FEBRUARY 1990 • £1.25

PRACTICAL ELECTRONICS

SCIENCE AND TECHNOLOGY

Making Connections

COMPUTERS
Understanding their Secrets

MOCK STEREO
Splitting your Musical Affinities

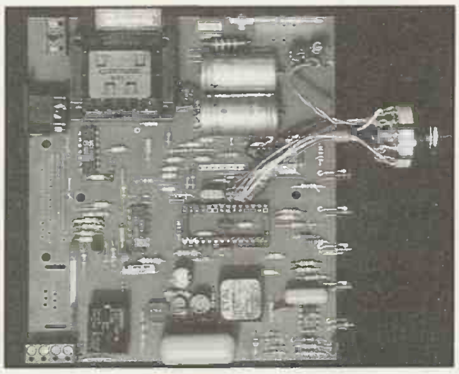
BASIC ELECTRONICS
Newcomer's Guide to the Hi–tech Universe

BUDGET EEPROM PROGRAMMER
Put Processing Power in your Pocket

Build a Modem

02
9 770032 637000

Page 21 ▲ Page12 ▼



Page 4 ▼

NEXT MONTH

We show you how to: tune in to the radio times with our Rugby-programmed automatic clock receiver, clean up your motoring with a rear wiper controller, put eprom programming under micro-processor control, and excitingly explore inductors and capacitors in our Basic Electronics adventure.

★ SO DON'T MISS OUR MARCH 1990 ISSUE

★ ON SALE FROM FRIDAY FEBRUARY 2ND

★ YOU CAN'T BEAT OUR VALUE

★ OR OUR CELEBRATED OFFERINGS!

PRACTICAL ELECTRONICS

VOL 26 NO 2 FEBRUARY 1990

CONTENTS

PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

TEXTURISED NICAM VCR

Ferguson, proudly claiming to have been the market leader in video for over a decade, appear equally proud of their new Nicam hifi vcr. Aimed at the mid-price sector of the market, the Videostar

FV37 is a slimline, three-head machine with an innovative Fastext-capable lcd handset, and retailing at around £499.

The major benefit of the FV37H, say Ferguson, is its ability to decode and record Nicam digital stereo transmissions and, in audio long play mode, to record up to eight hours of hifi stereo sound. A Peritel (Scart) connector and separate audio phono sockets ensure easy connection to virtually any other audio-visual product.

Plugging an optional teletext adapter into the rear socket allows it to receive and display teletext pages on screen, even on tv sets without text. And what a boon the provision of this teletext can be, enabling as it does the vcr to be easily programmed. Simple button selection on the remote control handset moves a cursor around the teletext programme pages. The desired programme info is then stored in the machine's memory, giving probably the simplest method yet of programming the vcr. It's also possible to record subtitles with this system, offering an extremely valuable benefit to the hard of hearing.

There's much more to the FV37 than there's space to publicise. For more details, rush down to your nearest Ferguson retailer, or contact Ferguson direct at Cambridge House, Great Cambridge Road, Enfield, Middx, EN1 1ND. Tel : 01-363 5353.

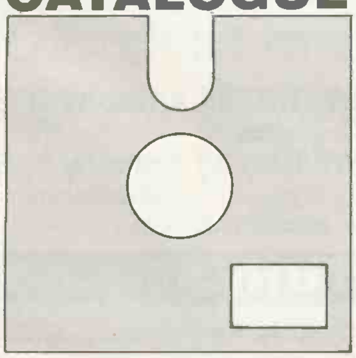
CONTROL TO RED LEADER

If you're looking for a unit that will control high intensity infrared lamps and modules, look into Lux-Therm's new model LX25 variable power controller.

The LX25 utilises a phase angle fired triac circuit, which allows control over the voltage to the lamps without any noticeable lamp flicker. Its use enables the intensity of IR lamps to be controlled from zero to maximum lamp voltage up to a total resistive load o f 25 amps.

J.F. Butler's the hot-man to handle your enquiries at Lux-Therm Products, Unit M, Portway Industrial Estate, Andover, Hants, SP10 3L U. Tel : 0264 51347.

CATALOGUE



Continuing our alphabetical browse through advertisers' literature

Rotalink are definitely a company you should contact if it's **motors that drive your robotic ambition!** Rotalink's product review and catalogue is full of detailed information on a wide range of miniature motors and associated products. Included are synchronous, dc, uni-directional, reversible and stepping motors, gear boxes, cycle timers and relays. Outline drawings and specification tables are given for each product, making your selection of the best item a very simple procedure. **Rotalink Ltd**, Cropmead, Crewkerne, Somerset, TA18 7HQ. Tel : 0460 72000.

Service Trading have been a **valuable source of unusual products** for many years. Their range, as shown in their recently received literature, includes such items as **photographic flash gun tubes, strobe kits**, rheostats, variable-voltage transformers, bilge pumps (!), UV and halogen lamps, water to heat exchangers, and eprom erasing kits, just to mention a few. **Service Trading Co.** 57 Bridgman Road, Chiswick, London W4 5BB. Tel : 01-995 1560.

Sony is a household name for **audio and vision consumer products** and the recently received catalogue details the full range available. It is well illustrated with colour photographs, and in addition to listing the product specs, other text is included that makes the booklet nearly as much like a magazine as a catalogue. The ranges include tv receivers, video recorders, hifi systems, radio receivers, speakers, turntables, headphones, cassette recorders, alarm clocks, tapes and accessories. **The full range of Walkman's is also well covered.** Did you know that the Sony Walkman has just celebrated its 10th anniversary? The catalogue is entitled *A Sense of Perception*, and has a £2 price marker on it. **Sony (UK) Ltd**, Sony House, South Street, Staines, Middx, TW18 4PF. Tel : 0784 67000.

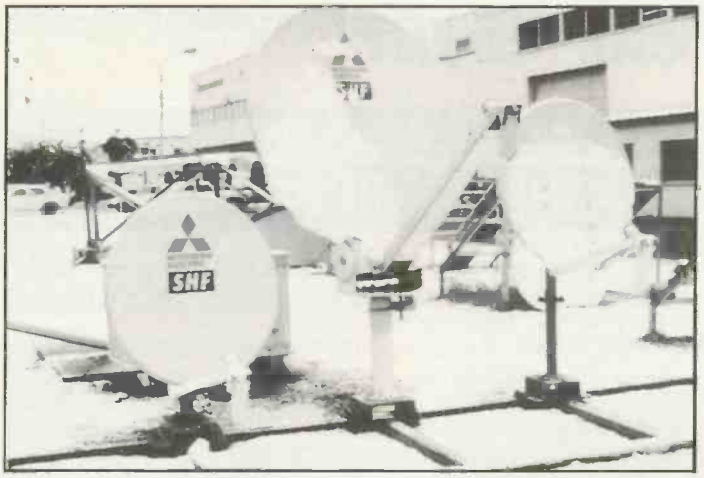
STC Instrument Services' latest catalogue includes full colour photographs of all the products detailed. There are over 300 pages covering computer systems, **test gear (from meters to oscilloscopes)**, counter timers, power supplies and **a large selection of technical books**. This is a catalogue that should be in the workshop of any serious electronics designer or constructor. **STC Instrument Services**, Dewar House, Central Road, Harlow, Essex, CM20 2TA. Tel : 0279 641641.

STC Mercator have sent their massive catalogue. This too ought to be on the shelves of anyone seriously involved in electronics. In addition to passive components such as capacitors and resistors, it **includes many products that are less widely available**. Such products include inductors, emi filters, varistors, vacuum fluorescent displays, resonators and speech systems. **STC Mercator**, South Denes, Great Yarmouth, Norfolk, NR30 3PX. Tel : 0493 844911.

Tandy's catalogue of **consumer and electronic products** is always a good read. You've probably already picked up your latest copy from your local Tandy store, but if you haven't, nip down now and get one! The contents of its 140 pages are too full to list, but **from aerials to watches through computers to videos** you'll find a wealth of products to make your mouth water! If you don't have a Tandy store in your area (unlikely!) contact their head office : **Intertan UK Ltd**, Tandy Centre, Leamore Lane, Walsall, WS2 7PS. Tel : 0922 710000.

Three-Five Semiconductor Ltd is a company formed in 1985 after the purchase of National Semiconductor's optoelectronics division. Their recent leaflet lists the **range of optoelectronic products available**, including lamps, digits, optocouplers, lcd and led displays, bargraphs, clock modules, and much more. For more information contact **III-V** direct at Suite 32, Cherry Orchard North, Kembrey Business Park, Kembrey Street, Swindon, SN2 6UH. Tel : 0793 618835. Alternatively, contact their main distributors, **Hawke Components**, tel : 01-979 7799.

NEWS



DISHING OUT COLD COMFORT

Do you dread the thought of trudging through the snow on a bleak night in order to clear the snow from the satellite tv receiver in your back garden?

Well, Mandoval Coatings may well have the cool answer to cleaning up the Sat-Soaps. They've announced the launch of Vellox, a unique hydrophobic coating specially formulated to repel water from satellite dishes. Surfaces coated with Vellox refuse water to such an extent that a visible air layer, recognised as a silver sheen, can be seen between the water and the treated surface. Water in contact with these surfaces forms tiny droplets which literally roll across the surface in an almost frictionless manner.

Originally developed for the US Air Force, Vellox has been keeping communications equipment free of ice, snow and water for over five years. It is a two component product comprising a range of primers and topcoats which can be adjusted to take account of almost any surface. A kit is available which contains everything necessary to prepare and coat a satellite dish up to 90cm in diameter. Other uses for Vellox include applications as diverse as the protection of radar equipment, pcbs, and even cardboard packaging!

It seems that whenever ice, snow, water sheeting or high humidity present a problem, Vellox can provide an answer. I wonder if it would protect an Editor caught out on his bike in a storm?

Graham Ellicott might know if I find the time to ask him - he's the man you should contact for more information about Mandoval Coatings Ltd, at Lawn Road, Carlton-in-Lindrick, Nr Worksop, Notts. S81 9LB. Tel : 0909 730059.

PLUMBING PE'S DEPTHS

"Dear John", writes Mike Everett, "I have enclosed details of a Proton Magnetometer we have developed. You may not remember, but I spoke to you some 18 months ago on the subject, and you sent a copy of PE's original article of Oct 70 which provided the inspiration to develop it.

"It is now perhaps the highest specified unit for under £10k anywhere worldwide. I thought you might be interested, if only from the inspirational point of view."

Yes, Mike, I do remember. The PE issue is the one with Founding Editor Fred Bennett on the cover, testing out the original on the Thames waterfront! I am always delighted to know of products and careers that have been inspired by PE.

Mike Everett also sent complete specifications of the Wreckmaster Proton Magnetometer. Very healthy and interesting reading they make. Applications for the detector include scuba diving, fishing, salvage, surveying, archeology and engineering. It allows rapid, positive location of existing and new wrecks from distances of up to 300 metres. The unit measures 340 x 300 x 140mm, is microprocessor controlled, and has an lcd readout. As you can hopefully see from the photo, it has a selection of several water repellant control pads, and is reputedly inflatable-boat proof. (That indeed is a harsh environment to design for!)

The Wreckmaster sells at £1695 plus post, and is available from Capricorn Marine Technology, 19 Pickeridge Close, Taunton, Somerset, TA2 7HN. Tel : 0823 278093.

EVENTS DIARY

If you are organising any event to do with electronics, big or small, drop us a line, we shall be glad to include it here.

Please note : Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Mar 7-8. Laboratory 90. G-Mex Centre, Manchester. 0799 26699.

Mar 9-10. London Amateur Radio Show. Picketts Lock Centre, Edmonton, North London. Advance ticket sales and trade enquiries to The Secretary. LARS, 126 Mount Pleasant Lane, Bricket Wood, Herts AL2 3XD. 0923 678770.

Mar 28-29. Laboratory, Science & Technology Show. Kelsey Kerridge Sports Hall, Cambridge. 0799 26699.

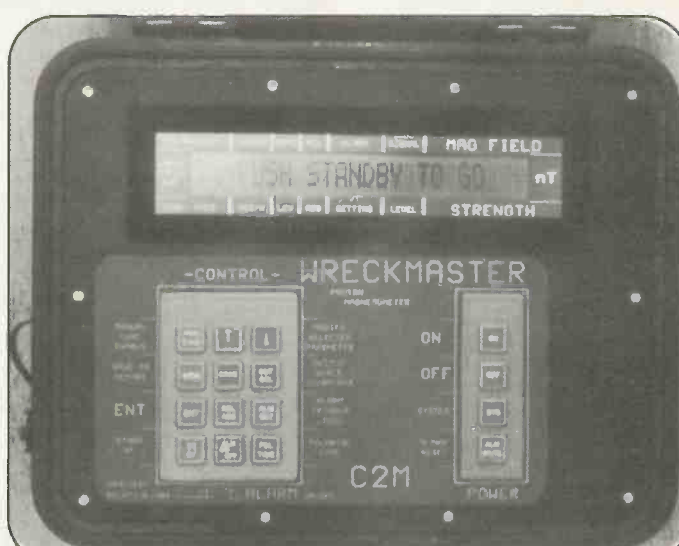
Apr 9-11. Cable and satellite exhibition and conference. Olympia, London. 01-486 1951.

Apr 4-5. Drives, Motors, Controls. New Century Hall, Manchester. 0799 26699.

Apr 24-26. British Electronics Week. Olympia, London. 0799 26699.

Jun 26-28. Infrared Technology. Wembley Conference Centre. 0799 26699.

Sep 25-27. British Laboratory Week. Olympia, London. 0799 26699.



NEWS

HIGH CHAPARRAL

New to the UK is the home satellite tv receiver from Chaparral Communications. The Monterey 20 will enable users to choose from the 30 or so available US and European national tv channels, including Sky and Superchannel. Microprocessor controlled, the fully integrated receiver and dish positioner have been especially designed to meet the needs of the European market.

Chaparral claim to be the first company to offer a satellite receiver for Europe with an audio/video switcher. The switcher accepts three inputs which can accommodate satellite decoders, vcrs, laser disks, video games, cd players, security cameras, or any other audio-video source.

The receiver's auto track feature simplifies set-up by allowing the installer to automatically locate satellites, while the favourite channel selector enables users to quickly tune to their preferred programmes. The suggested retail price in the UK is £995, including vat.

You can find out more about the Monterey 20 from Steve Chilver, Chaparral Communications, 10 Campbell Road, Hanwell, London W7 3EA. Tel : 01-579 6587.

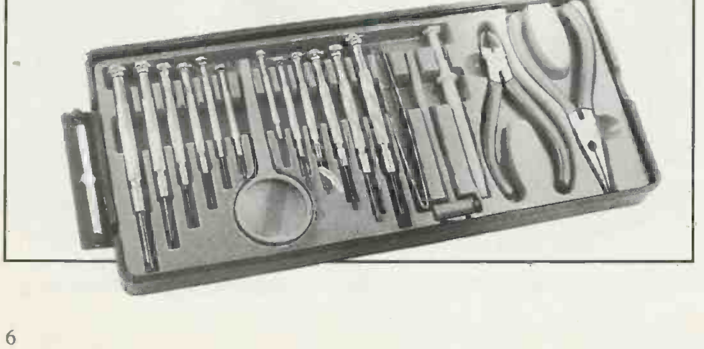
TOOL-UP PRECISELY!

Who's heart doesn't race at the thought of new tools for the workshop? You're not a true diyer if it doesn't!

Maplins' new tool set should certainly get the adrenalin flowing, and the price won't give you a heart attack. The photo shows the tools in the set, and the specially designed black plastic box, with slide-on lid, that contains them.

The long nose pliers have serrated jaws, plus sprung insulated handles, as do the cutters. There are six flat-blade and six Phillips screwdrivers in a range of good sizes, plus serrated grip steel tweezers and a pearl catcher. A nice touch is the inclusion of a glass magnifier and of course a hammer: no workshop's complete without one! This one has both plastic and metal faces.

The price for the FK52G micro tool set is only £9.95 including vat, and is available from any of Maplin's nationwide shops, or through their head office at PO Box 3, Rayleigh, Essex, SS6 8LR. Tel : 0707 554161.



CHIP COUNT

Of special interest to PE readers this month are a new eprom, an lcd module and a 1 Mbit sram.

1MBIT EPROM 27C210

Philips (the new name for Mullard) have added a new higher performance lower power 1Mbit eprom to their range. This addition of the 27C210 now extends the range from 64K to 1Mbit.

The 27C210 is organised as 65536 words of 16 bits and is currently offered with an access time of 200ns. It is available in windowed ceramic and plastic 40-pin dil as well as 44-pin plcc packages. (Most readers will probably only be interested in the more usual plastic 40-pin version.) The new eprom is designed to be used with the new families of 16-bit microprocessors and avoids the need for multiple devices. It also increases system performance when used to replace older, slower or smaller nmos roms and eproms. The 27C210 is manufactured using Philips' 1 micron cmos process which ensures a low power consumption (100μA standby) and high noise immunity.

All Philips eproms use the Quick Pulse Programming Algorithm, a capability which allows the device to be programmed in less than 12 seconds. Programming can be carried out on any standard programmer.

B&W LCD PANEL LM296D XBF

Hitachi have announced a new lcd graphics panel that uses their advanced third generation supertwist technology, cold fluorescent lamp (cfl) backlighting and TAB packaging technology to achieve exceptional high visual performance combined with small size, low weight and high reliability.

The LM296DXBF is a true black-on-white, 640 x 400 display, fully compatible with the popular ega graphics format. It is ideal for use in many applications where crts have traditionally been used. Hitachi say that the display uses an additional plane of liquid crystal cells to cancel out the colour effects associated with earlier supertwist technologies, while enhancing the performance for a high contrast ratio of 15:1, and a wide viewing angle of 50 degrees. Coupled with the bright, white background by the cfl backlight, this results in a high quality b&w display that matches the visual performance of crt monitors.

Containing all the necessary row and column drivers, the display also has an integral inverter that allows the cfl backlight to oper ate from a 12V supply. The module interfaces directly to the HD63645 advanced lcd controller, or the HD66840F lcd-video interface controller, which converts standard RGB signals into lcd drive signals.

1MBIT SRAM HM628128

For some time Hitachi have had a 1M sram available, but only in the sop package (largely unavailable to the diy market). They have now introduced the more conventional dil package version which should have greater PE reader appeal.

The HM628128 is organised as 128K x 8 and is manufactured with a cell area of only 5.2 x 8.6 micrometres, allowing 6,400,000 transistors and resistors to be placed on a chip measuring just 5.7 x 14.4 millimetres! This sram will find particular appeal among users of fast microprocessors who want to minimise wait states. Srams are preferred to drams where speed is critical or where battery operation is essential.

MANUFACTURERS' ADDRESSES

Hitachi Europe Ltd, 21 Upton Road, Watford, Herts, WD1 7TB. Tel: 0923 246488.

Philips Components Ltd, Mullard House, Torrington Place, London WC1E 7HD. Tel : 01-580 6633.

CLEVAR TESTER

New from TMK Instruments is the Multi-Vartest, a single instrument which is suitable for a wide variety of uses on both single and 3 phase electrical networks. Some applications include the calculation of Power Factor correction and the measurement of Active and Reactive energy with an indication of harmonic component. Measurements and their parameters are set up by simple front panel touchpad programming. AC current and voltage, Cos Phi, kW, kWh, kVALh, and kVACh are displayed on a 16 character alphanumeric liquid crystal display.

Battery operated, this handheld instrument includes a clip-on ammeter for the two current ranges of 2 to 200A, 20 to 1500A as well as test leads for phase rotation and the 500V voltage range. Other accurate measurements include a percentage voltage variation from a pre-set value and the overcurrent as a percentage that is absorbed by network capacitance and harmonic effects. Active energy is shown as kWh consumed since the reading commenced and the elapsed time in minutes. Most results can be shown as a maximum or minimum value and are average values taken over an adjustable period of 1 to 20 seconds.

Fully guaranteed this truly portable tester is housed in a sturdy moulded case and measures just 210 x 116 x 32mm and weighs 450gm. Supplied accessories include a quality carrying/storage case.

The price of the Multi-Vartest excluding vat is £399.00.

For more information, contact: TMK Instruments, Building 3, GEC Estate, East Lane, Wembley, Middx. HA9 7PJ. Tel: 01-908 3355.

DIGITAL STEREO TV UPDATE

You'll recall that Barry Fox looked at the change over to Digital Stereo TV Sound in PE Oct 89. The IBA television transmitters covering the London area and a large part of Yorkshire became fully operational for Nicam digital stereo sound from 11 September on both ITV and Channel 4.

The high-quality digital sound system, known as Nicam 728, has been developed jointly by the broadcasters and receiver manufacturers. Initially equipped for stereo will be the Crystal Palace (London) and Emley Moor (Yorkshire) main transmitting stations, together with associated relay transmitters.

At the same time, the programme distribution network linking Channel 4's studios with all the regional ITV programme companies is being equipped with dual-channel sound-in-sync arrangements. The same digital coding system will carry the signals all the way from the studio to the home ensuring extremely high quality, comparable to that of the compact disc.

During 1990, the IBA will be extending the availability of Nicam transmissions to reach about 75% of the UK population by the end of the year.

PATENTLY GOOD NEWS

With thirty million specifications comprising complete holdings for all the major patenting bodies and many documents from other issuing bodies throughout the world, the British Library is regarded by many as the patent source.

The British Library's Patent Express service already provides photocopies rapidly and at a competetive price not only to the UK, but to every part of the globe. As part of its continuing drive to improve the quality of service it provides, Patent Express has just launched its own newsletter exclusively for account customers.

The aim in launching the Newsletter is to improve communications with customers. It will report on items of interest to customers, everything from improved machines being brought into use, to, changes in the law, and will give them the opportunity to talk back about issues with which Patent Express may be able to help.

It costs nothing to be a Patent Express account customer, so if you want to keep truly up-to-date with this unique information source contact Richard Garner on 01-323-7929. Alternatively, write to SRIS Marketing and Public Relations, 25 Southampton Buildings, Chancery Lane, London WC2A 1AW.

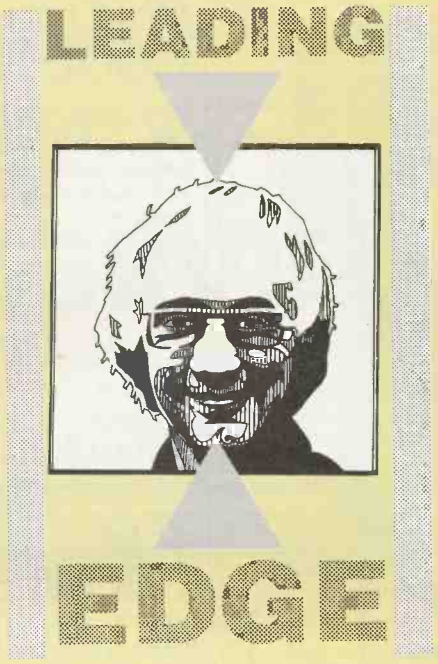
THE GROWLER RETURNS

Now available from Clare Instruments is an Armature and field winding tester known by the old school as a "Growler". Model V180 is designed to indicate fault conditions in armatures, field coils, rotors and stators and is sufficiently sensitive to pick up single short or open circuit windings from the smallest to the largest power tool motor.

The latest test set from Clare is compact, easy to use and mains powered. V180 uses a probe head, bearing two sets of pole pieces, one pair to induce a small current into the winding under test and the second pair to detect that current. The signal cable connected to the probe head returns the signal to the main instrument, where it is displayed using a sensitive analogue meter. Short circuit turns are indicated as an increase in meter reading, while open circuit turns are shown as a reduction in the reading. Full adjustment of the meter sensitivity gives a variety of test methods.

Fully guaranteed, the V180 is supplied ready for use in a sturdy carrying case with the operating instructions permanently affixed in the lid. The price is £285 plus vat.

For further information contact: Clare Instruments Ltd, Clare Works, Woodsway, Goring By Sea, Worthing, West Sussex, BN12 4QY.



CD VIDEO

BY BARRY FOX
Winner of the UK Technology Award

The picture behind the sound is the first step towards multi-media cd.

CD Video, the re-launch of Laservision video disc, has been confused by use of the CDV tag on all disc sizes, 5in, 8in and 12in. This is only one of many reasons why CDV has failed to take off in Europe, while video disc has sold very well in Japan and not too badly in the USA.

Don't shed too many tears. Although CDV has digital sound (the justification for re-launch) the picture signal is still fm analogue. The future lies with discs which store digital video. In this respect, Europe (except France, which looks likely to "buy" CDV) may well benefit from the failure of Laservision and CDV. We have a clear deck for digital video on 5in discs.

BURIED BITS

Although few people realise it there are already 5in cds in the shops which have digital video buried in the bitstream along with stereo sound. Talking Heads' album Naked was the first. The system is called CD+Graphics, or BGV (BackGround Video). JVC was the first to start selling CD Graphics players, in the USA, last July (1989). They connect to a tv set, as well as a hi-fi system.

All cd audio discs have part of the data stream allocated for "sub-codes" which index the disc and tell the control programming circuitry of a cd player where music tracks begin and end. The sub-codes can also carry text and graphics. But until recently the facility was not exploited.

One problem is that it costs money to produce the graphics programme material and unless there is decoding hardware on the market there is little point in the record companies making the investment. By launching hardware, JVC hoped to break the vicious circle. A launch for Europe is planned for next spring (1990).

But CD+G is limited in scope because of the limited number of bits per second available in addition to digital stereo. The final count is 97% of the usable data available for music and 3% for sub codes. Here's how it breaks down and adds up.

SAMPLE FRAMES

For a music disc, the sound is sampled at 44100Hz, or 44.1kHz. Each sample is described in a 16 bit code word. The code words, with right and left channels interleaved, are grouped together in "frames" and error correction bits added. So are the sub codes, and bits to synchronise the whole system. The data streams off disc at 4.3218MHz although only around half the bits represent music or usable data.

There are eight sub code streams, labelled P,Q,R,S,T,U,V,W. The sub code data rate is around 60 kilobits/second.

The P bits will be used in the future by very simple compact disc players, with virtually no fancy features. So far no players use the P sub code channel. They all use the Q channel.

The Q channel bits tell the player about the disc track (0-99) and index numbers, they give information on pauses, timing, whether the disc is in stereo or four channel quadraphonic, whether the sound has been recorded with pre-emphasis, whether it is an audio disc or a cd rom data disc and so on.

KUDOS

Without the Q sub code channel, a cd player would not be able to work. The Q channel can also carry a code number to identify a disc. But many record companies are not using this code. Likewise the Q channel carries a "digital copy prohibited" flag. This can be set to stop a digital tape recorder copying digital data from the disc. Curiously, not all the record companies have been using this facility either.

The information bits for the remaining six channels (R,S,T,U,V,W) convey text and graphics. They stream at only around 45 kilobits/second and offer only around 20 megabytes of 8-bit ASCII coding for an hour-long disc.

Hence the result on screen is often trivial, simply still pictures and running text, which soon become tiresome. The Talking Heads cd gives a clue to more constructive uses of cd graphics. As the music plays, guitar chords are displayed if a tv screen is connected to the cd player. Likewise foreign opera discs can contain the libretto in a choice of languages. The disc can also generate MIDI codes to control electronic music instruments.

Already the cd-rom and CD-Interactive formats reproduce much higher quality images, with a degree of cartoon animation by turning over the entire data stream to various mixes of computer code, text, graphics and compressed sound.

VIEWING HOUR

The long term aim is make the 5in disc a one hour video disc!

There is nothing new in converting moving video pictures into digital code and recording them; professional video tape recorders are already available which perform this trick. The difficulty is that the digital code needed to record the picture streams so fast that there is no hope of a compact disc recording, and replaying, it in raw state. The only way is to compress the data so that the bit stream reduces to the same rate as cd audio.

This is seen as an important challenge, not so much to provide movies on 5in discs, but pave the way to a "hyper media system" where sound, graphics, text and moving video are all combined on the same carrier and accessed from the same computer work station.

The technology is daunting and there are now several different lines of research, all incompatible. Recently, a Working Group (8) of the International Standards Organisation and International Electrotechnical Commission met at JVC's new Kurihama research and development centre at Kanagawa, near Tokyo. Next month I will report on the technology they saw and discussed. PE

PRACTICAL
ELECTRONICS

BEWARE THE CAT

CMOS chips have been with us for many years and it would, perhaps, seem reasonable to assume that most readers will be at ease in handling them. True, up to a point. Naturally, one does not expect newcomers to know instinctively that, though requiring moderately respectful handling techniques, the use of cmos devices should not be the cause for unnecessary concern. One would expect, however, that experienced constructors would regard cmos handling as second nature.

The fallacy of the latter expectation was brought home to me only a few days ago. A reader told me that he had started investigating electronics back in the days of valves. He'd made the change to transistors and standard ttl logic chips but then job pressures prevented him from keeping abreast with improving technology. Now that he had retired he wanted to become more involved in electronics, but was reluctant to construct cmos-orientated projects since he had heard that the chips could easily be killed by static electricity.

His concern, and that of any reader who has not yet used cmos for similar reasons, is almost totally unjustified. In the course of my own constructional and experimental work, I have seldom killed a cmos chip, even though on many occasions I have grossly mistreated them, violating the procedures stated in manufacturers' data books.

The instructions given in some data books can run to several pages, covering a variety of situations, most of which only apply to the assembly and handling of cmos on a commercial scale. For example, the use of earthing wrist straps and work pads by operators is detailed at some length. In a commercial situation you would probably also need to reduce static build up by using ionized air blowers, anti-static sprays, and room humidifiers. Similarly, brush and spray cleaning of cmos products would be severely frowned on, and you might be heavily reprimanded if you didn't place your assembly in a vapour degreaser immediately upon its removal from antistatic or conductive containers!

These requirements, and many others, although absolutely valid in a commercial environment, are of little relevance to the average diy constructor. The most important, but very simple rule you as a diyer should observe when handling a cmos device, is that you make sure you have discharged any static electricity from your body immediately prior to touching it. Since your soldering iron ought to be earthed, preventing any electrical charge building up on it, all you need to do is to briefly touch the cooler end of the iron's metal part every few minutes while handling cmos chips. Alternatively, simultaneously touch a finger and the iron to another metallic surface. In my own workshop I have another technique - I touch the bare metal surface of a test unit which I know is adequately earthed.

There are three other simple precautions to take with cmos. Never insert or extract chips when the power is on. Never allow power supply or other voltages to exceed those stated in circuit diagrams or data sheets. Keep static generating items away from the chips; such items include many man-made fibres and plastics, wool, hair and fur. There's no need to let the last precaution dictate what you wear, but I strongly suggest you keep the cat off the workbench!

THE EDITOR

Editor:
John Becker

Sub-Editor:
Helen Armstrong

Technical Illustrator:
Derek Gooding

Advertisement Executive:
David Bonner

Office Manager:
Louise Hewett

Production Manager:
David Hewett

Deputy Publisher:
Tom Robson

Publisher:
Angelo Zgorelec

Practical Electronics,
Intra House, 193 Uxbridge Road,
London W12 9RA
Tel: 01-743 8888
Telecom Gold: 87: SQQ567
Fax: 01-743 3062

Readers' Enquiries

All editorial correspondence should be addressed to the editor and **any letters requiring a reply should be accompanied by a stamped addressed envelope, or equivalent payment.**

We regret that lengthy technical enquiries cannot be answered over the phone.

Advertisements

The Publishers of PE take reasonable precautions to ensure that advertisements published in the magazine are genuine, but we cannot take any responsibility in respect of statements or claims made by advertisers. The Publishers also cannot accept any liability in respect of goods not being delivered or not working properly.

ISSN 0032-6372

PE Services

SUBSCIPTIONS - Annual subscription rates are £15.00 for the U.K. or £18.00 overseas (Air mail overseas is £36.00). Please send your cheques (payable to Intra Press), payment by Visa or Access also accepted, to: Practical Electronics, Subscription Dept., P.O. Box 500, Leicester LE99 0AA. Telephone: 0858 410510 (ask for Practical Electronics Subscriptions).

BACK ISSUES - We still have a limited number of the back issues from the last three years available (Certain issues from earlier years are also available, but check before ordering). Price £1.50 - overseas £2.00 (inclusive of postage). Orders should be sent to our editorial address.

BINDERS - to hold 12 issues of PE are also available from our editorial address. Price £5.95 (overseas £6.95 - surface mail). Post included.

BOOK SERVICE - see the Book Service advertisement in the magazine.

PCB SERVICE - details inside.

Cover Photo:
Ed. Davis

Published on 1st Friday of each month by Intra Press, 193 Uxbridge Road, London W12 9RA. Printed in England by Andover Press Ltd. Andover, Hants. Distributed by Quadrant Publishing Services 01-661 8526. PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

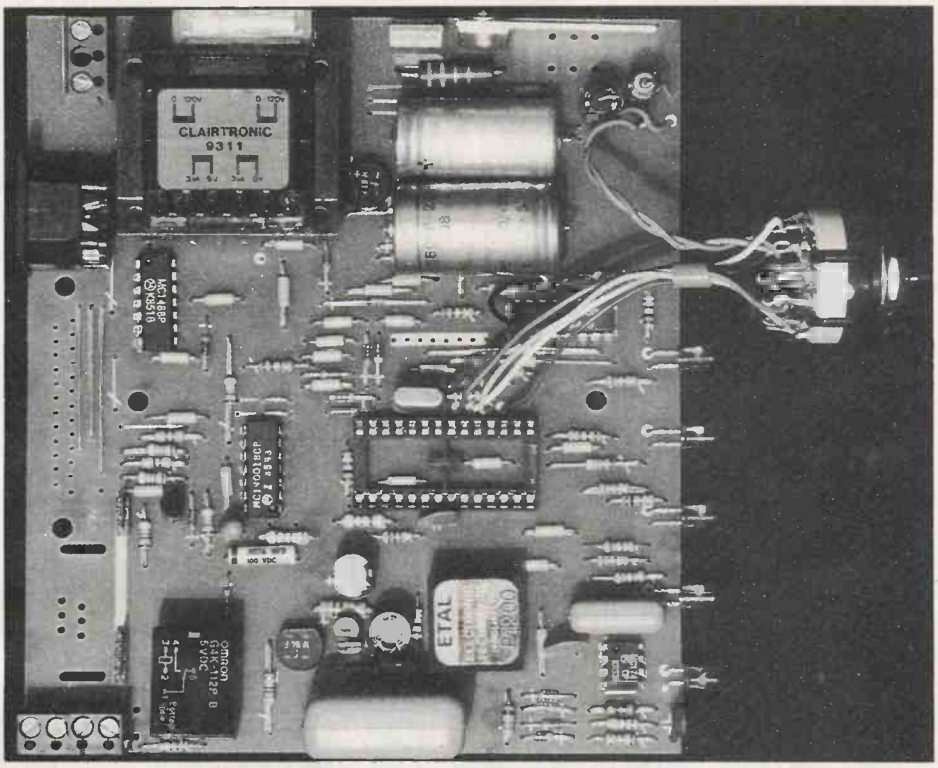
The Modulator/DEModulator is finding increasing uses in industry, commerce and the home. It is used mainly where the bandwidth of the carrying medium is restricted, such as on telephone lines or via the mains wiring for home control systems.

MODEM PRINCIPLES

Simple modems usually use either fsk (frequency shift keying) or ask (amplitude shift keying) techniques but are restricted usually by bandwidth constraints to around 1200 baud in any single direction or 300 baud simultaneously in two directions. More complex modems feature a variety of techniques to increase the throughput on a given line these include dpsk (delta phase shift keying) such as that used on V22, qam (quadrate amplitude shift keying) such as that found on V22 bis and tcm (trellis coded modulation) as found on V32 modems.

WHY A MODEM?

To communicate effectively over a telephone line requires not only the communications medium but also a host of other features. For example, there must be some form of 'handshaking' between each end to determine whether the far end is present and ready to send and also the speed that it is to be sent at.



Photograph of the author's prototype modem board. There are some differences between the prototype and the project we present here, but the photo illustrates the basic ease of the construction.

PE MODEM

Kevin Kirk discloses the secrets of modems and shows you how to build your own line-up!

In addition, the telephone line has a top frequency limit of around 2.5 kHz into which we have to fit both the sending (or originating) signals and receive (or answering) signals. The transmit amplitude must be limited to less that 0dB, preferably at a level of -10dB, which reduces the possibility of cross talk on the telephone lines. The receiver must be capable of working down to around -35dB or better.

The modem must be matched to the line, which presents a complex impedance at a nominal 600 ohms. Safety must also be considered with all line functions being separated from the computer (or data terminal) by isolated barriers and lastly there must be some way of setting up a call, so dialling and answering mechanisms must be incorporated.

On the face of it, this appears to be a tall order, especially when you consider that the unit has to meet other requirements when going through approval such as radiated noise checks, acoustic shock tests, offline current and ren (ring equivalence number) checks. Plus, it is being connected to a medium over which the user has little control and which changes according to the weather!

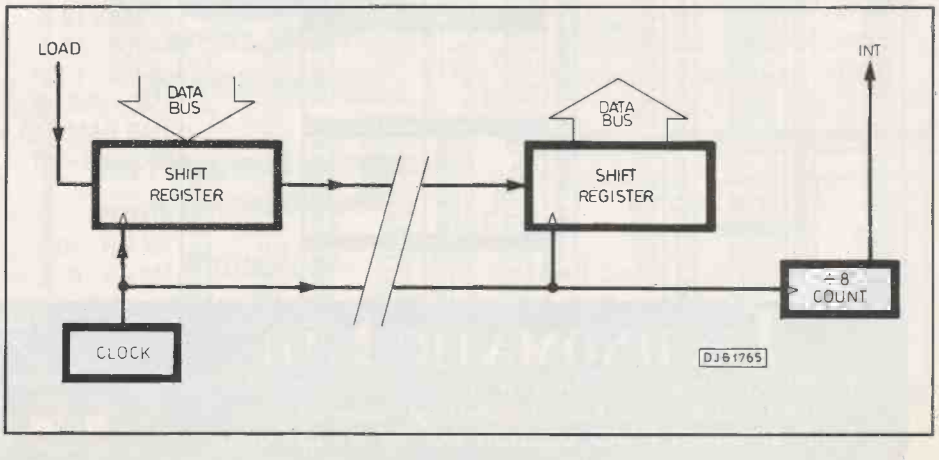
This is probably why modems tend to be pretty expensive considering their relative simplicity.

When isdn (integrated digital switched network) comes on stream then all telephone lines will be digital and so you should be able to connect your computer directly to the line, but you will have to connect your phone via a modem (called in this instance a codec) so modems will be with us for some time to come.

MODEM DESIGN

Modems require a digital input in the form of a series of 1s and 0s, usually referred to as the RS232 input. This digital input may take one of two forms, either synchronous or more commonly, asynchronous.

Fig 1. Synchronous comms link.



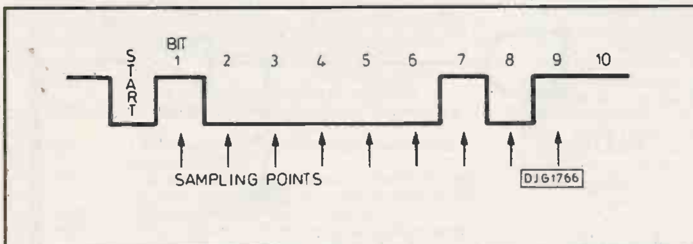


Fig 2. Typical data byte (in this case 'A'; 8 odd parity, 1 stop bit).

Synchronous communications are the most simple and fastest form of serial communications. They rely on the fact that for each serial bit there is a corresponding clock pulse so encoding and decoding the signal from a parallel computer bus is relatively simple. In addition, there is no need for synchronisation 'overhead' so the data throughput is correspondingly faster. Fig. 1 shows a typical synchronous comms set up, with a parallel in/serial out shift register being used to send the data and a serial in/parallel out-shift register being used to receive and reconstruct the data under the control of a master clock. Two of these circuits are required for a two way link.

This is fine for direct connection between computers and it is also used in faster modem designs (from V22 up) but in an fsk modem or in a simple two wire comms link it needs extra channels or wires to work.

In this instance we use an asynchronous link. This requires the use of a clock at each end which will time the bit stream. Each separate byte of data must be individually synchronised so the data byte is preceeded by a low going 'start' pulse. (Fig. 2).

On automatic speed sensing modems this pulse is measured to provide the baud rate. After one half of the width of this pulse has passed, and after the end of the pulse, then the input line is sampled to get the level of bit 1 of the byte. This is repeated 7,8 or 9 times depending on the protocol at intervals equal to the width of the start pulse, at which point the stop pulse will signal an end to the byte.

PROTOCOL

The protocol of the byte is its 'makeup'. For example, 7 Even 1 is used by Prestel and 8 No 2 is used by Telecom Gold. This means that the byte has either seven or eight data bits in the byte, has odd or no parity and has either one or two stop bits (ie, the stop bit is either one or two start pulse widths wide).

The parity is a crude form of error checking which adds either a 1 or a 0 to the byte to make up an odd or even number of 1 bits. For example, in the letter 'J' the byte would be 1 0 1 0 0 0 1 so if we had odd parity then the parity bit would be 0; similarly if it were even then we would add a 1.

Note that the byte is only seven bits long since ascii only uses the lower seven bits as it only has 128 different codes. So why people persist in using eight bits is beyond me as it actually slows down the throughput by over 10%!

The asynchronous conversion is usually handled by a device called a uart (universal asynchronous receiver transmitter) which will check for parity and framing errors (lack of stop pulses) automatically and will flag an interrupt to the processor. Fig. 3 shows a typical uart.

This device will usually provide other control and monitoring lines, usually referred to as 'handshake' lines. These lines are used for setting up and controlling of the modem and consist of two outputs and two inputs to the uart.

These go valid in the following order:

VALIDITY

DTR (data terminal ready output): signals to the modem that the uart (and hence the terminal) is ready, usually the modem will drop out if dtr is lost.

DSR (data set ready input): signals that the modem is ready.

RTS (request to send output): signals that the terminal is ready to send.

CTS (clear to send): signals that the modem has set up the data link and the terminal can proceed to send.

In addition there are two other lines from the modem:

CD (carrier detect): signal that the energy is present on the telephone line, signifying that the distant terminal is active. Loss of carrier will usually terminate the connection.

RI (ring indicate): signals that the phone line is ringing so the terminal may decide

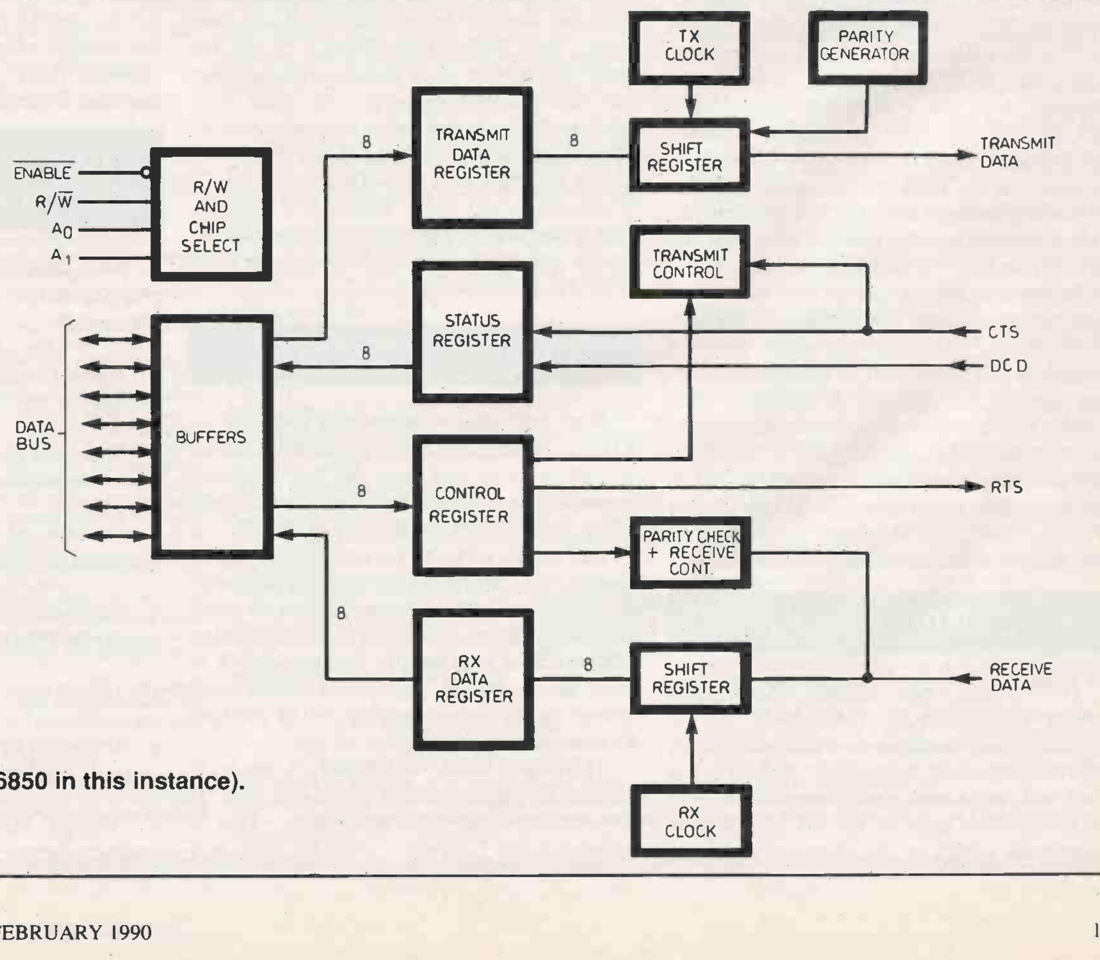


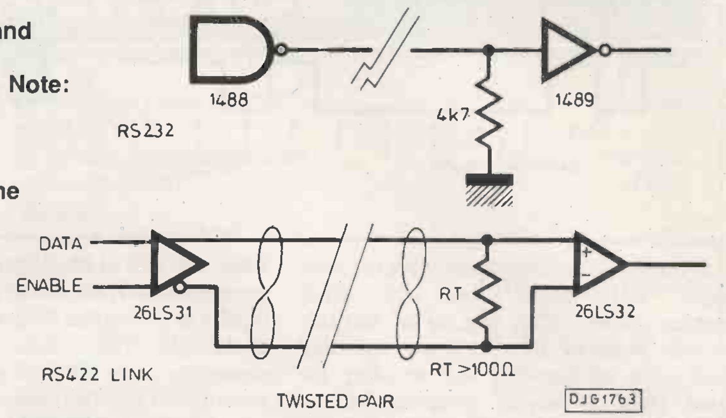
Fig 3. Typical UART (6850 in this instance).

whether to raise dtr and proceed with the incoming call.

These signals are active low and are passed via RS232 line drivers and receivers. These convert the ttl (0-5V) signals into + or - signals which are then passed between the terminal and the modem. RS232 is an awful standard as it is slow and limited to 20 metres. In addition, it must have been designed by the 'D' connector industry as it calls for the use of 25 way D connectors, while it only uses about nine conductors. However, it is reasonably standard so we are stuck with it.

Its main disadvantage is that is it unbalanced: that means that it has one output and one earth (return) which in turn means that it is susceptible to noise on the output which cannot easily be filtered out on the receiver. A balanced system, however, (like RE422) uses a differential input so that noise induced on one input is not amplified (series mode rejection) and noise on both inputs is cancelled out (common mode rejection). So RS422 can cope with line lengths of over one kilometre and speeds of 10 Mbaud compared with speeds of 19.2 kbaud for RS232. Fig. 4 shows the difference between the two systems.

Fig 4. RS232 and RS422 links (respectively). Note: noise may be reduced by inserting 1k resistors on the inputs to the 26LS32 amp.



CONVENTIONS

At this point we have converted out RS232 signals to ttl data and control signals inside the modem. The digital signals are then converted to tones. These tones will correspond to either the internationally recognised CCITT tones (referred to by their recommendation number, eg V21, V23 etc) or using the American BELL tones.

Thus a mark would be assigned (in V21 Originate) a tone of 980Hz and a space would be 1180Hz. Similarly, on V21 Answer the mark would be 1650Hz and the space would be 1850Hz. Note the spacing between 1180Hz and 1650Hz so that interference between transmit and receive is minimised. Convention requires that the modem making the call (the originating modem) uses the low frequencies, or low channel and the modem answering the call uses the high channel to avoid confusion.

As with everything else in datacomms this is not always obeyed. For example, in the case of the 'Hayes' command atr, which allows a modem to originate a call in answer mode, so that acoustic couplers can be called. This seems silly as most acoustic couplers (more about these later) can already be switched between answer and originate modes, and in any event, they require the manual intervention of an operator who, if it were me, would be very put out to be bleeped at by a modem!

CONVERSION

The modem chips on the market will provide this conversion function as well as providing the filtering on the receive to decode the incoming marks and spaces. Space = 0 and Mark = 1, incidentally, refers to the good old days when the state of the art comms link either made a mark or left a space on a piece of moving paper, giving a sort of visual binary code.

As analogue filters tend to be fairly difficult to make on silicon (not counting switched filters) then many modem chips use a fast D/A and A/D converter on the line side so that the tones are derived from a rom and are decoded using a dedicated microprocessor rather than a pll/filter network.

At higher speeds than V21, which is limited to 300 Baud, we have to use the data link in one direction only at any one time. This is referred to as half duplex. The reason for this, as previously explained, is bandwidth on the telephone line. If you look at the frequencies used in V23, of 1300Hz for a mark and 2100Hz for a space, you will see that there isn't space for another channel of the same speed. So what is done here is that we use the rts and cts control lines to create the handshaking. It works like this:

One end, say the originating end, is designated the master and the answering end is designated the slave. The master will call up the slave and after the link is established will raise its rts line. This has the effect of raising the carrier detect at the slave modem. After a preset time (usually 100ms) the cts will come back from the master modem and it may start to send. When it has finished it drops the rts line which in turn drops the slave cd and the master cts. It is now the slave's turn. It may if it wants to send to the master, raise its rts and the comms link is 'turned around', and the set up is as before but in reverse.

PACKET SENDING

Many half duplex systems use a 'packet' or XMODEM method of sending whereby a packet of 256 bytes is sent then the line is turned around and an acknowledge or checksum signal is sent back to check the integrity of the link.

Half duplex using V23 is an excellent way of sending data, especially over marginal lines with far less chance of errors than V22 (which relies on phase changes to a single frequency rather than switching between two frequencies). It is rarely used, though, except on professional systems as it requires a little bit of thinking about to set it up properly.

There is a twist in V23 which tends to confuse people, and that is where it is used on Viewdata systems such as Prestel. This is because in the bandwidth available there is a sliver of frequencies available at the low end which will allow the use of a low speed 75 baud 'Back' or Engineering channel whose frequencies are 390Hz for a mark and 450Hz for a space. This is (very cleverly) used by Prestel to allow the user to send control characters and page requests to Prestel while the bulk of the communication is from Prestel at 1200 Baud. In effect, this is full duplex but at different baud rates, so V23 can be used for full and half duplex communications. However, for neatness and accuracy we shall refer to it as assymmetric full duplex. This channel may, of course, be used to send the acknowledgements thus speeding up half duplex transmissions still further. There is another form of modulation called amplitude shift keying which is mainly used in mains-bourne communications systems. It is basically CW. It operates on a carrier of 120kHz which is switched on and off for a mark or a space. It is covered by a British Standard (BS6839) and normally uses a packet control system such as Kermit (not the frog) but is outside the scope of this article. Further details on this may be obtained from: BIMSA, Leicester House, 8 Leicester Street, London WC2H 7BN.

CONSTRUCTIONAL CONSIDERATIONS

For a modem that forms a constructional project, certain design criteria must be met, for example:

- It must be simple to build and test, even for relative novices to electronics.
- It should have communications software readily available for it.
- It should meet the International Communications standards.
- It should be capable of being approved for use on the Public Telephone Network.
- It must have a self test capability.
- It should be capable of being used with virtually any computer.
- The PE Modem does all this at a very modest price.

WHAT TYPE OF MODEM?

This modem is a dumb unit, which means that it does not have a processor in it and so cannot interpret software commands directly. This does have some disadvantages, in that it cannot use 'Hayes' software, such as that available on the majority of comms software packages. To use these packages it must be used as a manual modem, so the dialling etc must be done manually.

However, not having an internal processor does have a lot of advantages. For instance, when on line the processor in a 'clever' unit has very little to do (except crash!) so the manual unit is just as good. In fact it can be better since it is easier to get off line if there is a problem (flick of a switch), whereas a 'Hayes' compatable modem needs software escape codes, offline commands etc.

Another benefit is that it cannot accidentally be put on line if the processor crashes.

On balance, the 'clever' modem is easier to use, but the dumb modem is more reliable, cheaper, easier to build and simpler to modify for special functions (such as amateur radio, carphone or even cb use).

COMPATIBLE SOFTWARE PACKAGES

TABLE 1

This modem will work with any software written for the following modems, and should auto-dial and auto-answer:

Voyager 7 and 11
Magic Modem
Enterprise
Apollo
Commtel-x

It will also work with software written for the following modems, but may not support all the functions, such as automatic speed sensing and selection:

Unicom
Demon
Designer

It will also work with any software that has a manual modem capability, but will not support automatic functions such as auto dial and auto answer.

THE DESIGN

The heart of the unit is the 7910 modem chip. This is the chip that can be found in the vast majority of modems. If the modem supports V23 then it usually has a 7910 lurking in there somewhere.

It gives the capability of V21 (300 baud full duplex) and V23 (1200/75 asymmetrical duplex) plus a loopback test facility. It has all the filters, AD converters, etc, required to both MOdulate and DEModulate the digital signals. Since it does all this, all we need to do is hang the various little circuits on that perform the computer/telephone line/human interface functions.

TABLE 2. System frequencies in Hz.

	ORIGINATE		ANSWER		
Designation	Space	Mark	Space	Mark	Speed
CCITT V21	1180	980	1850	1650	300
CCITT V23	450	390	2100	1300	1200/75
BELL 103	1070	1270	2025	2225	300
BELL 202	2200	1200	See Note 1		1200 HD

Note: Bell 202 has no official 'back' channel like V23 so can only operate in one direction at a time (half duplex) whereas V23 can be used in both directions at once, albeit at a slower speed on the originating side. This is called asymmetric duplex. V21 and BELL 103 are both full duplex so may be used at up to 300 bauds in both directions simultaneously.

Fig.5 shows the basic block diagram for the modem. The circuit can be divided into two parts, the digital part on the left of the circuit in Fig. 6 and the analogue/telecom side on the right, with the 7910 bringing them both together.

The RS232 port on the far left of the diagram is fairly straight forward as it uses a conventional RS232 line driver which has a tailored slew rate and current limiting (to prevent damage if the outputs are shorted to earth). It also does level shifting.

The input does not use the conventional line receiver as I find they are not as flexible as this cmos design. The 4k7 resistors provide the loading (5k in the RS232 standard) and the 100k resistors provide a current limit into the cmos gate of around 120µA. The input voltage is then clamped by the gate's protection diodes to +5V and 0V from the original plus or minus 12V. This has the advantage of being able to drive the unit from direct logic (such as a user port on a BBC) rather than having to use a proper RS232 port. In this instance, a 4V7 zener diode on each of the 1488 outputs, with its cathode connected to the output and its anode connected to ground will ensure a correct 0-5V input to the logic.

The baud rates are selected by S2. It is shown on the diagram at 300 originate and will turn anti-clockwise through:

300 Answer
1200 Originate
1200 Answer
1200 Half Duplex
Test

Originate, incidentally, means the originator of the call (ie, the one who dials). Answer means the one who answers the call. This is a convention used to prevent both parties using the same set of tones. As a true experimenter, you need not stick to this convention.

The digital input is converted to tones by the 7910 and will find its way out on pin 8, which is transmit carrier. Here it goes into a circuit called a duplexer. Essentially, this is a four wire (TC, 0V and RC, OV) to two wire (line, return) converter. In conventional telephones this task is undertaken by a

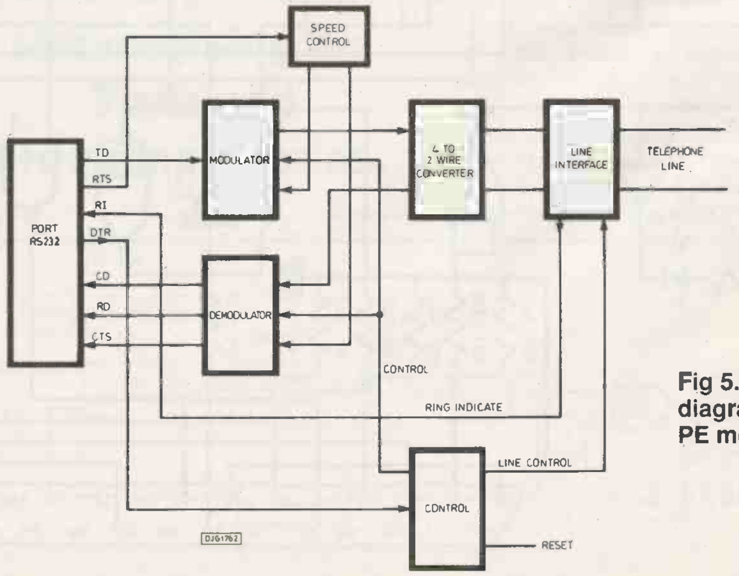
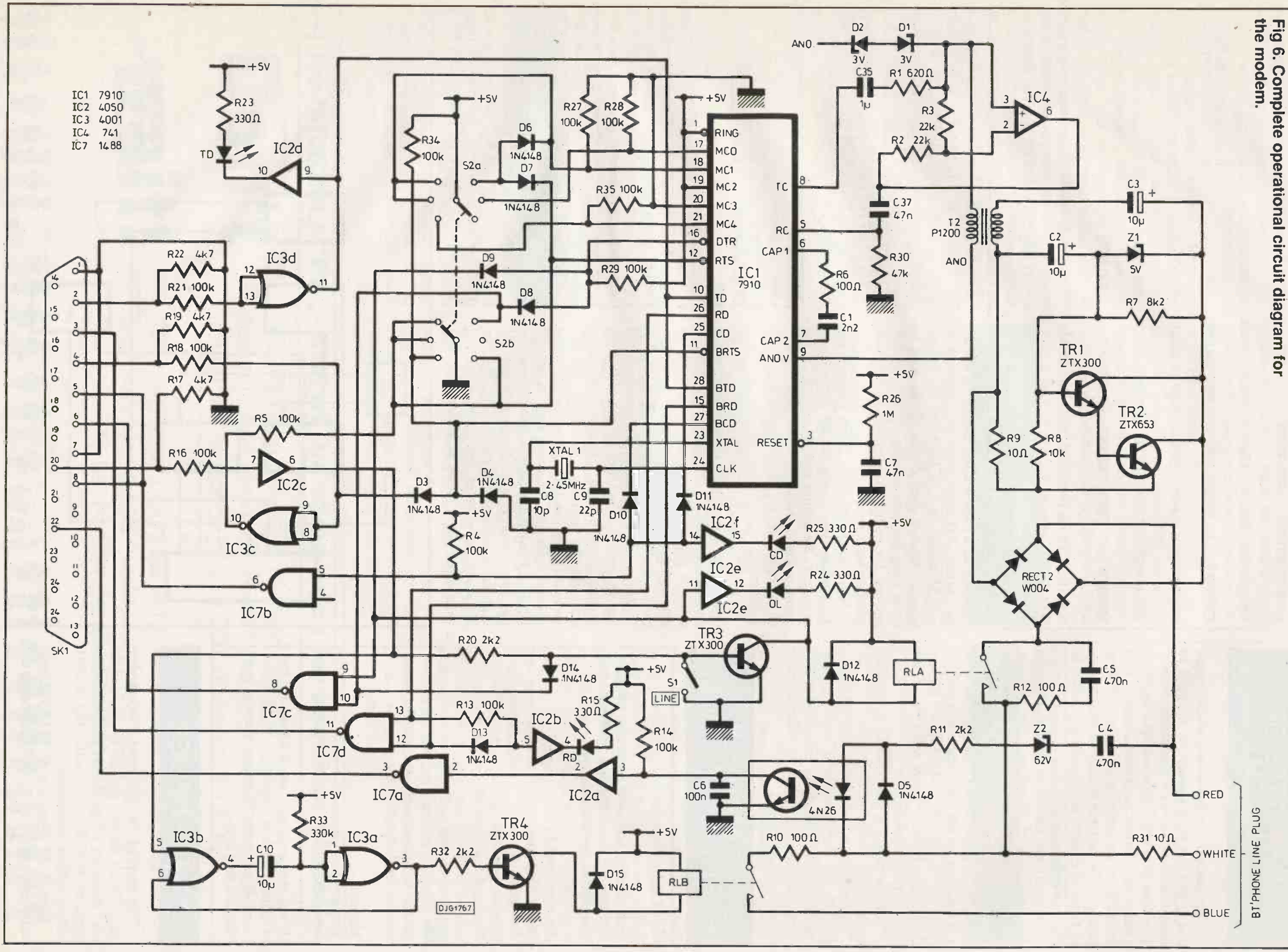


Fig 5. Block diagram for the PE modem.

Fig 6. Complete operational circuit diagram for the modem.



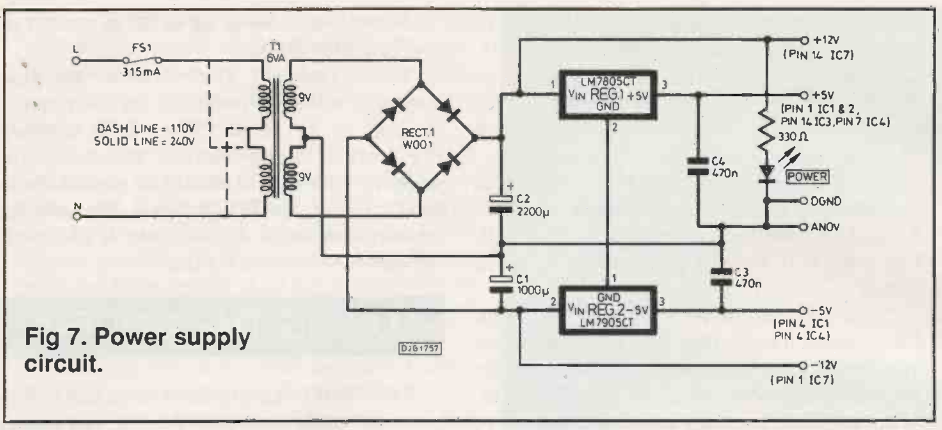


Fig 7. Power supply circuit.

specially wound transformer. This is inconvenient (and nowhere near as elegant) as this circuit. Its operation is worth describing as it has uses in many other areas such as amateur radio, for example.

Capacitor C35 decouples the 7910 from the circuit (to prevent dc offsets) and is fed through two resistors the first of which (R1) provides the signal path to the Telecom line and the non-inverting input of the op-amp. R3 then goes to the inverting input of the opamp.

The two signals will thus cancel each other out so that the receiver is not swamped by the transmitter. The receiver, on the other hand, comes from the line transformer and is only put onto the non-inverting input so that it is amplified and sent to the receiver. Resistor R2 sets the gain of the circuit, in this instance at unity. If you experience low signal levels on the inputs which cause errors, try increasing R2 to 33k.

On the other side of the transformer lies the gyrator circuit. On many telephones (and some modems) an inductor is used to draw dc current from the exchange to hold the relay on (around 20mA) while allowing the low level ac signals (around - 12dB) to be passed unattenuated to the duplexer. However, an inductor poses a few problems here as it is big and will need to be shorted out during dialling, otherwise the back emf will at best provide spurious dial pulses and at worst weld the relay contacts shut.

This circuit features a semiconductor gyrator which mimics a coil yet is less bulky and can, with the addition of a zener, be used without shorting out during dialling. A version of this circuit has passed BABT approval, so it works!

The zener turns the transistors hard on when the relay first closes, so providing a low impedance path for the dial current. This prevents spurious pulses caused by the capacitor charging. When the voltage reaches the transistor turn on threshold the zener reduces the voltage again, thus providing a 'knee' which can be interpreted by the exchange as two pulses.

The 10µF capacitor in series with the transformer is to provide a dc block since it cannot take very much current. The bridge acts as 'steering' diodes to ensure the right polarity on the gyrator.

RL1 is the main online/dial relay.RL2 is used to prevent the bells on parallel connected phones undesirably tinkling by shorting them out while dialling. This circuit is driven from a simple monostable consisting of IC3A and IC3B which holds the relay on for a preset time (set by C10 and R33) after each valid transition of DTR.

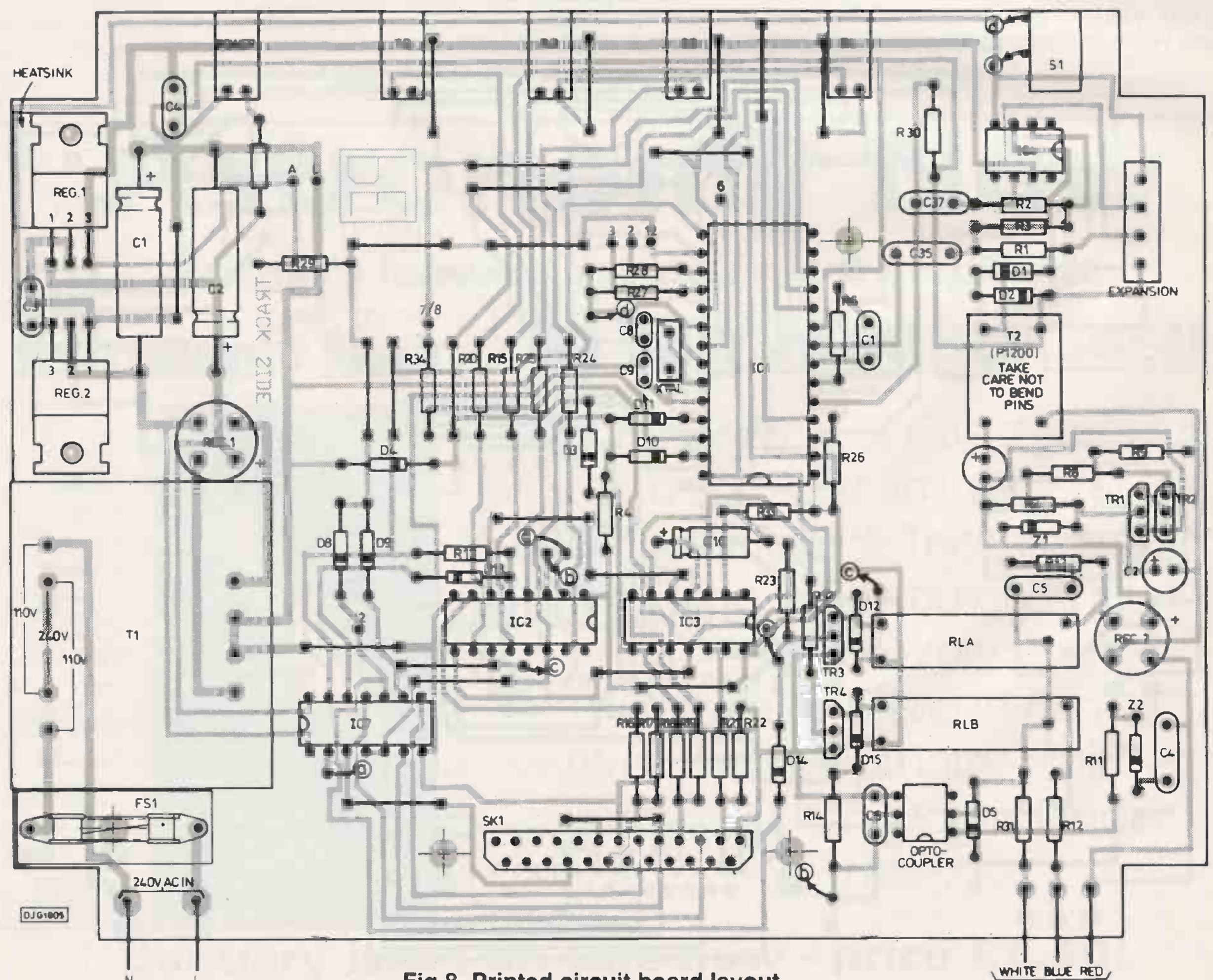


Fig 8. Printed circuit board layout.

The ring detector is quite simple: the ringing voltage of around 65Vac will find its way through the 470nF capacitor, C4, and as long as it exceeds 62V it will turn on the opto isolator led. The zener prevents it from triggering falsely if a parallel phone is used to dial, and the capacitor prevents it from going off during normal operation.

The isolator output is fed to a simple filter consisting of C6 and R14 which removes the 25Hz ac component from the ring signal. IC2a is used as a high impedance buffer to prevent filter loading. The output will be a pulse of the same duration as the ringing signal and is fed to the computer on the RI input.

The computer then decides whether or not to go on line if the line switch S1 is closed. S1 may be used to set the modem on or off line under operator control. Thus you can talk over the phone to the person at the far end and either of you decide when to go online.

The power supply in Fig.7 is a simple and familiar unit which doesn't really need any explanation.

CONSTRUCTION

It is recommended that you use the pcb layout shown here, this is because there are low level analogue signals (down to -40dB or so) with fairly high level digital signals. Consequently, ground loops MUST be avoided and this can only be done by careful layout with earth 'starpoints' etc. So a strip board layout may not work satisfactorily.

There is not really much to be said about the assembly except that I would recommend dil sockets for all ics, especially for the 7910. For which it should preferably be gold plated.

Note that there is provision on the layout for a mains transformer, but whatever place you decide to mount the transformer, ensure that full safety considerations are adhered to. Mains voltages must not be allowed to connect to a phone line, or to yourself! The modem must be boxed for further safety.

An external centre tapped supply, either ac or dc, up to 15Vdc or 12Vac may be connected at the points marked X on the overlay. Increase the size of the heatsink on the +5V regulator in this instance, though.

When you have fully assembled the unit, and before plugging in the 7910, check the 5 volt supply rails. If they are above 5 volts (or below in the case of the -5V) then the regulators could be oscillating, in which case putting a 1µF tantalum capacitor from the output to ground (observing the polarity) should cure it.

There is no setting up to do so switch off and insert the 7910.

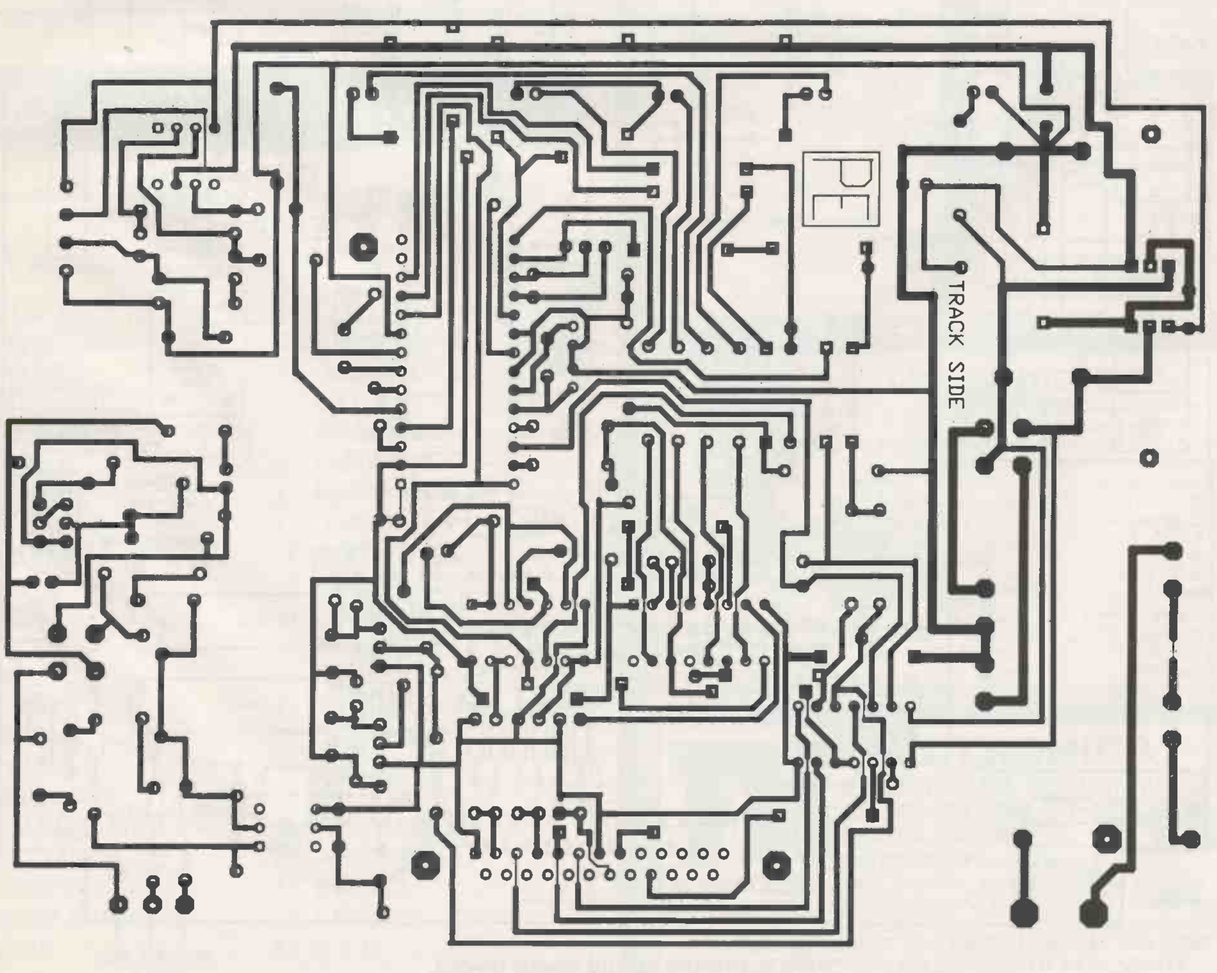
Then connect the modem to your computer's RS232 port, and set the terminal program to 300 Baud. When DTR is raised, the Carrier lamp should come on and whatever you type in should be printed on the screen. Also, the TD (transmit data) and RD (receive data) leds should flash. If all is well, the unit is now ready for use.

USING THE MODEM

The 7910 is an excellent chip but it does have one really annoying bug. If you change speeds without resetting the chip (by either switching off or raising DTR) then it will probably end up in a strange operating mode with the filters and transmitters set to the wrong frequencies. So always remember to either set the baud rate switch before going on line or before dialling.

The 7910 has the capability of operating using the BELL tones (Table 2) which are used in North America and Canada. So, if you intend to call American Bulletin Boards direct, you can modify the unit by disconnecting MC2 from +5V and connecting a changeover switch so it is connected to 0V for BELL or to + v for CCITT as used in Europe.

Fig 9. PCB track layout. When copying ensure that IC pin spacing is 0.1 inch.



COMPONENTS

RESISTORS

R1	620R
R2, R3	22k (2 off)
R4, R5, R13, R14, R16, R18, R21, R27-R29, R34, R35	100k (12 off)
R6, R9, R10, R12	100R (4 off)
R7	8k2
R8	10k
R11, R20, R32	2k2 (3 off)
R15, R23, R24, R25	330R (4 off)
R17, R19, R22	4k7 (3 off)
R26	1M
R30	47k
R31	10R
R33	330k

CAPACITORS

C1	2n2 polyester
C2, C3, C10	10µ (3 off) elect
C4, C5	470n (2 off) polyester
C6	100n polyester
C7	47n polyester
C8	10p polystyrene
C9	22p polystyrene
C35	1µ 16V elect
C37	47n polyester

SEMICONDUCTORS

D1, D2	3V zener (2 off)
D3-D15	IN4148 (13 off)
Z1	5Vzener
Z2	62V zener
TR1, TR2, TR3	ZTX300 (3 off)
TR2	ZTX 653
ICI	7910
IC2	4050
IC3	4001
IC4	741
IC5	4N26 opto coupler
IC7	1488
REC2	W004 Bridge rectifier

MISCELLANEOUS

LEDS (CD, OL, RD, TD) (4 off)
RLA, RLB, 2PCO relays (PCB mounting) (2 off)
2.45 MHz crystal
S1 SPST toggle switch
S2 2p6w rotary switch

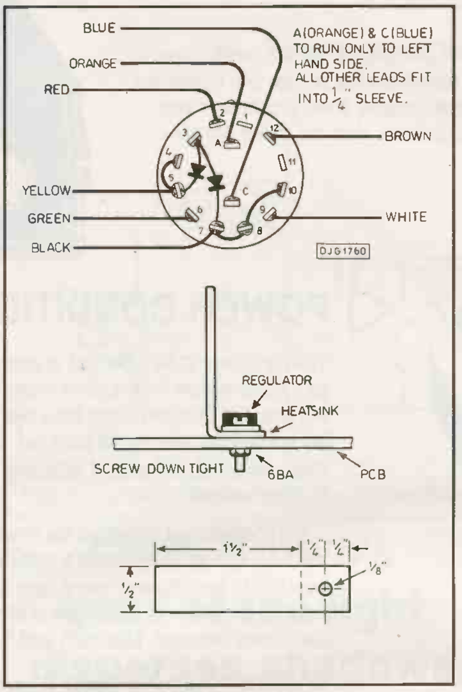
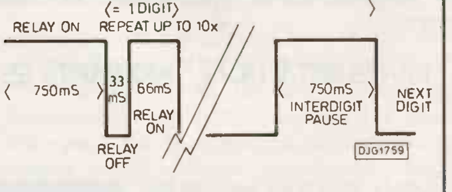


Fig 10. Switch wiring details, and heatsink construction and mounting for regulator.

The ring input on the 7910 will enable the unit to produce the V25 ring if pulled low. However, for flexibility and being able to answer when switched to originate, I haven't used it here. There is nothing to stop you from using it, though; experimentation is the name of the game! Try connecting it to pin 2 of IC2 (after disconnecting it from +5V first) so that when DTR is raised by the computer it should answer correctly after ringing. It will only work in answer mode, though.

If you want to use the unit to drive a 4-wire circuit (a ham radio, cb or carphone), omit the circuit from the 741 onwards. They



POWER SUPPLY COMPONENTS

C1, C2	1000µ 25V elect (2 off)
C3, C4	470n polyester (2 off)
REC 1	Bridge rectifier W001
REG 1	7805
REG 2	7905
T1	Mains transformer, 9V-0-9V 1 amp secondary.

connect directly to pins 5,8 and 9 on the 7910.

A word of caution if you are using the SGS Thomson version of the chip. It is very easily upset (for some reason) by dc offsets on its receive inputs so I would recommend leaving the decoupling capacitors and the 47k resistor in circuit. If DTR (pin 16) is tied low, then the relay can be used with DTR from the computer to toggle the transmit key on a ham transmitter. Again, experiment with it.

If you want to use the unit simply with a pair of wires slung across a fence to your friend's computer, then you will need to provide a dc supply to forward bias the bridge rectifier. Connected it via a 2k2 1W resistor directly across the line to each modem, isolating each dc-wise with a 2µ2 polyester capacitator, as in Fig. 11.

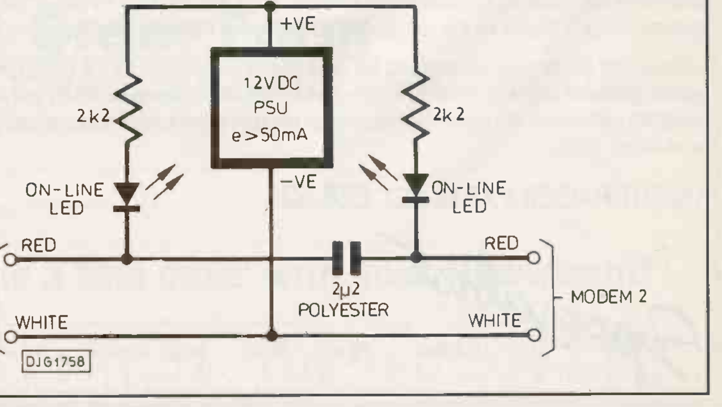
Alternatively, leave out the gyrator etc, and connect directly to the line transformer via the 10µF capacitor. You may find with this latter arrangement that it may need some attenuation, so try experimenting with a few different value attenuators.

The unit can be made to dial by toggling the DTR input and hence the relay. First of all put the relay on for about 750mS then turn it off for 33mS, and then on again for 66mS for each digit followed by the inter digit pause of 750mS (see Fig. 12) and then stay on at the end. It is that easy. Most software packages mentioned in Table 1 will do this for you. Plus a load of other clever stuff!

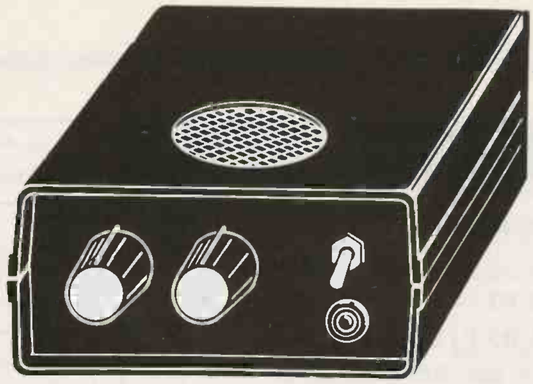
Kevin Kirk is a lecturer in electronics at the Aberystwyth College of Further Education.

PE

Fig 11. (right) connecting two modems back to back.
Fig 12. (above) dialling timing waveforms.



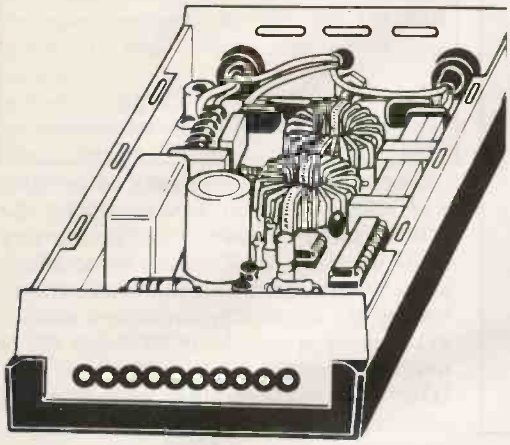
THE DREAM MACHINE ▷



Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a deep, refreshing sleep.

For many the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to act out your most secret wishes and fantasies. With the Dream Machine anything is possible.

DREAM MACHINE PARTS SET **£22.77**



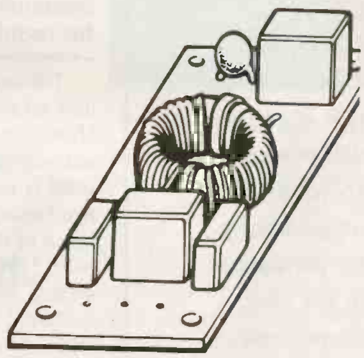
◁ POWER CONDITIONER

You don't have to be a hi-fi nut to notice the huge improvement in sound quality when you run your music system from a clean mains supply. How do you describe the difference? It's as if all this time your favourite artists have been playing and singing inside a wardrobe . . . and someone just opened the door and let them out. You could spend twenty times as much on special cables, plugs, mats and stuff without achieving a tenth of the difference. But don't take my word for it. Try it for yourself.

The sophisticated circuitry of the Power Conditioner begins with a bank of six VDRs to eliminate impulsive spikes. Then comes a massive filter with thirteen capacitors and two current-balanced inductors to smooth away every trace of noise and interference. A ten LED logarithmic display flicks up and down as each spike is eliminated, and gives a second by second account of the interference removed. Maximum load 1.5kW.

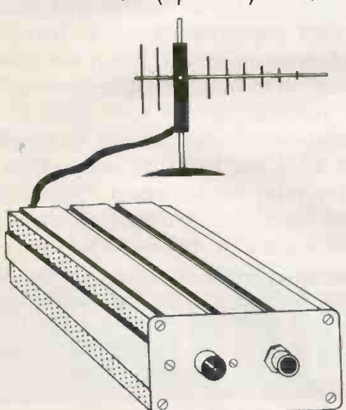
POWER CONDITIONER PARTS SET **£34.27**

MAINS CONDITIONER ▷



A general purpose workhorse for cleaning up the mains supply to computers, hi-fi, television sets, and any other electronic equipment that might be disturbed by mains interference. The solid, no-nonsense circuit will handle loads up to 1kW, and the PCB can be built into the equipment to be protected or housed in the optional case.

MAINS CONDITIONER PARTS SET (no case) **£6.21**
RUGGED CASE (optional) **£2.07**



◁ AERIAL BOOSTER

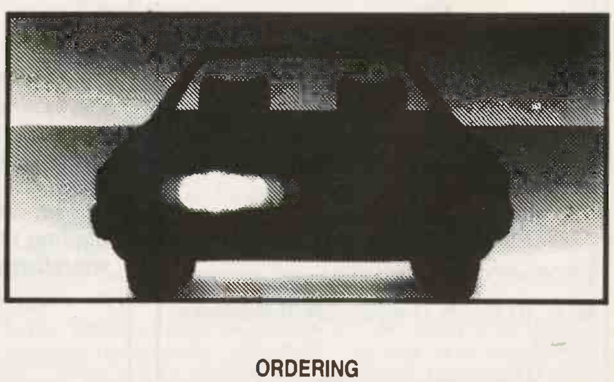
Good TV pictures from an indoor aerial, from a caravan aerial, or in areas of poor reception. This booster ranks with the very best, giving wideband operation from 10MHz to 1.4GHz (it will boost FM radio signals too), mid-band gain of up to 26dB, and a wide supply voltage range of 9V to 26V. It will run from car batteries for caravanners, dry batteries for campers, or a battery eliminator for use in the home.

There are two parts sets for the project. AA1 gives you the PCB, hybrid amplifier, components and instructions. AA2 is the optional case set: rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

AA1 PARTS SET **£14.72** AA2 PARTS SET **£5.52**

KNIGHT RAIDER ▷

The ultimate lighting effect for your car. Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip another switch and the point becomes a bar, bouncing backwards and forwards along the row. Now try one of the other six patterns. An LED display on the console lets you see what the main lights are doing.



The Knight Raider parts set contains the case and all components for the control box. The pattern generator and lamp driver is supplied as a PCB with all components for you to mount anywhere convenient. We supply the electronics, you supply the lamps (from any car accessories shop).

KNIGHT RAIDER PARTS SET **£28.52**

Specialist SEMICONDUCTORS LIMITED

Tel: (0600) 3715
SALES DEPT., ROOM 108, FOUNDERS HOUSE, REDBROOK, MONMOUTH, GWENT.

ORDERING
All prices include VAT
UK orders: please add £1.15 postage and packing.
Eire and overseas: please deduct VAT and add £5.00 carriage and insurance.

ACCESS
Phone 0600 3715 for immediate attention to your Access order.

COMPUTERS

Does it all add up? Yes, and the rest as well. From Ascii to Zilog, this is the computer story, told by Mike Sanders.

What is a computer? That which computes of course. So is a pocket calculator a computer? No, computers are accepted as being capable of more than just adding or multiplying two numbers. Computers are expected to be able to run programs with 'branch' or 'jump' instructions, displaying greater intelligence than a calculator. However, there are programmable pocket calculators and these may be classed as computers.

With a whole range of computers springing up in the last ten years it is difficult to distinguish between microcomputers, minicomputers and computers. Going by the word size they can handle, minis and micros use word sizes of 8, 12 and 16 bits. Medium sized computers use 16, 24 and 32 bits and large computers 64 bits. However, with personal computers (pcs) becoming more and more powerful, the dividing line is becoming less noticeable.

Another interesting difference between computers is the difference between the Harvard class of computers and the Von Neuman (or Princeton) class. Both have input/output peripherals, memory, arithmetic units and control devices. But whereas the Harvard class allocates separate portions of memory for instructions and data, the Princeton (built at Princeton University) stores instructions and data in the same form and in the same portion of memory. This means that instructions can be treated as data and the machine can modify its own instructions, which is a very powerful tool for complex operations like space missions.

Microprocessors are stripped down versions of microcomputers. Although they have memories and arithmetic units, they do not as a rule have an input device, eg a keyboard, or a separate output device, eg printer. They are usually programmed in machine code (ones and noughts) as opposed to high level language (statements in English). They usually have a dedicated function like controlling the wash programmes in a washing machine or controlling the central heating boiler.

HISTORY OF COMPUTING

The abacus was probably invented in several countries around 1500 BC. All goes quiet after that for a long time while people were happy to count beads. It took 3000 years before John Napier invented the logarithms in 1614 AD and the slide rule appeared soon after.

Babbage's analytical engine was designed in 1832 but never completed because the technology could not cope with the ideas. The famous Collosus designed by Newman, Flowers et al used 1500 valves and was built in 1943 at Bletchley Park for decoding German messages. The US military built the UNIAC in 1946 and its 18000 valves used about 150kW of power.

Manchester and Cambridge universities were both developing computers and so were the American universities. In 1952 the Von Neuman machine appeared and in 1963 IBM introduced its famous 360 series which is still going strong.

Then microprocessors started arriving. In 1971 Intel produced their 4004 and 8008 which were 4-bit and 8-bit microprocessors respectively and in 1973 the 8080, an improved 8-bit processor. Not to be outdone, Motorola introduced their 6800 the same year and Zilog, the Z80 in 1975. Today, most home computers and business machines are built around these popular processors: 8080, 8085, Z80, 6502, 6800.

In 1978 the Commodore Pet appeared and around that time all the popular machines that we are familiar with: the Sinclair range, the BBC micro, Acorn, Electron, etc. Knowledge and technology increase on an exponential scale. So, what next?

COMPUTER ARCHITECTURE

In order to function satisfactorily, a computer needs four parts, broadly speaking, as shown in Fig. 1. Basically a central processing unit (cpu) is responsible for all the arithmetic operations and needs a memory for storing results, partial results, raw data and even the program to be run. An input interface is required for loading the program

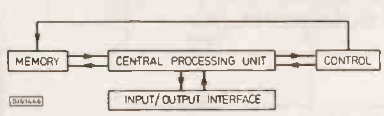
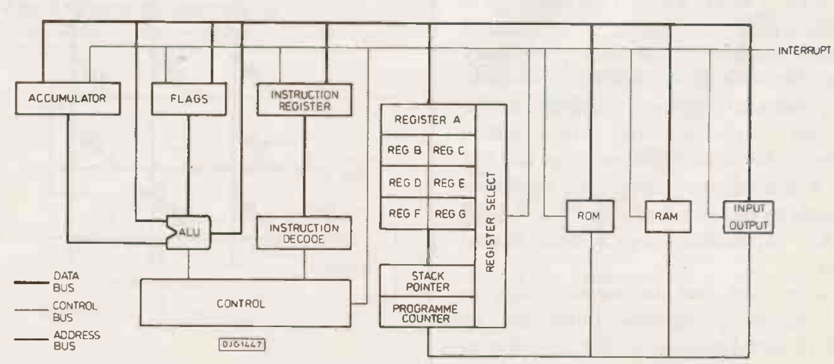
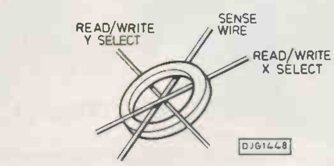


Fig 1 (left). Computer basic block diagram.
Fig 2 (below). A computer in more detail.





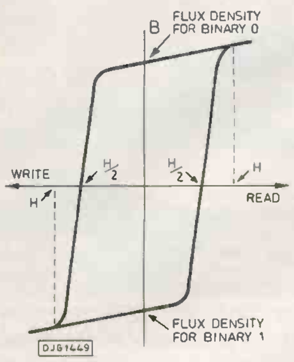


Fig 3 (top). Ferrite core.
Fig 4 (bottom). Hysteris loop.

and data, and an output interface for obtaining the results. Co-ordinating all these activities is the control unit which opens and shuts gates as required so that data reaches its intended destination.

Fig. 2 shows a more detailed arrangement of the processes within a typical small computer. All the parts will be dealt with in detail and any that do not fit into a particular category will be discussed subsequently in Computer Architecture II.

MEMORY

A computer's physical size is taken up by memory mainly and it is interesting to compare the different kinds: old and new, volatile and non-volatile, internal and external. Memory can be external like discs, punched cards, magnetic tapes, etc., but here, only internal memories will be examined.

Modern memories are semiconductor types which can be volatile or non-volatile. Diodes are passive and non-volatile. On the other hand capacitors are volatile since the charge leaks away and needs to be refreshed. In large scale integration (lsi), thousands of transistors can be formed on a chip and the capacitance associated with each can be regarded as a memory device. This capacitor holds a logic 1 when charged up and logic 0 when discharged.

Silicon sapphire cmos (complementary symmetry mos) is the fastest of the mosfets. Dynamic and static memories are alternative terms for volatile and non-volatile respectively. Dynamic mos costs less and has a lower heat dissipation than other memories but it needs to be refreshed every 150 - 2000 µs. This is achieved by a time shared amplifier.

Memories can also be serial access or random access. Magnetic tapes are an example of serial access, ie, the tape has to run from the beginning till the required point is reached. A matrix would be an example of random access since only the x and y co-ordinates need to be specified in order to access a particular element (cell) of memory.

Old memory systems used rotating magnetic drums and there are still computers around with ferrite core memories. Reading the information in memory is destructive, ie, reduces it to zero, so a write after read function needs to be built in. Fig. 3 shows a ferrite core with the read/write wires and Fig. 4 a hysteresis loop. A wire carrying current and surrounded by magnetic metal will generate a loop such as in Fig. 4 where B is flux density and H is magnetomotive force. This loop is read by the sense wire and a large flux is sensed in reading a 1, typically the kind of flux generated by 50mV. A 0 will be sensed by the kind of flux generated by 10mV.

Since the x and y wires thread every core, an inhibit wire is required to cancel the read current through the unwanted cores. Write after read is accomplished by reversing the currents in the x and y wires which reduces the number of wires and amplifiers that would otherwise be required.

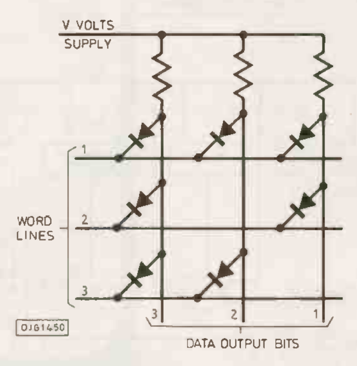
READ ONLY MEMORY (ROM)

As the name implies, reading is allowed but writing into this position of memory is not allowed. Roms used as look up tables, like converting Hex codes to binary or for reading values of contents like II. Memory size is in terms of bits or bytes where 8 bits = one byte (and 4 bits = a nibble). Often memory sizes are stated in terms of kilobytes where kilo does not have the usual 1000 equivalent but 1024 (210) and has the symbol K.

Roms can easily be implemented using diodes as in Fig. 5. Table 1 shows the effect of earthing any of the word lines: the diodes conduct giving a 0 output. Only where a diode is absent is the supply voltage available which represents a logic 1.

It follows from the above that information cannot be written into this device for temporary storage, hence read only facilities.

Fig 5. ROM matrix.



RANDOM ACCESS MEMORY (RAM)

Random access memories are faster than sequential access and are therefore used in modern computers. A typical home computer has a memory between 1K and 64K words (bytes) with cycle times between 300ns and 3000ns. Cycle time is the time that it takes to read a word from memory and rewrite it back into memory. Some operations require three or four cycles and cycle time is a useful unit for calculating how long a series of operations will take.

Rams used to be synonymous with ferrite core stores but semiconductors have taken over. However the method of selecting a particular memory location using x and y co-ordinates is still the same (Fig. 6). In addition, there is an arrangement to specify whether reading or writing to memory is required.

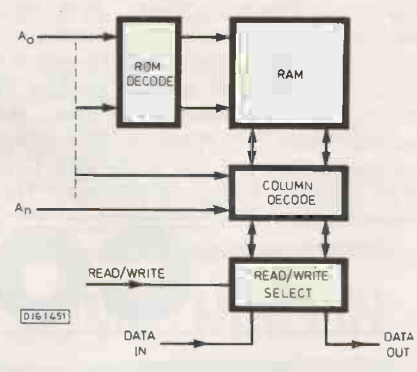


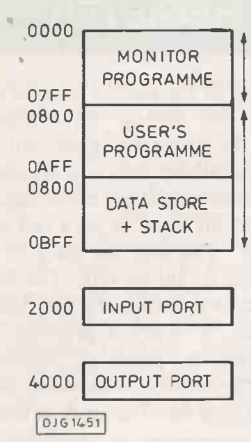
Fig 6. Accessing a RAM.

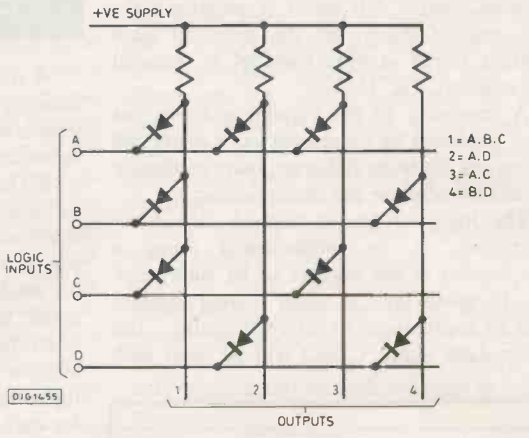
A 1K memory arranged as 4 bit words would have 256 different locations (256 x 4 = 1024). For each reading and writing, four lines are required. A chip select line is required for selecting the particular chip if there are several. Together with power supplies and read/write select this is a total of about 20 which can be met by a standard dual in line (dil) package of 22 pins.

Fig. 7 shows the memory map of a small memory where 2 Kbytes is devoted to rom and 1 Kbytes to ram. The input port is at address 2000 and the output port at address 4000. The monitor program scans the keyboard for inputs and also serves the vdu. In hex code the monitor occupies address 0000 to 07FF and the user area on the ram is from 0800 to OBFF.

PROGRAMMABLE ROM (PROM)

Standard roms manufactured in a factory use a mask for producing the right pattern. Also fets can be used instead of diodes. If the metalisation is left out on the source, drain and gate, this produces a high impedance giving a logic 1.





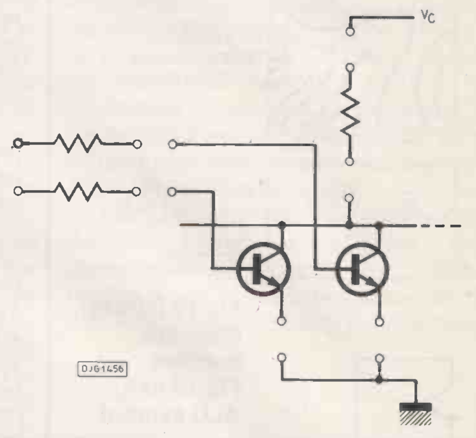
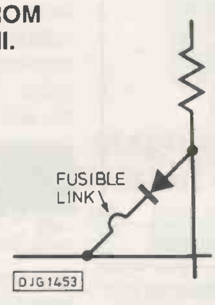
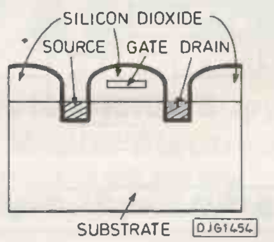


Fig 7 (above). Memory map.
Fig 8 (bottom). Programmable ROM
Fig 9 (bottom right). Memory cell.
Fig 10 (top middle). PLA.
Fig 11 (top right). ULA cell.





Roms can also be prepared for programming or 'burning' in the field. Fig. 8 shows the arrangement. A fusible link is burned by a pulse of current between 50 µA and 100µA for 2 µs. In this way the required pattern can be created but it is tedious and if a mistake is made the chip is spoilt.

In addition to programmable roms there are erasable roms which can be reprogrammed. These are of two kinds, those that use ultraviolet light and those that use electrical pulses - electrically alterable rom (earom).

The ultraviolet type (sometimes called uvprom) can be fabricated from an array of p-mos with floating gates, all in the non conducting state, logic 1. Applying a voltage between source and drain removes positive carriers from the gate leaving a negative charge which makes the source drain conductive. Applying a reverse voltage to cancel this would damage the device. Instead, ultra-violet light is applied for 10-20 minutes and for this operation, the chip needs to be removed from the computer or any other equipment it serves. The ultraviolet in sunlight or fluorescent lighting has no effect on these chips.

In order to respond to ultraviolet light the chip is equipped with a transparent quartz window. The ultraviolet ionises the gas inside the seal making the silicon dioxide slightly conductive and the charge leaks away (Fig. 9).

Early designs of memory arrays used memory cells containing all zeros in the unprogrammed state and the charge was used to turn the cell ON (logic 1). Present day memories contain logic 1 and the gate charges causes 'pinch off', logic 0 in the programmed state.

The ultraviolet type is inconvenient for several reasons. Ultraviolet can harm the eyes and skin, and ozone is also produced which is explosive. The main drawback of the uvprom is the fact that it needs to be removed from the equipment while the electrical type can be altered without removal. These are of two kinds: nitride insulated gates or field avalanche mos (famos) and require 30-40 volt pulses.

The nitride type has a read time of 2-5 µs which is not particularly fast but, since the charge leaks away so slowly, it can be classed as non-volatile and therefore offers almost infinite storage.

PROGRAMMABLE LOGIC ARRAY (PLA)

In some instances not all 2^n words of a rom may be required, converting a 12 bit Hollerith code into an 8 bit ASCII. In this case only 96 combinations are required out of $2^{12} = 4096$ since the Hollerith code has a high content of redundancy.

The pla is an arrangement of programmable AND gates driving programmable OR gates and the above code conversion requires a pla of 768 bits (96 words x 8 bits per word). An address decoder is also required which increases this to 3072 bits. Compared to this an equivalent rom would require 32,768 bits. For a pla to be economical, it needs to be able to reduce the rom equivalent by ten times and this application does exactly that.

Fig. 10 shows a simple example of pla which is available as both mask programmable or field programmable. Fig. 10 shows AND gates but OR gates are equally possible if a negative supply is used and the resistors are placed in the cathodes.

UNCOMMITTED LOGIC ARRAY (ULA)

In the pla, the memory array nodes are altered but if it is possible to alter the array interconnection, then an uncommitted logic array is created. This achieved as in Fig. 11 by creating the resistors and transistors but not the interconnections.

Since modern integrated circuits are manufactured by diffusion into a silicon slice with metalisation on top for interconnection, the metalisation can easily be left out until the customer specifies his requirements.

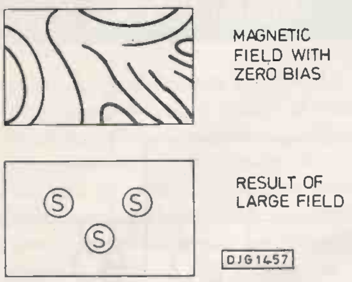
MATERIALS FOR MEMORIES

We have looked at old materials like ferrite cores and magnetic drums which have been replaced by newer types: semiconductor ttl and mos. In addition to these there are other materials of interest: plated wires and magnetic bubbles.

Plated wires have a thick film of magnetisable material deposited on wires. On this film, small zones of memory are created. As memory devices, plated wires are good since they are non-volatile and therefore non destructive. However, it is difficult to obtain materials of a uniform quality and production methods need improvement.

Magnetic memories went out with the ferrite core but scientific principles rarely die and quite often crop up as a different vegetable, in this case magnetic bubbles. Garnet crystals as thin as 10 µm can support 1500 bubbles per square millimetre and this is achieved by applying a magnetic field perpendicular to the crystal.

At a certain critical value of field strength the usual domains of a magnetic material break down into bubbles, each of which can be thought of as a separate magnet with north and south pole, Fig. 12. Since like poles repel, each bubble will repel its neighbour so there will be a limit to the packing density.



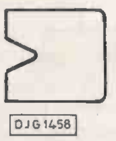


Fig 12 (above). Magnetic bubbles.
Fig 13 (left). ALU symbol.

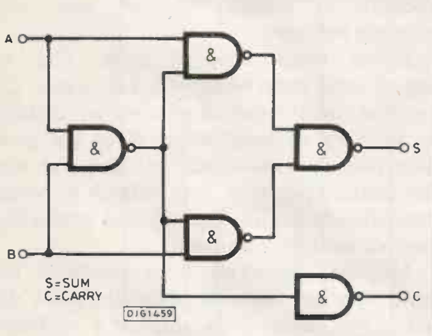
CENTRAL PROCESSING UNIT (CPU)

Basic to the central processing unit is the arithmetic and logic unit (alu) whose symbol is shown in Fig. 13. The cpu consists of alu plus registers. As the name indicates, the alu is capable of both arithmetic operations in binary as well as the logic functions AND. OR, etc.

The four arithmetic operations can all be carried out by a single circuit, an adder. A half adder using NAND gates is shown in Fig. 14 and the outputs in Table 2. From this table it can bee seen that it is similar to an exclusive - OR circuit, S = A + B and C = A.B.

This is called a half adder since two such circuits make a full adder, Fig. 15, in which the carry digit is taken into account from the previous stage of addition. A single full adder of this kind could add two digits at a time and is called a serial adder. If parallel addition is required, then a full adder is employed for each pair of digits and the result of each addition stored in pipo (parallel in, parallel out) registers, Fig. 16.

Fig 14. Half adder.



A drawback of the parallel adder is the delay produced by successive carry digits and computers use more elaborate, more expensive circuits for addition and multiplication.

The logic circuits mentioned also allow subtraction to be implemented using a complement of the number to be subtracted. Fig. 17 shows how an adder is used together with an accumulator to store the results. The accumulator status CZNO will be dealt with later.

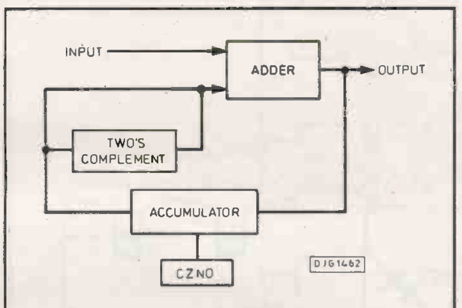


Fig 17. Subtraction using an adder

With reference to Fig. 2, it can be seen that several registers are associated with the cpu. Registers A to G can be used singly or in pairs, both for storing data temporarily or in conjunction with the memory for referring to a particular address in memory location. Notice the accumulator for temporary storage in the input to the alu.

PROGRAM COUNTER

The program counter has an obvious application and as with most obvious applications it is taken very much for granted. However, it cannot be dispensed with since some method is required to keep track of the program steps and the end detected by means of an END statement. What is even more important is the need to point to the next program step when the program is interrupted in order to go into a subroutine. The program counter (pc) points to the step to return to when the subroutine is completed.

If a program can be considered as a big job then a subroutine is a small job, complete in itself, within that big job. For instance while building a house, there will come a time when all the electrical wiring needs to be run before returning to the main task of building the house.

STACK REGISTER

A stack is a group of registers or an area of memory reserved for storing information temporarily while the program goes into a subroutine. A stack pointer (sp) is a register which holds the address of the top of the stack in binary. Access to the stack is on a last-in, first-out basis (lifo). Think of the stack as a pile of tins each with its lid on top. The top tin needs to be removed before one can look inside the next tin. So when a program is interrupted in order to jump to another location and perform another calculation, the registers need to be cleared. The stack is used for such dumping.

If one is programming using mnemonics, the instruction is PUSH, which pushes information onto the stack. To retrieve the information, the instruction is POP and of course the stack needs to be popped in reverse order. The stack pointer merely tells how full the stack is, as shown in Fig. 18.

STATUS REGISTER

In performing calculations, certain important limits need to be observed. For instance, the operator will want to know when a calculation results in a carry (C) digit, negative (N) value, zero (Z) or overflow (O). Carries often occur in additions, a negative value in monitoring a condition for less than a set value, zero in counting down. For instance if a calculation needs to be performed ten times, a counter is set to ten and the zero condition detected when the counter runs down.

Overflows often occur if two large numbers are multiplied and some indication needs to be given to the human eye that the answer is not correct.

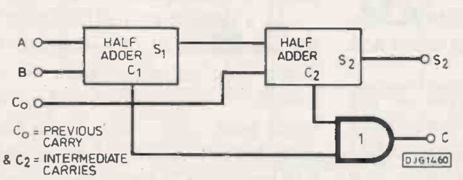
All these conditions can be flagged by flip-flops in a register, Fig. 19. The flag goes up if any of the zeroes changes to a one.

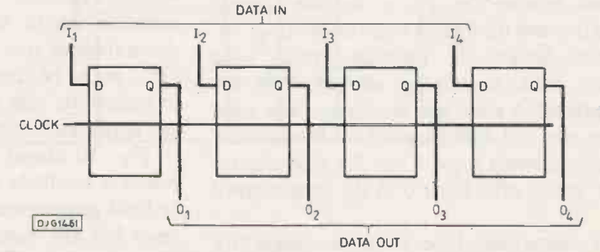
INSTRUCTIONS

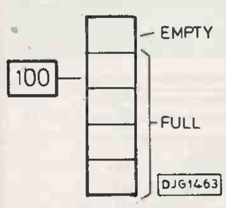
Each step of a program is called an instruction. These instructions are read from memory or any other device, sequentially into an instruction register.

An instruction cycle consists of one or more machine cycles and each machine cycle consists of two sub-cycles: 1) Fetch cycle 2) Execute cycle. During the fetch cycle, the cpu provides the address of an instruction via the

Fig 15 (below). Full adder.
Fig 16 (right). PIPO registers.







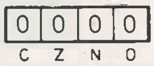


Fig 18 (left). Stack pointer. Fig 19 (above). Status Register.

address bus. The address is decoded by the memory and the instruction read from memory into the cpc via the memory data bus.

During the execute cycle, the instruction is decoded by the cpu and the required operation is performed. So it can be seen that during the instruction cycle, two kinds of words are being processed: instruction and data.

There are five different kinds of instruction which are found in programs: 1) data transfer; 2) control and branch; 3) subroutine linking; 4) operations; 5) input/output.

1. Data Transfer: This may involve instructions like Move, Load, Store and Exchange, either to a register or memory.

2. Control and branch: These involve Halt, Jump or conditional Jump. The jump instructions may involve the C,Z,N,O flags. At the Jump instruction the program will always jump to the subroutine before returning to the main program but the Conditional Jump depends on a condition pre-set by the programme, if the sum is greater than 100 or the remainder less than 0.001.

3. Subroutine linking: Call subroutine and return to main program at the end of it.

4. Operation: Arithmetic and logic operations. Clearing accumulators, incrementing/decrementing counters, shifting register contents to left or right. Also performing 1's complement and resettting C,Z,N,O flags.

5. Input/output operations: are self explanatory. They involve taking in or outputting information to the world outside the computer. The outside world, or peripherals, are those companions friendly to the computer: the vdu, line printer, tape, floppy disk, etc.

PROCESSORS IN GENERAL TERMS

It is useful to gain an appreciation of microprocessor chips in order to compare their performance against each other, for the purpose of selecting a computer that uses a particular chip or selecting a particular chip to perform a specific task.

The Intel 8008 was the first 8 bit commercial microprocessor in 1971. Two years later the 8080 appeared and the 8085 is therefore the third generation. The 8085 is faster than the 8080 and requires fewer support chips.

The 8080 requires a clock generator and system controller which are built in features of the 8085.

The Motorola 6800 was the first competitor of the 8080 and its followers. Sometimes comparing one processor against another can get complicated. For instance, a processor with a faster clock may be expected to be faster than one with a shower clock. Not necessarily so. The 6800 with 1MHz clock is actually faster than the 8085 with 3MHz clock simply because the 6800 needs only one clock cycle for a memory operation while the 8085 needs three to six clock cycles to open and shut the gates.

The 6800 has other interesting features. It has relative and indexed addressing in addition to direct addressing. Addressing will be dealt with later, but briefly: direct addressing refers to a register or memory location by name, Reg A or 0800H (memory location in hex code).

For indexed addressing, the 6800 has a 17-bit register called an index register which is useful for transferring blocks of data. In relative addressing, an address relative to the current instruction is stated enabling the operator to jump forward or backward by several addresses.

As mentioned before, processors using 4 bit, 8 bit, 12 bit and 16 bit words have been on the market. Many control applications do not require 8 bit processors; 4 bit is adequate. The big difference between 4 bit and 8 bit processors is that 4 bit processors use separate memory for data and instructions (program). The data memory is usually 4 bits wide but the program rom is 8 bits wide. The instructions require 8 bits since 4 bits can provide only 16 different instructions. The 4 bit processors are limited, then, by instructions.

The 16 bit processors on the other hand have been limited by number of pins in a package and the chip layout. The 8 bit processor is a happy medium except where 16 bit precision is required in calculations.

Finally, we come to bit slice processors which are chips of small words (say 4 bit). These can be stacked together to give the required length of word; three will give 12 bits. The disadvantage of bit slice processors is that the programmer must write the instruction set, and this is called microprogramming. Such an investment in time and effort can only be justified for special applications like high speed control or digital signal processing. In general, processors are built from mos but bit slice processors are bipolar transistors, which means they are faster and consume more power.

CHOOSING A PROCESSOR

In 1971 there were only two kinds of microprocessor; today there are 50. Rather than list the merits and demerits of each, it is useful to bear in mind certain essential features. This is useful both in purchasing a microprocessor for a specific task or selecting a computer depending on the cpu it uses.

In general, the larger the cpu, the greater the processing power. If the cpu has few registers, then memory space will have to be used by functions normally handled by registers. A stack will be limited if integral with a processor and a stack is better off as part of a ram. A clock may or may not be part of a microprocessor and if it is not then a separate chip has to be purchased. All clocks use an external piezo-electric crystal for deriving the clock frequency.

Having dealt with the cpu, one needs to consider access to it. How many bits wide are the data and address buses? Are they multiplexed, do they share the same highway? How many different kinds of address mode are available?

The number of ics to make a complete system needs to be considered. For instance, a salesman can state a minimum configuration of two chips but the fan out could be so poor as to require another two chips as buffers. Once again, if the processor is required to drive ttl circuits, then it needs to be ttl compatible.

A microprocessor may not have all the flags. Also, the number of interrupts available may be limited. Interrupts will be dealt with later.

Last but not least, the speed of a microprocessor is around 100µs so if a speed of faster than 100µs is required, then hardwired logic is required. This saves time over a processor which needs to read data and instructions in and out of registers and memories thus making a computer controlled arrangement slower.

INPUTS

Inputs to a computer can be from a keyboard, magnetic tape, paper tape, punched card or disk, or a plethora of specialised electronic control devices. Paper tapes and punched cards are similar in that they have holes of varying sizes to represent a code. This code is read by pins protruding from a read head and the mechanical action is converted to an electrical signal. These holes can also be scanned by a beam of light and the optical signal converted to an electrical one. Either way some form of transducer is required to convert from one form signal to another.

DISKS

Whereas paper tapes and magnetic tapes are accessed serially, from the start and moving until the required point is reached, disks can be accessed at random. The disk has a drive hole, where the drive mechanism connects and revolves the disk until a beam of light shines through the optical reference hole. This is the reference point at which the floppy disk starts. In response to coded instructions, the disk revolves the required distance forward and the read head aligns on the correct track outwards from the centre, without having to read every track.

Next month we'll continue looking at disks then move on to architectural matters.

PE

SWITCHED EEPROM PROGRAMMER

At last – Malcolm Harvey presents a low cost programmer for the occasional constructor!

Last month I looked at how some standard 2048 words by 8 bits eprom devices might be replaced by eeprom and lithium battery-backed devices that do not require an additional erasing unit. I went on to describe a simple keypad operated eeprom programming unit with alphanumeric readout displays.

This month I shall now describe an even simpler programming unit that uses hex-switched address and data coding, and a binary coded led strip for the read out. Following that unit, I shall show how either of the two programmers can be converted for programming standard eproms of up to 4096 words by 8 bits.

As I explained last month, in order to program an eeprom or similar, we need facilities which will allow us to specify an address code, a data code, and the read or write mode, together with a visual readout.

SWITCHING

In this month's circuit, as diagrammatically shown in Fig.1, we have two switches, S1 and S2, which define the data code to be entered into the eeprom. Three more switches, S3-S5 define the address within the eeprom at which the data will be stored.

Since this circuit is intended as a very cheap solution for those who may only occasionally wish to program an eeprom device, I have chosen the lowest cost switches that I could find. These are printed circuit mounting switches with which a small screwdriver is used to turn the switch to the correct position. The switches have a single common pin and four additional pins which are connected to the common pin in a fashion which allows them to be arranged to produce a binary relationship for the numbers 0 to 15. Instead of being coded from 0-15, the face of the switches is marked with the hexadecimal coding of 0-9 and A-F, consequently the hex codes required for easy programming can be readily selected.

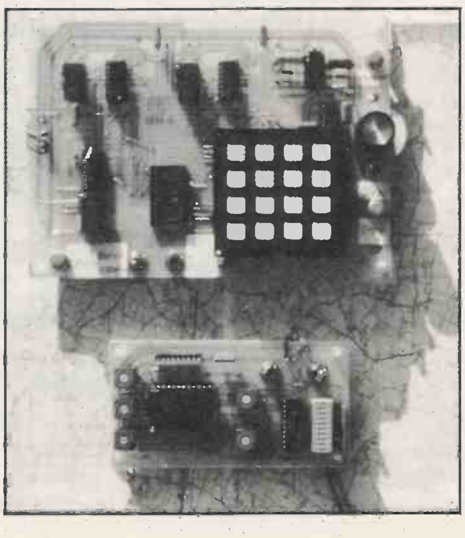
DATA PORT

In Fig.1, the eeprom is designated as IC1, and you will see that the data switches are connected to the eeprom's eight data input-output lines. Likewise, and not unexpectedly (!) the three address switches are connected to the eeprom's address lines. Internally, the switches are basically on-off types which means that any output line which is not switched to the common pin is completely open circuit. The common pin of each switch is taken to the +5V power supply line, consequently any output pin connected to the common pin will also have +5V on it, so presenting logic 1 to the eeprom data or address port. However, since the switch pins unconnected to the common pin are effectively left floating, they need to be biased to ground so that the eeprom sees logic 0 from those lines. The biasing is performed by connecting a resistor from each switch output to the ground line.

A second consideration to be overcome on the data input-output lines is that when the eeprom is in read mode, the switches are shorting all relevant pins together, which of course will affect the code seen on the eeprom lines. The use of the diodes D1-D8 between the switch pins and the eprom port lines prevents this mutual feedback.

When programming the eeprom, S6 switches the common pins of S1 and S2 to the +5V line. It also disables the eeprom output lines, configuring them instead as input lines. The eeprom is normally held in read mode by holding its read-write connection, pin 21, at +5V via R5. Pressing S7 sets the eeprom into write mode, whereupon the data present from S1 and S2 is written into the memory at the address location set by S3-S5. When S7 is released, the eeprom reverts to read mode with the data now stored in it. In order to check that the data is indeed stored correctly, S6 is switched to ground, so disabling S1 and S2, and enabling the eeprom output.

Top: last month's simple keypad operated programmer. Bottom: this month's even simpler switch operated unit.



READOUT BUFFER

The validity of the eeprom data could, very laboriously, be read by a voltmeter connected in turn to each data line. The better method is to read off the data by means of some form of visual display.

You could, if you wanted, use the hexadecimal decoding readout leds shown with the programmer I described last month. Cost is the only reason I have not used them in this simpler programmer. The cheaper solution is to use eight separate leds, each displaying the logic status of the data lines. Unfortunately, we cannot connect the leds directly to the eeprom since it does not have enough output power to drive them while retaining its correct logic level. Consequently, we have to use a buffer between the eeprom and the leds, in this instance using a non-inverting octal device, IC2. The leds are connected to IC2's respective output pins, and then taken via buffer resistors to ground.

MODULAR PARTS

For convenience, I used resistor modules for most of the biasing resistors. They take up far less space than conventional resistors, and require fewer solder connections. Internally, the modules simply consist of a given number of resistors, one end of which each comes to an output pin. The other ends of the resistors are internally joined together with a single output pin. Hence an 8-resistor module has nine pins. On the modules, the common pin has painted dot alongside it. If you are really penny-pinching, you could use standard resistors in place of the modules, mounting them vertically in the positions on the pcb, then hard wiring the remaining leads together into a common connection.

Again for convenience, I used a multi-led module for the displays. You could equally well use individual leds instead. The module actually has ten leds within it, and is commonly known as an led bargraph module, but only eight of the leds are used.

BINARY DISPLAYS

When programming the eeprom, the fact that the readout display is in binary format is of no great significance since the programmed output data should be identical to the data from the switches. When setting the switches, you will see the equivalent binary code displayed on the leds then, after writing the data into the eeprom and switching S6 to eeprom display mode, you should still see the same binary code displayed. Should you simply want to

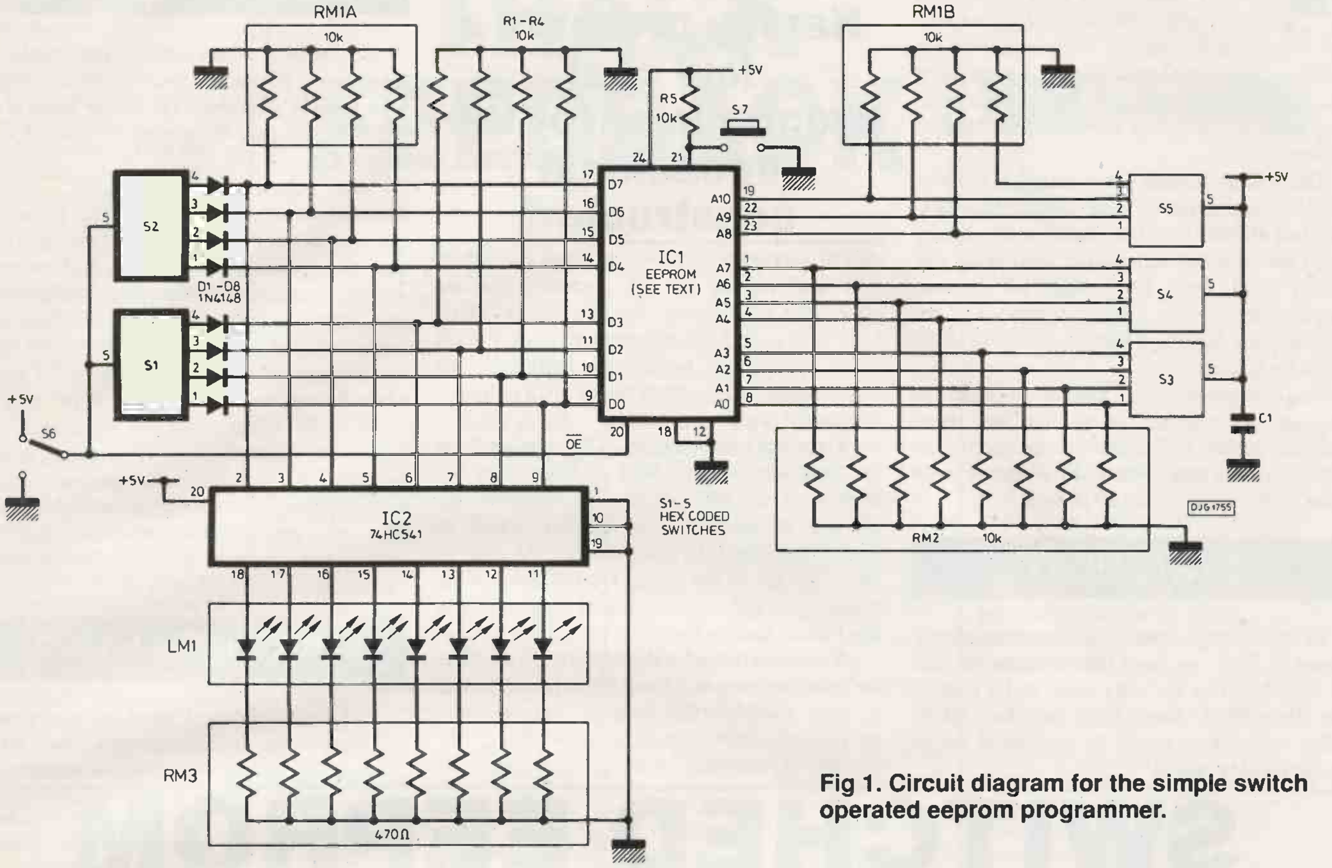


Fig 1. Circuit diagram for the simple switch operated eeprom programmer.

check the contents of the eeprom on some later occasion then it will be necessary to use a binary to hex conversion chart; only a minor problem considering the cost of this unit. If you find it is a problem, you can use the hex displays I mentioned earlier, wiring them on a separate board, such as a piece of Vero, driving them direct from the eeprom lines, so eliminating the need for IC2, LM1 and RM3.

Because eeproms and lithium battery-backed equivalents can be instantly reprogrammed at any address, if you make a mistake you can simply rewrite the correct data into that address point. You do not need to completely erase the device.

The unit must only be run from a 5V power supply; it draws about 90mA under maximum current drain conditions.

ASSEMBLY

As with last month's programmer, the switches are mounted directly on the pcb, the track and component layouts for which are shown in Fig.2. You should use a dil socket for the led module and IC2, and preferably use a zif socket for the eeprom. For my own convenience, I also used dil sockets for the hex switches and resistor modules, cutting them to suit the pin configurations needed.

A note of caution on the assembly: if you are in any doubt about the orientation of the led or resistor modules, check them out with a meter before soldering them in place!

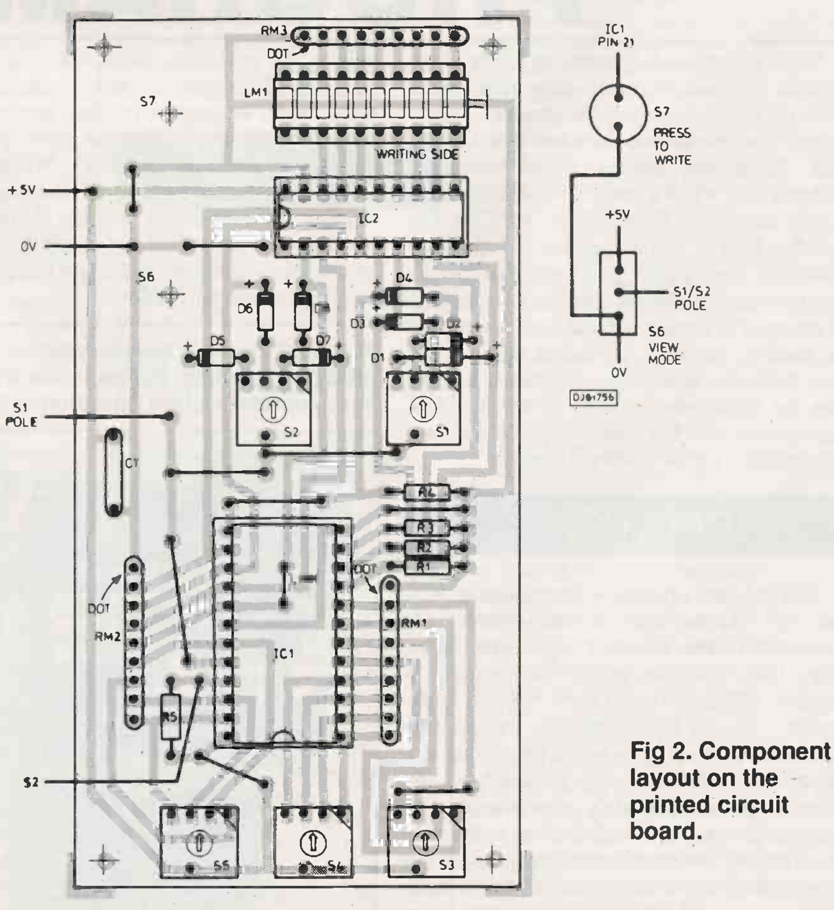


Fig 2. Component layout on the printed circuit board.

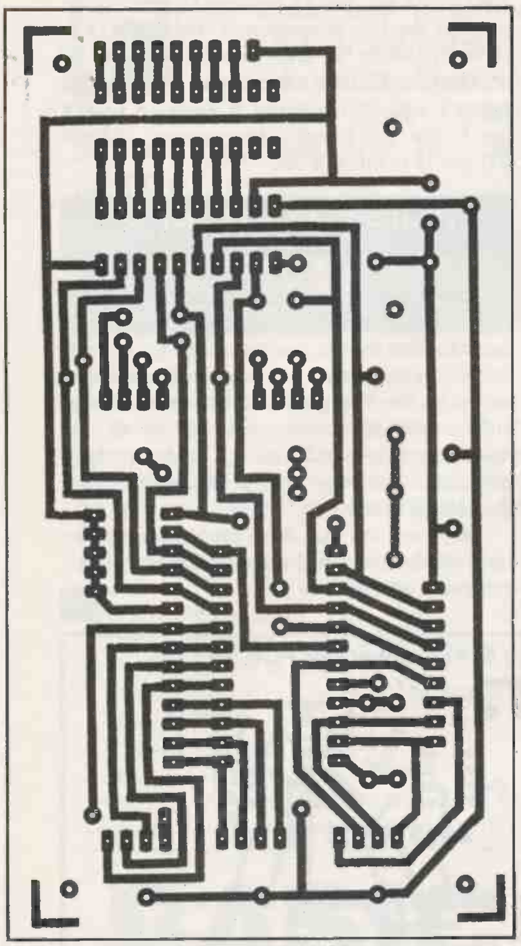


Fig 3. Switched eeprom PCB tracks.

It is quite likely that some PE advertisers may stock the hex switches and the modules, though I have not checked this out; my own, plus IC2, were bought from Electromail.

VPP CONVERSION

I have to confess that providing the facility for using either of the two units as standard eprom programmers was an after-thought! Consequently, the facility has been designed as a separate module. Its circuit diagram is shown in Fig.4. Regular readers will no doubt notice that it is a variation on part of the circuit used in my computer controlled 4K Eprom Programmer published in PE October 1987.

When programming standard eproms, the write control pin, usually marked as Vpp, is normally held at +5V, then toggled upwards to higher level voltage to 'burn in' the data, and then to be returned to +5V. The Vpp voltage required can vary with the type of eprom used, and I am aware of types requiring Vpp levels ranging from 12.5V to 25V. A general purpose eprom programmer must therefore be able to cater for a broad Vpp range.

Whereas in the Oct 87 circuit a high dc voltage was stepped down to the required Vpp level, and then down to +5V, for these two simpler programmers I am taking a basic +5V supply and stepping it up to the higher level.

SWITCHED PROGRAMMER COMPONENTS

RESISTORS

R1-R5	10k 0.25W 5% carbon film (5 off)
RM1, RM2	8 x 10k sil resistor module (2 off)
RM3	8 x 470R sil resistor module

CAPACITOR

C1	100n polyester

SEMICONDUCTORS

D1-D8	1N4148 (8 off)
IC1	see text
IC2	74HC541
LM1	10 x led dil module

SWITCHES

S1-S5 hex coded pcb mounting (5 off)
S6 min spco toggle
S7 min push-make

MISCELLANEOUS

20-pin dil sockets (2 off), 24-pin dil socket, printed circuit board.

VOLTAGE STEP-UP

Those of you who read George Kerridge's Battery to HT Converters articles in PE July and August 88 (and, I am sure, many more of you), will know that by using a frequency generator and a tuned inductive circuit, quite modest dc levels can raised to significantly higher voltages.

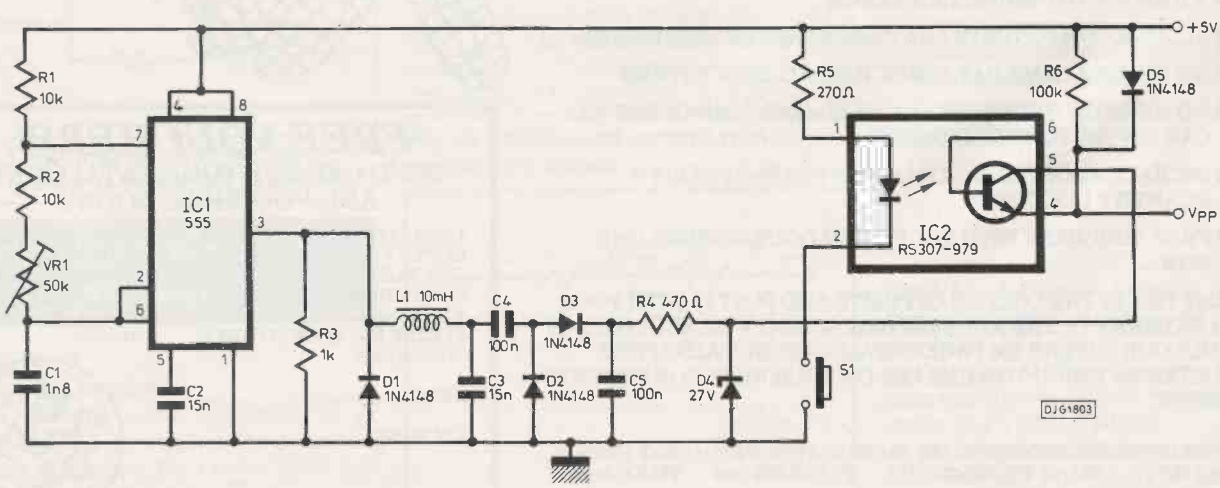
In Fig.4, a standard 555 timer is configured as the frequency generator. C1 sets the basic frequency, which is then adjustable by VR1. The squarewave output feeds into R3 and to the inductor L1 and its associated tuning capacitor C3. The ac voltage at the output of L1 is referenced to ground by D2, and then rectified by D3 and stored by C5.

The peak to peak output from L1, and thus the rectified dc level on C5, will depend upon two factors, the load seen by the inductor, and the frequency feeding into it. The closer the input frequency is to the tuned frequency of L1 and C3, so more power is transferred and a greater p-p output voltage will result. The tuning of the oscillator circuit can thus be used to set the final raised output dc voltage. Experimentally, with the circuit in Fig.3 and with the load following C5 omitted, I have achieved voltages well over 50Vdc. The maximum output required, though, is not likely to be over 25V, and so I have put in a safety limiter, R4 and zener diode D4, to restrict the output to no more than the value of D4. You could if you prefer, substitute a different value for D4 to suit your own needs.

OPTOCOUPLING

The control of the Vpp pulse is achieved by using an optocoupled device, IC2. Inside IC2 are an led and a photosensitive transistor. When current passes through the led, the phototransistor is turned on and conducts. Between them, R6 and D5 ensure that the transistor's emitter, which is fed to the eprom Vpp pin, is normally held at around +5V. When S1 is pressed, current flows through the led via R5, the transistor is turned on and the voltage stored on C5 is conducted to the Vpp pin, so

Fig 4. Circuit diagram for the VPP generator



VPP GENERATOR COMPONENTS

RESISTORS

R1, R2	10k (2 off)
R3	1k
R4	470R
R5	270R
R6	100k

All 0.25W 5% carbon film

CAPACITORS

C1	1n8 polystyrene
C2, C3	15n polyester (2 off)
C4, C5	100n polyester (2 off)

SEMICONDUCTORS

IC1	555
IC2	307-979 (Electromail)

MISCELLANEOUS

VR1	50k skeleton preset
L1	10mH inductor
S1	min push-make switch

Printed circuit board
8-pin dil sockets (2 off)

causing data to be written into the eprom.

Since the output from L1 depends on load as well as on frequency tuning, the charge on C5 will fall once the optodevice conducts. However, the charge will be at a high enough voltage sufficiently long to ensure that the eprom is programmed. As soon as S1 is released, so the charge on C5 will begin to build up again, and by the time you've manually set the address and data codes for the next byte, the voltage will be back up to its required level. In view of the delay required between each Vpp pulse, this is not a circuit suitable for putting under high speed automatic control.

VPP USING

To use the Vpp generating circuit with the simple switched programmer, delete S7 and R5 in that circuit, and take the Vpp output to the point at which S7 was connected, IC1 pin 21. To use the circuit with last month's programmer, delete S4 and R6 in that circuit and take the Vpp output to the point at which S4 was connected, IC3 pin 21.

(You could, alternatively, choose not to delete the resistors and switches just referred to, but instead change the resistor values to 100k, and then either delete R6 of the Vpp generator or increase it to about 1M.)

In order to use 4096 x 8 eprom devices in either of the programmers it is necessary to allow for an additional address line, A11, to be taken to the eprom. For eproms of the type 2532, 2732 etc, pin 18 is the A11 pin. As the pcbs for the two programmers stand, pin 18 is currently taken to 0V, it will therefore be necessary to cut the track at pin 18. With last month's unit, then connect IC3 pin 18 to IC4 pin 1. For this month's programmer, connect IC1 pin 18 to pin 4 of S5.

CHIP DATA CHECK

Before attempting to program any eprom with either of the two programmers you should ascertain that the pin configurations are correct, and also ensure that the correct Vpp voltages are set on the Vpp generator. The required Vpp voltage and pin connections will be on the manufacturer's data sheet, and a high impedance voltmeter should be used to check the voltage setting.

May you find that these programmers open up a whole new world of possibilities for your electronic interest. **PE**

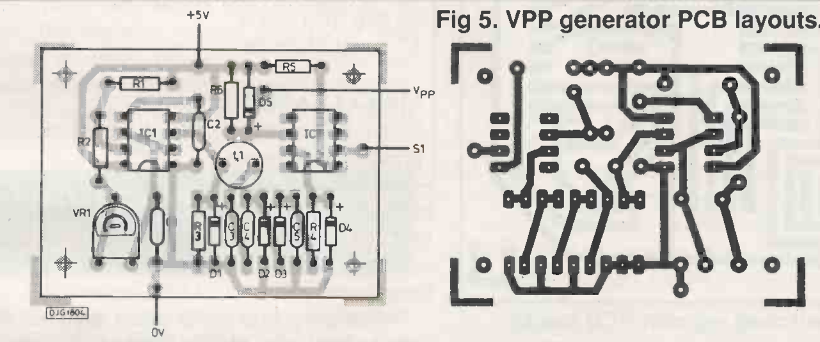


Fig 5. VPP generator PCB layouts.

Two for the price of one this month! (But, of course, PE always gives you great value for money!) What I show you here is a common filter circuit into which you feed a mono signal, and then wire up the three separate frequency outputs in one of two ways, resulting in either a simulated stereo circuit, or a three channel equaliser.

FILTERING

The filter circuit is shown in Fig.1 and is based upon one of my favourite chips, the LM13600. (You could also use the LM13700 without any circuit modifications if you wish.) The mono signal is brought into VR1, which enables you to preset the signal level. From there it goes into the opamp mixer stage, IC1a, on through two separate filter stages, and then fed back to IC1a. You might marvel that two filters can split the signal into three frequency bands, low, middle and high, but in fact it's not such a strange result because, of course, feeding the signal back on itself results in the third frequency band selection.

TCA

The LM13600 is a dual transconductance opamp (tca), of which the gain of each stage is controllable by the current feeding into the

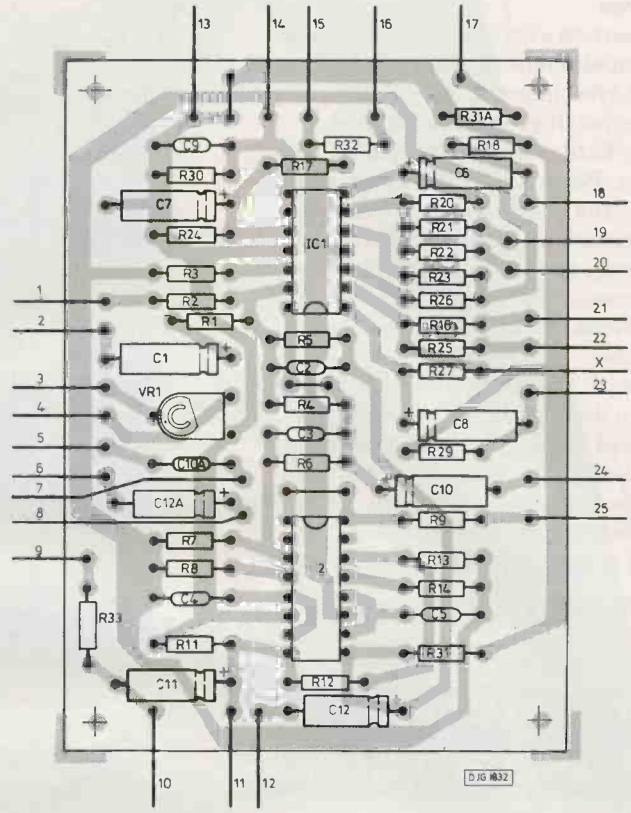


Fig 2. Printed circuit board layout.

MOCK STEREO

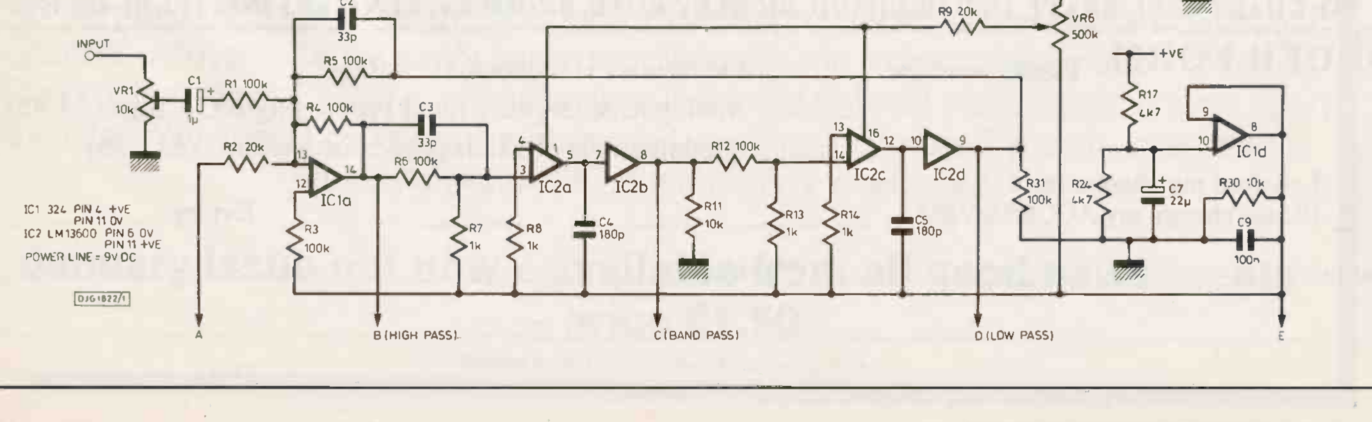
John Becker shows how to split your mono mods into three and double your audio listening perspective.

respective control node. In Fig.1 the two separate tca stages are IC2a and IC2c. Each tca stage also has a following high impedance buffer stage, IC2b and IC2d.

In the application here we can vary the current going into the control nodes via VR6 and R9. The controlling current has the effect of modifying the rate at which the capacitors on each tca output, C4 and C5, are allowed to charge up. As everyone knows (!) the rat e at which a capacitor charges and discharges determines how much of a given frequency will be mopped-up by the capacitor.

In the feedback configuration shown, the net result is that the high frequency end of the input signal is available at the output of IC1a, the middle (band pass) frequencies appear at IC2b's output, the low end of the spectrum emerges at output IC2d. There's no room to explain the maths, but it's a technique that works! By varying VR6 we can shift the entire frequency split up or down the scale.

Fig 1. The common frequency filter circuit diagram for both the mock stereo and equaliser units.



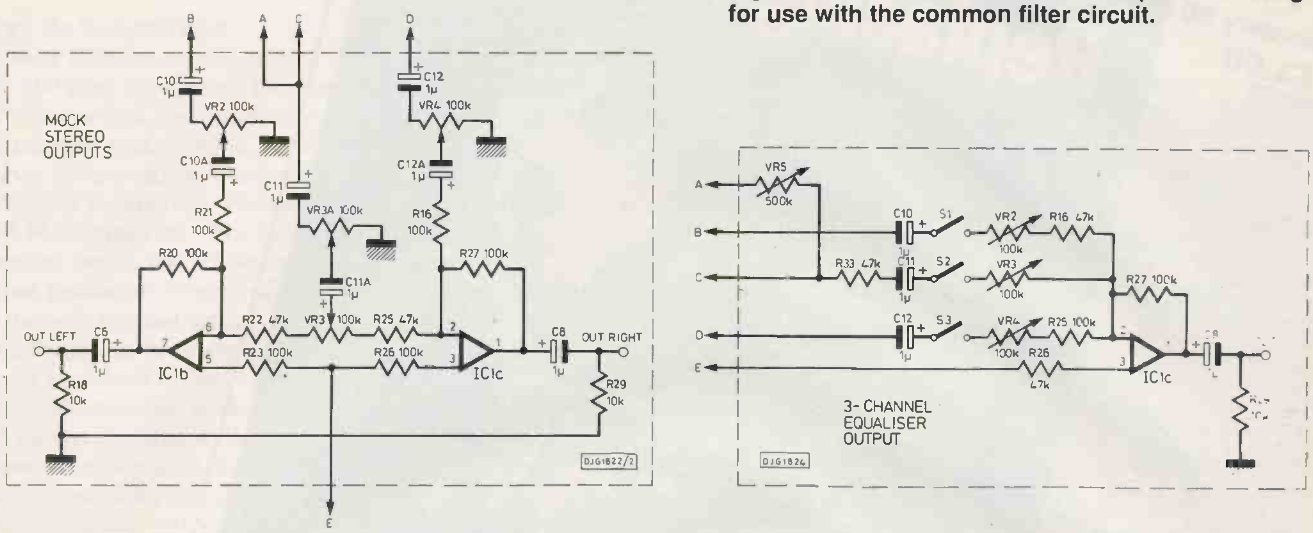


Fig 3. Circuits for the alternative output interfacing for use with the common filter circuit.

TRIPLEXING

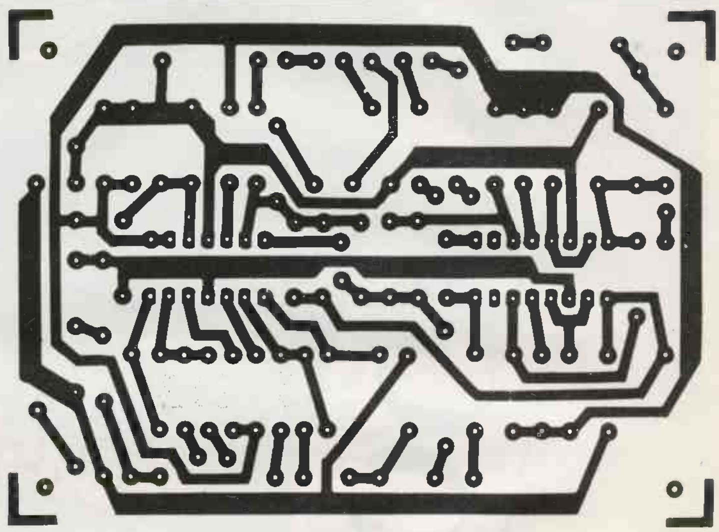
What we have achieved, of course, is three signals instead of one. What we do now is recombine them, as in Fig.3! Taking the mock st ereo option first, we feed the treble only to one output buffer amp, IC1b, and the bass only to buffer IC1c. So, left = treble, righ t = bass (or vice versa if you swap the connections). What about the mid range, do I hear you cry through the hole in the middle? No problem, we mix the bandpass signal equally into both left and right channels. I've also given you level and pan controls so that you can vary the relative signal strengths to each channel.

EQUALISED

Recombining the signals for equalisation purposes is even simpler. We just feed them into a common opamp mixer, varying the level of each signal to suit our tonal tastes. In this instance, I've nominated IC1c as the mixer, with VR2 to VR5 offering the panel control options.

All very nice and simple. Just build up the pcb, choose which wiring option you want from Fig.5, and join it!

Fig 4. PCB track layout, common to both modes of use.



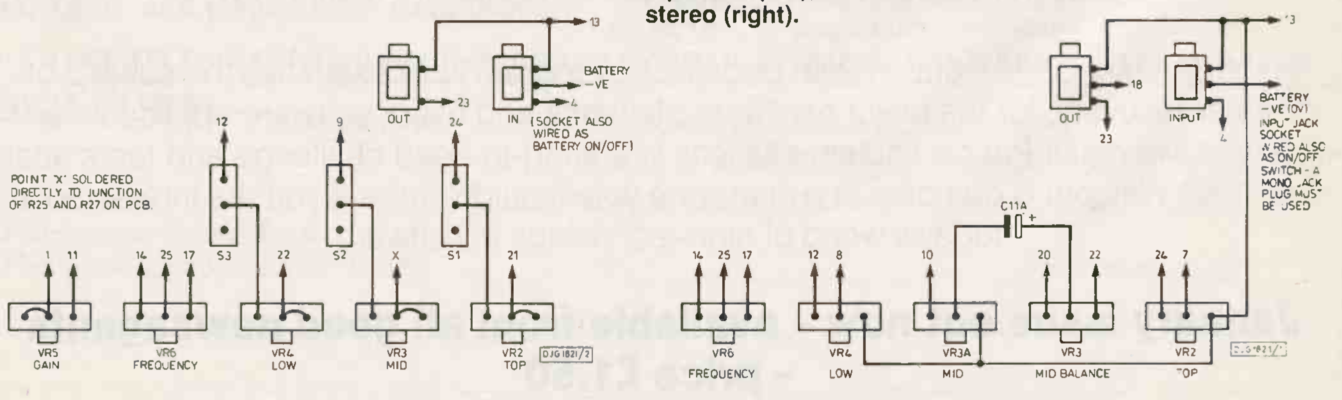
PARTING

Sorry, there's no space for a separate parts list, but all the values are given in the circuit diagrams. Resistors are 0.25W 5% cf, 'p' caps are polystyrene, 'n' caps polyester, 'u' caps electrolytic and all pots are linear. (PS, IC1d simply provides a split level reference voltage.)

Happy listening!

PE

Fig 5. Wiring details for the equaliser (left), and the mock stereo (right).



BASIC ELECTRONICS

PART TWO – MORE RESISTANCE

Volts and currents explained and illustrated – Owen Bishop offers more excellent advice on controlling your potential!

Fresh from last month's successful investigations, I expect you're keen to try some more: see what answers you can give to the next few!

RESISTANCES IN SERIES

Investigation 6
Resistances in series

You need the same equipment as in Investigation 5. Fig. 13 shows two resistors connected in *series*. The current flows through one resistor and then through the other.

Repeat Investigation 5 replacing the single resistor of Fig. 11 (last month) with two resistors connected in series. Measure the combined resistance of the two resistors and set out your results in a table:

Resistors (ohms)	Combined Resistance
100 and 150	
220 and 470	
etc.	

Can you work out a rule for calculating the combined resistance of two resistors in series?

Repeat the investigation with three resistors in series and try to work out a rule for calculating their combined resistance.

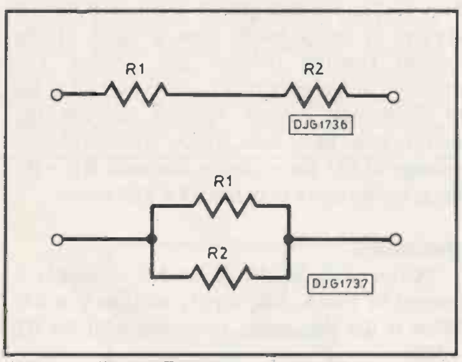


Fig 13. (Top). Resistors in series.
Fig 14. (Bottom). Resistors in parallel.

RESISTANCES IN PARALLEL

Investigation 7
Resistances in parallel

You need the same equipment as in Investigation 5. Fig. 14 shows two resistors connected in parallel. The current splits and part of it flows through each resistor.

Repeat Investigation 5 replacing the single resistor of Fig. 11 with two resistors connected in parallel. Measure the combined resistance of the two resistors and set out your results in a table:

Resistors (ohms)	Combined resistance
100 and 100	
100 and 150	
220 and 220	
220 and 470	
etc.	

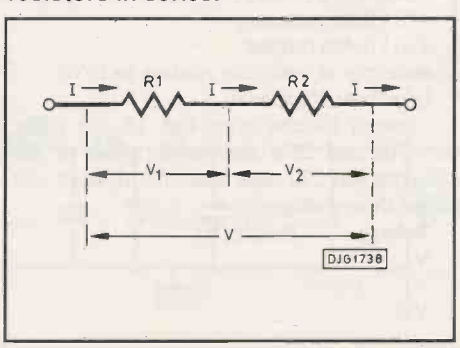
Can you work out a rule for calculating the combined resistance of two resistors in parallel?

VOLTAGES ACROSS SERIES RESISTORS

The rules about series and parallel resistors crop up often in electronics. They can be useful if you do not have a resistor of the correct value. By wiring two, possibly three, resistors together in series or in parallel, you can obtain the resistance you require.

Let us look at series resistors more closely (Fig. 15). The voltage drop across both resistors is V. This is in two parts, V1 the drop across R1, and V2 the drop across R2.

Fig 15. Voltage and current with resistors in series.



Since there is no other resistance present, there is nowhere else that voltage can drop and we can say that:

V = V1 + V2

Now to consider the relationship between V1 and V2. In this circuit, current flows through both resistors. For each resistor, the following equation applies, as explained earlier:

I = V1/R1 *and also* I = V2/R2

Since I is the same in both equations, we can write:

V1 /R1 = V2/R2

This can be rearranged to give:

V1/V2 = R1/R2

In words, the voltage drop across each resistor is proportional to its resistance. The bigger resistance has the bigger voltage drop across it. If the resistances are equal, the voltage drops across them are equal (both are V/2).

This explains why the circuit of Fig. 12 is not suitable for measuring low resistances. The ammeter has low resistance and R has low resistance. The voltage drops across them will be about the same size. The voltmeter measures the total voltage drop, which includes the appreciable drop across the ammeter. This leads to an error in measuring the drop across R. In the circuit that we actually used for measuring low resistance (Fig. 11), the voltmeter measures only the drop across the resistor, so it gives an accurate result.

USING RESISTORS IN SERIES

Investigation 8
Dividing the potential

You need:
- a battery box with 4 cells (6V);
- 470 ohm resistor;
- 220 ohm resistor;
- testmeter or voltmeter reading to 10V;
- breadboard (optional).

Connect the circuit of Fig. 16. Measure and record these voltages:

Voltage	Result (V)
V	
V1	
V2	

Confirm that V = V1 + V2. If you find that V1 + V2 comes to much less than V, there is a likely explanation, which we shall give later.

Calculate V1/V2. Calculate R1/R2. Do these calculations confirm the equation given above, that V1/V2 = R1/R2?

The simple circuit above is one that is used time and time again as part of larger

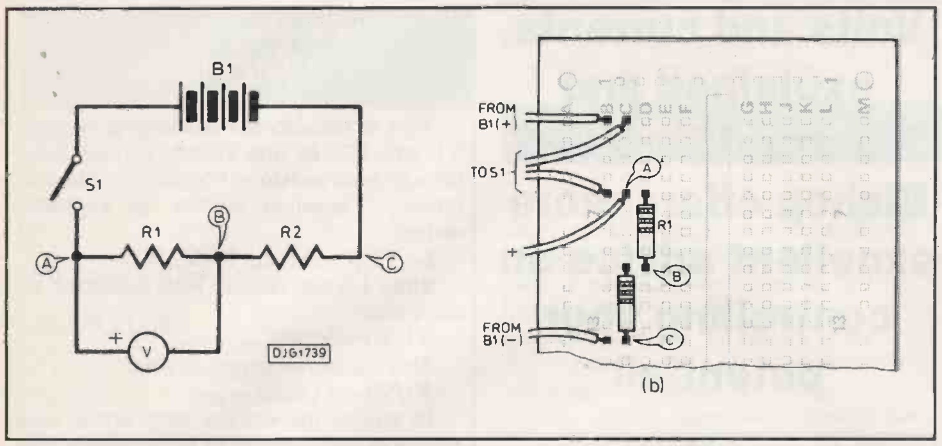


Fig 16. Investigation 8. (Left) circuit diagram for measuring V1; (right) breadboarded version. Connect voltmeter to B and C to measure V2, and to A and C to measure V.

electronic circuits. It is known as a *potential divider*. Often we need to obtain a voltage that is smaller than the supply voltage of the circuit. A potential divider is used for this purpose. Ths supply voltage V is connected across the divider (both resistors) and the smaller required voltage VOUT is obtained across one of the resistors (Fig. 17). The values of the output voltage from the divider is given by:

$$VOUT = \frac{V \times R2}{R2 + R2}$$

Fig 17. Potential divider circuit.

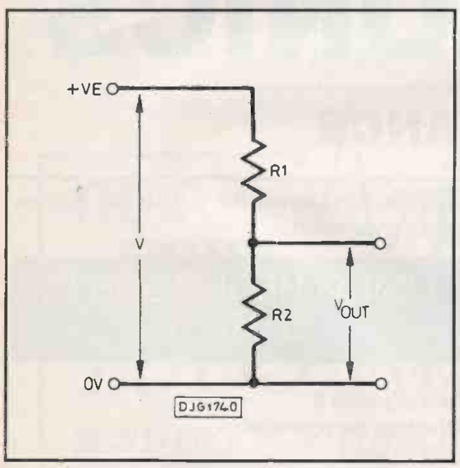


Fig 18. Using a potentiometer as a variable potential divider.

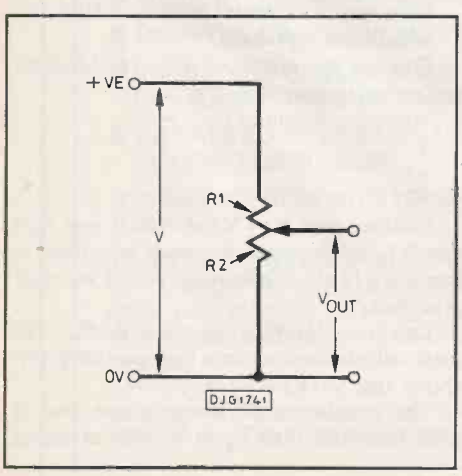


Fig. 18 shows another way of making a potential divider. It uses a variable resistor (often known as a *potentiometer*). As the knob of the resistor is turned, the output voltage ranges from zero to V. This is because, in effect, the variable resistor consists of two resistors in series. As we turn the knob, one resistor increases and the other decreases. The resulting change in the ratio between them (R1/R2) gives a variable output voltage.

CURRENTS THROUGH PARALLEL RESISTORS

If we apply a voltage V to two resistors in parallel, the current splits into two (not necessarily equal) currents that pass along the resistors (Fig. 19). Since V is the same for both resistors we can say that:

V = I1R1 and also V = I2R2

Since V is the same in both equations, we can write:

I1R1 = I2R2

This can be arranged to give:

I1/I2 = R2/R1

In words, the current through each resistor is *inversely* proportional to its resistance. The bigger resistance has the *smaller* current flowing through it. If the resistances are equal, the currents are equal (both are I/2).

MORE ABOUT POTENTIAL DIVIDERS

Investigation 9

A high-resistance potential divider

You need: a battery box with 4 cells (6V);
470 kilohm resistor;
220 kilohm resistor;
testmeter or voltmeter reading to 10V;
breadboard (optional).

Connect the circuit of Fig. 16, but using the 470k and 220k resistors in place of the 470 ohm and 220 ohm resistors. Measure and record these voltages:

Voltage	Result (V)
V	
V1	
V2	

Confirm that V = V1 + V2. If you find that V1 + V2 comes to much *less* than V, there is a likely explanation, given later. Calculate V1/V2. Calculate R1/R2. Do these calculations confirm the equation given above, that V1/V2 = R1/R2?

Since the ratio 470000/220000 equals the ratio 470/220, you expect to get the same results in this investigation as you got in Investigation 8 (allowing a little leeway for tolerance differences). Whether or not you get the expected results depends on the meter you are using. If you use a solid state digital meter, you probably will get the same result, since meters of this type require virtually no current to drive them. But if you use an inexpensive moving-coil meter (in which a needle moves across a scale), this requires an appreciable current to drive it. When you are measuring V2, for example, R2 and the coil of the meter are in parallel. If R2 has a low resistance, most of the current flows through R2. Connecting the meter to the divider has little effect.

In this investigation R2 has a *high* resistance, possibly *more than* the resistance of the meter coil. If so, the current through the meter is *larger than* the current through R2. Connecting the meter to the divider has, in effect, reduced the value of R2 by putting the coil in parallel with it. This reduces V2.

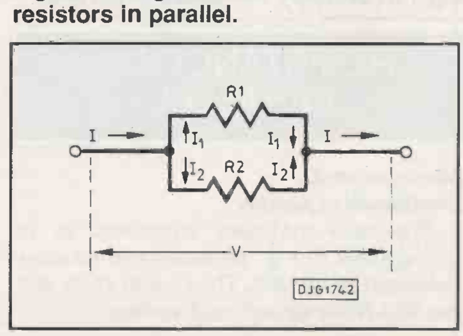
This investigation shows that, when using an inexpensive meter to measure voltages in circuits, we must beware when resistances in the circuits are high. Connecting the meter to the circuit drains current away and alters the voltage we are trying to measure.

There is another consequence of this effect. If we are using a potential divider to provide a given voltage to part of a circuit, and that part takes a large amount of current, the voltage obtained from the divider is less than expected. Worse still, if the current taken varies from time to time, the voltage from the divider varies too. As a practical rule, it is best if the current drawn from a potential divider is never more than a tenth of the current flowing through the divider. For example, if we want to provide a current of up to 5mA, the current flowing through the divider must be at least 50mA. Given a supply voltage of 6V, for example, the total R1 + R2 must not be more than 6/0.05 = 120 ohms.

Question A

A potential divider is needed to supply a current of 10mA. The supply voltage V is 8V. What is the maximum allowable total for R1 + R2?

Fig 19. Voltage and current with resistors in parallel.



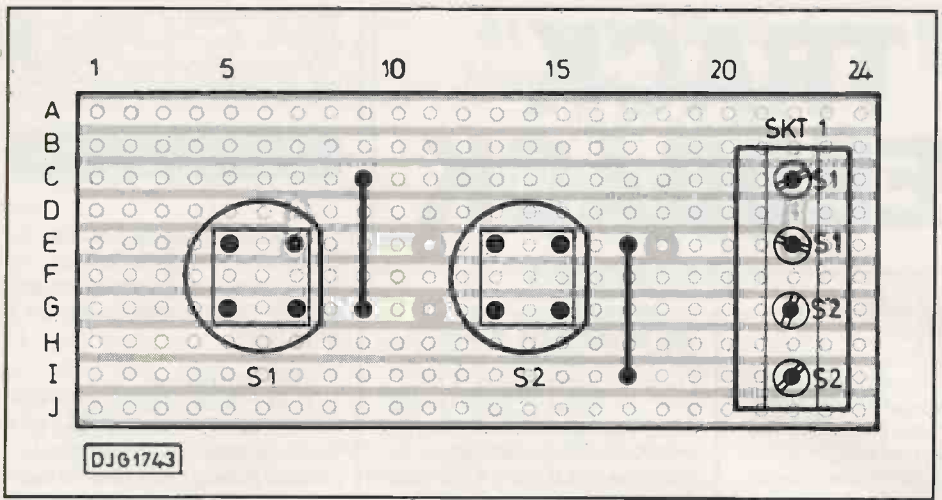


Fig 20. Module 1, stripboard layout. Note the track cuts and solder blob.

DESIGNING POTENTIAL DIVIDERS

The first step in design, to establish the maximum total resistance, was described above. Call this RMAX.

The second step is to decide on the values of the two resistors. Assuming that the output voltage is that across R2, we can adapt the equation given earlier:

$$R2 + \frac{VOUT.RMAX}{V}$$

For example we saw that if V = 6, and the current supplied is to be 5mA, then RMAX = 120 ohms. If VOUT is to be 2V, then:

$$R2 = \frac{2 \times 120}{6} = 40 \text{ ohms}$$

R1 would therefore be 80 ohms. The E12 series does not include these values, but we could approximate by using 39 ohms and 75 ohms (from the E24 series). Alternatively we could use a variable resistor as in Fig. 18 and set it to give the exact VOUT required.

Question B

If VOUT of the potential divider of Question A is to be 3.3V, suggest suitable values for the resistors.

We shall look at more examples of potential dividers later in the series.

MODULES OF THE MONTH

Most months we shall describe simple circuit units that you can build, and later join together into electronic systems. Most of the designs use a standard-sized stripboard and have screw-terminals for connecting one module with another:

Module 1: Press-buttons (Fig. 20)

Parts required: S1, S2 press-to-make click-switch, pcb mounting (2 off).

SKT1 4-way printed circuit terminal block.

Stripboard 65mm x 25mm (Vero 10401).

Module 2: Indicator lamp

Parts required: 6V 0.1A filament lamp, round MES type, and socket. Attach single-stranded wire, about 10cm long, to each terminal of the socket and strip about 7mm of insulation from the free ends.

Module 3: Potential Divider

Parts required: 10k carbon rotary potentiometer. Plastic knob to fit. Solder a single-stranded wire about 10cm long to each of its 3 terminals and strip about 7mm of insulation from the free ends.

SYSTEM OF THE MONTH

Lamp dimmer:

Use the potential divider module to provide a varying VOUT for dimming the lamp (Fig. 21a). Why does this not work very well? Why does the circuit of Fig. 21b, in which the module is used as a straightforward variable resistor, work better?

RESULTS AND ANSWERS

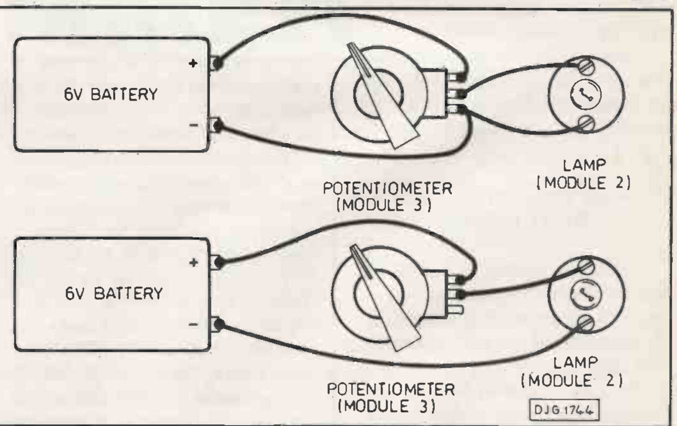
Investigation 6: R = R1 + R2 + R3 + etc.

Investigation 7: R = (R1 x R2)/(R1 + R2).

Potential dividers: (A) To supply up to 10mA, the divider current must be at least 100mA (=0.1A). Total resistance is 8/0.1 = 80 ohms (or less). (B) R2 = (3.3 x 80)/8 = 33 ohms. So R1 = 80-33 = 47 ohms.

Next month we look at capacitance and inductance. PE

Fig 21. Lamp dimmer systems.



TRACK FEEDBACK

KNIGHT HORRORS

Dear Mr Becker

I have been reading PE for a fair number of years (I started as a schoolboy in Nov 68) and I think it is fair to say that the solid grounding given me by PE in the days of Fred Bennett has stood me in good stead in my chosen career of electronics and computing.

As I have said before in previous correspondence, I am delighted by the way that you have restored PE to its former glory, and I was looking forward to the Silver Jubilee issue. *(This letter was written before the Nov 89 issue was published. Ed)*

Imagine my horror when I found that PE was to present an award to Clive Sinclair (I never could stomach the 'Sir'). Clive's name was, and is, synonymous with cheap and tacky gadgets, foisted on the unsuspecting public by misleading advertising. His adverts have been withdrawn by the Advertising Standards Authority on more than one occasion. Those of us who actually work in the industry heaved a sigh of relief when he finally quit the scene.

The fact that the readership of PE have voted him an award is simply another example of how he has successfully hoodwinked even a knowledgeable audience. I suspect that a poll of those of us who bought his products in the late sixties and seventies might have returned a different result.

That said, (and I don't expect you to publish this letter), carry on the good work. You are doing a wonderful job, and I hope to be still buying PE in 2014.

Nigel Titley MIEE, CEng, BA (Oxon), Hollesley, Suffolk.

You're too modest in expecting that we wouldn't publish your praising and provocative letter - I am pleased to do so with regard to both aspects of it.

First, many thanks for your kind comments and good wishes. I look forward to inviting you to PE's 50th Anniversary Party!

Quite possibly had we polled those who bought Sinclair products in the years you quote we may well have had a different result. That, though, would have been a totally biased and unjust survey. Our aim in carrying out the survey was to seek the opinions of a random cross-section of PE readers. Additionally, we asked the opinions of several of our regular contributors, a majority of whom also nominated Sinclair.

There is no doubt that Sinclair products suffered from problems in the early years, but I believe that the high regard in which Sir Clive is held by many people is derived not from his marketing achievements, but rather from the deeper perception the public have of his remarkable inventive capabilities. It seems unfair (though I guess it's human nature) that he should still be judged in some quarters by his failures rather than his achievements. He certainly would not have been knighted had his achievements not been recognised at a very high level. As I am sure you will know, Sir Clive is currently very much involved with several companies who are at the fore of major research into telecommunications, wafer scale integration and personal computer technology, namely Shaye Communications, Anamartic and Cambridge Computers.

You may be interested to know that our Publisher has recently bought the Cambridge Z88 for use in conjunction with our sophisticated DTP system. The facilities the Z88 offers, and at a remarkably low price, make it an ideal machine for occasional use by contributors to our sister magazine Astronomy Now. They borrow the machine for a few days, type in their article text, and return the machine to the office with the script held in memory. Direct transfer can then be made from the Z88 to the DTP, saving a lot of hassle!

Contrary to what may appear from this reply, I have no personal reason for defending Sir Clive's nomination other than the fact that I try to take a balanced view of any situation that deserves a fair appraisal. Though other names were put forward by readers, none came near to Sir Clive's popularity.

Just out of interest, who would you have nominated as the person who has done most for technology in the last 25 years? (I throw open this question to the readers at large, as well as to Mr Titley.) **Ed**

CAREERING AHEAD

Congratulations PE!

I remember the first issue in 1964, and as a spotty-faced teenager I used to pour over the articles and then save my pocket money (£..s.d. in those days) and rush off to my local electrical shop to buy the bits for the project of my fancy. In Nov 68 editor Fred Bennett introduced a series of articles on 'Bionics', which had me fascinated and my Meccano set was never the same after that!

Over the years I have thoroughly enjoyed reading PE and found series such as *On the Fringe* by Gerry Brown (1970) and *First Steps in Circuit Design* by A.P. Stephenson absorbing and informative. I am currently in my final year of a B.Ed in CDT (craft, design and technology), and the knowledge I have gained over the years, thanks to PE, now stands me in good stead as the need for teachers in electronics is very great. Back in 1964 as a pupil myself I never guessed that the enthusiasm for electronics which PE fostered would, 25 years later, be the key to a new career.

Thank you for all the articles and inspiration!

Malcolm D. Cook, Hexham, Northumberland.

It's good to have confirmation yet again that PE has played a role in shaping readers' futures. That is an aspect of PE's purpose of which I am extremely conscious.

Your comment on the need for electronics teachers reminds me of the following recent incident which emphasises the point:

SHORT CIRCUIT TEACHING

Someone rang me seeking clarification on a few points regarding a PE project. From the nature of the questioning and the responses to my answers, it became increasingly apparent that the caller knew virtually nothing about electronics, and could barely read a circuit diagram. Jumping to the conclusion that the caller was asking on behalf of someone else, I suggested that the originator of the questions should call me personally and we could discuss the matter more readily. To my amazement, the caller said that apart herself, only her pupil was involved. Her pupil? I queried. Yes, she said, she was teaching electronics to pupils at her school!

For once, I found myself short on words! What a profound criticism of technology education as it is being performed in some schools. Can there be any excuse, even when teachers may be in short supply, for electronics to be taught by someone who does not know how to read a circuit diagram? And what other other subjects are being taught by those with no knowledge of them? Ed.

TEACHER CRITICAL

Criticism of the educational system also comes from at least one of the affected participants, as the following extract from another letter shows.

Dear Mr Becker

I am 15 and am taking CDT for GCSE. Because I have decided to use electronics in my final project, I started getting PE in June 89 and have got a lot of useful information from it. If I send a copy of my circuit diagram for the electronics in my project would you be able to check the diagram and give me your expert advice on it?

The reason I ask is that I have lost confidence in my CDT teacher after many failures in past projects.

For obvious reasons I withhold the pupil's name.

I try to communicate enthusiasm for electronics amongst my readers, but it's blatantly obvious that I am not being backed up by those who have the responsibility for educating today's youngsters. The last statement in this pupil's letter, and the phone call quoted above, are not the only examples I've had of inadequate attention to technology education. I'm not going to air political points in these pages, but the only conclusion I can come to is that both Government and the teaching profession should have their heads knocked together and resolve a situation that is increasingly in danger of depriving this country of tomorrow's technologists. It's imperative that the situation should change.

To answer the reader's question, though, I much regret to disappoint him by saying that I cannot undertake to check his work for him - I'd never get PE to press if I were to offer such in-depth help to all readers who ask! I would also comment that one of the things the CDT examiners will be looking for is how much the student has shown initiative in solving the problem for him or herself. As frustrating as it may be to not achieve a working success, the method by which the project has been tackled will also count heavily towards the exam results.

Lastly, if this pupil truly believes he has no trust in his teacher, he should persuade his parents to complain to the headteacher at his school. Lack of attention to technology teaching must not be tolerated. Ed

MORE FEEDBACK

FOUNDATION TO EMPIRE

Dear John,

I must express my thanks to you all for the PE celebratory party. I was delighted to have the opportunity of meeting you again after all these years, and to meet for the first time Angelo, and other members of Intra Press. Thanks to you I also met up with many old friends and colleagues from my Newnes and IPC days.

It is perfectly obvious that you thoroughly enjoy your work as Editor. This I well understand, for it is a most satisfying job. I certainly enjoyed every moment I occupied that position. Since taking over, you have marked the pages of PE with your irrepressible energy, enthusiasm and humour. That this will prove infectious and encourage a host of new recruits to this hobby, I have little doubt.

Here's wishing you and all your associates good fortune in the future - and every success to PE as this journal enters upon its next 25-year era.

Fred Bennett, Hayes, Middx. (PE's Founding Editor)

Many thanks Fred. My sincerest hope is that I may encourage readers to enjoy electronics as much as you encouraged me through PE's pages.

I, too, was delighted to again meet you and everyone else who has been associated with PE across the years..Ed.

INTERAKTIVE

Dear Ed,

Congrats on your 25th year; I enjoyed your special issue just like all the rest. Sir Clive Sinclair is a man I admire very much, so I was very keen to read the interview. Yes, what will happen next?

I was also very interested to see from the Catalogues section that Greenbank had sent you some info! I built my first Interak computer about eight years ago, and it's still going strong, in fact I'm writing this letter on it. It is a very versatile machine, tape or disc based; software galore!

The hours of pleasure this computer has given me are unmeasurable, both in construction and computing itself.

Mel Saunders, Thurnby Lodge, Leicester.

It always gives me great pleasure to hear from people who enjoy the true 'hands-on' aspect of electronics, delighting in building things for construction's sake, irrespective of the availability of ready-made equivalents. Ed.

VIVE LA NOSTALGIA

Dear John,

Congratulations on a splendid anniversary edition!

I thoroughly enjoyed reading all the articles, especially those which looked back on the history of PE. I am pleased to say that I recognised many past editions mentioned, even though they were published many years ago. Excellent, nostalgic stuff!

Incidentally, I thought you might be interested to know that while on holiday in France I came across a French magazine called *Electronique Practique* - sounds vaguely familiar!

Tony Smith, Blackburn, Lancs.

Are you suggesting we have an imitator? The French may be unsurpassable for their vintage wines, but nothing matches up to vintage PE, in any language!

(Tony is, of course, the author of the current Time and Frequency series, lately discussing UCTs.) Ed.

MARKING TIME

At our 25th anniversary party in the Kew Bridge Steam Museum were many personalities who have been connected with PE in various ways . One of the was a kindly, elderly gentleman, Alfred Marks, who had for some time been Sir Clive Sinclair's advertising agent. It was a pleasure to see the warmth of greeting between Sir Clive and Alfred. Below is an extract from Alfred's delightful letter to David Bonner, PE's advertising executive, following the party. I should add that the clocks referred to were electronic clocks inscribed to commemorate the event and given as gifts to all who came to the party.

Dear David,

Thank you very much indeed for the clocks. They are much appreciated, I assure you. For myself, I am not keen on marking time's inexorable march onwards. On the other hand, it was well worth surviving to take part in that very pleasant evening with Sir Clive et al amidst those formidable Victorian monsters. If only they could have hissed and blown steam! They were beautiful.

Meanwhile, good luck to young PE - a mere quarter of a century old. Should I be around when the next 25 years have elapsed (that means my being 104) might not a grandfather clock be appropriate?

Alfred Marks, London.

NUMBER CRUNCHING

Dear Sir,

I do hope that you get your DTP system sorted out in the next *twentyfive years*, in your anniversary issue, you have constantly referred to "twenty five years". This means that you should be celebrating your centenary.

Also, in one advert one kit is listed as a "Community Tester"; I think that this should be "Continuity Tester", or is it a new measuring device for the Poll Tax?

Colin Long, Chigwell, Essex.

Wow! Does your first comment reopen Pandora's Box? I understand what you are saying, that "twenty five years" implies 20 x 5 (years) = 100. Have I never been taught to write English correctly? Perhaps so! Yet, when writing cheques, I would write 25 as two words, and would not expect the Bank to debit me with £100, or to reject my cheque on the grounds that words and figures differ. I do not recall ever running the two words into one, though my wife assures me she always hyphenates them.

Intrigued by this question, I checked several sources. Among my dictionaries, only Chambers gives a clue, hyphenating the words, which to me is more pleasing than running them together. The next research I did was into Fowler. To my surprise, he does not appear to tackle the question at all, although his publishers have hyphenated similar numeric forms in the texts. Fowler himself makes two comments that might validate the use of all three forms : "No two dictionaries and no two sets of style rules would be found to give consistently the same advice" (on hyphens); and, "Sir Winston Churchill wrote that 'One must regard the hyphen as a blemish to be avoided wherever possible.'"

Until I know better, I shall in future only use the figured form! As an aside, one written numeric form I find hard to accept is the dropping of 'and' following 'hundred', as in 'one hundred twenty' (120), for example.

Regarding the advert, yes, it was a Continuity Tester. Nonetheless, perhaps an enterprising PE designer could well come up with the public-spirited (?) project as listed!

P.S. Running this text through the spellcheck program, "twentyfive" has been rejected as a recognised form! Ed

SPELLBOUND!

Dear John,

Your DTPed magazine shows signs of having been run through an English spellcheck program. In my "Ask PE" number two I observe a caption saying "Circuit for a mosfet poser amplifier". I have lost the photocopy of my original text for this article, but I feel sure it should have read "mosfet *poseur* amplifier".

Andrew Armstrong, Leighton Buzzard, Beds.

Andy, your wit leaves me spellbound! Ed

REPRIZAL

Dear Editor,

Of course I accept your decision as to the draw result for the Sept 89 *Maplinoscopy* competition but am disappointed to learn that two of my reasoned answers were invalid.

I had briefly considered the CRT as common to all except for radio but remembered that CR Tuning indicators were also once common and CRT Spectrum displays were incorporated in a number of radios. Conversely, large numbers of computers, cameras, tvs, etc. do not use crts. So, that's not the common link in Q6, thus leaving RADAR as the logical answer since it is the only acronym in the list.

Thanks for reading this; I expect you get a number of different viewpoints and I just felt I had to air mine.

J.Councell, Crowborough, Sussex.

Yes, you're reasoning is quite valid, radar could well be regarded as the odd-one out. You'd be amazed, though, at the variety of answers I received regarding Q5 and Q6, each of which was perfectly logical in its own right. But, they weren't the answers I was after, nor did they tally with the majority of entrants who did deduce correctly the answers I wanted.

What you also needed to consider in answering the questions was, if you could see several possible choices, which one was most likely to be the most relevant. To be fair to the majority of contestants in any competition, the acceptable answers must be those which tally with the Questioner's and Adjudicator's opinion; both roles are played by your Kindly Editor, so naturally his decision is final!

Now for the astonishment! I'm writing this reply some time after the draw for the 25th Anniversary competition took place. Incredibly, I now note that the Mr J. Councell who wrote the above letter, is the same gentleman who has won first prize in that competition.

Total coincidence! Ed.

For simplicity the positive and negative peaks of the sawtooth are assumed to be equal.

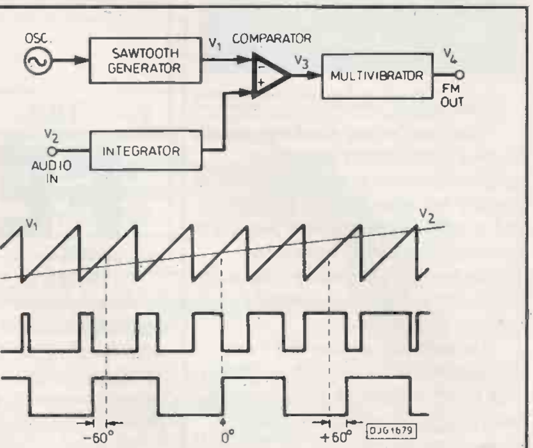
This results in a high output when the audio is greater than the sawtooth voltage. The output of the comparator is applied to a multivibrator which switches at each falling edge and the output of the multivibrator is a rectangular pulse whose phase is proportionate to the instantaneous value of the audio voltage.

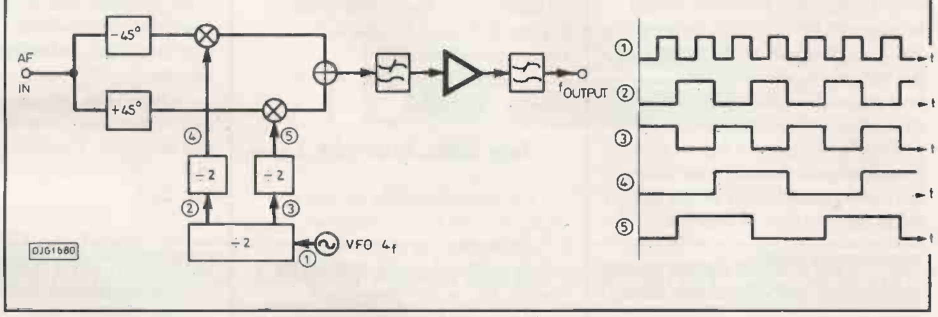
Such modulators are available in ic form for operation up to a few MHz. The linearity of the sawtooth determines the linearity of the modulator. The maximum deviation of 180 degrees is not usually achieved because of switching delays and fall time.

Frequency modulated feedback (fmfb) and automatic frequency control (afc) can be used to improve the linearity and stability of frequency modulators. The methods are similar to feedback in good quality audio amplifiers and available as ics.

The circuits detect the frequency of the oscillator or modulator output, compare it to the audio input or detector output reference and generate a correction voltage. Fmfb acts at the audio frequency rate while afc acts at a lower rate.

Fig 25. (right) FM modulator using a comparator.
Fig 26 (below). Direct conversion.





SSB TRANSMITTERS

Single sideband transmitters are used in aircraft, marine, military and amateur communication. Here the communication spectrum could occupy slots over several octaves whereas that for cw, am and fm is confined to discrete bands.

The modulating signal is usually speech and therefore speech compression is usually employed. Transmitters and receivers may be classed as direct conversion, multiple conversion or broadband. In multiple conversion, several stages of frequency translation are employed.

DIRECT CONVERSION

Direct conversion is used in low cost transmitters when a single band of frequencies needs to be transmitted. Fig. 26 shows one possible configuration.

DISCRETE BAND MULTIPLE CONVERSION

HF communication in the range 1.6MHz to 30MHz using the ionosphere is subject to rapid fading depending on the frequency used, condition of ionosphere, time of day, latitude, season of year, etc. Therefore several bands within the spectrum are allocated. In order to switch bands the stages need to be ganged together, (Fig. 27) so that they may be switched simultaneously.

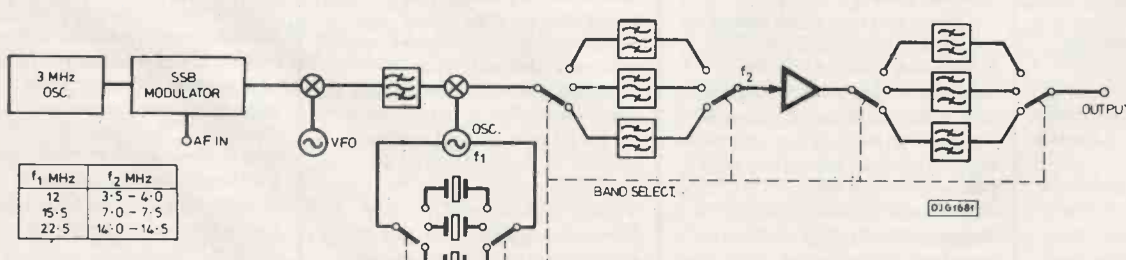
Discrete band frequency translation started during the vacuum tube era. At 3.5MHz and during daytime one would expect a range of 300km, and 1000km to 2000km at 14MHz on the first hop.

In Fig. 27, the variable frequency oscillator 5MHz to 5.5MHz translates the 3MHz ssb input into the 8MHz to 8.5MHz band. A crystal oscillator then translates this band into a discrete 0.5MHz band depending on the crystal and bandpass filter selected. Fig. 27 shows some possibilities but the harmonics require careful investigation. For instance the third harmonic of the vfo is in the range 15MHz to 16.5MHz.

When mixed with the crystal oscillator output of 12MHz, the output is in the 3MHz to 4.5MHz band. Therefore if the third harmonic of the vfo reaches the second mixer when operating in the 3.5MHz to 4.0MHz range, spurious signals will be heard.

BROADBAND CONVERSION

Newer transmitters and receivers use broadband conversion since it is beneficial to standardise a design. Also military applications require transmitters to operate anywhere in the hf band.



f_1 MHz	f_2 MHz
12	3·5 – 4·0
15·5	7·0 – 7·5
22·5	14·0 – 14·5

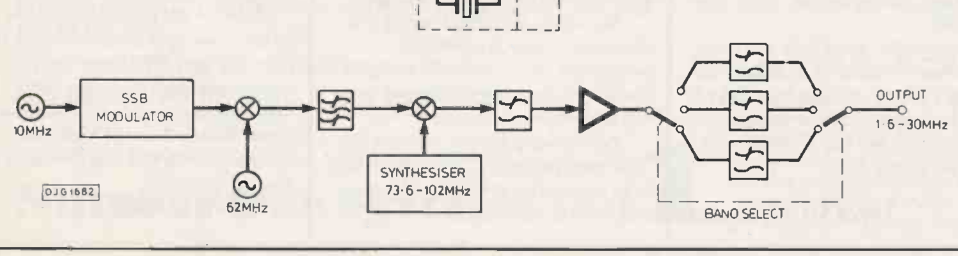


Fig 27. (Above) Discrete and multiple conversion
Fig 28. (Left) Broadband conversion.

starting point for experimentation. This frequency is set by R2, R3 and C2.

A degree of motor speed stabilisation is achieved by measuring the current drawn by the motor, and applying positive current feedback to the circuit. Thus, if the current in the motor rises due to an increase in the load, the mark:space ratio is increased to provide more power. It is necessary to measure the average current rather than the peak current in the motor, so a filter circuit consisting of R5, C3, R6 and C4 is provided. The gain of the feedback is adjusted by VR1, which should be set to provide reasonable speed stability without causing oscillation due to too much feedback. The feedback signal is added to the basic speed control signal, and fed to the 555's control input via IC2a and R1. C1 provides decoupling to give noise immunity. R4, which measures the motor current when the hexfet is switched on, may be made from several strands of resistance wire (eg old fire element) in parallel.

The 555 is notoriously susceptible to noise problems, so a decoupling capacitor must be fitted close to the ic. It is also important to route the wiring sensibly to avoid imposing spikes and switching transients on the ic's power supply. The only other point to make is that D1 needs to be rated at at least 15A and 15V, and to be a fairly fast switching device. There are no doubt a number of suitable devices, but the one chosen here is a BYW31. This diode must be mounted on a heat sink, and the heat sink must be isolated from the rest of the metal work, because the stud of the diode is one of the terminals.

This circuit has been designed without a detailed knowledge of the motor characteristics, including leakage reactance, so some experimentation with component values is likely to be necessary.

PE

HEX KEYBOARD

Ready-made hexadecimal keyboards are widely used for data entry to many digital circuits. The alternative keyboard design described here is much simpler, cheaper and can be used in more applications than the customary hexadecimal keyboards. It also has fewer components and can be used in many projects. The 4-Bit output is ttl compatible.

A normal hex keyboard has 16 keys, but in this circuit only 10 keys are used. Keys 2-7 also serve as keys a,b,c,d,e,f when pressed along with the SHIFT key.

The circuit diagram is given in Fig. 1. Its heart is IC1, a ttl 74LS147, 10-to-4 priority encoder. Operation is straightforward and uses a decimal to binary conversion method rather than the more common keyboard scanning technique. The latter technique is ideal for computer keyboards, but for smaller applications it seems unnecessarily expensive.

IC1 assigns the binary equivalent value to each depressed key's decimal value. For instance, if key 6 is pressed then the output obtained will be binary 0110. If the same key is pressed along with the SHIFT key, the output bit 'D' will go high. Consequently the number obtained will be binary 1110, becoming 14, or E. D1 is used to prevent shorting IC1's output 'D' to ground. R1 to R9 positively bias the chip inputs when the keys are open. The 74LS147 can be replaced by the high speed CMOS equivalent 74HC147.

Masroor HS Bukhari
Pakistan

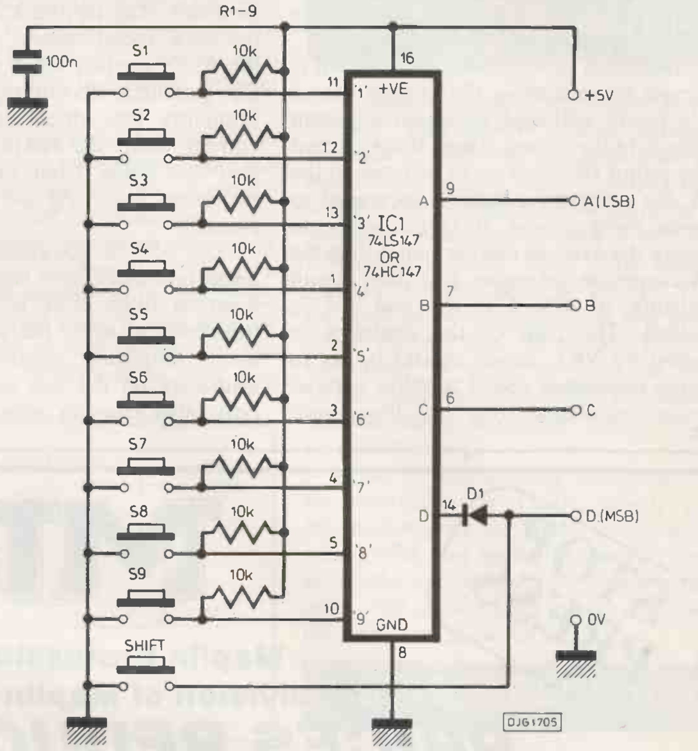


Fig 1. Simple hexadecimal keyboard circuit.

INGENUITY UNLIMITED

A selection of novel ideas from enthusiastic readers

CAR BURGLAR ALARM

The circuit may be separated into two stages: IC1 and its surrounding circuitry forms a 40 second timer with its time period controlled by R3 and C2. Upon receipt of a negative going edge at the trigger input (by connecting this via a switch to ground) the

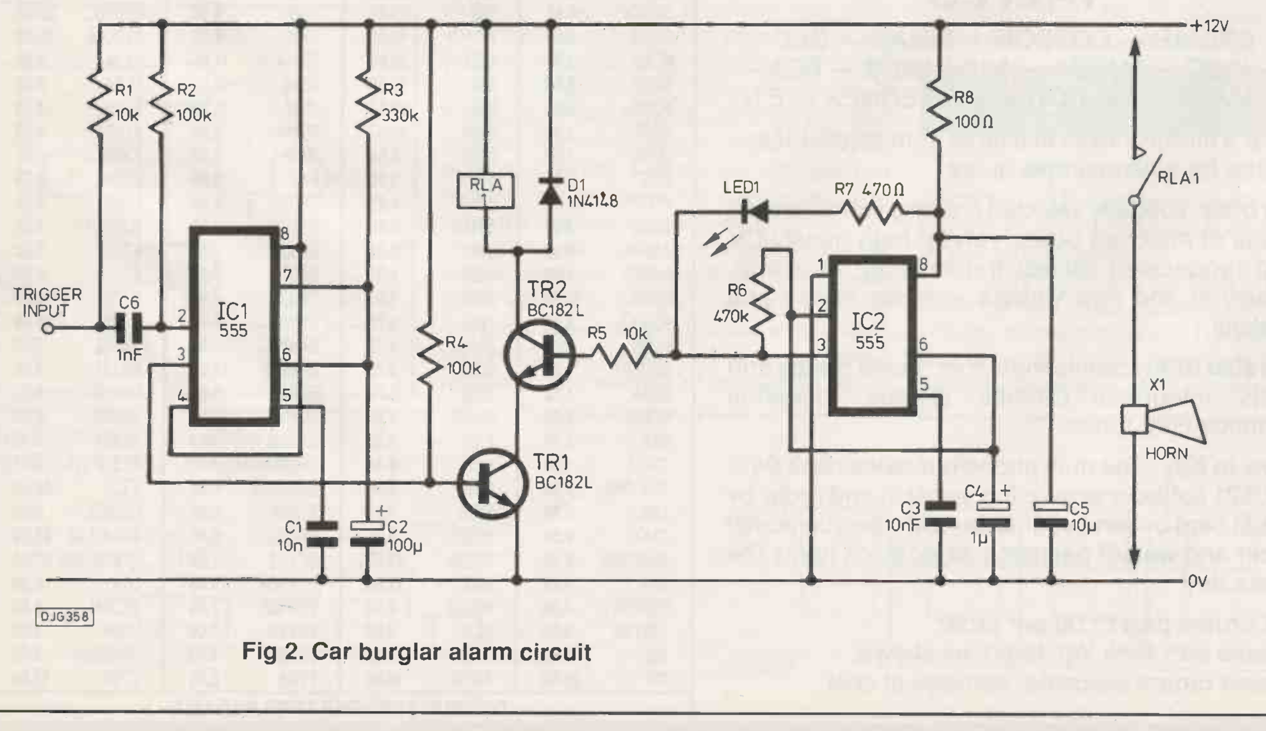


Fig 2. Car burglar alarm circuit

timer is activated, which switches TR1 on, thus grounding the emitter of TR2.

IC2 is configured as an astable the output of which pulses TR2 on and off, with a frequency of approximately 1Hz. With both TR1 and TR2 on, the horn will sound on and off at one second intervals.

LED1 should be mounted in a prominent position to let any prospective intruders know that an alarm has been installed.

To avoid the possibility of false triggering due to ignition noise R1, R2, and C6 have been added. It is also advisable to mount the circuit in an earthed metal case.

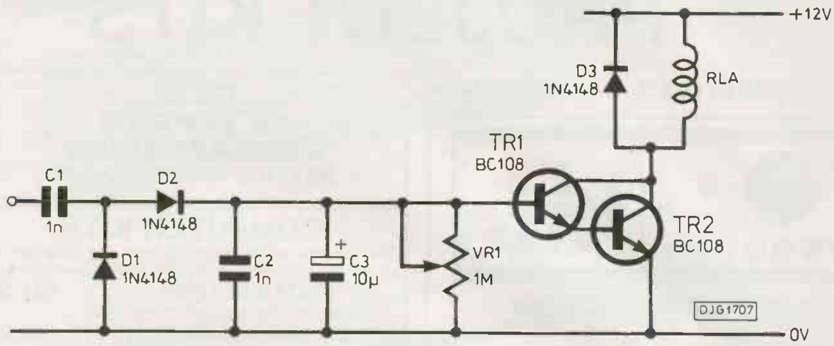
M.S. McNich, Bangor

RF OPERATED RELAY

This simple circuit was designed out of necessity, after I had built two separate modules, ie a rf amplifier and a pre-amplifier, to boost both transmit and receive performance of an ageing mobile two-metres transceiver. The idea of the circuit is to sense radio frequency power to switch ancillary equipment on or off when the transmitter is powered up. Possible uses are many, for example you may wish to perform an aerial change-over function for transmit/receive operation, crossband working, receiver muting capability requirement, or how about controlling a studio type ON AIR sign outside the shack door?

The basic circuit is shown in Fig. 3.

Fig 3. Basic RF operated relay

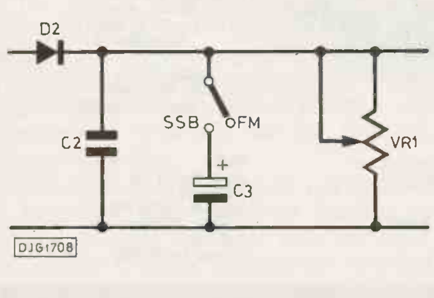


Operation is relatively straightforward. The rf is picked up and coupled by C1 to the demodulator and rf decoupling circuit comprising of D1, D2 and C2. This dc is taken to the base of TR1, which along with TR2 forms a Darlington pair high gain amplifier. The signal causes the Darlington amplifier to switch on, so turning on the relay. D3 protects the transistors from being damaged by back emf produced every time the relay is turned off.

The combination of C3 and VR1 produce what is known as a "hang-time" which is required during cw or ssb transmission, since the pauses between information would otherwise produce chopped speech, and an annoying relay contact chatter.

To increase the hang-time, increase the value of C3. It may be prudent to include a switch so as to switch the hang-time in and out, eg for use in ssb or fm mode of operation respectively (see Fig. 4).

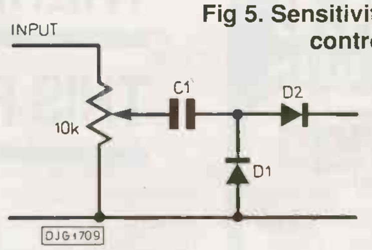
Fig 4. SSB/FM switch



As the circuit stands, it will switch when minute quantities of radio frequency power are around. With the prototype, it was found that with 18 inches of hook-up wire attached to the input at C1, a small child's walkie-talkie caused switching when it was a foot or so away. When the pick-up wire was connected directly to the aerial, the relay switched over straight away when the walkie-talkie was on receive! The rf switch was being activated by the receiver's local oscillator. Therefore, if you find that this circuit is a little too sensitive for your purpose, then it may be necessary to dampen it a little by installing a sensitivity control in the form of a preset potentiometer at the front of the circuit (Fig. 5).

Another consideration is that it may be required to operate this circuit remotely, ie at some distance away from the actual transmitter itself. This may be achieved with varying degrees of success, dependant upon frequency, output power of the control transmitter, etc. The requirement is a parallel tuned circuit at the front end of the circuit, resonant at the same frequency of the transmitter (Fig. 6).

Fig 5. Sensitivity control



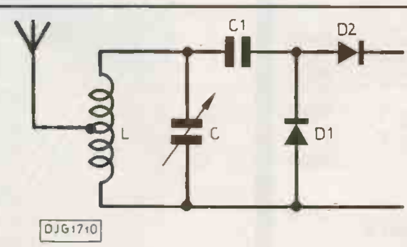


Fig 6. Remote operation

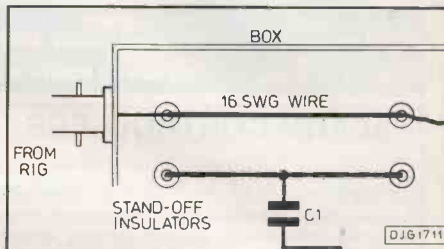


Fig 7. Method of coupling

If you wish to have "positive" control over the rf operated switch, and have reservations about connecting an expensive black box to an unknown quantity, then you may like to consider a type of parallel lines pick-up similar in idea to those used in some rf swr power meters. The general idea is shown in Fig. 7.

A further modification that may be required is a manual overide. This can achieved simply by means of a dpdt switch (as in Fig. 8).

Fig. 9 shows how the rf operated relay could be used to switch in either a linear amplifier or a receiver preamplifier.

Paul Benton, Staffs

PE

Fig 8. Manual overide

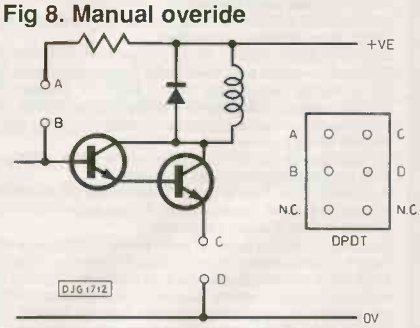
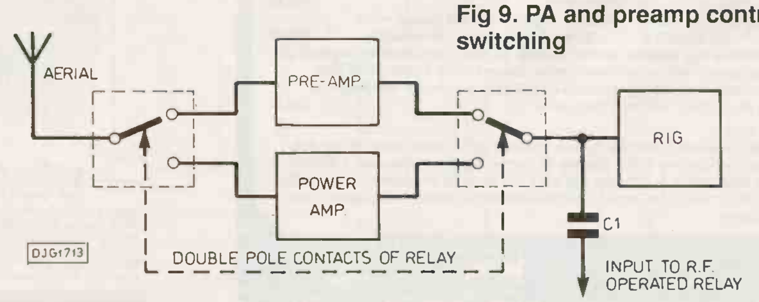


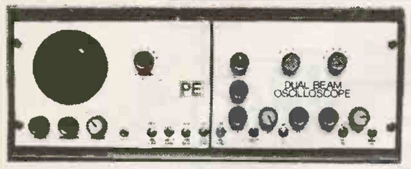
Fig 9. PA and preamp control switching



★ LEARN BY BUILDING ★ ENJOY BY USING ★

PROJECT KITS

★ BE CREATIVE ★ GET KITTED! ★



PE DUAL BEAM OSCILLOSCOPE
Electronic comps. incl. pcbs, excluding crt, transformer and case. SET 290 £57.50.

MORE KITS IN CATALOGUE
SEND MEDIUM S.A.E. FOR CATALOGUE AND WITH ALL ENQUIRIES
(OVERSEAS SEND £1.00 TO COVER POSTAGE)

ALARM CONTROLLERS

MULTIZONE CONTROL SET280 £23.90
Two entry-zones, anti-tamper loop, personal attack, entry-exit timing, timed duration, automatic resetting, latching LED monitors.

SINGLE ZONE CONTROL SET279 £10.50
With timed duration control and latching LED monitor.
Both units can be used with any standard detection devices, such as contact or magnetic switches, pressure pads, tremblers, ultrasonics, infrared etc., and will activate standard bells, strobes or sirens.

NEW! PE EEPROM PROGRAMMERS
DETAILS IN CATALOGUE

COMPUTER KITS

The software listings published with the computer kit projects are for use with C64, PET and BBC computers.

CHIP TESTER SET258F £41.50
Computer controlled logic and chip analyser.

EPROM PROGRAMMER SET277 £26.20
Computer controlled unit for 4K Eproms.

MICRO-CHAT SET276 £69.50
Computer controlled speech synthesiser.

MICRO-SCOPE SET247 £49.50
Turns a computer into an oscilloscope.

MICRO-TUNER SET257 £57.40
Computer controlled, tuning aid and freq counter.

MORSE DECODER SET269 £26.70
Computer controlled morse code-decoder.

VARIOUS

VOICE SCRAMBLER SET287 £49.50
32 switchable channels to keep your communications confidential.

STORMS! £35.50 each unit
Raw nature under panel controll Wind & Rain SET250W. Thunder & Lightning SET250T.

DISCO-LIGHTS SET245F £69.50
3 chan sound to light, chasers, auto level.

EVENT COUNTER SET278 £36.60
4-digit display counting for any logic source.

PE ECHO STATION
Multiple extended delays version SET 294L £65.00
Standard delay version SET 294S £33.50

PE FREQ COUNTER/GEN
Counting to 4MHz, digital generator to 2MHz, variable wave form generator to 20kHz.
SET 296 £33.50

ENVIRONMENT

BAROMETER SET285 £41.20
Computer controlled unit for monitoring atmospheric pressure.

GEIGER COUNTER SET264 £65.50
A nuclear radiation detector for environmental and geological monitoring. With built in speaker, meter and digital output. This project was demonstrated on BBC TV.

ORDERING

Add 15% VAT. Add P&P – Sets over £50 add £3.00. Others add £2.00. Overseas P&P in catalogue. Text photocopies – Oscilloscope £3.00, Geiger £3.00, Weather £3.00, others £1.00, plus 50p post or large SAE. Insurance 50p per £50. MAIL ORDER, CWO, CHQ, PO, ACCESS VISA. **Telephone orders: Mon-Fri, 9am – 6pm. 0689 37821. (answering machine).**

PHONOSONICS, DEPT PE92, 8 FINUCANE DRIVE, ORPINGTON, KENT, BR5 4ED. MAIL ORDER

SURVEILLANCE
PROFESSIONAL QUALITY KITS

A range of high quality kits as supplied to leading UK security companies, all in-house designed and produced, not to be confused with cheap imports. All kits come fully documented with concise assembly and setting-up details, fibreglass PCB and all components. All transmitters are fully tuneable and can be monitored on a normal VHF radio or tuned higher for greater security. Build up service available if required.

MTX Micro Miniature audio transmitter.
17mm x 17mm. 9V operation. 1000m range. £12.95
VT500 Hi-power audio transmitter.
250mW output. 20mm x 40mm. 9-12V operation. 2-3000m range £15.95
VOX75 Voice activated transmitter.
Variable sensitivity. 30mm x 40mm. 9V operation. 1000m range £18.95
CTX900 Sub-carrier scrambled audio transmitter. Cannot be monitored without decoder fitted to radio. 30mm x 40mm. 9V operation. 1000m range £21.95
DSX900 Sub-carrier decoder unit for monitoring CTX900. Connects to radio earphone socket. Provides output for headphones.35mm x 50mm. 9-12V operation £21.95
HVX400 Mains powered audio transmitter.
Connects directly to 240V AC supply. 30mm x 35mm. 500m range £18.95
XT89 Crystal controlled audio transmitter.
High performance. 100mW output. Supplied with xtal for 108MHz. Others available to 116MHz. 85mm x 28mm. 9V operation. 2-3000m range........ £36.95
TKX900 Tracker/Bleeper transmitter.
Transmits continuous stream of audio pulses. Variable tone and rate. Powerful 200mW output. 63mm x 25mm. 9V operation. 2-3000m range. £21.95
ATR2 Micro size telephone recording interface. Connects between telephone line (anywhere) and cassette recorder. Tape switches automatically with use of phone. All conversations recorded.Powered from line. 10mm x 35mm £12.95
TLX700 Micro Miniature telephone transmitter. Connects to line (anywhere) switches on and off with phone use. All conversations transmitted. 20mm x 20mm. Powered from line. 1000m range........ £12.95
XML900 RF bug detector. Variable sensitivity. Triggers LED and bleeper when in presence of RF field. Detects MTX 15-20 feet. 55mm x 55mm. 9V operation £26.95
XL7000 Professional bug detector/locator. Variable sensitivy. Twin mode ten segment LED readout of signal strength with variable rate bleeper. Second mode AUDIO CONFIRM distinguishes between localised bug transmission and normal legitimate signal such as pagers, cellular etc. 70mm x 100mm. 9V operation. £54.95

UK customers please send cheques, PO's or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft or Eurocheque and add £5.00 per order for shipment. Credit card orders accepted on 0827 714476. Full catalogue available on receipt of 28p stamp. Trade enquiries welcome.

SUMA DESIGNS
THE WORKSHOPS
95 MAIN ROAD, BAXTERLEY
Nr Atherstone, WARKS CV9 2LE
VISA
☎ 0827 714476

THERE IS SOMETHING IN THIS FOR EVERYBODY

no matter how far you are into electronics
with 134 new style pages and absolutely
FREE!

PHONE
Englefield Green
0784 433 603
Fax 0784 435 216
Telex 264475

Manchester
061 432 4549
Fax 061 432 412

● ORDERS SENT POST FREE IN U.K.
● ACCESS/VISA FACILITIES
(min. order £5.)
Head office/sales/Admin/Shop
28 St Jude's Rd., Englefield Green, Egham
Surrey TW20 0HB. (0784 435 216)
Manchester
680 Burnage Lane, Manchester M19 1NA
(061 432 4945) (Fax 061 432 4127)

WRITE
Electrovalue Ltd
FREEPOST
28(c) St. Judes Rd.,
Englefield Green,
Egham
Surrey TW20 8BR

Please mention this mag. when writing

Many people who take flash pictures simply plonk the gun on top of the camera, and fire away. With some cameras, you don't get much option about where the flashgun sits as it's already incorporated into the camera body! This will invariably lead to pictures with nice black shadows thrown against the wall, and if you're really lucky, your subjects will also get red glowing pupils into the bargain! Better results can be obtained either by moving the first gun and/or using a second gun to brighten up the shadows, so giving some modelling form to the subject.

The device described here will fire a second, (or third, fourth and fifth) flashgun without any direct connection to the main flashgun. It doesn't require any additional power; it derives this directly from the gun.

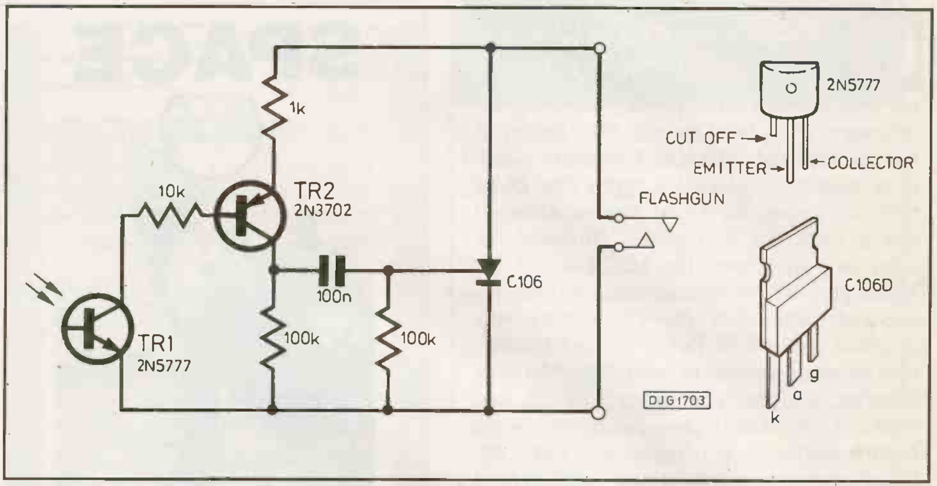


Fig 1. Circuit diagram for the Slave Flash.

FLASHY CIRCUIT

Light from the main flashgun causes light sensitive transistor TR1 to conduct, pulling TR2's base down to the negative line. Since TR2 is a pnp device, current will flow in through its emitter, and out via its collector. Attached to the collector is a differentiator. When TR2 conducts suddenly, a pulse of current reaches C1. The opposite plate of the capacitor pushes out a similar current pulse, which fires the thyristor via its gate. This effectively shorts the two power lines together,

Chris Brown's genii of the light disperses shadows in milliseconds. Find it other tasks too!

SLAVE FLASH

which acts like a closed switch over the flash contacts, and so the gun fires. All this happens very, very fast, so the second gun appears to flash at exactly the same instance as the main gun. The gun now starts charging again, and will flash again on the next burst of light.

The differentiator, ie the capacitor and the resistors which join it to the neg line, are needed to avoid the unit firing when the ambient or surrounding light changes. Without the differentiator, if you were working outdoors on an overcast cloudy day and the sun came from behind a cloud, the gun could fire as conditions brightened. However, with the circuit, these slow changes of light charge and discharge the capacitor too slowly to fire the thyristor. However, when the flash fires, there's a sudden increase in current, and the capacitor passes a largish current. It's like a slow waterfall emptying into a stream; the stream below gently ripples. But drop a large stone into the stream, and you get a mini tidal wave due to the sudden surge!

CONSTRUCTION

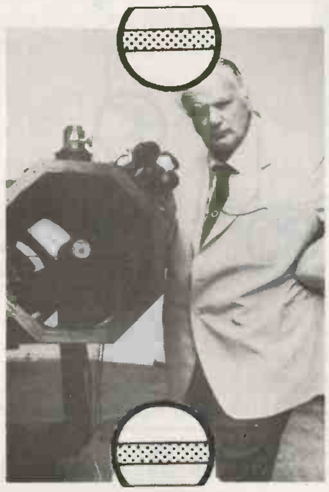
Nothing too complicated here, so I'm sure you can find an odd bit of veroboard and figure out your own layout. Be sure to mount the thyristor the correct way around. The flash leads must also be connected the correct way around, usually with the outer screened braid connecting to the negative line, and the inner shielded wire connecting to the positive. The unit is in fact so small, with the photocell mounted aloft the thyristor, the whole caboodle can be housed in a Tic Tac box!

Plug the unit into the flashgun, and charge the latter. In a normally lit room, with the sensor pointing away from bright light sources, nothing should happen. Now, using a torch, shine the beam at, or across the photo-transistor. The gun should fire. If not, check your wiring. It's so simple, not a lot can go wrong. Now try the same experiment, but using a flashgun in place of the torch.

OTHER USES

Of course, the unit need not be limited to flashguns. It'll serve purpose wherever a brief flash of light indicates a certain event has occurred, such as when a reel to reel tape has broken, or come to the end. Normally, the cell sees no light, but when the break occurs, it sees light from a nearby source, and the circuit is triggered. Similarly, in a blacked out room, the unit could fire an alarm if a burglar's light falls on the cell. Or a cupboard could be made to draw attention whenever it's opened, and daylight falls onto the cell. The uses are endless with a bit of imagination. PE

SPACE WATCH



BY DR PATRICK MOORE CBE

The damage at Sidmouth is being repaired. Will space "advertising" be the next threat?

One of Britain's important small observatories, the Norman/Lockyer Observatory at Sidmouth in Devon, has been through a bad period; following the retirement of its last Director, D.R. Barber, it fell into the hands of Exeter University, who - to be honest - neglected it badly. One of its three telescopes, the Mond, was so damaged that it could not be repaired. However, the other two telescopes, the McClean and the Kensington - both medium-sized refractors - survived, and when the Observatory was acquired by the East Devon District Council renovations were put in hand. The McClean refractor has been completely restored, and work on the Kensington telescope should begin soon. It is hoped to turn the Observatory into an educational centre as well as making the instruments available for research. The official re-opening took place in October; I was honoured to be invited to officiate at the ceremony!

Efforts continue to be made to salvage something from the Hipparcos disaster. Hipparcos, the astrometric satellite, was expected to provide the best-ever measurements of the positions and parallaxes of stars, but the failure of the on-board rocket motor put the satellite into the wrong orbit. Since then, technicians have managed to raise the orbit to the extent that its lowest point is now at an altitude of 600 km, but whether or not Hipparcos will provide really good results is by no means certain; for one thing, its solar cells have been damaged by repeated passages through the Van Allen zones. At all events, it is clear that Hipparcos will not be able to carry out more than a part of its planned programme. If it is a total loss from a technological point of view, there will be a campaign to build a replacement - but this, like many other proposals, will be a slow process.

Traces of activity on the Moon have often been reported; they are generaly known as TLP or Transient Lunar Phenomena. The latest case to be recorded photographically was that on 23 May 1985, when the Greek astronomer G. Kolovos secured a picture of a slash near the lunar crater Proclus C, and suggested, very reasonably, that it was due to an electrical charge in gas rising from cracks in the surface at the time of sunrise.

Proclus is an area in which TLP have been recorded on various occasions. However, two investigators, H. Rast and P. Maley, of Houston in Texas, suggest that the flash could have been due to reflection from an artificial satellite; they claim that a large meterological satellite was passing some 800 km above the Earth, and was directly between the Earth and the Moon, at the moment of Kolovos' photograph.

This seems very unlikely. The agreement is by no means good, and in any case the outline of the flash was confined by features on the Moon's surface, indicating that it really was lunar in origin. Decisive proof is lacking, but the earth satellite theory seems to be very unconvincing indeed.

BRIGHT LIGHTS IN THE SKY

Many years ago, one irritated German astronomer described asteroids or minor planets as 'vermin of the skies', because photographic plates exposed for quite different reasons were often found to be crawling with asteroid trails. But an asteroid is a faint object; a much brighter moving body can do real damage, and it is true that some artificial satellites have produced effects which astronomers find unwelcome.

However, the idea of sending up a 'light ring' to celebrate the centenary of the Eiffel Tower was much more dangerous. A brilliant object of this type, passing across the field of

THE JANUARY SKY

The start of 1990 is not very encouraging for planetary observers inasmuch as Mercury, Mars and Saturn are all very badly placed, while Venus passes through inferior conjunction on January 18 and is visible only for a brief period as an evening object in the south-west (for the start of the month) then as a morning object in the south-east (at the very end). However, Jupiter at least is on view for most of the hours of darkness. It lies in Gemini, the Twins, and is very brilliant, so that it cannot be mistaken. At the moment it is of special interest for telescopic observers; the Red Spot, which had been obscure for some years up to the autumn of 1989, has now reappeared, while the South Equatorial Belt has almost vanished. The 'weather' on Jupiter is strange at the moment; the planet is worth monitoring.

The Moon is at First Quarter on January 4, full on January 11, Last Quarter on January 18 and new on January 26. On the 26th there is an annular eclipse of the Sun, but unfortunately anyone who wants to have a really good view of it will have to go to Antarctica; not even the partial phase can be seen from Britain.

The evening of January 3 sees the maximum of the annual Quadrantid meteor shower. The Quadrantids can be spectacular, but the maximum is always very short and sharp. This year there will not be a great deal of interference from moonlight, so the Quadrantids may well put on a good display.

The glorious winter constellations are now at their best, with Orion high in the south after dark; the three stars of the belt point downward to Sirius, upward to Aldebaran, the orange 'Eye of the Bull'. Sirius, 26 times as luminous as the Sun, is a pure white star, but it seems to twinkle, and to show various colours of the rainbow - not because it is actually doing so, but because its light is coming to us via a thick layer of the Earth's turbulent atmosphere. It is strange to recall that many ancient astronomers described Sirius as 'red'. It is certainly not red now, and it is not the kind of star to show any major short-term changes, so that presumably there must be an error in interpretation; all the same, it is decidedly odd.

Ursa Major, the Great Bear or Plough, is in the north-east; the W of Cassiopeia, on the opposite side of the Pole Star, is in the north-west. Overhead, the brilliant yellow Capella is very prominent. The Square of Pegasus has now almost set in the west, and much of the southern aspect is filled by the large but very faint and formless constellation of Cetus (the Whale).

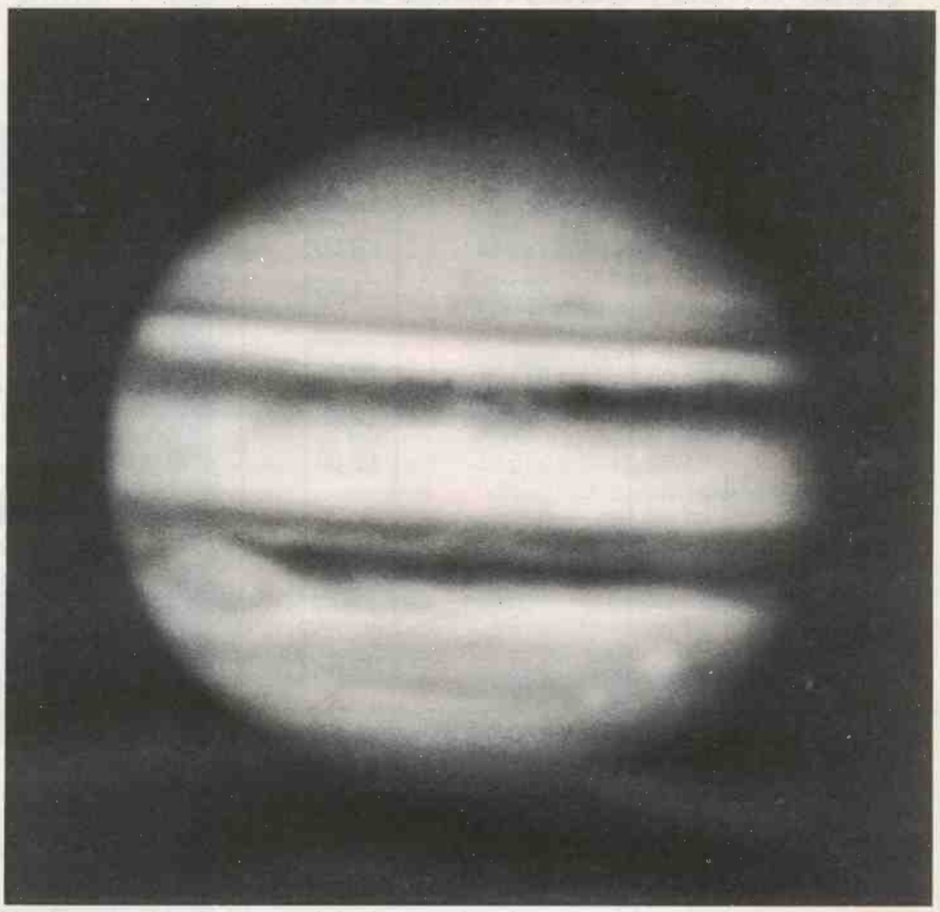
view of a telescope using sensitive electronic equipment, would cause immense damage. Scientists all over the world were so voluble in their protests that the entire project was dropped.

Now there is a rather different idea. This time it is proposed to launch a 'clock', or rather two hands of a clock, which will cross the sky several times a day and provide GMT for the entire world. Financial backing for this plan has been sought. And again there will be protests if there is any fear that the project will be followed up.

It is not easy to see what use such a clock would be - after all, it is much easier to look at one's wrist-watch. And suppose that the clock went wrong? Presumably it would have to be regularly adjusted, which would not be easy.

However, the main objection is the same: a bright moving object can damage delicate equipment, even if its orbit is well known. The fewer bright artificial objects we launch, the better. Of course, not everyone would agree, and one can picture advertisers licking their lips; no doubt they would be delighted to see sunlit space-probes urging the merits of indigestion tablets, double glazing, or cat-food! But it would indeed be the thin end of the cosmical wedge; and we can only hope that the space clock, like the Eiffel Tower light ring, will never 'get off the ground' either literally or metaphorically.

(Hear, hear! I'll be among the first to sign a petition against such outrageous ideas if anyone starts one. Ed.) PE



Jupiter: on view for most of the hours of darkness during January. You'll see it with the naked eye, but not as clearly as in this photograph taken by Jean Dragesco at the Pic-du-Midi observatory in France.

CROSSWORD ANSWERS !

How you should have answered in our Jan 90 crossword:

ACROSS	DOWN
1 COULOMB	1 CLIVE SINCLAIR
4 RECTIFICATION	2 ULTRASONIC
9 INTENSITY	3 OMNIDIRECTIONAL
10 SENSE INPUT	4 RAY
12 VOLUMETRIC RADAR	5 INTER CELL
14 ISOTROPIC	6 INSTITUTE
15 OVERUSE	7 IMPEDANCE
17 CHIP COUNT	8 NATURAL
18 HALL EMF	11 SMOOTH
19 EVM	12 VAPOURS
21 BIASED	13 LOCATED
22 TRIACS	16 EFFECTIVE VALUES
25 ROM	20 MUSIC RECORDER
27 NOT GATE	22 THERMAL
31 EXTRINSIC	23 IN TO RAM
33 LAPLACE	24 ASSOCIATED
34 MORSE CODE	26 MILLIAMPS
35 FOIL AND TANTALUM	28 TAPED DATA
36 ADMITTANCE	29 AVALANCHE
37 CONDUCTED	30 EVENTS
38 TEST ON AGE RATE	32 REFRACT
39 INSIDER	37 C A E

INCREASING UCT PERFORMANCE

PART TWO

Time and τD *will* wait for any man, concludes Anthony Smith, summarising his Time and Frequency series.

Previously we saw how the resolution and accuracy of a low frequency measurement can be improved by measuring the period and then finding the reciprocal. For counters not fitted with the circuitry required to compute the reciprocal, it is necessary to determine it manually, which can be a tedious business, especially if we are making many measurements, or if the input frequency is gradually changing.

FREQUENCY MULTIPLIERS

An alternative approach is to multiply the low frequency before feeding it to the main gate. Consider, for example, an input frequency of 23.456 Hz: measuring this in the conventional manner with a one second gate time will yield a reading of 23Hz (±1Hz), ie, a resolution of 1Hz, and an inaccuracy of ±1/23 = ±4.3 per cent (neglecting time base errors).

If, however, we multiply the frequency by 1000, the counter will accumulate 23,456 (±1) counts during the one second gate time; with suitable decimal point selection, the reading can be displayed as 23.456Hz, ie, a resolution of 0.001Hz, and a quantisation inaccuracy of only ±1/23,456 = ±0.0043 per cent. Obviously, both resolution and accuracy are increased by the multiplication factor, N (in this case, by 1000).

The multiplication can be carried out by a phase-locked loop - see Fig. 10. The phase detector compares its two input signals, fin and f0/N, and generates an error signal Se, which is low pass filtered to provide an error voltage Ve, proportional to the phase difference between the inputs. The voltage Ve controls the vco, whose output frequency, f0, is divided by N and fed back to the phase detector, thus completing the loop.

The effect of the closed loop is to maintain a constant phase relationship between fin and f0/N, ie, f0/N is kept at the same requency as fin. If, for example, fin increases, Se and Ve also increase, such that f0, and thus f0/N, increase, too.

Consequently, because fin = f0/N, it follows that f0 = Nfin, and so the counted signal is actually fin multiplied by N. The actual value of N (usually a multiple of 10) is limited by the maximum frequency of the vco. For example, if f0(MAX) = 1MHz, a value of N = 1000 will limit the maximum input frequency to 1kHz:(fin(MAX) = f0(MAX)/N = 1MHz/1000).

For input signals with varying frequency, the rate of change must not be too great, otherwise the pll will 'loose lock', thus invalidating the readings. On some units, an indicator is illuminated when the loop is not locked, or the circuit may even blank the display to avoid false readings.

Despite these restrictions, the pll multiplier is insensitive to high frequency noise, and can be added to the basic counter without requiring any extra computing circuitry.

SPECIAL TECHNIQUES

As well as methods for increasing the range, accuracy and resolution of measurements, many ucts feature special techniques to simplify operation, or to allow measurements on signals which would usually cause false readings.

A good example is the 'Trigger Delay' control, sometimes called 'Trigger Hold-Off'. This feature is especially useful in measuring signals output from relays and other types of switches, where contact bounce would normally cause gross errors.

For example, assume we wish to measure the contact closure time of the signal in Fig. 11. The presence of contact bounce results in

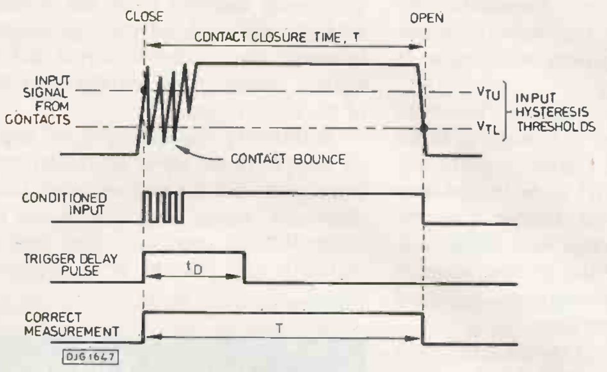


Fig. 11. Avoiding contact bounce errors.

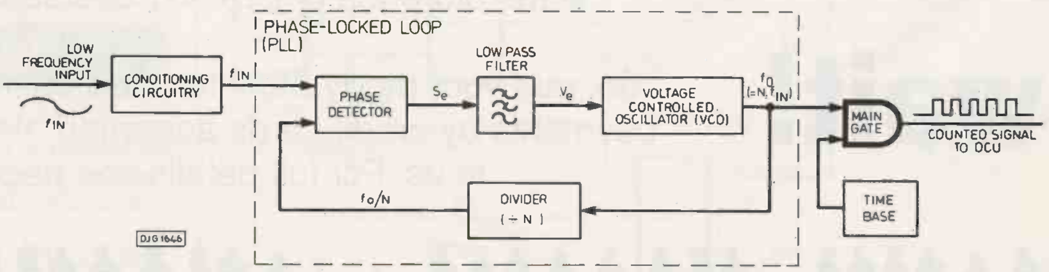


Fig 10. Frequency multiplier scheme.

three short pulses occuring at the start of the conditioned input signal. Normally, the counter would measure the duration of the first of these 'bounce' pulses, resulting in a totally erroneous reading.

The trigger delay feature, however, generates a delay pulse, tD, starting at the leading edge of the input signal. By adjusting the length of tD to be longer than the bounce duration, but shorter than the closure time, the operator can delay any further triggering until the trailing edge of the input signal, such that the displayed reading is the true closure time.

Trigger delay is found on counters such as the Philips PM6652 and PM6671, and on the Hewlett Packard HP5335A; the delay is adjusted by a front panel knob, and typically covers a range from a few microseconds to a few hundred milliseconds.

As well as eliminating the effects of contact bounce, trigger delay can be used to make pulse train measurements; for example, in Fig. 12, tD is adjusted to 'blank out' the individual input pulses, allowing us to measure the duration of the pulse train itself.

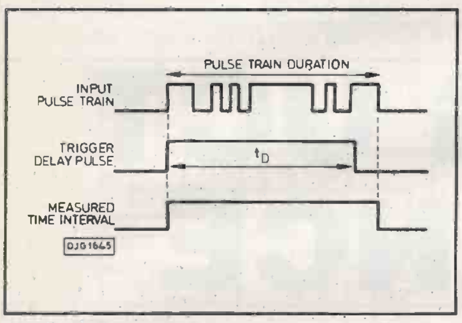


Fig 12. Pulse train measurements

ARMING

'Arming' is a versatile feature, usually found only on the more sophisticated ucts, and, like trigger delay, is used to prevent triggering on unwanted pulses. Unlike trigger delay, however, it relies on an external arming signal to determine which pulses are ignored.

Fig. 13 shows how the counter is effectively disabled while the arming signal is high: as soon as the signal goes low, however, the counter is armed and ready to initiate measurement on the next transition of the input signal.

In this way, the arming signal can be used to select which input transition opens the main gate, and the trigger delay feature can determine which transition closes the gate, such that we can 'pick out' and measure virtually any portion of a complex input signal.

ADDITIONAL FEATURES

In addition to the techniques discussed so far, several uct manufacturers offer special features intended to extend the performance and measuring power of their products.

For example, many modern counters can communicate with - and be controlled by - a microcomputer via a standard interface bus, typically the IEEE 488/IEC-625. This allows the computer to set up all the relevant measurement parameters - such as measuring mode, averaging range, trigger levels, attenuation, etc - using only digital codes sent via the bus. On completion of the measurement, the results are sent back to the computer in the same way. Because there is no need for user intervention, the counter can easily be incorporated into an ate (automatic test equipment) system.

Many ucts are now fitted with front-panel keypads which enable the operator to set up analogue parameters with digital simplicity and precision. The Philips PM652, for example, has keyboard trigger level selection over the range -5V to +5V in 10mV steps. The same keyboard is also used for mathematics operations, such as measurement scaling, display off-setting, and units conversions. Also, this model - like several others on the market - can make voltage measurements, such that the maximum, minimum, peak-peak, or rms values of the input signal can be read from the digital display.

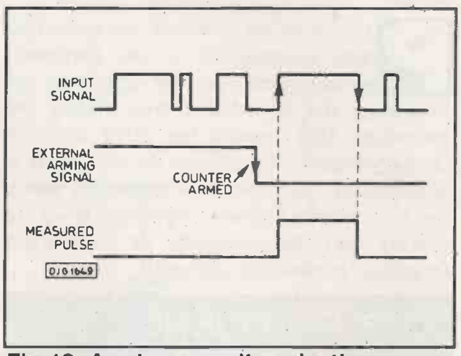


Fig 13. Arming permits selective measurements.

CONCLUSIONS

Over the past few months we've looked at many aspects of time and frequency measurement, concentrating mainly on the Universal Counter Timer, both from an operational and a technical point of view.

The primary aim was to examine all the major topics in detail, and in the articles we've dealt with the basic measurement configurations; the requirements of the input conditioning circuits; the time base and the different frequency standards available; sources of error and how to avoid them; and some of the more specialised techniques available to improve performance.

Although we've covered quite a lot of ground, the series is not a totally comprehensive treatment of the subject, and many areas have had to be left unexplored. Nevertheless, I hope the fundamentals have been dealt with in enough detail to enable you to get optimum performance from your counter, or - if you're thinking of buying a new one - to allow you to choose the model best suited to your budget and your intended range of applications.

Alternatively, I hope that any inspired constructors will now be in a good position to attempt to build their own Universal Counter Timers! PE

We shall soon be encouraging them to do so when we publish Tony Smith's UCT project. Don't miss it! Ed.

BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2	5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9	2 6V 1A mains transformers upright mounting with fixing clamps.
BD11	1 6.5-in speaker cabinet ideal for extensions, takes our speaker. Ref. BD137.
BD13	12 30 watt reed switches, it's surprising what you can make with these - burglar alarms, secret switches, relay, etc., etc.
BD22	2 25 watt loudspeaker two unit crossovers.
BD30	2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32	2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42	5 13A rocker switch three tags so on/off, or change over with centre off.
BD45	1 24hr time switch, ex-Electricity Board, automatically adjust lof lengthening and shortening day, original cost £40 each.
BD49	5 Neon valves, with series resistor, these make good night lights.
BD56	1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67	1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A	1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120	2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD128	10 Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132	2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134	10 Motors for model aeroplanes, spin to start so needs no switch.
BD139	6 Microphone inserts - magnetic 400 ohm also act as speakers.
BD148	4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149	6 Safety cover for 13A sockets - prevent those inquisitive little fingers getting nasty shocks.
BD180	6 Neon indicators in panel mounting holders with lens.
BD193	6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199	1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201	8 Keyboard switches - made for computers but have many other applications.
BD211	1 Electric clock, mains operated, put this in a box and you need never be late.
BD221	5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242	2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252	1 Panostat, controls output of boiling ring from simmer up boil.
BD259	50 Leads with push-on 1/4in tags - a must for hook-ups - mains connections etc.
BD263	2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268	1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283	3 Mild steel boxes approx 3in x 3in x 1in deep - standard electrical.
BD305	1 Tubular dynamic mic with optional table rest.
BD400	4 Books, useful for beginners, describes amplifiers equipment and kit sets.
BD653	2 Miniature driver transformers. Ref. LT44, 20k to 1k centre tapped.
BD548	2 3.5V relays each with 2 pairs changeover contacts.
BD667	2 4.7 uf non-polarised block capacitors, pcb mounting.

There are over 1,000 items in our Bakers Dozen List. If you want a complete copy please request this when ordering.

TOASTERS 2 SLICE toasters - may need slight attention only £3 each ref 3P84.

PERSONAL STEREOS Again customer returns but complete and with stereo head phones a bargain at only £3.00 each. Our ref 3P83.

MAINS OPERATED MICROWAVE CONTROL PANEL with Touch switches. This unit has a 4 digit display with a built in clock and 2 relay outputs - one for power and 1 for pulsed power level. Could be used for all sorts of timer control applications. Only £6.00. Our ref 6P18.

EQUIPMENT WALL MOUNT It is a multi-adjustable metal bracket that could be used for mounting flood light, loudspeaker, TV camera, even a fan and on almost any sort of wall or ceiling even between wall and ceiling. The main fixing brackets rotate such that an inward or an outward corner can be accomodated. Front panel also tilts upward or downwards to a reasonable angle and can be easily removed separately for wiring. A very useful bracket. Regular price would be around £6 each. Our price only £3. Our ref 3P72. Or 2 for £5. Our ref 5P152.

SUB-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly sixing nuts. 3 for £1. Order ref BD649.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8.5in wide. Double-sided on fibreglass middle which is quite thick (about 1/16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your existing car stereo, so needs no pre-amp. Works into speakers ref. 30P7 described below. A real bargain at only £57.50. Order ref: 57P1.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ET1 and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder - a complete mains operated kit, case included £12.50 + £2 p&p. Our ref 12P5/1.

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 4-Ohm impedence and consisting of 6.5in woofer, 2in mid range and 1in tweeter. Each set in a compact purpose built shelf mounting unit. Ideal to work with the amplifier described above. Price per pair £29.96. Order ref: 30P7.

STEREO CAR SPEAKERS. Not quite so powerful - 70w per channel. 3in woofer, 2in mid range and 1in tweeter. Again, in a super purpose built shelf mounting unit. Price per pair: £27.95. Order ref: 28P1.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. Or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kits with really detailed instructions. Ideal present for budding youg electrician. A youngster should be able to assemble but you may have to help wiht the soldering of the components on the pcb. Complete kit £10. Our ref. 10P81.

12" HIGH RESOLUTION MONITOR Black and white screen, beautifully cased for free standing, needs only a 12v 1.5 amp supply. Technical data is on its way but we understand these are TTL input. Brand new in makers' cartons. Price: £22.00 Free delivery. Order ref: 25P10.

14" COLOUR MONITOR made by the American Display Tek Company. Uses high resolution tube made by the famous Japanese Toshiba company. Beautifully made unit intended for console mounting, but top and sides adequately covered by plated metal panels. Full technical spec, on its way to us. We have a limited number of these. All brand new still in maker's cartons. Price: £89 each plus £6 insured carriage. Order ref: 89P/1.

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, Vsync and video. Price £8.00. Our ref 8P39.

BUSH RADIO MIDI SPEAKERS Stereo pair. BASS reflex system, using a full range 4in driver of 4 ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8.5in wide, 14in high and 3.5in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3.5in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new. Insured-delivery £3 on each or both.

ATARI 65XE COMPUTER

At 64K this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 delivery.

REMOTE CONTROL FOR YOUR 65XE COMPUTER With this outfit you can be as much as 20 feet away as you will have a joystick that can transmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12v 2.5A, +5v 6A, +-5v .5A, +-12v 5A. Size: 7.5in long x 4.75in wide x 2.25in high. Cased ready for use. Brand new. Normal price £30+, our price only £12.95. Order ref 13P2.

VERY POWERFUL 12 VOLT MOTORS. 1/3rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £20 + £2 postage. Our ref. 20P22.

PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. As above for 12V battery. Also £15. Our ref 15P22.

ORGAN MASTER is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers, request information sheet. Brand new, only £15 plus £3 postage. Our ref. 15P15.

FULL RANGE OF COMPONENTS at very keen prices are available from our associate company SCS COMPONENTS. You may already have their catalogue, if not request one and we will send it FOC with your goods.

HIGH RESOLUTION MONITOR. 9in black and white, used Philips tube M24/306W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £16 plus £5 post. Our ref 16P1.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4.5in x 4.5in x 1.75in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. £8 each. Our ref 8P26.

MINI MONO AMP on p.c.b. size 4in x 2in (app.) Fitted Volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.

J&N BULL ELECTRICAL
Dept. PE 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT.

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £2.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/Card orders accepted - minimum £5. Phone (0273) 734648 or 203500.

POPULAR ITEMS - MANY NEW THIS MONTH

JOYSTICKS for BBC, Atari, Dragon Commodore, etc. All £5.00 each. All brand new, state which required.

TELEPHONE TYPE KEYPAD. Really first class rear mounting unit. White lettering on black buttons. Has conductive rubber contacts with soft click operation. Circuit arranged in telephone type array. Requires 70mm by 55mm cutout and has a 10 IDC connector. Price £2.00. Ref. 2P251.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole PCB mounting. 3 for £1.00. Our ref BD688.

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4.00. Our ref. 4P44.

20 WATT 4 OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hifi 6.5in dia. Price £5.00. Our ref; 5P155 or 10 for £40.00 ref. 40P7.

MINI RADIO MODULE Only 2in square with ferrite aerial and solid dia. tuner with own knob. It is superhet and operates from a PP3 battery and would drive a crystal headphone. Price £1.00. Our ref. BD716.

BULGIN MAINS PLUG AND SOCKET The old and faithful 3 pin with screw terminals. The plug is panel mounted and the socket is cable mounted. 2 pairs for £1.00 or 4 plugs or 4 sockets for £1.00. Our ref. BD715, BD715P, or BD715S.

MICROPHONE Low cost hand held dynamic microphone with on/off switch in handle. Lead terminates in 1 3.5mm and 1.25mm plug. Only £1.00. Ref. BD711.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140v 100watt pair made by Hitachi. Ref 2SK413 and its complement 2SJ118. Only £4.00 a pair. Our Ref. 4P42.

Also available in H pack Ref 2SJ99 and 2SK343 £4.00 a pair. Ref 4P51.

TIME AND TEMPERATURE LCD MODULE A 12 hour clock a Celsius and Fahrenheit thermometer a too hot alarm and a too cold alarm. Approx 50x20mm with 12.7mm digits. Requires 1AA battery and a few switches. Comes with full data and diagram. Price £6.00. Our ref. 6P12.

REMOTE TEMPERATURE PROBE FOR ABOVE. £3.00. Our ref. 3P60.

A REAL AIR MOVER Circular axial fan moves 205 cubic foot per min which is about twice as much as our standard 4.5in fans. Low noise mains operated 6.5in dia, brand new. Regular price over £30.00. Our price only £10.00. Our ref 10P71.

600 WATT AIR OR LIQUID MAINS HEATER Small coil heater made for heating air or liquids. Will not corrode, lasts for years. Coil size 3in x 2in mounted on a metal plate for easy fixing. 4in dia. Price £3.00. Ref. 3P78 or 4 for £10.0. Our ref. 10P76.

EX-EQUIPMENT SWITCHED MODE POWER SUPPLIES Various makes and specs but generally +-5, +-12V ideal bench supply. Only £8.00. Our ref 8P36.

ACORN DATA RECORDER Made for the Electron or BBC computer but suitable for others. Includes mains adaptor, leads and book. £12.00. Ref. 12P15.

PTFE COATED SILVER PLATED CABLE 19 strands of .2mm copper will carry up to 30A and is virtually indestructible. Available in red or black. Regular price is over £120 per reel. Our price only £20.00 for 100m reel. Ref. 20P21 or 1 of each for £35.00. Ref 35P2. Makes absolutely superb speaker cable!

NEW PIR SENSORS Infra red movement sensors will switch up to 500w mains, UK made, 12 month manufacturers warranty, 15-20m range with a 0-10min timer, adjustable wall bracket. Only £20.00. Ref 20P24.

MITSUBISHI 3.5IN DISC DRIVES Brand new drives, 1/2 height double sided, double density warranted. Our price £60.00. Ref. 60P5.

10 MEMORY PUSHBUTTON TELEPHONES These are customer returns and sold as seen. They are complete and may need slight attention. Price £6.00 Ref 6P16 or 2 for £10.00 Ref 10P77 BT approved.

NON-MEMORY PUSHBUTTON TELEPHONES. Same condition as above with redial £3.00. Our ref. 3P79. BT approved.

DEHUMIDIFIERS Domestic mains powered dehumidifiers these are customer returns and sold as seen. Price £30.00. Our ref 30P9. Callers only please. Also working dehumidifiers at £99.00 each.

SPECTRUM PRINTER INTERFACE. Add a centronics interface to your Spectrum complete with printer cable for only £4.00. Our ref. 4P52.

SPECTRUM SOUND BOX Add sound to your Spectrum with this device. Just plug in. Complete with speaker, volume control and nicely boxed. A snip at only £4.00. Our ref. 4P53.

BBC JOYSTICK INTERFACE Converts a BBC joystick port to an Atari type port. Price £2.00. Our ref. 2P261.

TELEPHONE EXTENSION LEAD 5m phone extension lead with plug on one end, socket on the other. White. Price £3.00. Our ref. 3P70 or 10 leads for only £19.00 Ref. 19P2.

LCD DISPLAY 4.5in digits supplied with connection data £3.00. Ref. 3P77 or 5 for £10. Ref. 10P78.

CROSS OVER NETWORK 8 Ohm 3 way for tweeter midrange and woofer nicely cased with connections marked. Only £2.00. Our ref. 2P255 or 10 for £15.00. Ref. 15P32.

REVERSING LIGHT ALARM Fits to car reversing light and sounds when reversing. Only £2.00. Our ref. 2P248.

BASE STATION MICROPHONE Top quality uni-directional electret condenser mic 600r impedence sensitivity 16-18KHz - 68db built in chime complete with mic stand bracket. £15.00. Ref. 15P28.

MICROPHONE STAND Very heavy chromed mic stand, magnetic base 4in high. £3.00 if ordered with above mic. Our ref. 3P80.

SOLAR POWERED NICAD CHARGER 4 Nicad AA battery charger. Charges 4 batteries in 8 hours. Price £6.00. Our ref. 6P3.

MAINS SOLDERING IRON Price £3.00. Our ref. 3P65.

SOLDERING IRON STAND Price £3.00. Our ref. 3P66.

PIR SENSORS Suitable for alarm systems etc. Nicely boxed. Priced at only £10.00. Our ref. 10P79.

SHARP PLOTTER PRINTER New 4 colour printer originally intended for Sharp computers but may be adaptable for other machines. Complete with pens, paper etc. Price £16.00. Our ref. 16P3.

CAR IONIZER KIT Improve the air in your car, clears smoke and helps prevent fatigue. Case req. Price £12.00. Our ref. 12P8.

NEW FM BUG KIT New design with PCB embedded coil 9v operation. Priced at £5.00. Our ref. 5P158.

NEW PANEL METERS 50UA movement with three different scales that are brought nto view with a lever. Price only £3.00. Ref. 3P81.

STROBE LIGHTS Fit a standard edison screw light fitting 240V 40/min. flash rate available in yellow, blue, green and red. Complete with socket. Price £10 each. Ref. 10P80 (state colour required).

ELECTRONIC SPEED CONTROL KIT Suitable for controlling our powerful 12v motors. Price £17.00. Ref. 17P3 (heatsink required).

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and look tidy. 4 core, suitable for alarms, phones etc. Our price only £5.00 for 50m reel. Ref. 5P153.

METAL PROJECT BOX Ideal for battery charger, power supply etc. Sprayed grey size 8in x 4in x 4.5in. Louvred for ventilation. Price £3.00. Ref. 3P75.

PE PCB SERVICE

IT IS EASY TO BUILD PRACTICAL ELECTRONICS PROJECTS!

Simplify your project assembly - use a ready-made printed circuit board. All are fully drilled and roller tinned. Just slot in the components as shown in the project texts, and solder them. PCBs are the professional route to project perfection.

MAIL ORDERING

Select the boards you want, and send your order to: PE PCB SERVICE, PRACTICAL ELECTRONICS, 193 UXBRIDGE ROAD, LONDON W12 9RA.

Prices include VAT and postage and packing. Add £2 per board for overseas airmail. Cheques should be made payable to Intra Press (Payments by Access and Visa also accepted). Quote the project name and PCB Code Number, and print your name and address in Block Capitals. Do not send any other correspondence with your order.

TELEPHONE ORDERS

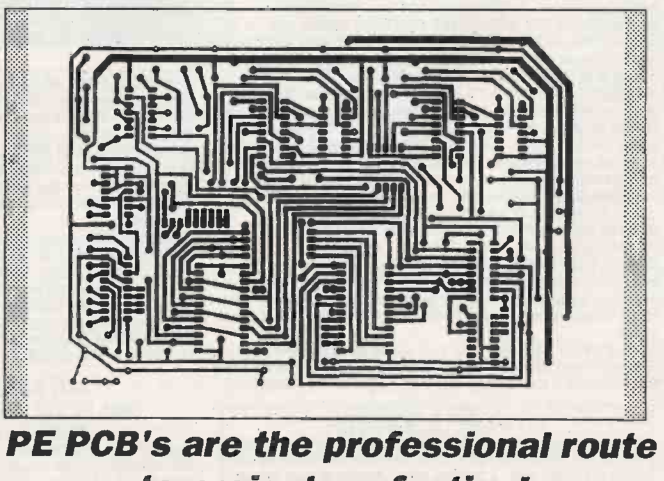
Use your Access or Visa card and phone your order to **01-743-8888** clearly stating your name and address, card number and order details. All orders receive priority attention. Many PCB's are held in stock, so they are dispatched within few days, but please still allow 28 days for delivery in case a PCB is temporarily out of stock.

We can only supply the PCB's listed here! Please always check the latest issue of PE before ordering.

We can also supply the photocopies of the text at £1.50 for each project part inclusive of postage and packing (overseas £2.00).

Please note that we do not supply components - they can ordered from our advertisers!

APRIL	Code	
VIGILANTE CAR ALARM - keeps cars alert	139	£5.90
MAY 87		
BRIGHT FUZZ - Foot operated overdrive	145	£3.90
JUNE 87		
AUDIO SIGNAL GENERATOR	146	£10.20
JUL 87		
WORD GENERATOR - 16 bit binary words	147	£13.42
SCOPE STORE oscilloscope add-on data storage	148	£11.94
SEP 87		
SPEECH PROCESSOR - clarifies speech	150	£5.86
GCSE TIMER UNIT - versatile variable delay	151	£5.18
FUNGEN - triple waveform signal generator	152/153	£9.69
OCT 87		
TEACHER LOCKER - digital lock control	155	£7.50
POWER SUPPLY - stabilised ±15V	156	£7.50
GUITAR TO SYNTH - music interface	157A/B	£9.95
NOV 87		
DUAL POWER SUPPLY - GCSE	158	£6.20
MIDI EXPANDER - Music Interface	159	£5.04
DEC 87		
RS 232C TO MIDI	160	£6.43
TEACHER RADIO - GCSE	161	£5.58
JAN 88		
LEGO BUGGY DRIVER	163	£6. 42
FEB 88		
TEACHER TALKBACK - GCSE	164	£6.36
DC MOTOR SERVO	165	£7.53
MAR 88		
APPLIANCE TIMER	166A/B	£9.38
TEACHER LIGHTSHOW - GCSE	167A/B	£9.09
LOGIC ANALYSER - Double-sided	168	£20.65
APR 88		
LIGHT METAL EFFECTS	169	£7.10
MAY 88		
RF SPEECH PROCESSOR	172	£6.26
JUNE 88		
AMSTRAD ROM EXPANSION	173	£10.80
MAINS MODEM	174	£4.27
JULY 88		
VOCALS ELIMINATOR	175	£4.31
AUG 88		
SPEAKING CLOCK	176	£16.75
SEPT 88		
BBC MULTIPLEXER	177	£4.50
OCT 88		
METAL DETECTOR	178	£6.50
DEC 88		
PANNING MIXER	181	£7.80
JAN 89		
RUDOLPH'S NOSE	182	£6.25
ANGEL'S HALO	183A/B	£9.40
CANDLE FLICKER	184	£6.25
MAR 89		
CAMERA SHUTTER TIMER	187	£9.95
APR 89		
PC MULTIPORT	188A/B	£20.55
MAY 89		
KIRLIAN CAMERA	189A/C	£10.50
JUNE 89		
SOLAR HEATING CONTROLLER	197	£7.20
DELUXE METRONOME	198	£10.95
JULY 89		
PROJECTOR SYNCHRONISER	190A	£9.50
AUG 89		
EASI-BUILD - VODALEK	191	£4.90
HAND CLAPPER	192	£6.50
SEP 89		
EASI-BUILD - COMPRESSOR	193	£4.90
FREQUENCY COUNTER-GENERATOR	194A/B	£12.50
OCT 89		
EASI-BUILD VOICE-OP-SWITCH	195	£4.90
HOME SECURITY CONTROLLER	196A/C	£19.50
DEC 89		
VIDEO AGC STABILISER	199	£6.50
ECHO STATION	200A/B	£11.50
MINI METRONOME	201	£4.90
JAN 90		
BARGRAPH TACHOMETER	202	£5.90
EEPROM PROGRAMMER (KEYBOARD VER)	203	£14.50
FEB 90		
EEPROM PROGRAMMER 9SWITCH VERSION)	204	£4.90
MODEM	205	£11.50
MOCK STEREO	206	£4.90



PE PCB's are the professional route to project perfection!

PRACTICAL ELECTRONICS CLASSIFIED

Reach thousands of serious electronic and computer enthusiasts. Advertise in PE Classified pages: Rates 20p per word or £8.50 per single column cm (plus VAT). All classified advertisements must be pre-paid. Send your copy with the remittance (payable to Intra Press or payment by Visa or Access accepted) to: **Practical Electronics, Intra House, 193 Uxbridge Road, London W12 9RA. Tel: 01-743 8888. Fax: 01-743-3062**

LET PE WORK FOR YOU!

CLASSIFIEDS

Resistors 1/4 W 5% carbon (E12) 1p metal film 1% 3p
Resistor Pack 85 different E12 values + zero ohm link total content
1000 resistors £8.95
LEDs red/green 3/5mm ....6p each. Yellow 11p
Cable ties 75mm ....1p each £5.95/1,000 £49.50 per 10,000
Stepping motor 4 phase 12v 7.5' step 50 ohms £8.95
SAA1027 stepping motor driver chip £3.95
FM transmitter Kit good quality sound £7.94
High quality photo resist coper clad epoxy glass boards

Dimensions	single sided	double sided
3x4 inches	£0.95	£1.07
4x8 inches	£2.40	£2.68
6x12 inches	£5.37	
12x12 inches	£10.66	

Special Offers

Computer Grade Capacitors with screw terminals 38000uf 20v £2.50
8700uf 10v £1.95, 68000uf 15v £2.95, 10000uf 16v £1.50
7 segment Commom anode led display 12mm £0.45
LM2931AT5.0 Low drop out 5V regulator T0220 package £0.85
BS250 P channel MOSFET £0.45, BC559 transistor .....£3.95 per 100
74LS05 hex inverter £10.00 per 100, used 8748 Microcontroller £3.50
Stereo LW/MW/FM Tuner pre-amp assembly complete with
volume/tone controls and tuning scale Brand new in makers carton .....
....£5.95, faulty £2.50
Circuit diagram description and setting up procedure for tuner
assembly described above £0.50. 5 digit 6v electromagnetic counter ...
....£1.95
Hour counter (used) 7 digit mains 240V AC 50Hz £0.95
LCD display 16 digit 7x5 dots dot matrix £2.50
Querty keyboard 58 key good quality switches £5.00

95p for P&P per order (VAT inc.)

wide range of CMOS TTL 74HC 74F Linear transistors kits
capacitors, resistors tools etc always in stock
JPG Electronics 276 Chatsworth Road Chesterfield S40 2BH
Access orders (0246) 211202. Callers welcome

Carbon Film Resistors ¼W E24 series 0·51R to10M0 – 1p
100 off per value – 75p 1000 off in even hundreds per value – **£7**
Metal Film ¼W 10R0 to 1M0 5% E12 series – 2p 1% E24 series – 3p
½Watt metal/carbon film E24 series 1R0 to 10M0 – 1½p
1 Watt metal/carbon film E12 series 4R7 to 10M0 – 5p
BC107/8/9 – 12p BC547/8/9 – 8p BC182L 184L – 10p
BFY50/51/52 – 20p 2N3055 – 50p TIP31A,32A – 25p TIP41,42, – 40p

Tantalum head subminiature electrolytics (Mids/Volts)
0·1/35, 0·22/35, 0·47/35, 3·3/16, 4·7/16 – 14p 4·7/35 – 15p
2·2/35, 4·7/25, 10/5 – 15p 4·7/35, 6/8/16 – 16p 10/16,22/6 – 20p
22/16 – 30p 33/10 – 30p 47/10 – 35p 100/6 – 40p

Aluminium Electrolytics (Mids/Volts)
1/50, 2·2/50, 4·7/25, 4·7/50, 10/16, 10/25, 10/50 – 5p 22/16, 22/25 – 6p
22/50, 47/16, 47/25, 47/50 – 6p 100/16, 100/25 – 7p 100/50 – 12p
100/100 – 14p 220/16 – 8p 220/25, 220/50 – 10p 470/16, 470/25 – 11p
1000/25 – 18p 1000/35, 220/25 – 22p 4700/25 – 70p

Miniature Polyester Capacitors 250V Wkg. Vertical Mounting
·01, ·015, ·022, ·033, ·047, ·068 – 4p 0·1 – 5p 0·15, ·22 – 6p 0·47 – 8p

Mylar Capacitors 100V Wkg. Vertical Mounting E12 Series
1000p to 8200p – 3p ·01 to ·068 – 4p 0·1 – 5p 0·15, 0·22 – 6p

Subminiature Ceramic Plate 100V Wkg. E12 Series Vertical Mounting
2% 1P8 to 47P – 3p 56P to 330P – 4p 10% 390P to 4700P – 4p
Ceramic plate/disc E6 Series 50V 22P to .047 – 2p

Polystyrene Capacitors 63V Wkg. E12 Series Axial Mounting
10P to 820P – 3p 1000P to 10,000 – 4p 12,000P – 5p
1N4148 – 2p 1N4002 – 4p 1N5404 – 14p W01 bridge – 25p
0A91 – 6p AA143 – 8p W005 – 20p 1N4006 – 6p
Zener diodes E24 series 3V3 to 33V 400mW – 8p 1 watt – 12p
L.E.D's Red, Green & Yellow 3mm & 5mm – 10p 8mm – 35p
20mm fuse 0·1A to 5A quick blow – 5p Anti Surge – 8p
High Speed drills 0·8mm, 1·0mm, 1·3mm, 1·5mm, 2mm – 30p
Expo Reliant drilling machines 12V d.c. with improved 3-jaw chuck £6.50
Nicads AA – 80p HP11 – £2 PP3 – £4.20 Universal Chargers – £6.50
Glass reed switches single pole make contacts – 8p Magnets – 12p

VAT inclusive. Return postage 25p (free over £5). Lists free.

THE C.R. SUPPLY CO.,
127 Chesterfield Road,
Sheffield S8 ORN. Tel. 557771.

★ Series X Mixer Kits
★ up to 1.000 inputs
★ 60+100 mm faders, pots, panels and audio switches
★ 6-9 echo sends
★ versions for recording PA, radio, disco
★ circuit diagrams
★ From £9.92

Send 40p for catalogue to: **K. Tek, P.O. Box 172a, Surbiton, Surrey KT6 6HN. Tel:01-399-3990**

TURN YOUR SURPLUS

ICS transistors etc into cash, immediate settlement. WE welcome the opportunity to quote for complete factory clearance.
Contact:
COLES-HARDING & CO.,
103 South Brink, Wisbech, Cambs.
ESTABLISHED 15 YEARS
Tel:0945 584188 - Fax: 0945 588844

CAMBRIDGE COMPUTER SCIENCE LTD

10MByte Winchesters, used, 3 months Wty,	£42.00 each
5.25" Disk Drives, 80 Track DSDD	£34.00 each
5.25" Disk Drives, 80Tk, DSDD Used, No Wty	£15.00 each
Buy a case, winchester & PSU together for	£ 64.00 set
Small cases, to fit 2 Half Ht 5.25" drives	£ 10.00 each
5.25" Drives, used-untested-no warranty (untested drives are sold on a strictly "as is" basis)	£15.00 each
5.25" Disks, DSDD, 48tpi boxes of 10	£3.00/box
50W PSU 5V 6A, 12V 2.5A, -5V 0.5A, -12V 0.5A	£16.00 each
Gould PSU 0-30V @5A Limited quantity only at	£45.00 each
Dual Data lead (BBC Micro to 2 Disk Drives)	£ 4.00 each
Power lead (BBC Micro to Disk Drive)	£2.00 each
Dual power lead (BBC Micro to 2 Disk Drives)	£ 4.00 each
68000 CPUs (The first orders get 10MHz chips)	£3.50 each
z80A CPU, CTC, P10 £1.20 each; DMA £2.00	£4.50 all 4
74LS TTL , pick and mix, buy 10 or more for	£0.12 each

Types available: '00 '02 '04 '08 '11 '13 15' '20 '21 '26 '27 '30 '32 '38 '42 '75 '83 '96 '107 '109 '122 '132 '136 '139 '145 '151 '153 '157 '158 '163 '164 '166 '191 '193 '298 '365 '670

EPROMS 27128 used £1.50 each;	new 27128-25 £2.50 each
6264 8K Byte SRAM	-15 £3.00 each -12 £3.80 each
65256 32K Byte rams	£7.00 each
8K Byte NV ram chips	£3.00 each £10.00 four
20 pin dil low profile IC sockets	£0.50 (ten) - £ 4.00 (100)
40 pin dil low profile IC sockets	£0.60 (ten) - £ 5.00 (100)
Keyboard, 100 keys on board LCD & micro i/f	£8.00 each
Toroidal mains transformer 12V 4A & 0.4A, 12-0-12 @0.1A & 2A , 9-0-9 @0.2A	£4.00 each - £6.00 for 2. - £8.00 for 3

Prices include postage. Add 50p to orders below £5.00. All items new unless stated . Add 15% VAT to all prices. Send an SAE for our latest list or for more info. **Dept PE, 374 Milton Road, Cambridge, CB4 1SU Tel: 0223 424602 or 0831 430496 or 0831 430552**

(Mail order only, no facilities for callers)

SURPLUS/REDUNDANT ELECTRONICS COMPONENTS WANTED

ICs - Tuners - Transistors - Valves - Diodes etc - any quantity considered -immediate payment.
ADM ELECTRONICS SUPPLIES
Tel 0827 873311 Fax: 0827 874835

SURPLUS ★ STOCK ★ CLEAROUT

Surplus IC's & Electronic Components at cost prices.
Please phone for quote.
Also available masses of 74's all types at super low prices. IE 74HC14 @ .15p each - P+P .40p plus VAT on total order value.
Cheque or P.O. with order please. 48 hour guaranteed despatch.
Phone J. Philpot on 0532-489048

Do not gamble with your advertising!

Use Practical Electronics with confidence!

Phone our Advertisement Dept. on 01-743-8888 for details!

Cooke International

DO YOU WANT
SCOPES, GENERATORS, POWER SUPPLIES, POWER METERS, DVM'S, OSCILLATORS, ATTENUATORS.
TEST EQUIPMENT.

Contact: Cooke International, Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex PO22 0EB.
Tel: 0243 545111, Fax: 0243 542457
Wide range of items available. Send for lists.

74HC series ICs

74HC00 19p	74HC02 19p	74HC03 19p
74HC04 19p	74HC08 19p	74HC10 19p
74HC11 26p	74HC14 39p	74HC20 19p
74HC27 31p	74HC30 35p	74HC74 38p
74HC86 29p	74HC107 36p	74HC138 41p
74HC161 48p	74HC175 52p	74HC393 69p

74LS series ICs

74LS00 20p	74LS02 20p	74LS05 20p
74LS30 20p	74LS32 20p	74LS51 20p
74LS90 30p	74LS93 30p	74LS107 23p
74LS112 23p	74LS138 35p	74LS139 35p
74LS151 38p	74LS164 38p	74LS193 55p
74LS245 58p	74LS374 52p	74LS375 64p

74F series ICs

74F00 32p	74F02 32p	74F64 32p
74F174 77p	74F251 64p	74F353 64p
74F373 91p	74F398 96p	74F399 96p

ECL series ICs

10101 1.15	10102 1.15	10103 1.15
10104 1.15	10124 3.68	10125 3.68

A wide range of components and TTL. CMOS and ECL ICs are available. We also supply PC, XT and AT spares at *LOW PRICES*. Write or phone for our FREE catalogue.

Resistors at bulk prices *Your Mix*
Carbon film, 0.25W, 5% 1p each or 45p for 50
Metal film, 0.25W, 1% 3p each or £1.35 for 50

I/C sockets, solder type (pin:price)
14:10p, 16:11p. 20:14p, 24(0.6 or 0.3):16p.

I/C sockets with 0.1uF decoupler
14:60p, 16:65p.

Prototyping boards (Vero)
IBM XT £45.00, IBM AT £52.00

ACCESS welcome by post or phone. Callers by appointment please. VAT INCLUDED. Please add 50p for post and packing. Catalogue free. No minimum order charge.

BLACKMORE ELECTRONICS LTD.
FREEPOST, Blandford Forum
Dorset DT11 7BR

☎ 0258 451347 (24hr answerphone)

Laboratory stock clearance equipment, computers, ECG transducers, Geigers, anemometers, spare motors etc. SAE list from:
Laboratories, Maplehurst RH13 6LL
Tel: 0403 891 236

Remember!

Good Selection of Electronic & Computer Books is available from PE Book Service!

SERVICES

For Electronic Design and PCB Manufacture call
PROTO DESIGN
Unit 8, Ilford Trading Estate
Paycocke Road Basildon
Essex SS14 4DR
Tel: 0268 289923

COMPONENTS

R.J.E COMPONENTS,
207, Godman Road,
Chadwell-St-Mary,
Grays, Essex RM16 4TR

Free Mail order catalogue of electronic components, Velleman project Kits, Tools etc.
Also
PCB Design -Manufacture -Assembly
Repair-Service Commercial PCB's & Equipment

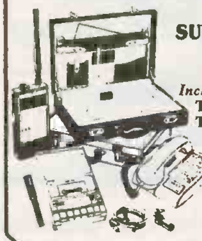
ELECTRONICS COMPONENTS & TEST EQUIPMENT - For bargain list send SAE to: Dept. PE , 76 Wensleydale Road, Great Barr, BirminghamB42 1PL

C.S. COMPONENTS (Est. 4 years). Suppliers & stockist of electronic components, electronic valves, military equipment and spares. Obsolete and hard to find products are our speciality. C.S. Components, Southfield House, 11 Liverpool Gardens, Worthing, West Sussex BN11 1R

SURVEILLANCE

ESKAN
ELECTRONICS

SURVEILLANCE & COUNTER SURVEILLANCE EQUIPMENT
WE MANUFACTURE AND SUPPLY TOP QUALITY SURVEILLANCE AND SECURITY EQUIPMENT



Including VHF and UHF -s, Transmitters, Automatic Telephone Recorders, Recording Briefcases, Bug Detectors, Telephone Counter-Tap Units
We also offer a complete range of accessories, including microcassette recorders, microphones, receivers, cassettes and batteries

ESKAN ELECTRONICS LTD.
DEPT. PE 172 CALEDONIAN ROAD, LONDON N1
01-278 1768
CCTV AND SECURITY SYSTEMS SPECIALISTS

NEW VHF MICROTRANSMITTER KIT, tuneable 80-115 MHz, 500 metre range, sensitive electret microphone, high quality PCB. SPECIAL OFFER complete kit **ONLY £5, assembled and ready to use £8.95** post free. Access orders telephone 021 411 1821. Cheques/ P.O.'s to: **Quantek Electronics Ltd, (Dept P.E.), 45a Station Road, Northfield, Birmingham, B31 3TE**

Surveillance devices, lasers, Tesla coils, scramblers, ultrasonic and many more, over 150 designs. Send SAE to: **Plancentre, Old Wharf, Dynock Road, Ledbury HR8 2HS**

KITS MICROTRANSMITTER, VHF/FM, received on standard radio, 25x15mm, free microphone included - £4.50. Telephone transmitter, amazingly uses no batteries - £5.49. Bleeper transmitter vhf - £8.59 inc p&p. SAE list. Remittance to: **A.C.E. (PE), 99 Greenheath, Hednesford, Staffs.** - Access orders 05438 71902 - same day dispatch.

JOBS

SERVICE ENGINEER
required
MUSIC VILLAGE
Require a service Engineer to work at their Chadwell Heath store, repairing amplifiers, keyboards, recording equipment and some computers. Training available. Ring Ian Woodcock on 01-597-7043

BOOKS

Digital Logic Gates and Flip-Flops
by Ian R. Sinclair, 200 pp, £8.95
- An intro to the basic building blocks of all digital circuits, for enthusiasts, students and technicians

"Recommended" by PE (see review in Sept 89)

Computers and Music
by RA Penfold,184 pp, £7.95
- How to make music with your micro

"Highly recommended"

Cheques payable to PC Publishing (add 50 p for P&P) to:
Dept. PE, PC Publishing, 4 Brook Street, Tonbridge, Kent TN9 2PJ
Send SAE for more info on our books!
PC Publishing
leaders in technology publishing

73 AMATEUR RADIO
World's leading ham radio magazine.
Annual subscription $39.00 (US Funds) from: 73 Amateur Radio, P.O. Box 58866, Boulder, CO 80322-8866, U.S.A.

Heathkit
home learning manuals with experimenter. discs and cassettes, components, all practically unused, only £100 or offer to:
Mr. D. Pinnock, 39 Common End Lane, Lepton,Huddersfield, W. Yorks
Tel: 0484-605691

INFOTECH
76 Church St., Larkhall, Lanarkshire ML9 1HE

Servicing Black and White Television - G.R. Wilding
~~Standard price £17.95~~ - Special offer £9.95
★ ★ ★
Servicing Colour Television - Gordon G. King
~~Standard price £14.95~~ - Special offer £9.95

Offer closes February 28th - Access and Visa accepted, -immediate dispatch
Tel: 0698-884585 (Mon-Fri 9-5)
0698-883334 (any other time)

SERVICE MANUALS
Available for Colour Televisions, Mono Televisions, Video Recorders, Audio Equipment, Music Systems, Car Radio's, Cameras, Test Equipment etc etc.
Over 100,000 stocked, originals and photostats.
LSAE enquiries with Make/Model wanted.
FREE catalogue Unique Repair and Data Guides for LSAE
MAURITON (PE), 8 Cherry Tree Road, Chinor, Oxoforshire OX9 4QY
Tel: (0844) 51694 office hours - Fax:(0844) 52554 (any time)

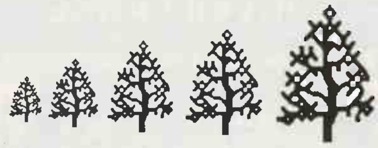
MISCELLANEOUS

Have a good idea?
Ideas, designs and inventions wanted.
S.A.E. for more information: Martin Bliss Prop. MD, Adapta Plan, Dept. PE, 28 Clerkenwell Crescent, Malvern, Worcs WR14 2TX

Are you an electronics hobbyist?
If so, you will benefit from joining British Amateur Electronics Club!
BAEC, C. Bogod, 26 Forrest Rd., Penarth, South Glamorgan

R1155, T1154 original unmodded, Eddystone 770R needs attention. Hallicrafters S27, PCR3 Rx offers or swap scanner. M. Lane 56 Main Street, Bushby, Leicestershire Tel: 0533 413892

BP34 wanted. Practical Repair and Renovation of Colour TV's. Good price paid for book or photocopy. Contact: B.S. Smart 27 Knowle Road, Maidstone, Kent Tel: 01-945-5338 (day) or 0622 51501 (evenings)



From little acorns mighty oaks will grow!

Small businesses - use PE Classified section for your products or services and watch your business develop!

Phone David Bonner on 01-743-8888 for details!

Three Monitels, Telephone cost display devices; one international, one UK and one for spares. £35 the lot inc. P+P. Contact: Steve Cousins on 0908 641548

For Sale - Console only, two manual full pedal 35 tab Chorister organ plus bench. Offers to 020-881-2886 (Cornwall)

LS1 Octopus 8086 CPU Z80 CPU 16 bit Computer 10 Mbt Hard drive Monitor, spare CPU board, five RS232 parallel ports, only £250. Contact: J.E. Lee on 0373-84-861 (Somerset)

Voice/Sound activated switches easy to follow diagrams and uses only £1.00. Components and P.C.B.s available from Herrington, 63 Home Farm Road, Hanwell, London W7 1NL

Fine hand made telescopes! Terrestrial and astronomical. Contact Ian Poyser, 15 Dale Road, Rochester, Kent ME21 2PJ Tel: Medway 401220

RM Nimbus Experimental Analogue port. Two analogue and two digital channels, using mouse socket. Circuit, layaout and listing £5.00 - PCB £3.50. From: Logical Answers, 24 Elmwood, Mersea, Colchester, Essex CO5 8RD

EVENTS

LONDON RADIO AMATEUR SHOW
9th and 10th March,
Picketts Lock Centre, Edmonton, North London,
Information from: LARS on 0923 678770

TRAVEL

SOLAR ECLIPSE JULY 1990 - Finland
For your travel and accommodation needs phone Margaret at Salford Travel Agency on 061-832913.
ABTA Members

CLASSIFIED COUPON

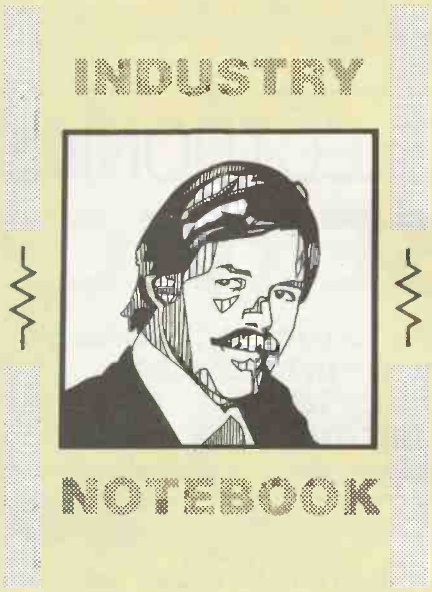
						£2.80
						£4.20
						£5.60
						£7.00
						£8.40
						£9.80

Rates are 20 per word (lineage, for semi-display advertisements contact our Ad. Dept.). All classified advertisements must be pre-paid. Please send your copy with the remittance (payable to Intra Press,or payments by Visa or Access accepted) to: Practical Electronics Classified Dept., Intra House, 193 Uxbridge Road, London W12 9RA. Tel: 01-743-8888, Fax: 01-743-3062

The Two Cultures Revisited

By Tom Ivall

The split between "arts" and "sciences" creates a lack of true understanding.



Some years ago I went to a special exhibition at the Victoria and Albert Museum, London, called 'The Wireless Show'. It was an historical survey of the external design of radio sets, taking some account of the electronic technology as well. Half-way along the chronological line from kitsch crystal-sets to severe 'utility' boxes I was stopped in my tracks by a shock of recognition. There, complete with explanatory label, sat an identical model to the little Bush table radio we were then using at home.

My surprise wasn't entirely the result of discovering wê owned a working museum-piece. It was the shock of seeing something familiar in a completely new role. At home the old radio was a disregarded household object, inherited without enthusiasm from a previous generation. It did a useful job for us, from an ignoble position of being wedged in a corner with domestic junk piled on top of it and generally treated rather roughly. But here in the V&A, it - or at least its clone - had suddenly become an object of appreciation and regard, something of aesthetic value and perhaps scholarly interest. It had acquired a place in history.

SCIENCE AND HUMANITIES

This little experience, of suddenly seeing a technological object transformed into an objet d'art, set me thinking again about the old problem of the separation between the humanities and the sciences. C.P. Snow, the scientist turned novelist, identified it as "The two cultures" in a famous lecture and book a few decades ago.

He was right to use the word 'culture'. Educational specialisation in the past - when you had to decide at an absurdly early age to become either an 'arts' person or a 'sciences' person - has fostered different ways of thinking, feeling and believing which amount to different ways of living. People have become polarised in outlook. From my own experience the two sides are often unable to communicate with each other on more than a humdrum, superficial level.

It is a problem for two reasons. First, individuals who are culturally polarised in this way are poorly educated, in terms of the development of the whole person. This means not only a limitation of their own personal enjoyment and fulfilment but also - the second reason - they bring a narrow, impoverished attitude to the (necessarily specialised) work they do in the world. All of us must be the losers from this artificial restriction of understanding.

TECHNOLOGICAL BRIDGE

I see it as a spiritual deformity. Trying to think about it therapeutically, I wondered initially if technology (of which electronics is a part) could form a bridge between the arts and the sciences. After all many technologies are derived from both, if you consider the arts as embracing crafts. Modern chemistry, for example, didn't arrive fully armed as a science. It developed gradually out of alchemy. And nowadays the artist is increasingly making use of technological tools. Musicians compose with electronic synthesisers, painters and graphics designers make pictures with computer 'paint-boxes'.

But this 'technological bridge' is only a theoretical or superficial one. It doesn't go deep enough to be able to weld together two fundamentally different philosophies for understanding the world. At one extreme you have the narrow scientific view which sees art merely as decoration, not as a way of experiencing reality. At the other extreme you have the narrow artistic view which sees science merely as instruments and machines, not as a way of exploring reality. Something pretty powerful is needed to knock these two heads together.

The scientific world view has become highly influential partly because of technology but mainly because it strives for objectivity and uses contact with the real as a criterion of truth. But when, as part of scientific enquiry, we have obtained objectively true knowledge of ourselves this still doesn't tell us what to do with the result - in short, how to live. Only the realm of values, expressed through art, religion, ethics, philosophy, aesthetics and other such distillations of experience helps us with the immediate question of what to do next. We can't avoid action.

Our knowledge seems to be divided fundamentally between facts (the subject matter of science) and values (the subject matter of the humanities). But some recent thinking may be breaking down the dividing wall.

CONCEPTUAL MODELS

The approach is that perhaps we have been a bit too arrogant in claiming that science has privileged access to reality. After all, its method is to build conceptual models (eg mathematical equations) which fit as closely as possible our empirical observations and measurements. All the time these models are being improved. But the map is not the territory. The model is not, and never can be, the actuality. Other creatures (say extra-terrestrial beings) could have different mental models of the same reality. Who is to say which picture in the mind would be the truth?

Aristotle observed what he called 'natural downward motion'. After Newton and his equation, we say in a superior tone "Of course, what Aristotle *really* meant was gravitation." But does the quantitative description in Newton's equation of universal gravitation get us any closer to reality? Apples still fall, regardless of how we describe the process.

Science, according to the American philosopher Willard Quine, is a way of coping with the world. As such it is like art, religion, politics, etc. - another way of adjusting ourselves to our experiences, using a mental framework of images, theories, intuitions, convictions, revelations.

On this basis Newton's theory and equation of universal gravitation helped us to cope - with our ceaseless curiosity and desire to understand the natural world - better than Aristotle's idea did, because it was a more satisfactory explanation to us as humans. Whether it was truer to reality was an open question. Anyway, Einstein came along and modified Newton.

The Quinean view is behaviouristic. It seems to present the analytical search for objective truth as a way of finding 'what works' in satisfying the human mind. I wonder if this approach to bridging the two cultures will ever have an influence on the national curriculum.

UPDATE

In last month's column, the date of 1988 given for the sale of Inmos and Plessey should, of course, have been quoted as 1989! PE

PRACTICAL ELECTRONICS BOOK SERVICE

Here is your Editor's choice of books he thinks will be of interest to electronics and computer enthusiasts

BEGINNERS AND EARLY STARTERS

NEW Mini-Matrix Board Projects.
R.A.Penfold. 112 pages. £2.50.
Order Code BP99
Shows a selection of 20 useful and interesting circuits that can be built on a mini-matrix board of 24 holes by 10 copper strips in size - an ideal book for early experimenters.

NEW From Atoms to Amperes.
F.A.Wilson. 160 pages. £2.95.
Order Code BP254.
For the absolute beginner, clearly explaining the fundamentals behind the whole subject of electricity and electronics.

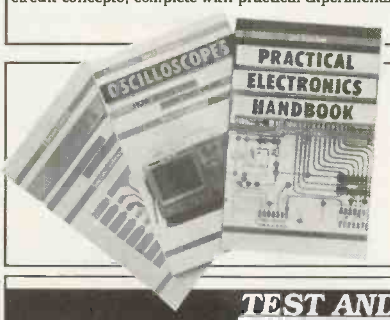
NEW Electronic Projects for Beginners.
F.G.Rayer. 128 pages. £1.95.
Order Code BP48
Specially for the newcomer to electronics who is looking for a book containing a wide range of easily made projects. Some circuits need no soldering and many others show actual component and wiring layouts.

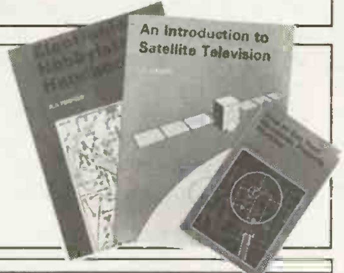
Electronics Build and Learn
R.A.Penfold. 128 Pages. £5,95.
Order Code PC 101
Combining theory and practice, the book describes a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components and circuit concepts, complete with practical experiments.

Practical Electronic Building Blocks
R.A.Penfold. There are two books -
Book 1 : 128 pages. £1.95.
Order Code BP117
Book 2 : 112 pages. £1.95.
Order Code BP118
Book 1 is about oscillators and gives circuits for a wide range, including sine, triangle, square, sawtooth and pulse waveforms and numerous others from voltage controlled to customised ic types.
Book 2 looks at amplifiers, ranging from low level discrete and opamp types to ic power amps. A selection of mixers, filters and regulators is included.

30 Solderless Breadboard Projects
R.A.Penfold. Two books each of 160 pages. Book 1 : £2.25. Order Code BP107. Book 2 : £2.25. Order Code BP113.
Each project is designed for building on a Verobloc breadboard and is accompanied by a description, circuit and layout diagrams and relevant constructional notes. Many of the components are common to several projects. Book 1 covers linear devices, and Book 2 covers cmos logic chips.

Beginners Guide to Building Electronic Projects R.A.Penfold. 112 pages. £1.95. Order Code BP 227
Shows the complete beginner how to tackle the practical side of electronics and includes simple constructional projects.





TEST AND MEASUREMENT

Getting the Most from Your Multimeter
R.A.Penfold. 112 pages. £2.95.
Order Code BP239
There's more to what you can do with a meter than meets the casual eye. The book covers the basics of what you can do with analogue and digital meters and discusses component and circuit testing.

NEW Test Equipment Construction
R.A. Penfold £2.95.
Order Code BP248
Describes in detail how to construct some simple and inexpensive, but extremely useful, pieces of test equipment.

Oscilloscopes
I.Hickman. £6.95.
Order Code NT3
Subtitled 'How to Use Them, How They Work' the book is illustrated with diagrams and photographs and is essential reading for any one who wants to know about scopes, from first principles to practical applications.

How to Get Your Electronic Projects Working.
R.A.Penfold. 96 pages. £2.50.
Order Code BP110.
Essential reading for anyone who wants first-time success in project assembly. Covers tracing mechanical faults as well as testing for failures of active and passive components of most types.

SATELLITE TV

***NEW* Satellite TV Installation Guide - 2nd edition John Breeds. £11.95. Order Code STV1**
Full of vital information for any competent diyer who wishes to install a satellite tv antenna and obtain optimum reception quality.

An Introduction to Satellite Television
F.A.Wilson. 112 pages. £5.95.
Order Code BP195
Informative answers to many of the questions about this communications revolution. The information is presented on two levels, one aimed at the complete beginner, the other at professional engineers and serious amateur enthusiasts.

AUDIO AND MUSIC

Introducing Digital Audio
I.Sinclair. 112 pages. £5.95.
Order Code PC102
A non-mathematical introduction to the new digital technology, discussing the principles and methods involved in devices such as cd, dat and sampling.

Electronic Music Projects
R.A.Penfold. 112 pages. £2.50.
Order Code BP74
24 practical constructional projects covering fuzz, wah, sustain, reverb, phasing, tremolo etc. The text is split into four sections covering guitar, general, sound generation and accessory projects.

More Advanced Electronic Music Projects
R.A.Penfold. 96 pages. £2.95.
Order Code BP174
Complementing BP74 by covering more advanced and complex projects including flanging, chorus, ring modulation, plus a selection of drum, cymbal and gong circuits.

NEW Computer Music Projects
R.A.Penfold. 112 pages. £2.95.
Order Code BP173
Shows how home computers can produce electronic music and covers sequencing, analogue and Midi interfacing, digital delay lines and sound generators.

Practical Midi Handbook
R.A.Penfold. 160 pages. £5.95.
Order Code PC103
A practical how-to-do-it book for musicians and enthusiasts who want to exploit the capabilities of Midi. Covers keyboards, drums, sequencers, effects, mixers, guitars, and computer music software.

Midi Projects
R.A.Penfold. 112 pages. £2.95.
Order Code BP182
Practical details of interfacing many popular home computers with Midi systems, and also covering Midi interfacing to analogue and percussion synths.

NEW Electronic Synthesiser Construction.
R.A.Penfold. 112 pages. £2.95.
Order Code BP185.
Even relative beginners should find the monophonic synthesiser described here within their capabilities if the book is thoroughly read. Individual aspects of the synth are dealt with separately and pcb designs are shown for the main modules.

Books

DIGITAL AND COMPUTING

NEW A Concise Introduction to MS-DOS.
N. Kantaris. 64 pages. £2.95.
Order Code BP232
A ready-reference guide for those who need a quick insight into the essential command functions of this operating system, but who don't have the time to learn it fully.

An Introduction to Computer Peripherals
R.A. and J.W. Penfold. 80 pages. £2.50. Order Code BP170
Covers such items as monitors, printers, disc drives, cassettes, modems, etc, explaining what they are and how to use them with your computer and with each other.

Microprocessing Systems and Circuits
F.A.Wilson. 256 pages. £2.95.
Order Code BP77
A comprehensive guide to the elements of microprocessing systems, covering the fundamental principles behind this important subject.

Introduction to 6800/6802 Microprocessor Systems
R.J.Simpson and T.J.Terrell. 238 pages. £10.95. Order Code NT9
The book covers systems hardware, programming concepts and practical experimental work that will assist in understanding the 6800/6802 microprocessor, with additional information on the 6802D5E evaluation system.

NEW An Introduction to 68000 Assembly Language.
R.A. and J.W.Penfold. 112 pages. £2.95. Order Code BP184
Covers the fundamentals of writing programs that will vastly increase the speed of 68000 based machines such as the Commodore Amiga, Atari ST range, Apple Mackintosh, etc.

Getting the Most from Your Printer
J.W.Penfold. 96 pages. £2.95.
Order Code BP181
How to use the features found on most dot-matrix printers from programs and popular wordprocessors, showing examples of what must be typed to achieve a given effect.

Micro Interfacing Circuits
R.A.Penfold. Two books, each of 112 pages.
Book 1 : £2.25.Order Code BP130.
Book 2 : £2.25. Order Code BP131
Both books include practical circuits and useful background information though pcb layouts are not included. Book 1 mainly covers computer input-output techniques. Book 2 deals primarily with practical application circuits.

NEW An Introduction to 6502 Machine Code.
R.A. and R.W. Penfold. 112 pages. £2.50. Order Code BP147
Covers the main principles of machine code programming on 6502-based machines such as the Vic-20, Oric-1/Atmos, Electron, BBC and Commodore 64. It assumes no previous knowledge of microprocessors or machine code and gives illustrative programming examples.

NEW A Z-80 Workshop Manual.
E.A.Parr. 192 pages. £3.50.
Order Code BP112
A book for those who already know Basic but wish to explore machine code and assembly language programming on Z80 based computers.

Practical Digital Electronics Handbook
M.Tooley. 208 pages. £6.95.
Order Code PC 104
Nine constructional projects introduce digital circuits, logic gates, timers, microprocessors, memory and interface circuits - an essential book for anyone interested in digital devices.

GENERAL CONSTRUCTIONAL

NEW Electronic Science Projects.
Owen Bishop. 144 pages. £2.95.
Order Code BP104
A bumper bundle of experimental projects ranging in complexity and including a colour temperature meter, electronic clock, a solid state (led display) scope, an infra-red laser, a fascinating circuit for measuring the earth's electrical field strength, and many more.

Electronic Security Devices
R.A.Penfold. 112 pages. £2.50. BP56
Full of ideas for keeping your valuables safe. The circuits include designs for light, infra-red, ultrasonic, gas, smoke, flood, door and baby sensors.

NEW More Advanced Electronic Security Projects. R.A.Penfold. 112 pages. £2.95. Order Code BP190
Follows on from where BP56 leaves off and describes a number of more up-to-date and sophisticated projects, such as pyro-sensors, infra-red and doppler-shift detection, fibre-optic loops, and many others.

NEW Electronic Projects for Cars and Boats.
R.A.Penfold. 96 pages. £1.95.
Order Code BP94
15 fairly simple projects that can be used with a car and/or boat. Stripboard constructional details are included, as are explanations of the circuit theory.

Power Supply Projects
R.A.Penfold. 96 pages. £2.50.
Order Code BP76
A selection of power supply designs, including simple unstabilised, fixed voltage regulated and variable voltage stabilised, ni-cad charger, voltage step-up, and inverter.

More Advanced Power Supply Projects
R.A.Penfold. 96 pages. £2.95.
Order Code BP192
Covers more advanced topics than BP76 and includes precision supplies, switch mode and computer controlled supplies, plus a selection of miscellaneous circuits.

NEW Popular Electronic Circuits.
R.A.Penfold. 160 pages. £2.95.
Order Code BP80
Containing a wide range of circuit designs for experienced constructors who are capable of producing working projects direct from a circuit diagram without specific constructional details.

DATA AND INFORMATION BOOKS

Digital IC Equivalents and Pin Connections
A.Michaels. 320 pages. £5.95.
Order Code BP140
Linear IC Equivalents and Pin Connections
A.Michaels. 256 pages. £5.95.
Order Code BP141
Between them these two books show equivalents and pin connections of a popular user-orientated selection of European, American and Japanese ics. They also include details of functions, manufacturer and country of origin. The Digital ICs book also quotes details of packaging and families.

Opamps
B.Dance. £6.50.
Order CodeNT2
Subtitled 'Their Principles and Applications' this interesting book is written in a simple non-mathematical style and provides a source of practical circuits that use both commonplace and more sophisticated opamps.

Electronic Hobbyists Handbook
R.A.Penfold. 96 pages. £4.95. Order Code BP233
Provides a source of useful information that the amateur enthusiast is likely to need for day-to-day pursuance of hobby electronics.

Practical Electronics Handbook
I. Sinclair. £7.95.
Order Code NT1
A useful and carefully selected collection of standard circuits, rules-of-thumb and design data for enthusiasts, students and engineers involved in radio, computing and general electronics

Newnes Electronics Pocket Book
I.E.Parr. £6.95.
Order Code NT10
Presents all aspects of modern electronics in a readable and largely non-mathematical style, and is a good source of valuable information for enthusiasts and professional engineers alike.

NEW Key Techniques for Circuit Design
G.C. Loveday. £6.95.
Order Code BM 101
Tackles the problems of designing circuits from scratch, introducing the concept of target specifications, the design sequence, device selection, rules of thumb, and useful equivalent circuits.

HOW TO ORDER

State your order code and your name and address clearly. Enclose a cheque, PO or international money order (add 50p postage per book - £1.00 for overseas surface mail), and send to:

PE Book Service
Intra House
193 Uxbridge Road
London W12 9RA

Books are normally delivered within 10 days but please allow 28 days for delivery.

PE COMPETITION RESULTS

EUREKA – WE'VE FOUND THEM!

THE 25 SILVERED WINNERS HAVE BEEN DRAWN IN OUR 25TH ANNIVERSARY COMPETITION!

DO YOU SHINE AMONG THEM?

MR J.COUNCELL OF CROWBOROUGH, SUSSEX, DOES!

He's won the fabulous Acorn Archimedes A3000 computer! Over £1000's worth of First Prize -
fantastic!

WELL DRAWN TOO ARE:

D. Crome of West Kingsdown, Kent;
M.J. Ward of Canvey Island, Essex;
C.J. Winscom of Pinner, Middx;

who have each won 25 years' subscription to PE - worth at least £375 at the time of winning!
The true value is priceless!

THEN THE SCALES REGISTERED HIGHLY FOR:

Michael Hammond of Newcastle-under-Lyne, Staffs; John McCloskey of Carrickfergus, Co Antrim; I. Pepper of Stevenage, Herts; David Wi lson of Sowerby Bridge, W. Yorks; P.H. Tanner of Glasgow; K.J.Corbett of Didcot, Oxon; David Thompson of Callander, Perth; D.R. Good all of Horsham, Sussex; Roger Merrick of Erdington, Birmingham; Nicholas Brown of Winscombe, Avon;

all of whom have each won a superb Cirkit TM5365 digital multimeter, worth £40 apiece but invaluable for any workshop!

AND WELL SUBMITTED WERE:

Peter Haverty of Craughwell, Co. Galway;
J.F.Long of Wimbledon, London;
J.G. Seal of North Allerton, N. Yorks;
Robert Williamson of Crumlin, Co. Antrim;
Roger Barnes of Hendon, London;
Douglas Hunt of Kilwinning (it didn't this week!), Ayrshire;
Desmond Kavanagh of Grenville, Dublin;
P.J. Marsden of Maidstone, Kent;
Derek Gledding of Hathersage, Sheffield;
Roy Gillies of Dagenham, Essex;
W. Borrmann of Westpoint, Co. Mayo,

these eleven lucky entrants were drawn to be awarded a full years subscription to Practical Electronics – amazing return for just the cost of a postage stamp!

★ ★ ★

NEXT MONTH WE'LL LOOK AT THE ANSWERS!

ELMASET INSTRUMENT CASE
300 x 133 x 217mm deep ..... £10 ea (£2.20)

REGULATORS
LM317T PLASTIC T0220 variable £1
LM317 METAL £2.20
7812 METAL 12V 1A £1
7805/12/15/24V plastic ..... 35p 100+20p 1000+ 15p
7905/12/15/24 plastic ..... 35p 100+20p 1000+ 15p
CA3085 T099 variable reg ..... 2/£1
LM338 5A VARIABLE £5

COMPUTER ICS
80C31 MICRO £2
P8749H MICRO £5
BBC MICRO PARTS
VIDEO ULA 201647 ..... £10ea 10+ £8
6845 CRT £5
6522 PIA £3
DM88LS120 ..... £4.50
AY31015D UART £2.50
8086 processor equipment £2
USED 41256-15 ..... £3.00
USED 4164-15 ex-equipment £1
9 x 41256-15 SIMM MODULE NEW £25
8 x 4164 SIP MODULE NEW £8
HD 146818 CLOCK IC £2
2864 EEPROM £3
27128A 250nS EPROM USED ..... £2 NEW £2.30
FLOPPY DISC CONTROLLER CHIPS 1771 ..... £10 ea
FLOPPY DISC CONTROLLER CHIPS 1772 ..... £16 ea
68000-8 PROCESSOR NEW £5
HD63484-8 ..... £5
ALL USED EPROMS ERASED AND BLANK CHECKED CAN BE PROGRAMMED IF DESIRED.
2716-45 USED ..... £2 100/£1
2732-45 USED ..... £2 100/£1
2764-30 USED ..... £2 100/£1.60
27C256-30 USED £2
27C512 USED £3.50
1702 EPROM EX EQPT £5
2114 EX EQPR 60p 4116 EX EQPT 70p
6264-15 8k static ram £3.50
4416 RAM £3.50
USED 4416-15 RAM £2
USED 41464-15 ..... £7

CRYSTAL OSCILLATOR
1.8342 MHz ..... £1 each

CRYSTALS
2.77 MHz/4.000 MHz/4.9152MHz 20MHz 49.504MHz, 8M, 16.588M

TRANSISTORS
BC107, BCY70 PREFORMED LEADS
full spec £1 £4/100 £30/1000
BC557, BC548B ..... 30/£1 £3.50100

POWER TRANSISTORS
POWER FET IRF9531 8A 60V ..... 2/£1
2SC1520 sim BF259 ..... 3/£1 100/£22
TIP141/2 £1 ea TIP112/125/42B ..... 2/£1
TIP35B TIP35C £1.50
SE9301 100V 10A DARL. SIM TIP121 ..... 2/£1
2N3055 EX EQPT TESTED ..... 4/£1
PLASTIC 3055 OR 2955 equiv 50p ..... 100/£35
2N3773 NPN 25A 160V £1.80 ..... 10/£16

QUARTZ HALOGEN LAMPS
A1/216 24V 150 WATTS £2.25
H1 12V 50W (CAR SPOT) £1.50

14 WAY AMP ZIF SOCKET ..... 2/£1
TEXTOOL single in line 32 way. Can be ganged (coupling supplied) for use with any dual in line devices.
28 WAY TEXTOOL ZIF SOCKET EX NEW EQUIPMENT £2

CAPACITORS COMPUTER GRADE
3300uF 350V SIC SAFCO FELSIC 037 ..... £6(£1.50)
2200uF 160V SIC SAFCO FELSIC CO38 ..... £4(£1.20)

TURNS COUNTING DIALS all for 0.25" shaft
10 turn dial 21 mm dia. fits 3mm spindle £2
10 turn digital dial (3 digits) for 3mm or 6mm shaft £3.50
10 turn clock face dial for 6mm spindle £4

MISCELLANEOUS
SLOPING FRONT PLASTIC CASE 225 x 215 x 76mm
76 mm WITH ALI FRONT PANEL 200 x 130mm ... £4.00(£1)
HUMIDITY SWITCH ADJUSTABLE £2
WIRE ENDED FUSES 0.25A ..... 30/£1
NEW ULTRASONIC TRANSDUCERS 40kHz £2/pair
12 CORE CABLE 7/0.2mm OVERALL SCREEN..£1/3 metres
POWERFUL SMALL CYLINDRICAL MAGNETS ..... 3/£1
OP AMP LM10CLN £2.90
BNC 50 OHM SCREENED CHASSIS SOCKET ..... 3/£1
BNC TO CROC CLIPS LEAD 1 metre £1
MOULDED INDUCTOR 470µH
size of a 1 watt film resistor ..... 5/£1

TO-220 HEAT SINK sim RS 403-162 ..... 10/£2.50
SMALL MICROWAVE DIODES AEI DC1028A ..... 2/£1
D.I.L. SWITCHES 10 WAY £1 8 WAY 80p 4/5/6 WAY ... 50p
180 volt 1 watt ZENERS also 12v & 75v ..... 20/£1
PLASTIC EQUIPMENT CASE 9 x 6 x 1.25 in. WITH FRONT AND REAR PANELS CONTAINING PCB WITH EPROM 2764-30 AND ICS 7417 LS30 LS32 LS74 LS367 LM311 7805 REG, 9 WAY D PLUG, PUSH BUTTON SWITCH, DIN SOCKET £1.90
VN10LM 60v ½A 5ohm TO-92 mosfet ..... 4/£1 100/£20
MIN GLASS NEONS ..... 10/£1
RELAY 5v 2 pole changeover looks like RS 355-741 marked STC 47WB05T ..... £1 ea
MINIATURE CO-AX FREE PLUG RS 456-071 ..... 2/£1
MINIATURE CO-AX FREE SKT. RS 456-273 ..... 2/£1.50
DIL REED RELAY 2 POLE n/o CONTACTS £1
PCB WITH 2N2646 UNIJUNCTION with 12v 4 POLE RELAY £1
400m 0.5w thick film resistors (yes four hundred megohms) 4/£1
STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy ..... £1.50 ea 10+ £1
ELECTRET MICROPHONE INSERT £0.90
Linear Hall effect IC Micro Switch no 613 SS4 sim RS 304-267 ..... £2.50 100+ £1.50
HALL EFFECT IC UGS3040 + MAGNET £1
OSCILLOSCOPE PROBE SWITCHED X1 X10 ..... £10
CHEAP PHONO PLUGS ..... 100/£2 1000/£18
1 pole 12 way rotary switch ..... 4/£1
AUDIO ICS LM380 LM386 ..... £1 ea
555 TIMER 5/£1 741 OP AMP ..... 5/£1
ZN414 AM RADIO CHIP 80p
COAX PLUGS nice ones ..... 4/£1
COAX BACK TO BACK JOINERS ..... 3/£1
4 x 4 MEMBRANE KEYBOARD £1.50
15.000uF 40V £2.50 (£1.25)
INDUCTOR 20uH 1.5A ..... 5/£1
NEW BT PLUG + LEAD £1.50
1.25" PANEL FUSEHOLDERS ..... 3/£1
CHROMED STEEL HINGES 14.5 x 1" OPEN ..... £1 each
12v 1.2w small wire ended lamps fit AUDI VW TR7 SAAB VOLVO ..... 10/£1
12V MES LAMPS ..... 10/£1
STEREO CASSETTE HEAD £2
MONO CASS.HEAD £1 ERASE HEAD 50p
THERMAL CUT OUTS 50 77 85 120°C ..... £1 ea
THERMAL FUSE 121°C 240V 15A ..... 5/£1
TRANSISTOR MOUNTING PADS TO-5/TO-18 ..... £3/1000
TO-3 TRANSISTOR COVERS ..... 10/£1
STICK ON CABINET FEET ..... 30/£1
PCB PINS FIT 0.1" VERO ..... 200/£1
TO-220 micas + bushes ..... 10/50p 100/£2
TO-3 micas + bushes ..... 15/£1
PTFE min screened cable ..... 10m/£1
Large heat shrink sleeving pack £2
CERAMIC FILTERS 6M/9M/10.7M ..... 50p 100/£20
MAINS LEAD WITH MOULDED 13A PLUG AND IEC SOCKET £1.50
IEC chassis plug rfi filter 10A £3
Potentiometers short spindles values 2k5 10k 25k 1m
2M5 lin ..... 5/£1
500k lin 500k log ..... 4/£1
40Khz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA £1/pr
PLESSEY INVERTER TRANSFORMER ..... 50 CYCLES
11.5-0-11.5V to 240v 200VA £6 (£3)

DIODES AND RECTIFIERS
1N4148 ..... 100/£1.50
1N4004/SD4 1A 300V ..... 100/£3
1N5401 3A 100V ..... 10/£1
BA158 1A 400V fast recovery ..... 100/£3
BA159 1A 1000V fast recovery ..... 100/£4
120V 35A STUD 65p
BY127 1200V 1.2A ..... 10/£1
BY254 800V 3A ..... 8/£1
BY255 1300V 3A ..... 6/£1
6A 100V SIMILAR MR751 ..... 4/£1
1A 800V BRIDGE RECTIFIER ..... 4/£1
4A 100V BRIDGE ..... 3/£1
6A 100V BRIDGE ..... 2/£1
8A 200V BRIDGE ..... 2/£1.35
10A 200V BRIDGE £1.50
25A 200V BRIDGE £2 ..... 10/£18
25A 400V BRIDGE £2.50 ..... 10/£22

SCRS
PULSE TRANSFORMERS 1:1+1 ..... £1.25
2P4M EQUIV CI06D ..... 3/£1
MCR72-6 10A 600V SCR £1
35A 600V STUD SCR £2
TICV106D 800mA 400V SCR ..... 3/£1 100/£15
MEU21 PROG. UNIJUNCTION ..... 3/£1

TRIACS ..... DIACS 4/£1
BT137-600 8A TO-220 ..... 2/£1
BT138-600 12A TO-220 ..... 70p
NEC TRIAC AC08F 8A 600V TO220 ..... 5/£2 100/£30
TXAL225 8A 400V 5mA GATE ..... 2/£1 100/£35
TRAL2230D 30A 400V ISOLATED STUD ..... £4 each

CONNECTORS
D25 IDC SOCKET FUJITSU £2
34 way card edge IDC CONNECTOR (disk drive type) £1.25
CENTRONICS 36 WAY IDC PLUG £2.50
CENTRONICS 36 WAY IDC SKT £4.00
BBC TO CENTRONICS PRINTER LEAD 1.5M £3.50
CENTRONICS 36 WAY PLUG SOLDER TYPE £4
USED CENTRONICS 36W PLUG+SKT £3

USED D CONNECTORS price per pair
D9 60p, D15 £1.50, D25 £2, D37 £2, D50 £3.50 covers 50p ea.

WIRE WOUND RESISTORS
W21 or sim 2.5W 10 of one value £1
R10 OR15 OR22 2R0 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 47R 56R 62R 91R 120R 180R 390R 430R 470R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0 R05 (50 milli-ohm) 1% 3w ..... 4 FOR £1
W22 or sim 6W 7 OF ONE VALUE £1
R47 R62 1R0 1R5 1R8 3R3 6R8 9R1 12R 20R 24R 27R 33R 51R 56R 62R 68R 100R 120R 180R 220R 390R 560R 620R 910R 1K0 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 8K2 10k 15K 16K 20K
W23 or sim 9W 6 of one value £1
R22 R47 1R0 1R1 56R 62R 100R 120R 180R 220R 300R 390R 680R 1KO 1K5 5K1 10K
W24 or sim 12W 4 OF ONE VALUE £1
R50 2R0 9R1 18R 22R 27R 56R 68R 75R 82R 100R 150R 180R 200R 220R 270R 400R 620R 1K0 6K8 8K2 10K 15K

PHOTO DEVICES
SLOTTED OPTO-SWITCH OPCOA OPB815 ..... £1.30
2N5777 ..... 50p
TIL81 PHOTO TRANSISTOR £1
TIL38 INFRA RED LED ..... 5/£1
4N25, OP12252 OPTO ISOLATOR 50p
PHOTO DIODE 50p ..... 6/£2
MEL12 (PHOTO DARLINGTON BASE n/c) 50p

LEDs RED 3 or 5mm 12/£1 ..... 100/£6
LEDs GREEN OR YELLOW 10/£1 ..... 100/£6.50
LEDS ASSORTED RD/GN/YW + INFRA/RED ..... 200/£5
FLASHING RED OR GREEN LED 5mm 50p ..... 100/£40

STC NTC BEAD THERMISTORS
G22 22OR, G13 1K, G23 2K, G24 20K, G54 50K, G25 200K, G16 1M, RES @ 20°C DIRECTLY HEATED TYPE ..... £1 ea
FS22BW NTC BEAD INSIDE END OF 1" GLASS PROBE RES @ 20°C 200R ..... £1 ea
A13 DIRECTLY HEATED BEAD THERMISTOR 1k res. Ideal for audio Wien ..... £2 ea

CERMET MULTI TURN PRESETS ¾"
10R 20R 100R 200R 250R 500R 2K 2K2 2K5 5K 10K 47K 50K 100K 200K 500K 2M2 ..... 50p each

IC SOCKETS
6 pin 15/£1 8 pin 12/£1 14/16 pin 10/£1 18/20 pin 7/£1, 22/24/28 pin 4/£1 40 pin 30p

SOLID STATE RELAYS
40A 250V AC SOLID STATE RELAYS £18

POLYESTER/POLYCARB CAPS
100n 63v 5mm ..... 20/£1 100/£3 1000/£25
1n/3n3/5n6/8n2/10n 1% 63v 10mm ..... 100/£6
10n/15n/22n/33n/47n/68n 10mm rad ..... 100/£3.50
100n 250v radial 10mm ..... 100/£3
100n 600v sprague axial 10/£1 ..... 100/£6 (£1)
2u2 160v rad 22mm ..... 100/£10
10n/33n/47n 250v ac x rated 15mm ..... 10/£1
470n 250v ac x rated rad ..... 4/£1
1U 600V MIXED DIELECTRIC ..... 50p ea.

RF BITS
MINIATURE CO-AX 50Ω URM95 ..... 100m/£12

Ex-equipment, with BNC tails
TRIMMER CAPS ALL 4/50p
SMALL 5pf 2 pin mounting 5mm centres
SMALL MULLARD 2 to 22pF 4/50p
SMALL MULLARD 5 to 50pF 4/50p
larger type grey 2 to 25pF black 15 to 90pf
TRANSISTORS 2N4427 ..... 60p
FEED THRU CERAMIC CAPS 1000pF ..... 10/£1

MINIATURE RELAYS Suitable for RF
5 volt coil 1 pole changeover £1
5 volt coil 2 pole changeover £1
12 volt coil 1 pole changeover £1

MONOLITHIC CERAMIC CAPICITORS
10n 50v 2.5mm ..... 100/£4.50
100n 50v 2.5mm or 5mm ..... 100/£6
100n ax short leads ..... 100/£3
100n ax long leads ..... 100/£6

100n 50v dil package 0.3" rad £10/100

STEPPER MOTORS
4 PHASE 2 9V WINDINGS £3.50

KEYTRONICS
TEL. 0279-505543
FAX. 0279-757656
P O BOX 634
BISHOPS STORTFORD
HERTFORDSHIRE CM23 2RX

MAIL ORDER ONLY
MIN CASH ORDER £3.00 OFFICIAL ORDERS WELCOME
UNIVERSITIES COLLEGES SCHOOLS GOVT. DEPARTMENTS
MIN. ACCOUNT ORDER £10.00
P&P AS SHOWN IN BRACKETS (HEAVY) ITEMS
65p OTHERWISE (LIGHT) ITEMS
ADD 15% VAT TO TOTAL
ELECTRONIC COMPONENTS BOUGHT FOR CASH

INDEX TO ADVERTISERS

PLEASE MENTION PRACTICAL ELECTRONICS WHEN REPLYING TO ADVERTS

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

* PRICES INCLUDE V.A.T. * PROMPT DELIVERIES * FRIENDLY SERVICE *
LARGE S.A.E., 30p STAMPED FOR CURRENT LIST.

OMP POWER AMPLIFIER MODULES

Supplied ready built and tested.

OMP POWER AMPLIFIER MODULES Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market, i.e., Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof.

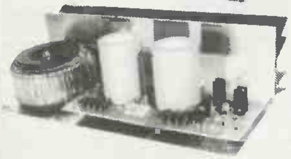
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP100 Mk 11 Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz – 30KHz –3dB, T.H.D. 0.01%, S.N.R. –118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115×65mm.
PRICE £33.99 + £3.00 P&P.

NEW SERIES II MOS-FET MODULES

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor, >300, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. –125dB. Size 300 × 123 × 60mm.
PRICE £39.99 + £3.00 P&P.

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. –130dB. Size 300 × 155 × 100mm.
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. –130dB. Size 330 × 175 × 100mm.
PRICE £79.99 + £4.50 P&P.

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

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE S.A.E. (30p STAMPED) FOR COMPLETE LIST.

McKENZIE:— INSTRUMENTS, P.A., DISCO, ETC.

ALL McKENZIE UNITS 8 OHMS IMPEDENCE

8" 100 WATT C8100GPM GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID., DISCO.
RES. FREQ. 80Hz. FREQ. RESP. TO 14KHz. SENS. 99dB. .... **PRICE £28.59 + £2.00 P&P.**

10" 100 WATT C10100GP GUITAR, VOICE, ORGAN, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 70Hz. FREQ. RESP. TO 6KHz. SENS. 100dB. .... **PRICE £34.70 + £2.50 P&P.**

10" 200 WATT C10200GP GUITAR, KEYBOARD, DISCO, EXCELLENT HIGH POWER MID.
RES. FREQ. 45Hz. FREQ. RESP. TO 7KHz. SENS. 103dB. .... **PRICE £47.48 + £2.50 P&P.**

12" 100 WATT C12100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO.
RES. FREQ. 45Hz. FREQ. RESP. TO 7KHz. SENS. 98dB. .... **PRICE £36.66 + £3.50 P&P.**

12" 100 WATT C12100TC TWIN CONE) HIGH POWER WIDE RESPONSE, P.A., VOICE, DISCO.
RES. FREQ. 45Hz. FREQ. RESP. TO 14KHz. SENS. 100dB. .... **PRICE £37.63 + £3.50 P&P.**

12" 200 WATT C12200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 40Hz. FREQ. RESP. TO 7KHz. SENS. 100dB. .... **PRICE £64.17 + £3.50 P&P.**

12" 300 WATT C12300GP HIGH POWER BASS LEAD GUITAR, KEYBOARDS, DISCO, ETC.
RES. FREQ. 45Hz. FREQ. RESP. TO 5KHz. SENS. 100dB. .... **PRICE £85.79 + £3.50 P&P.**

15" 100 WATT C15100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO.
RES. FREQ. 40Hz. FREQ. RESP. TO 5KHz. SENS. 98dB. .... **PRICE £53.70 + £4.00 P&P.**

15" 200 WATT C15200BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 99dB. .... **PRICE £73.26 + £4.00 P&P.**

15" 250 WATT C15250BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 99dB. .... **PRICE £80.53 + £4.50 P&P.**

15" 400 WATT C15400BS VERY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 40Hz. FREQ. RESP. TO 4KHz. SENS. 102dB. .... **PRICE £94.12 + £4.50 P&P.**

18" 400 WATT C18404BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 27Hz. FREQ. RESP. TO 3KHz. SENS. 99dB. .... **PRICE £167.85 + £5.00 P&P.**

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

ALL EARBENDER UNITS 8 OHMS EXCEPT EB8-50 AND EB10-50 DUAL 4 AND 8 OHM.
BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED FOAM SURROUND

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

10" 50 WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40HZ. FREQ. RESP. TO 5KHz. SENS. 99dB. .... **PRICE £12.00 + £2.50 P&P.**

10" 100 WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz. FREQ. RESP. TO 3KHz. SENS. 96dB. .... **PRICE £27.50 + £3.50 P&P.**

12" 60 WATT EB12-60 BASS, HI-FI, STUDIO.
RES. FREQ. 28Hz. FREQ. RESP. TO 3KHz. SENS. 92dB. .... **PRICE £21.00 + £3.00 P&P.**

12" 100 WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz. FREQ. RESP. TO 3KHz. SENS. 93dB. .... **PRICE £32.00 + £3.50 P&P.**

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

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

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

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

10" 60 WATT EB10-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 35Hz. FREQ. RESP. TO 12KHz. SENS. 86dB. .... **PRICE £16.49 + £2.00 P&P.**

TRANSMITTER HOBBY KITS

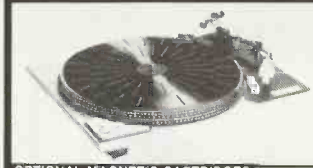
PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W FM TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 × 123mm, SUPPLY 12V @ 0.5AMP, PRICE £14.49 + £1.00 P&P

FM MICRO TRANSMITTER (BUG) 100-108MHz VARICAP TUNED COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 × 46mm, SUPPLY 9V BATT. PRICE £8.62 + £1.00 P&P

3 watt FM Transmitter

OMP VARISPEED TURNTABLE CHASSIS.



★ MANUAL ARM ★ STEEL CHASSIS ★ ELECTRONIC SPEED CONTROL 33 & 45 ★ VARI PITCH CONTROL ★ HIGH TORQUE SERVO DRIVEN DC MOTOR ★ TRANSIT SCREWS ★ 12" DIE CAST PLATTER ★ NEON STROBE ★ CALIBRATED BAL WEIGHT ★ REMOVABLE HEAD SHELL ★ ½" CARTRIDGE FIXINGS ★ CUE LEVER ★ POWER 220/240V 50/60Hz ★ 390×305mm ★ SUPPLIED WITH MOUNTING CUT-OUT TEMPLATE.

PRICE £59.99 + £3.50 P&P.

OPTIONAL MAGNETIC CARTRIDGES

STANTON AL500	**GOLDRING G850**
PRICE £16.99 + 50p P&P	**PRICE £6.99 + 50p P&P**

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

THOUSANDS PURCHASED BY PROFESSIONAL USERS

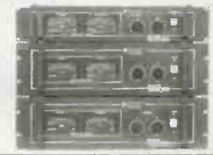
NEW MXF SERIES OF POWER AMPLIFIERS

THREE MODELS:— **MXF200** (100w + 100w)
MXF400 (200w + 200w) **MXF600** (300w + 300w)
All power ratings R.M.S. into 4 ohms.

FEATURES: ★ Independent power supplies with two Toroidal Transformers ★ Twin L.E.D. Vu meters ★ Rotary indended level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 Fan Cooled with D.C. Loudspeaker and Thermal Protection.

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

SIZES:— MXF 200 W19"×H3½" (2U)×D11"
MXF 400 W19"×H5¼" (3U)×D12"
MXF 600 W19"×H5¼" (3U)×D13"



PRICES: MXF200 £171.35
MXF400 £228.85
MXF600 £322.00

SECURICOR DELIVERY £12.00 EACH

OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

MADE ESPECIALLY TO SUIT TODAY'S NEED FOR COMPACTNESS WITH HIGH OUTPUT SOUND LEVELS, FINISHED IN HARDWEARING BLACK VYNIDE WITH PROTECTIVE CORNERS, GRILLE AND CARRYING HANDLE. INCORPORATES 12" DRIVER PLUS HIGH FREQ. HORN FOR FULL FREQ. RANGE 45Hz-20KHz BOTH MODELS 8 OHM. SIZE H18" × W15" × D12".

CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100 (100W 100dB) PRICE £159.99 PER PAIR
OMP 12-200 (200W 102dB) PRICE £209.99 PER PAIR

SECURICOR DEL.:— £12.00 PER PAIR

OMP SLIDE DIMMER 1K WATT & 2.5K WATT

CONTROLS LOADS UP TO 1KW & 2.5KW, SUITABLE FOR RESISTIVE AND INDUCTIVE LOADS BLACK ANODISED CASE. READILY FLUSH MOUNTED THROUGH PANEL/CABINET CUT-OUTS. **ADVANCED FEATURES INCLUDE:—**

- ★ FULL 65mm SLIDE TRAVEL
- ★ NEON MONITOR INDICATOR
- ★ FLASH OVERRIDE BUTTON
- ★ HIGH & LOW LEVEL PRESETS
- ★ FULLY SUPPRESSED TO BS 800

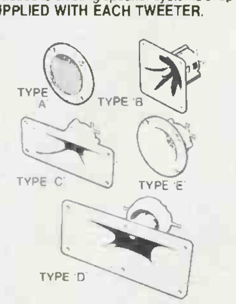
SIZES:—
1KW H128×W40×D55mm
2.5KW H128×W76×D79mm

PRICES:— 1K WATT £15.99
2.5K WATT £24.99 + 60p P&P

PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 50p P&P.**

TYPE 'B' (KSN1005a) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.00 each + 50p P&P.**

TYPE 'C' (KSN6016A) 2"×5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each + 50p P&P.**

TYPE 'D' (KSN1025A) 2"×6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 50p P&P.**

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

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85×85mm. **Price £3.99 + 50p P&P.**

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:—
3 Turntables (Mag). 3 Mics. 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360×280×90mm. Supply 220-240v.
Price £134.99 — £4.00 P&P

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

Access — BARCLAYCARD VISA

B. K. ELECTRONICS Dept PE

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL: 0702-527572 FAX: 0702-420243


ORDER YOUR COPY OF THE NEW MAPLIN CATALOGUE ON SALE NOW
Pick up a copy from any W.H. Smith for just £2.25 or post this coupon now to receive your copy for just £2.25 + 50p p & p. If you live outside the U.K. send £4 or 17 International Reply Coupons. I enclose £2.75.
Name
Address
Post Code
Send to Maplin Electronics, P.O. Box 3, Rayleigh, Essex SS6 8LR.
AVAILABLE FROM 10th NOVEMBER 1989 IN ALL W.H. SMITH STORES
PE 90
MAPLIN
OVER 580 PAGES WITH HUNDREDS OF NEW PRODUCTS AT SUPER LOW PRICES
THE NEW MAPLIN CATALOGUE – WORLDS APART!
1990 BUYER'S GUIDE TO ELECTRONIC COMPONENTS SEND FOR YOUR COPY TODAY