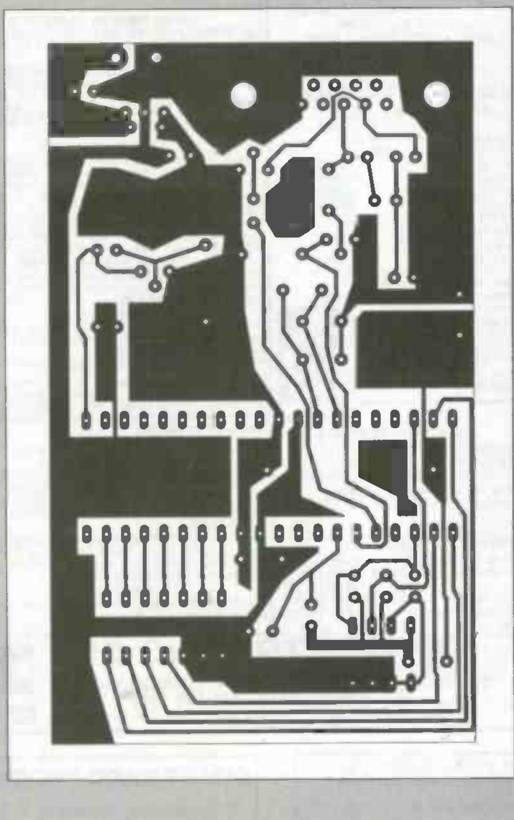

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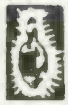

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Around the Corner

When the history of technology development in the latter half of the twentieth century comes to be written probably one of the most significant developments, and certainly one with potentially enormous impact on the future of everyone, is the development of optical fibre data communications. Very high speed data communications is a key component of virtually every technological advance that is being made today, and will probably assume even greater importance in the future. @B:Already we can start to see the results, the fax, and e-mail have started to supplant conventional letters in business communications, and are now starting to replace the letter in private communications. The Internet and World Wide Web are starting to become the primary source of information on a wide range of subjects, and are thus replacing books, magazines, libraries and newspapers. Radio broadcasts from all over the world can now be received over the Internet, and will soon be joined by TV broadcasts. The natural conclusion about these developments is that physical newspapers, and magazines, as well as radio and TV sets, all with rather restricted local coverage, are on their way out. They will be replaced by a global information network that uses optical fibre communications technology to bring the world to everyone's doorstep. The availability of high capacity data communications will not only affect the media, information, and entertainment industries; it will affect every industry, every human activity, and even the structure of society and the culture and attitudes of society. What is so revolutionary about it is that data communications have shrunk the world in a way that transportation systems could never do. Today, and in the future, every part of the world is, at most, just a few seconds away from every other part of the world. This means that if we couple high speed data communications with virtual reality and robotic technology it will be possible for any individual to be instantly 'transported' to any other part of the world. Not just in a visual/auditory way but with full tactile/sensory feedback and interactivity with the physical world at the location to which he has been 'transported'. The first steps along this path are already being taken with the development by the US military of remote surgery technology which will use 'robot surgeons' controlled directly by human surgeons to perform operations in hazardous areas, such as battlefields. The human surgeons' use of virtual reality systems means that they get all the sensory feedback and interaction that they would get if they were physically in the same room as the patient, instead of being perhaps a few thousand miles away. Robot surgical technology can also be used to allow a specialist to perform an operation in another part of the world without either patient or doctor having to travel. Technology that can be used by a doctor to remotely perform a delicate operation can also be applied to any other activity that requires physical interaction with the remote environment. It will make it possible to work in hazardous, or unpleasant environments, such as the bottom of the sea, or in space. However, the greatest impact of this type of technology will be in more mundane activities. It will, for example, make it far easier to manufacture products near to the source of demand for those products even though certain skills may not be present in the local workforce. Instead of shipping in expensive skilled labour, enter virtual manufacturing systems. This technology could open up new concepts in manufacturing where small general-purpose factories fitted with remote control robotic equipment could be used to manufacture a very wide range of products for the local market. By almost manufacturing to demand products that are tailored to local needs, a company could both increase its sales as well as decreasing transportation and stock holding costs. A move which could be bad news for shipping companies and airlines. Airlines, and the traditional tourist industry could also be hit if this sort of technology was applied to the leisure industry. Imagine being able to go to an entertainment complex which could offer you the choice of visiting the Moon or Mars, swimming with sharks off the Barrier Reef, walking to the North Pole, or through the Amazon jungle. Experiences which, thanks to that combination of communications, virtual reality and robotics, would seem completely real and totally unique, not a theme park scripted experience. An experience where you were interacting with the real world, just as if you were physically there. This type of virtual tourism is being planned right now, and is probably just a few years away from being commercially available. Without a doubt communications is the key to the future.

Next Month......

In the June 1996 issue of Electronics Today International we continue Paul Stenning's look at restoring antique electronics, whilst from Terry Balbirnie there is a project to build a simple, easy to use burglar alarm system. Bart Trepak introduces another PIC microcontroller project, whilst Dr Pei An will continue his 8051/80535 single board computer project. The main feature articles will include a look by Douglas Clarkeson at the technology and application of wind power

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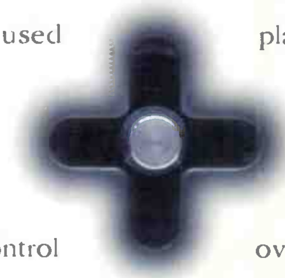

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