TV & VIDEO • ELECTROMUSIC • COMPUTERS • SECURITY

No. 77

FULL SOR

ELECTRONICS

The Maplin Magazine

Britain's Best Selling Electronics Magazine

MAY 1994 • £2.00

Printed in the United Kingdom

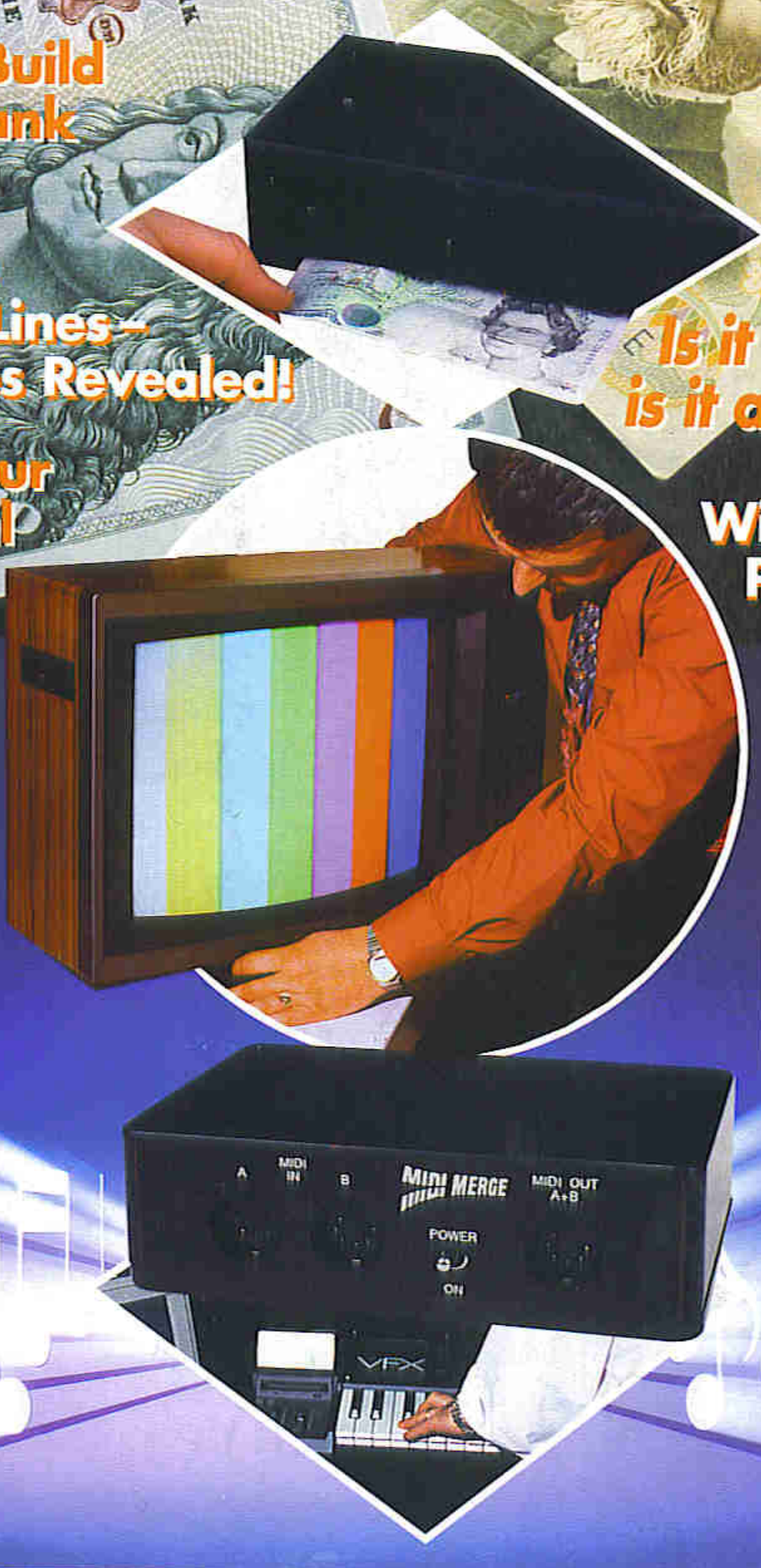
SAVE £££s! Build this Forged Bank Note Detector

NEW SERIES: Transmission Lines – Their Mysteries Revealed!

Super TV Colour Bar Test Signal Generator

Easy to Build Simple MIDI Merge Unit

5 SUPER PROJECTS TO BUILD!



Is it Real or is it a Dud?

Will Your TV Pass the Fitness Test?

PLUS Lots, Lots more inside...

MAY 1994
VOL 13. No. 77

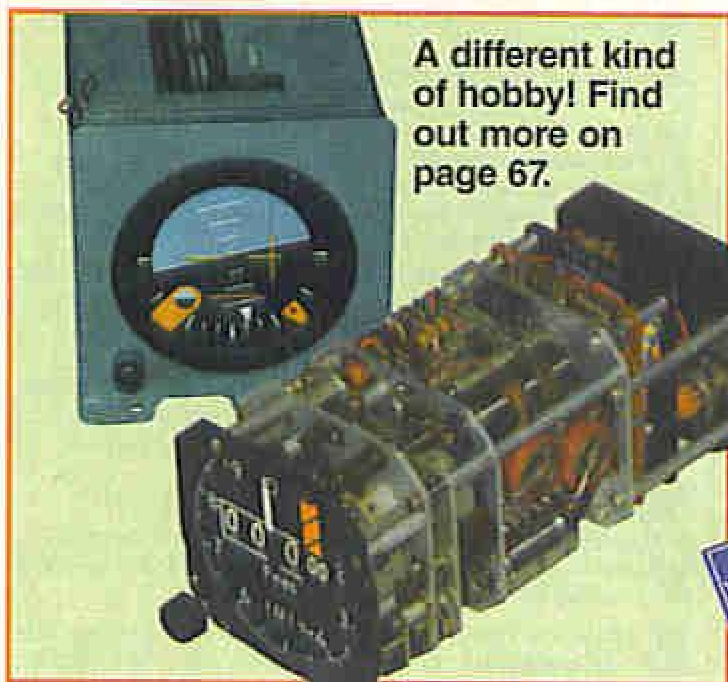
IN THIS ISSUE...

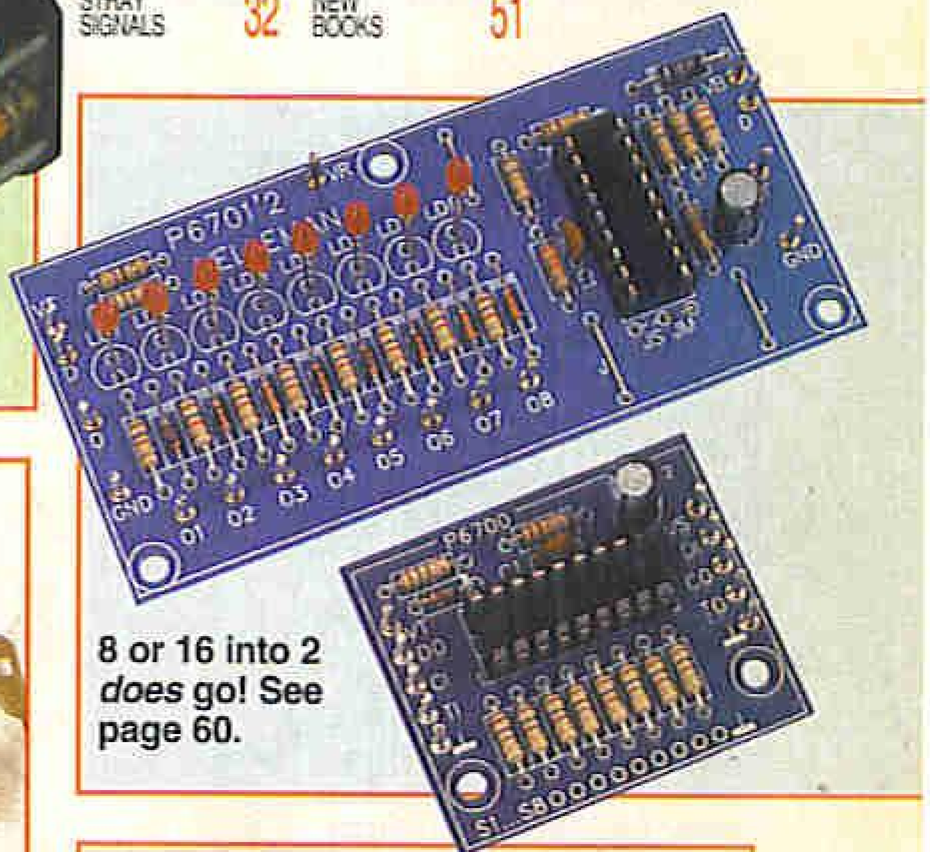
PROJECTS FOR YOU TO BUILD!

FEATURES ESSENTIAL READING!

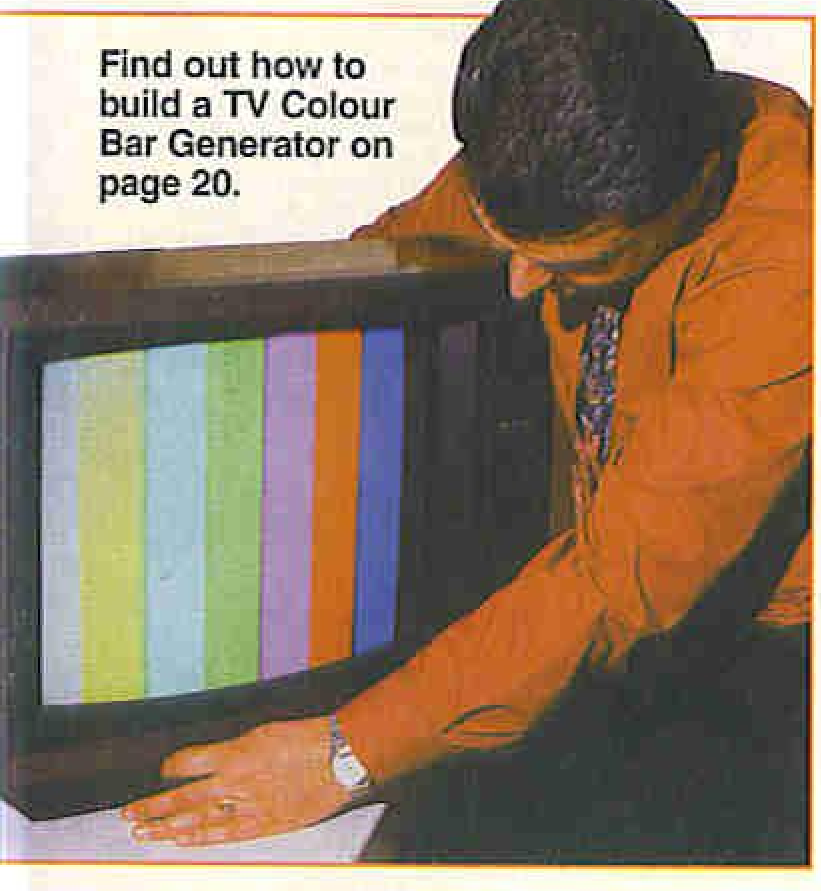
REGULARS NOT TO BE MISSED!

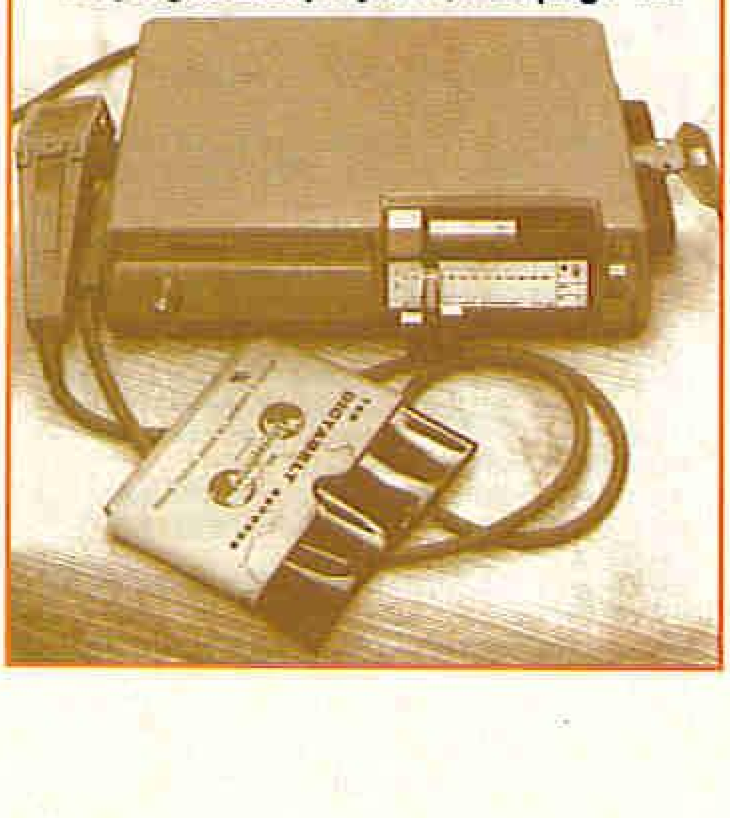

Save £££s on page 4!

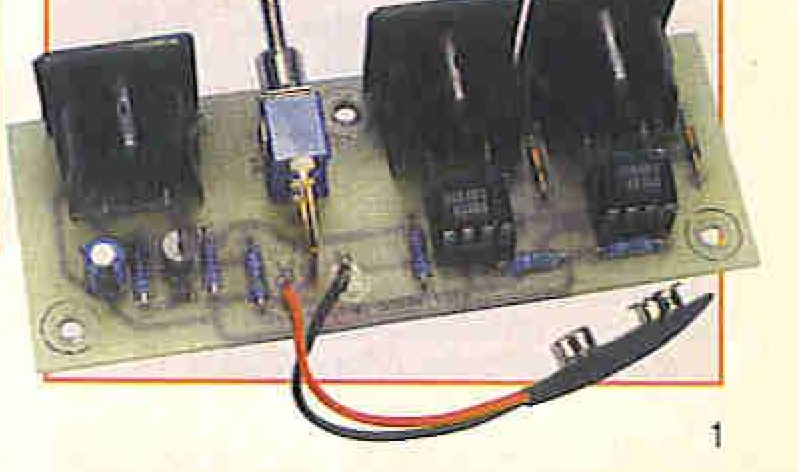

A different kind of hobby! Find out more on page 67.



8 or 16 into 2 *does* go! See page 60.


Find out how to build a TV Colour Bar Generator on page 20.


Playing the unplayable, see page 12.


Simple MIDI Merge, see page 46.

ABOUT THIS ISSUE . . .

At last! In this issue are the long awaited results of the Readership Survey conducted during September 1993. The response was massive – 2,811 questionnaires were returned, which is a 70% increase on the number returned during the last survey conducted in 1984. Compared to the national surveys conducted by market research companies, who are after facts and figures about which washing powder we buy or what political party we will vote for, the percentage sample for this survey is far greater, which means it will accurately reflect the opinions of the readership as a whole. The bottom line is that everyone here at *Electronics* has now got a much better picture of what *you*, the readers, actually like to see published every month. From the results, decisions have already been made, and will continue to be made, about the direction and content of *Electronics*. Over the coming months you will see the effect of 'reader power'! Survey forms were returned from all corners of the globe as well as the United Kingdom – so a big thank you to everyone who returned their survey form! The main results of the survey are summarised on pages 35 to 38. From the questionnaires received, 61 were drawn as Prize Winning Questionnaires, the list of prizes and winners can be found on page 59.

Shocking State of Affairs

In the November 1993 and February 1994 issues of *Electronics*, Keith Brindley raised the subject of the European Commission's Low Voltage Directive in respect to 110V electrical supplies for power tools used on British construction sites. Whilst this area of electrical supplies probably won't affect the majority of readers, it does represent a test case in respect of disputes over safety legislation.

For those of you who can't remember what was said or didn't see the articles in question, here's a quick resumé: there is an obligatory requirement that only 110V AC (55V AC either side of earth) supplies and power tools are used on British construction sites. The reason for this is obvious – the potential shock current is reduced – if equipment becomes faulty or a trailing cable becomes damaged, the maximum shock voltage to earth is 55V, less than one quarter of the voltage for 'domestic' 240V power tools. A shock to earth is potentially the most likely and most dangerous where construction workers are concerned. Often they work in direct contact with the general mass of earth in damp or wet conditions. These and similar conditions provide a comparatively low resistance path to earth though the worker's body; the current would pass from the worker's hand, through the chest cavity, to earth though the lower body or other hand. However, continental Europe does not see things the same way and does not require mandatory use of reduced voltage supplies on construction sites.

The Low Voltage Directive requires that to enable the free circulation of electrical equipment, electrical systems must be standardised in European Community Member States. Standards are agreed and adopted on a European basis, so defining, amongst other things, what is *safe*. To quote Mr Bangeman from the European Commission, ". . . the free movement within the [European] Community of equipment complying with safety objectives cannot be impeded for reasons of safety". The EC is basically saying that the 'full voltage' system used outside of Britain is safe so we must not prohibit its use. To quote Mr Bangeman again, ". . . if, for safety reasons, a Member State prohibits the placing on the market of electrical equipment or impedes its free movement a consultation procedure should be started in order to reach an agreement". So discussions are under way as to whether the British 110V requirements are justified – if they are, it looks like Europe as a whole may have to adopt the 110V system too, if not Britain will no longer be able to *require* the use of the 110V system. I know what I would rather see, a safer system for everyone. I'll keep you informed of any further developments – watch this space!

This is likely to be just one of the first disputes over safety, many more will probably follow – not just related to electrical and electronic systems and standards, but affecting every aspect of our (and our families) lives. Our objections to the relaxation of safety (and other standards) should not be raised on the basis of 'defending Britain from meddling politicians in Brussels', but simply, following the ideals of the European Community, *everyone* should benefit from improved safety standards. If you feel strongly enough about this, write to your local MP, Stephen Hughes MEP (both through the House of Commons) and Tim Sainsbury (Consumer Safety Unit) at the DTI, *they* need *your* support to raise and deal with *your* concerns.

Front Cover Pictures: © Copyright 1994 Pictor International and Maplin Electronics plc. *Three diverse applications of electronics – all easily accessible to the electronics hobbyist.*

EDITORIAL

Editor Robert Ball AMIPRE
Technical Authors Robin Hall FBIS, G4DVJ, Mike Holmes
Print Co-ordinators John Craddock
News Editor Stephen Waddington BEng (Hons)
Technical Illustrators Ross Nisbet, Lesley Foster, Paul Evans, Nicola Hull
Project Development Chris Barlow, Dennis Butcher, Alan Williamson, Nigel Skeels

PRODUCTION

Art Director Peter Blackmore
Production Controller Steve Drake
Designer Jim Bowler
Layout Artists Tracey Walker, Adrian Dulwich, Nadine Clark, Paul Andrews
Published by Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Tel: (0702) 554155. Fax: (0702) 553935.
Lithographic Reproduction by Planagraphic Studios, 18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed in the United Kingdom by St Ives (Caerphilly) Ltd. Mid-Glamorgan, CF8 3SU.

MANAGEMENT

Publications Manager Roy Smith
Development Manager Tony Bricknell
Drawing Office Manager John Dudley
Marketing Manager Vic Sutton

ADVERTISING

Jackson-Rudd & Associates Ltd., 2 Luke Street, London, EC21 4NT. Tel: (071) 613 0717. Fax: (071) 613 1108.
Advertisement Managers Eric Richardson, Jim Slater

UK NEWSTRADE DISTRIBUTION

United Magazine Distribution Ltd., Castle House, 37-45 Paul Street, London EC2A 4PB. Tel: (071) 490 2020. Fax: (071) 490 1239.

Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

1. Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering iron, side cutters, pliers, wire strippers and screwdriver). Test gear not required and no setting-up needed.
2. Easy to build, but not suitable for absolute beginners. Some test gear (e.g., multimeter) may be required, and may also need setting-up or testing.
3. Average. Some skill in construction or more extensive setting-up required.
4. Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.
5. Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

Ordering Information

Kits, components and products stocked by Maplin can be easily obtained in a number of ways:

Visit your local Maplin store, where you will find a wide range of electronic products. If you do not know where your nearest store is, refer to the advert in this issue or Tel: (0702) 552911. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance.

Write your order on the form printed in this issue and send it to Maplin Electronics, P.O. Box 3, Rayleigh, Essex, SS6 8LR. Payment can be made using Cheque, Postal Order, or Credit Card.

Telephone your order, call the Maplin Electronics Credit Card Hotline on (0702) 554161.

If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (0702) 552941. If you do not have a customer number Tel: (0702) 552911 and we will happily issue you with one. Payment can be made by credit card.

If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place orders directly onto the Maplin computer 24 hours a day by simply dialling (0702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system. If you do not have a customer number or a PIN number Tel: (0702) 552911 and we will happily issue you with one.

Full details of all of the methods of ordering from Maplin can be found in the current Maplin Catalogue.

Prices

Prices of products and services available from Maplin, shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%) and are valid between 1st April and 31st August 1994. Prices shown do not include mail order postage and handling charges, which are levied at the current rates indicated on the Order Coupon in this issue.

Technical Enquiries

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics*, the Customer Technical Services Department may be able to help. You can obtain help in several ways; over the phone, Tel: (0702) 556001 between 2pm and 4pm Monday to Friday, except public holidays; by sending a facsimile, Fax: (0702) 553935; or by writing to: Customer Technical Services, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Don't forget to include a stamped self-addressed envelope if you want a written reply! Customer Technical Services are unable to answer enquiries relating to third-party products or components which are not stocked by Maplin.

'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service, return the complete kit to: Returns Department, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Enclose a cheque or Postal Order based on the price of the kit as shown in the table below (minimum £17). If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due any error on your part, you will be charged the standard servicing cost plus parts.

Kit Retail Price	Standard Servicing Cost
up to £24.99	£17
£25 to £39.99	£24
£40 to £59.99	£30
£60 to £79.99	£40
£80 to £99.99	£50
£100 to £149.99	£60
Over £150	£60 minimum

Readers Letters

We very much regret that the editorial team are unable to answer technical queries of any kind, however, we are very pleased to receive your comments about *Electronics* and suggestions for projects, features, series, etc. Due to the sheer volume of letters received, we are unfortunately unable to reply to every letter, however, every letter is read — your time and opinion is greatly appreciated. Letters of particular interest and significance may be published at the Editors discretion. Any correspondence not intended for publication must be clearly marked as such.

TECHNOLOGY WATCH!

with Keith Brindley

If you're worried about intrusion of personal privacy (and this is something we should all be concerned over) then the emergence of future electronics multimedia technologies relying on the so-called *information superhighways* must just about scare you to death. Just what exactly am I talking about? Well, the *information superhighway* is a phrase coined, I think, by Microsoft's Bill Gates which describes the multimedia home services we can all expect to emerge over the next few years. These are all based on the use of the television as a complete interactive entertainment and customer services console. Phew – try saying that with a mouthful of cat and chips (read on!).

In other words, there'll be a box on top of the TV (to complement your satellite receiver, decoder, CD-I, Photo-CD, laser disc, VCR, Pro-Logic surround sound amplifier and so on) which connects to a network, along and through which your whole house can be run. You will choose what television programmes you want to watch this way, in much the same way as you do now except you will be able to choose the programme whenever *you* want, not when the broadcaster chooses to transmit it. Your gas and electricity meters will be read automatically this way. You will be able to buy products advertised on the screen over the network. You will naturally, be able to make 'phone calls over the network. Your TV may double as a computer monitor screen, connected simultaneously to your home machine, the PC at the office, and that of Fred your next-door neighbour. Your kids (or, indeed, you yourself) will be playing games with someone at the other end of the network, even at the other end of the world.

It all sounds great – especially if you're a gadget-lover like me (and lets face it, I don't think you'd be reading an electronics mag if you weren't more than just a trifle interested in gadgets) and personally I can't wait to get my hands on one.

But there must surely be some regulation over such services. After all, it doesn't take much to work out that every telephone call you make is logged on the network. Every film you choose to view is noted at head-office. Each product you buy off-screen is notched up in a massive database. The number of times your system is on will be recorded, as well as the times it is off (what's the point of advertising an exclusive product to the Bean household, when there's not a Bean in sight?).

What all this recording of personal information amounts to is a snapshot of your life. The service providers at the other end of the network (and anyone else who hacks into the system; illegally or otherwise) essentially know what you're about. If you like to watch a late-night soft-porn movie on Channel WANC, the service providers know it. If you're a sucker for the exclusive set of self-cleaning kitchen knives with a free onion peeler-cum-tomato corer-cum-grapefruit squeezer, you won't be the only one who knows. If you spend your couch-potato days watching re-re-re-re-re-runs of Dallas you can guarantee the ads in the middle are specifically designed for you – crisps, beer, meal-for-one lasagna, garden barbecues.

Yes, yes, I know I've stuck this under your nose with tongue in cheek. But really it's no joke. The technology is about to fall into place. Large companies like Microsoft (mind you, Gates' baby is by no means the only one) are forging ahead with standards and techniques to do everything I've described so far – and more. The situation requires close monitoring. When you have individual entertainment systems like the current ones the closest anyone gets to an infringement of personal liberties is the Jehovah's Witness couple at the door, the replacement windows (pun thoroughly intended) 'phone salesperson, the odd obscene 'phone call (dirty windows?), next-door's cat doing its business on your front lawn and, to crown it all, junk mail landing on the doormat every morning and only helping to fill up the dustbin two days before the council sanitation and refuse technicians arrive.

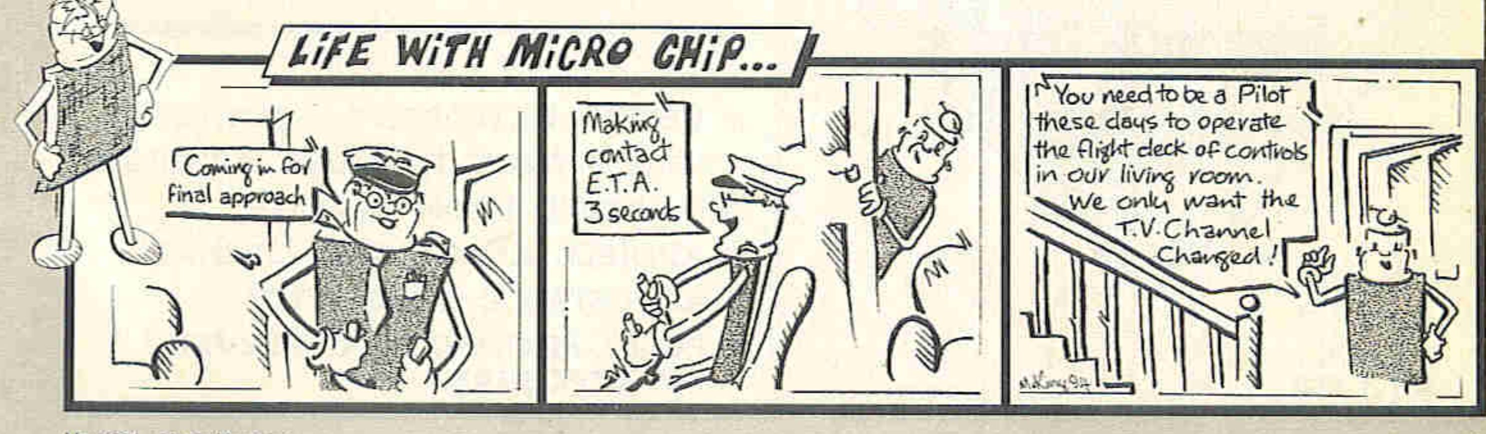
Yet these are physical things essentially under your control. You can always slam the door to heaven in the Jehovah's Witnesses' faces, take the 'phone off-hook, cover the lawn with lion dung, and burn the junk mail. Information flow is one-way, only *into* your private residence. All these things are as yet non-interactive – unless you want them to be otherwise. We are *watching* Big Brother.

The problem is (or at least will be) that junk mail ten years from now will be electronic and interactive. Data exchange will be two-way, as much leaving your home as coming into it. Big Brother could be watching us!

At the very, very least, when your name is added to the list of subscribers to these interactive services, tens, hundreds, and maybe thousands of manufacturers will be clamouring to buy it and electronically mail you junk. The worst scenario is that your personal habits and lifestyle will be observed by others with as yet uncertain results.Still, we can always put the Jehovah's Witnesses down, eat next-door's cat (invite Fred around for the barbecue, but don't tell him what he's munching), go ex-directory, tape up the letter box, and pull the plug on our new-fangled information superhighway, can't we?

In the ideal world, long before the *information superhighway* and its resultant 'services' are started up we would, on the other hand, ensure that privacy can be maintained, electronically, physically, and legally.

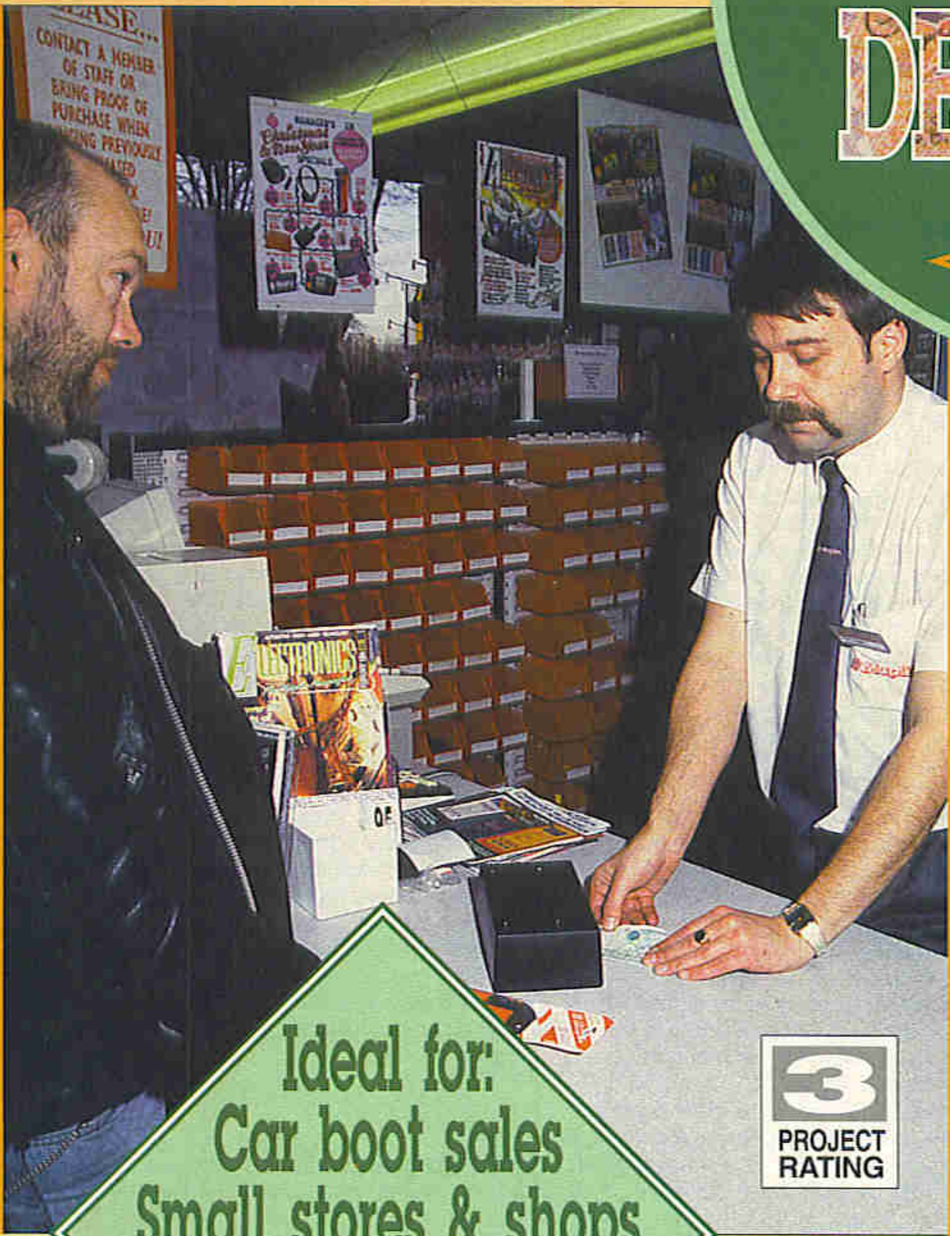
The opinions expressed by the author are not necessarily those of the publisher or the editor.



Design by Nigel Skeels
Text by Nigel Skeels and Robin Hall

Recently you may have noticed a strange blue glow being emitted from behind cashiers' desks and tills? No, it's not aliens taking over. It's the notorious bank-note checker, where an ultraviolet fluorescent tube is used to illuminate the bank-notes. The reason is that fake or counterfeit notes reflect the UV light whereas real ones do not.

FORGED BANK-NOTE DETECTOR



Ideal for:
Car boot sales
Small stores & shops
Bazaars & Fetes
Pubs/Clubs

3
PROJECT RATING

Our idea, a slight variation on the standard type of checker, is to incorporate an extra circuit which sounds a buzzer and illuminates an LED if the note is OK, but if the note is fake then the LED will not light and the buzzer will not sound. Since the unit will operate from a +12V DC supply, it is ideal for use at Car Boot Sales, where counterfeit notes are often tendered. As 'Forged Bank-Note Detector' is a bit of a mouthful it will be referred to simply as the 'Till Saver'.

Is it real or is it a dud?

Kit Available (LT54J)
PRICE £14.99

Please note: Box shown is not included in the kit.

FEATURES

* VISIBLE DETERRENT * LOW-COST
* SIMPLE THREE TRANSISTOR DESIGN
* POWERED FROM +12V DC
* AUDIBLE AND VISUAL SIGNALS
* ADJUSTABLE SENSITIVITY
* FULLY ENCLOSED TO PREVENT UV EXPOSURE

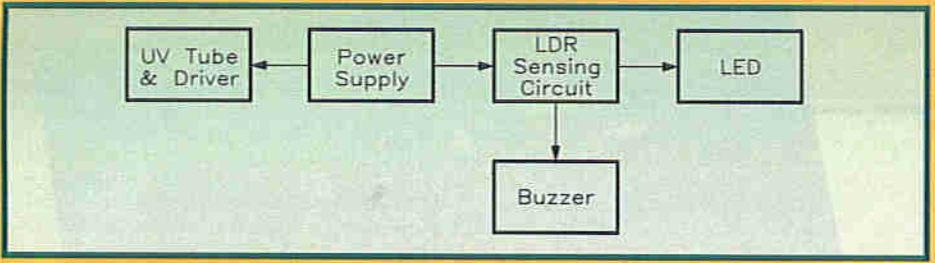


Figure 1. Block diagram of the Till Saver.

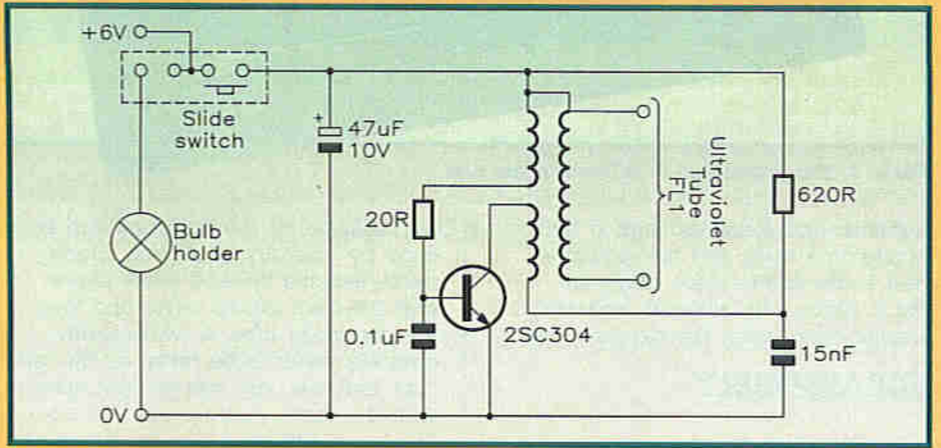


Figure 2. Circuit diagram of the fluorescent tube driver.

CIRCUIT DESCRIPTION

The design of the circuit is very simple and comprises of two main sections; these being the tube driver and the LDR Sensing circuit. The full block diagram is given in Figure 1. The tube driver circuit, already constructed on a small PCB, is a very simple circuit using a specially wound transformer. The detection circuit comprises of a light dependent resistor (LDR) sensor and associated components which operates a buzzer and LED.

The fluorescent tube driver circuit is shown in Figure 2. The power supply, (smoothed by a 47µF capacitor) on being applied charges up the 0·1µF capacitor via the feedback winding of the transformer and the 20Ω resistor. The voltage on reaching approximately 0·6 to 0·7V the transistor switches on. The 15nF capacitor, charged via the 620Ω, resistor then dumps its charge through the transformer primary; (the capacitor is required for the current pulse). A sufficiently high voltage develops on the secondary of the transformer to excite the gas in the UV tube and cause illumination. The feedback winding on the transformer will apply a negative voltage to the base of the transistor, the base capacitor will turn off the transistor and allow the cycle to continue. The actual oscillator frequency is approximately 60kHZ.

Warning: the tube voltage is around 1,000V Pk-to-Pk so be extremely careful not to touch anything in this area when the unit is powered up.

The detection circuit is shown in Figure 3. The Till Saver is polarity protected by diode D1 and uses a LM317T regulator along with resistors R1 and R2 to obtain an output voltage of +6V. Capacitor C1 provides high frequency decoupling at the input of the regulator, and capacitor C2 promotes stability at the output of the regulator. Capacitor C3

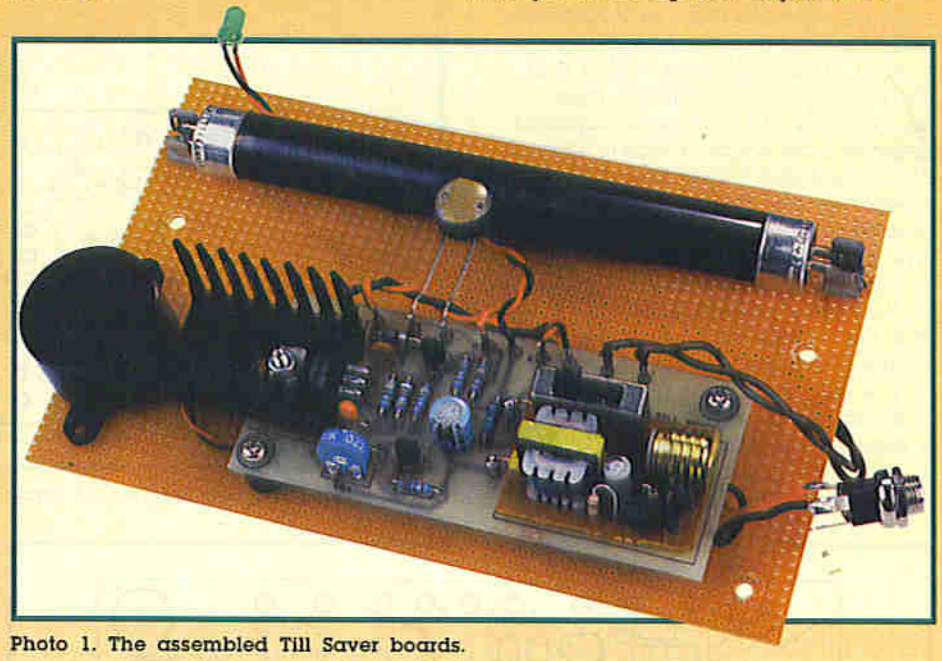


Photo 1. The assembled Till Saver boards.

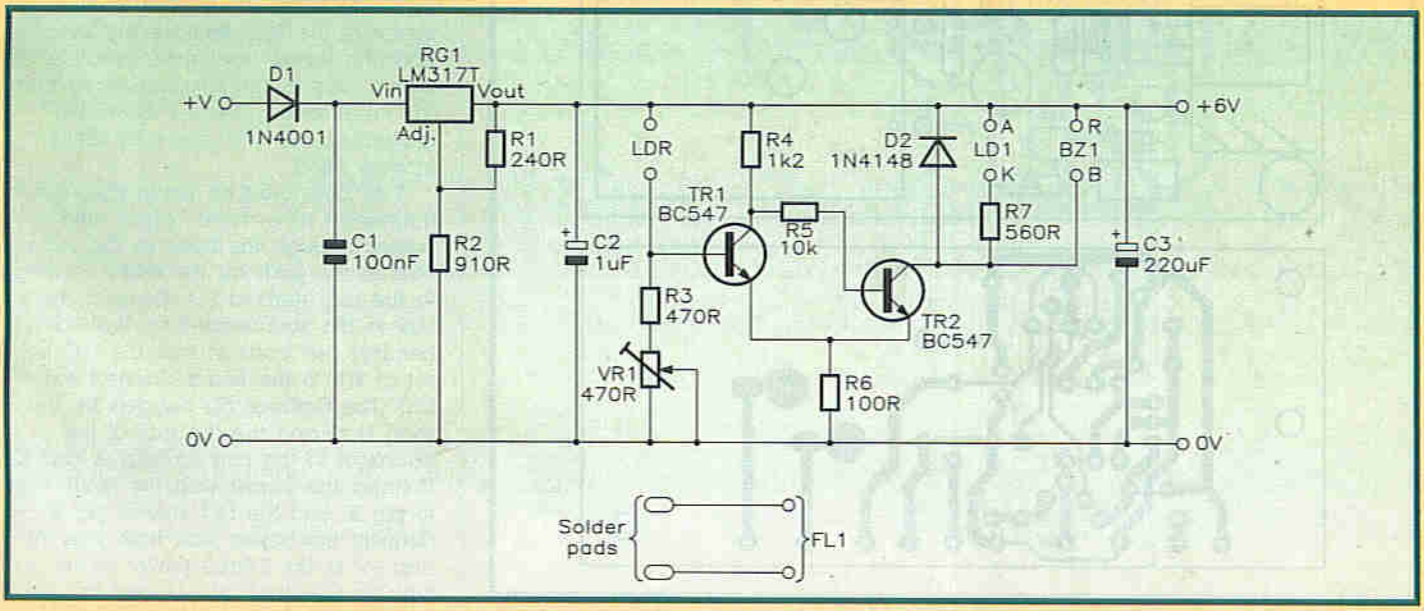


Figure 3. Circuit diagram of the Till Saver.

is a reservoir capacitor for the power supply to the tube driver.

The light dependent resistor (LDR), R3 and VR1 form a potential divider network, where VR1 is the sensitivity control. Under normal conditions the UV light falling on the LDR will lower its resistance and biase TR1 on; with TR2 biased off LED LD1 and buzzer BZ1 will not operate. When the amount of UV light falling on the LDR is low, its resistance will be high thus, TR1 switches off, and this in turn allows TR2 to switch on, operating the LED LD1 and sounding the buzzer BZ1. When the UV light level increases once again this will be detected by the LDR and consequently the circuitry will switch the LED and buzzer off.

CONSTRUCTION

Referring to the PCB legend and track in Figure 4 and the Parts List, start by fitting the resistors and the vertical preset resistor. Then fit the diodes, making sure that they are orientated correctly, with the band at the cathode end matching that on the PCB legend.

Next fit the capacitors, noting that the electrolytic and tantalum types are polarised. The electrolytic capacitor negative lead, which is shown by a black band and (–) symbols is fitted towards R6 and the longer lead (+) towards R4 and R5. Fit the tantalum type with the (+) marked on the body towards the (+) symbol on the PCB.

Next fit the transistors, making sure that the outlines match those as shown on the PCB legend.

The PCB pins should be fitted next, and can be pushed home with the tip of a soldering iron and soldered in position.

Next bend the legs of the regulator to enable it to lay flat on top of the

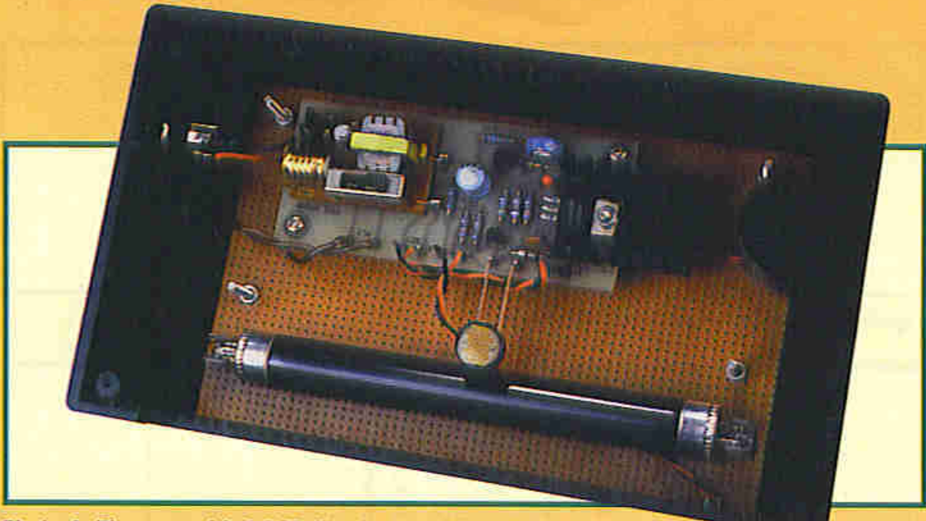


Photo 2. The assembled PCB fitted in the box.

heatsink, and place the legs in the appropriate holes. Bolt the regulator and heatsink into place using an M3 x 10mm bolt, nut and shakeproof washer; then solder the regulator legs.

SUBASSEMBLY

To complete the project use the fluorescent tube driver board from an Ultraviolet Mini Lantern. This needs to be taken out of the case and can be done by carefully taking the casing apart. Remove the end cover plates and the clear plastic cover and then the ultraviolet tube. A white plastic covering needs to be taken off the red case and the case can be split apart with the driver board easily extracted. The two white wires can be cut or desoldered. Cut the curly battery

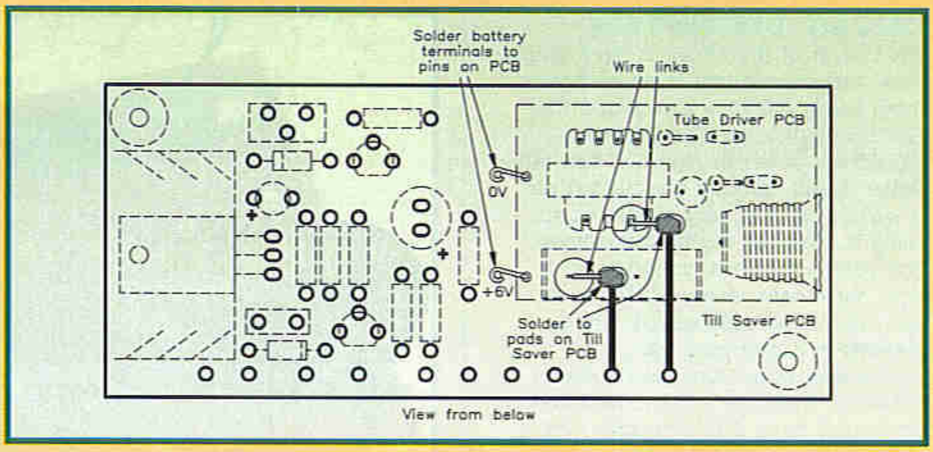


Figure 5. Mounting the Fluorescent Driver PCB onto the Till Saver PCB.

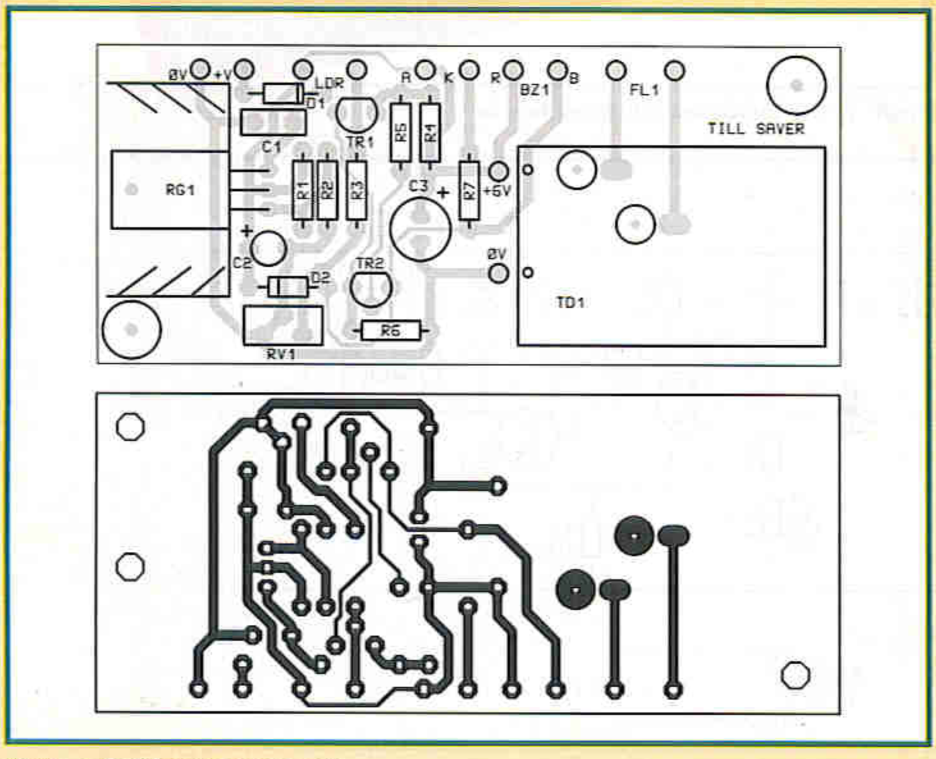


Figure 4. PCB legend and track.

terminals off leaving an excess of about 8mm. The tube driver board can then be mounted with the cut down terminals soldered to the pins on the main PCB marked 0V and +6V, (refer to Figure 5), these are located towards the centre of the PCB. Remove the lamp from the board, and move the slide switch fully in the direction away from the lamp socket. Photo 1 shows the assembled PCB with the tube driver module fitted.

Two links must be made from the fluorescent tube driver output, and passed through the holes in the main PCB, to the pads on the board leading to the pins marked FL1. Connect the LDR to the pins marked on the PCB, bending the leads so that the LDR is set at 90° to the board. Connect the LED (The Cathode (K) denoted by the short lead and the flat side of the package) to the pins marked A and K. Connect the buzzer with the black wire to pin B, and the red wire to pin R. Connect the power lead from pins 0V and +V to the 2.5mm power socket, making sure that the +V lead is connected to the centre pin.

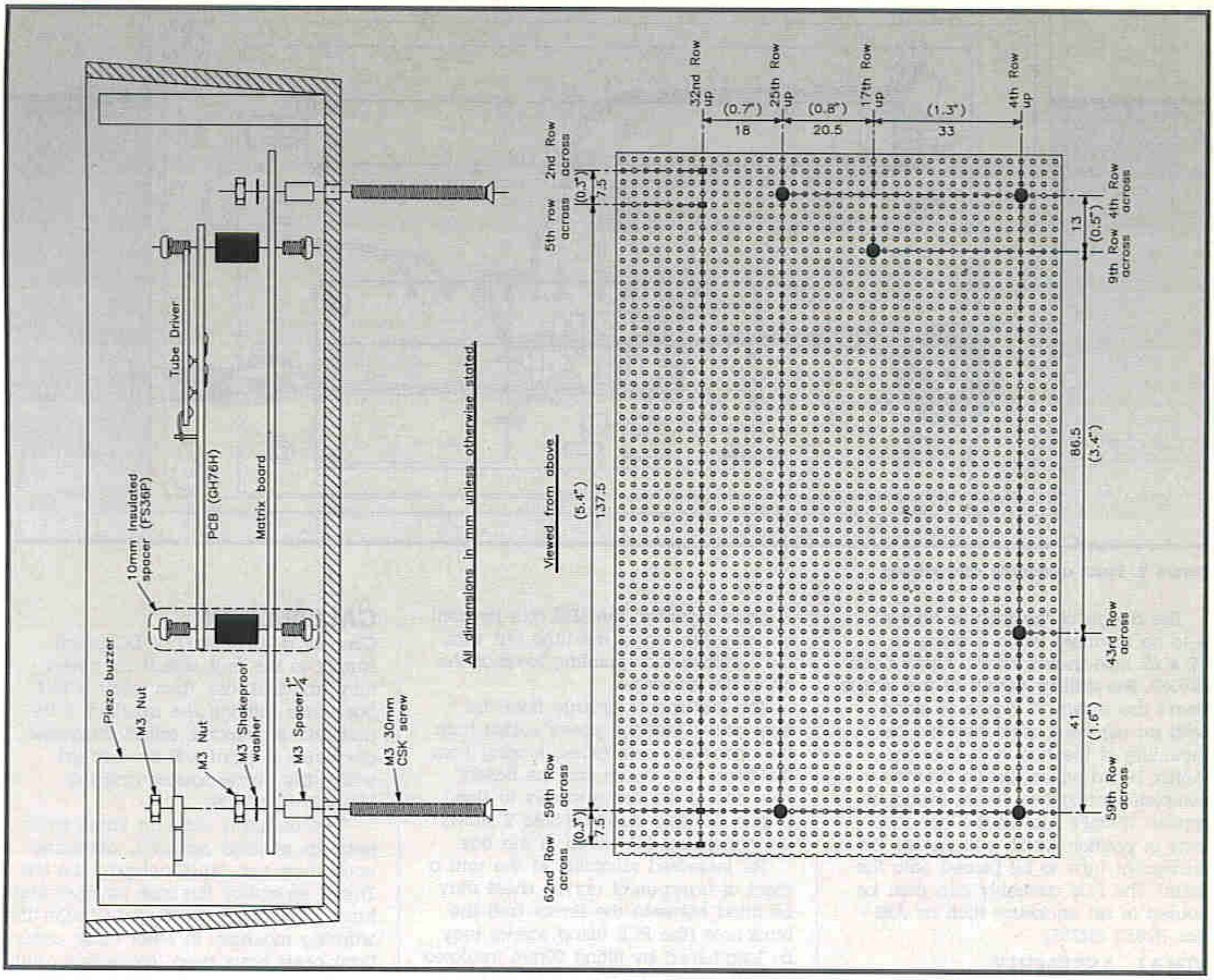


Figure 6. Matrix board drilling details and exploded view showing mounting of the PCB onto the matrix board.

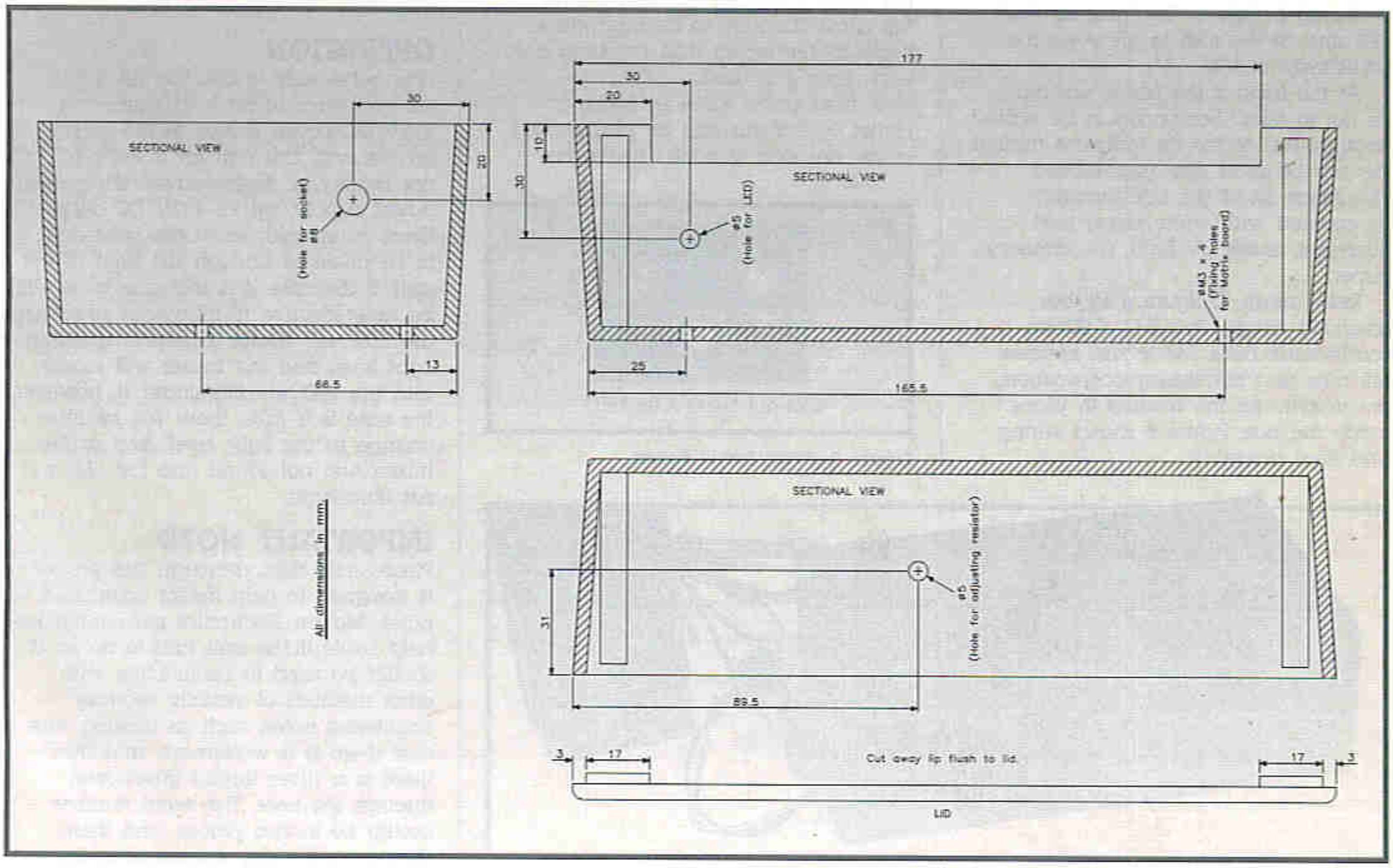


Figure 7. Box drilling details.

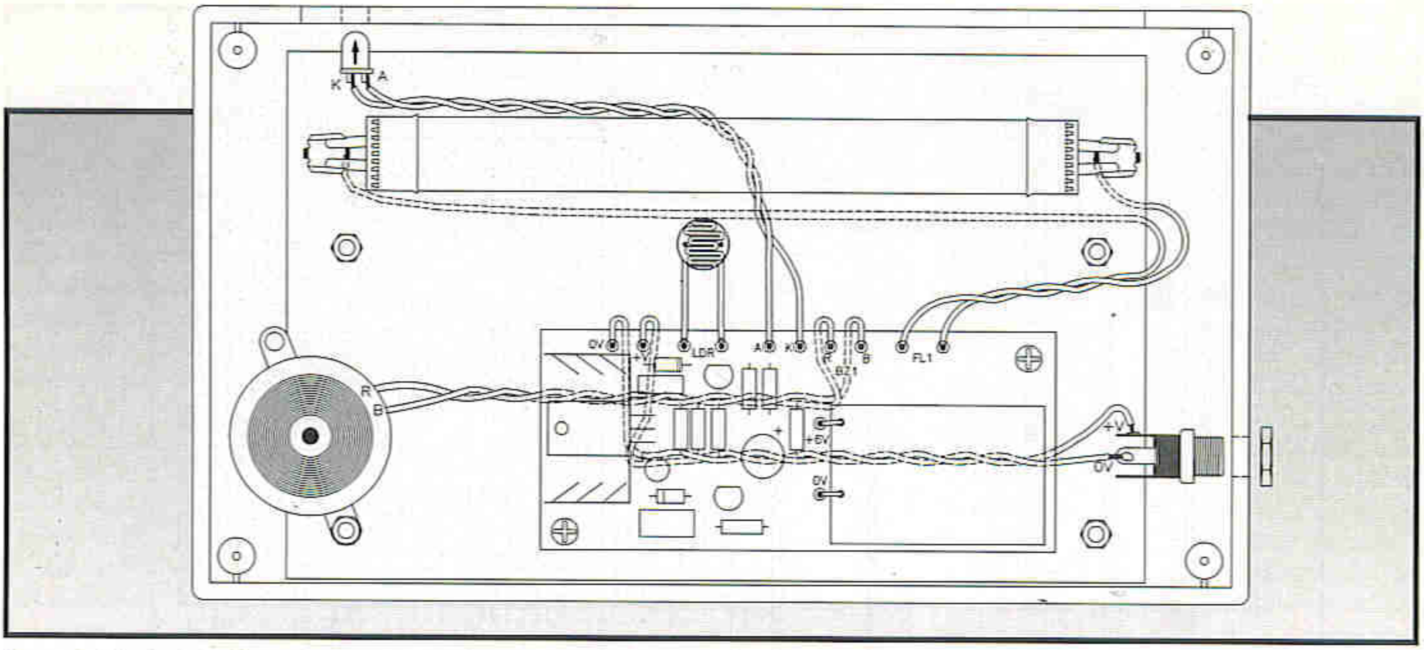


Figure 8. Final assembly and wiring.

The design of the module allows it to be mounted on to a piece of 39 x 62 hole matrix board (Order Code JP53H). The drilling details of the matrix board are shown in Figure 6; along with an exploded view showing the mounting of the two PCBs onto the matrix board which should then be completed using two 10mm insulated spacers (FS36P). Also fit the two fuse clips in position which will enable the fluorescent tube to be placed onto the board. The PCB assembly can then be housed in an enclosure such as ABS box H2852 (BZ75S).

FINAL ASSEMBLY

Figure 7 shows the box drilling and cutting details. Drill the holes as shown, including a hole at the front for the LED and at the rear to allow for the adjustment of VR1.

At the front of the box a slot must be cut to allow bank-notes to be passed through. Part of the lip that runs around the box lid must also be removed. The inside lid of the box should be covered with white paper that fluoresces under UV light, (i.e. ordinary paper).

Refer again to figure 6 for box assembly details. Four M3 x 30mm countersunk bolts, M3 x ¼in. spacers; M3 nuts and M3 shakeproof washers are used to fix the module in place inside the box. Figure 8 shows wiring and final assembly.

Once installed, the LDR can be bent out over the top of the tube but with the sensitive face pointing towards the lid of the enclosure.

The LED should emerge from the front panel and the power socket from the right-hand side (when looking from the front). The buzzer can be bolted onto one of the fixing screws to stop it from moving around. Photo 2 shows the assembled PCB fitted in the box.

For increased reliability of the unit a sheet of transparent acrylic sheet may be fitted between the sensor and the bank-note (the PCB fixing screws may be lengthened by fitting 20mm insulated spacers (FS38R) to allow it to be fixed). This will help to keep the bank-note flat when it is inserted, and enable the same distance to be maintained between the sensor and the bank-note each time it is used.

A front panel label is shown in Figure 9 and this can be photocopied or cut out and attached to the box.

Figure 9. Front Panel Label.

CALIBRATION

Connect a suitable +12V DC power supply to the unit, adjust the preset fully anticlockwise, then insert a real bank-note through the aperture. If the unit fails to respond, adjust the preset clockwise. A point will be reached where the buzzer sounds and the LED will illuminate.

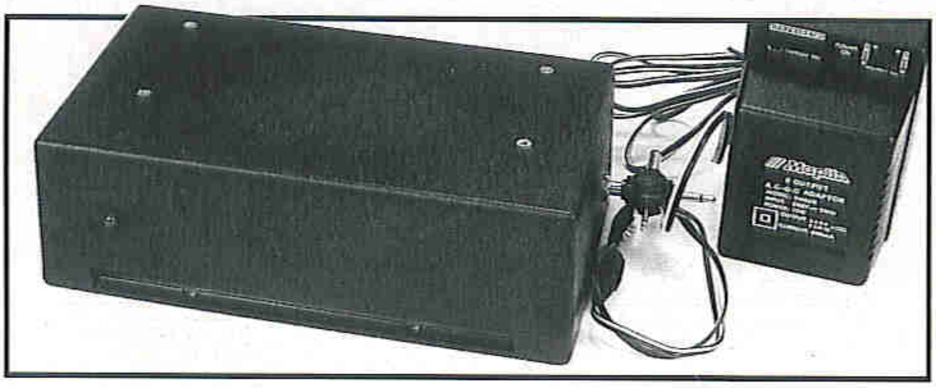
'Test' as many different value bank-notes as possible; however, 'old' bank-notes may sometimes not pass the test. This is especially the case for ones that have accidentally been put through the washing machine. In other cases, some bank-notes have been 'vandalised' with ultraviolet marker pens. However, a genuine note can be confirmed by inspection, as explained below.

OPERATION

It is quite easy to use the Till Saver. All you have to do is to connect a +12V DC power source to the socket on the unit, this can be a +12V DC car battery, or mains driven unregulated power supply, set for +12V DC output. Once connected, insert the bank-note to be checked through the front of the unit. If the note is a real one, as it will be non-reflective to ultraviolet radiation, the LDR will detect a drop in reflected light level and the buzzer will sound and the LED will illuminate. If, however, the note is a fake, there will be little change in the light level, and so the buzzer will not sound and the LED will not illuminate.

IMPORTANT NOTE

Please note that, although this project is designed to help detect counterfeit notes, Maplin Electronics plc cannot be held liable if the unit fails to do so. It should be used in conjunction with other methods of visually spotting counterfeit notes, such as making sure that there is a watermark, and that there is a silver thread interwoven through the note. The serial number should be in two places, and there should not be any blemishes in the printing.



The Till saver ready for action.

TILL SAVER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)

R1	240Ω	1	(M240R)
R2	910Ω	1	(M910R)
R3	470Ω	1	(470R)
R4	1k2	1	(M1K2)
R5	10k	1	(M10K)
R6	100Ω	1	(M100R)
R7	560Ω	1	(M560R)
RV1	470Ω Vertical Enclosed Preset	1	(UH12N)

CAPACITORS

C1	100nF Miniature Disc Ceramic	1	(YR75S)
C2	1μF 35V Tantalum	1	(WW60Q)
C3	220μF 10V Miniature Electrolytic	1	(JL06G)

SEMICONDUCTORS

D1	1N4001	1	(QL73Q)
D2	1N4148	1	(QL80B)
LD1	LED Green	1	(WL28F)
TR1,2	BC547	2	(QQ14Q)
RG1	LM317T Voltage Regulator	1	(UF27E)

MISCELLANEOUS

LDR	ORP12 (Light Dependent Resistor)	1	(HB10L)
	Single-ended PCB Pin 1mm (0·4in.)	1 Pkt	(FL24B)
	UV Mini Lantern	1	(ZC10L)
	Heatsink	1	(FG55K)
BZ1	DC Piezo Buzzer	1	(CR34M)
	3A Red 10m wire	1 Pkt	(FA33L)
	3A Black 10m wire	1 Pkt	(FA26D)
	PCB	1	(GH76H)
	Instruction Leaflet	1	(XU61R)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

Panel Mount Power Socket 2·5mm	1	(JK10L)
M3 x 30mm Pozi Screw	1 Pkt	(JC72P)
M3 Steel Nut	1 Pkt	(JD61R)
M3 Shakeproof Washer	1 Pkt	(BF44X)
AC Adapter Unregulated 800mA	1	(YM85G)
Plain Stripboard Board Type 3962	1	(JP53H)
1¼ in. Fuse Clip	2	(KU28F)
M3 x 10mm Insulated Spacer	1 Pkt	(FS36P)
M3 x ¼ in. Spacer	1 Pkt	(FG33L)
Matt Black ABS Box Type H2852	1	(BZ75S)
Stick-on-Feet	1 Pkt	(FD75S)
2·5mm Standard Power Plug	1	(HH62S)
Zip Wire (Bell Wire)	As Req.	(XR39N)
Large Battery Clip Red	1	(FS86T)
Large Battery Clip Black	1	(FS87U)
5mm LED Clip	1	(YY40T)
Quickstick Pads	1 Pkt	(HB22Y)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit, which offers a saving over buying the parts separately.

Order As LT54J (Till Saver Kit) Price £14.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g. packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1994 Maplin Catalogue.

Till Saver PCB **Order As GH76H Price £2.56**

NEWS Report

Kodak Launches New Portable Photo CD Player

Kodak has announced this month that it is launching a new portable Photo CD player, with a view to capturing a slice of the fast-growing UK portable CD market.

The Kodak Photo CD portable player PCD 960 has a recommended retail price of £299.00. It is smaller and lighter than the previous portable model, the PCD 885, being roughly the same size and weight as a VHS video cassette. In addition to its range of Photo CD features, the PCD 960 is also a fully-fledged audio CD player.

The PCD 960 offers users the opportunity to share their photographs (scanned onto Photo CD discs) with groups of family or friends wherever there's a television. Business users who want to present photographic images while on the road are another potential target for the PCD 960. Contact: Kodak

Pharmacists Get Faster Prescriptions

Pharmacists in Switzerland and other European countries, starting with France, Germany and Spain, will soon have instant access to analysis and interaction data on some 200,000 drugs and pharmaceutical substances listed on Euromed, a new multilingual CD-ROM disc from Amedis International and Ofac, the Swiss pharmacists' co-operative.

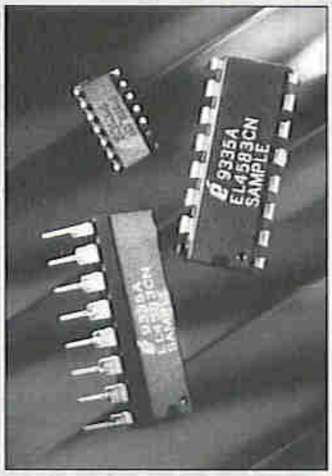
The Euromed compact disc was developed by Ofac's computer applications subsidiary Astral who brought in a British Company, Clarinet Systems of Camberley Surrey, to investigate the thirteen databases and compress them onto a single CD along with the retrieval software. Contact: Clarinet Systems (0276) 600398.

Broadcast Quality Video

Elantec's EL4583 is a precision video sync separator built using their high performance CMOS process. It offers NTSC, PAL and SECAM sync separation, extracting timing information and field information from video signals in the range from 0·5V to 2V Pk-to-Pk. The precision 50% slicing feature provides precise sync edge detection in the presence of noise and variable signal amplitudes. An optional built-in linear phase, third order, colour burst filter minimises spurious timing data and reduces external discrete components.

The EL4583 is also capable of providing sync separation for non-standard, faster horizontal rate video signals by an external bias resistor change. The vertical output is produced on the rising edge of the first serration in the vertical sync period. An output is also provided to indicate the loss of input signal, and a default vertical output is produced after a time delay, if the rising edge does not occur within the set delay period. A level output signal provides a DC measure of the sync pulse amplitude, which can be used for AGC applications.

The EL4583 is available in 16-pin DIP and SO packages, and is socket compatible with Elantec's low-cost EL4581 video sync separator. Contact: Elantec (071) 482 4596.



Technology Revives Musician of Old

What if George Gershwin could record his first published song today? Well pianist and american music scholar Artis Wodehouse has the answer.

Together with a talented group of computer musicians in the USA, Wodehouse has brought to life an early work of Gershwin using an authentic pianola and a Yamaha Disklavier piano.

In addition to his well-known and highly acclaimed compositions, Gershwin left behind more than 120 piano rolls – a body of work which until now has remained largely unknown. Wodehouse employed innovative computer techniques to transfer the fragile roles to 3·5in. floppy disk for playback on the Yamaha Disklavier piano.

The Disklavier is a unique acoustic piano which has the ability to record and reproduce an artist's performance. Hence when Gershwin's piano rolls were transcribed for the Disklavier and played back in a recording studio, it appeared as if the ghost of Gershwin were seated at the instrument.

Wodehouse's recording is available on the Elektra Nonesuch label entitled, 'Gershwin plays Gershwin'. Contact: Yamaha (0908) 366700.

New High-Sensitivity Frequency Counter/Finder

Quantek Electronics has introduced a high-sensitivity pocket size frequency counter/finder, model FC2000 capable of measuring frequencies from 1MHz to 2·4GHz.

While conventional frequency counters typically have a specified sensitivity of 10mV, the sensitivity of the FC2000 is less than 1mV between 10MHz and 850MHz, falling to 225µV at 150MHz. This enables the FC2000 to be used for transmitted radio frequency signals as well as laboratory bench measurements.

The compact and rugged design makes the FC2000 ideally suited for use by field service engineers. Other potential users include radio amateurs, scanning receiver owners for frequency finding, and counter surveillance operatives.

The FC2000, priced £119, features a bright 8 digit LED display, variable gate times, hold function, charge and gate LEDs, 50Ω BNC input, internal 700mAH Ni-Cad batteries, and is supplied complete with AC mains adaptor/charger and telescopic BNC antenna. Contact: Quantek Electronics (021) 411 1821.

Noise Annoyance

Over 50% of homes in the UK are exposed to daytime noise levels that exceed World Health Organisation (WHO) recommendations, rising to 63% at night, according to research from the Building Research Institute (BRE) on the noise climate around homes and its effects on occupants.

Findings from the BRE's Information Paper IP 21/93, 'The noise around our homes', are based on noise levels recorded for 24 hours outside 1,000 individual homes over a one-year survey period.

It concludes that 56% of dwellings are exposed to noise levels in excess of 55dB(A) which is the level recommended by WHO to prevent significant community annoyance. The study also showed that traffic noise was noticeable outside 90% of properties (although only 5% of those in the survey faced main roads) with 7% above the qualifying level for sound insulation on new roads.

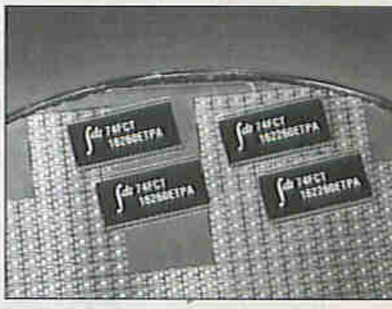
The Paper includes information on the types of noise affecting homes, the percentage of people exposed to different levels, and hourly and geographical patterns. The national survey will be repeated every five years to provide data on long-term trends in the noise climate, as well as indicating the success of further reductions in road vehicle noise limits planned for 1996.

Copies of IP23, 'The noise climate around our homes', are available from the BRE priced £3.50. Contact: BRE (0923) 664083.

4·2ns Tri-Port Bus Exchanger

Integrated Device Technology's (IDT) new tri-port bus exchanger is ideal for MIPS, Pentium and Power PC based applications.

Supporting speeds of up to 66MHz, the 4·2ns, 12-bit, latched CFCT16260 improves data flow performance and row/column address mixing to and from main memory in memory interleaving schemes.



By integrating the functions of latches, multiplexers and control logic into a single flexible device, the FCT16260 simplifies the design of multiplexing data into two high-speed output ports, increases performance and reduces external components.

The high level of integration and compact packaging saves more than 50% of board area. For example, a 36-bit main memory interleaving scheme requires only three 56-pin FCT16260s, compared to a traditional design using ten 24-pin octal '543 transceivers.

The 12-bit 2:1 multiplexer with latch provides bidirectional control for multiplexing and demultiplexing applications, and individual output enable controls to its internal latches.

Two output configurations are available. The FCT16260 with High Drive configuration is suitable for low impedance, heavy capacitance loads such as loaded backpanels and terminated lines. The FCT162260 configuration's ±24mA balanced drive output is intended for general applications such as point-to-point on board buses, memory driving and applications requiring a low noise solution.

Both are available in 300 mil-wide, 25 mil-pitch 56-pin SSOP and in 240 mil-wide, 20 mil-pitch 56-pin TSSOP. Contact: Integrated Device Technology (0372) 363734.

2A Step-Down Controllers offer 90% Efficiency

Maxim Integrated Products has introduced the MAX649/MAX651/MAX652 compact CMOS DC-to-DC step-down controllers with greater than 90% efficiency for 10mA to 2A loads – a 200:1 dynamic range.

The device maximises battery life in systems which sleep for long periods but periodically deliver high power – such as detectors, alarms and portable equipment. The low 100µA quiescent eliminates the need for a separate low-current back-up regulator or a DC-to-DC converter, while the 5µA logic-controlled shutdown effectively prevents battery drain.

These devices use tiny external components. They drive external P-channel MOSFET switches at high frequencies (up to 300kHz) which allow for surface-mount magnetics of 5mm height and less than 9mm diameter. They are capable of delivering up to 5W power.

The MAX649/MAX651/MAX652 accept input voltages from +4V to +16V and have preset output voltages of +5V, +3·3V and +3V respectively. The output can be user-adjusted to any voltage from +1·5V to the input voltage using two resistors.

The MAX649/MAX651/MAX652 are available in 8-pin DIP and SO packages. Contact: Maxim (0734) 845255.

Digital Audio Broadcasting Spectrum Allocation

The Radio Authority has welcomed the announcement by the Department of Trade and Industry earlier this year that frequency band 217·5 to 230MHz is to be made available to Terrestrial Digital Audio Broadcasting (T-DAB) in the UK.

Commenting on this development, Mr. Peter Baldwin, Chief Executive of the Authority said; "We have been planning for DAB for over two years, and are delighted by this news. We have had decades of wringing our hands about patchy, hissy and crackly radio reception.

Now we can look forward from 1995/96 onwards to getting most, if not all of our national and local licensees on to a reliable modern system purposely designed for listening in the portable and mobile way that the audiences actually use their radios."

DAB is an entirely new system for sound broadcast transmission. It has been developed by a multinational co-operative research project Eureka 147, whose membership includes manufacturers, research institutions, and broadcasters, initially from Europe, but now from all over the world, including Japan. The DAB system has been demonstrated for some years and has now been refined to the point where the standardisation process is nearing maturity. Contact: Radio Authority (071) 405 7058.

Green Microcontrollers

Intel Corporation has announced a new +3V version of its industry standard MCS '51 8-bit microcontroller family. Equivalent in performance and peripheral integration levels to existing +5V 8051 microcontrollers, the new low-voltage devices are targeted at energy-efficient applications in portable computing, personal communications, digital assistants, mobile telephones and other communications devices.

"Unlike the majority of low-voltage products that are simply recharacterised at 3V, which can affect performance, the 8051 core was actually redesigned to operate at lower voltage, reducing power consumption levels with no performance degradation", claims Mr. S. H. Wong, General Manager of Intel's 8-bit microcontroller group. "This new design results in longer battery life for users of mobile and portable products, while giving our customers many new options for designing hand-held, battery-operated systems."

The new low-voltage microcontrollers operate from +2·7V to +3·6V at up to 20MHz maximum frequency for the commercial temperature range (0°C to 70°C) or 16MHz for the extended temperature range (–40°C to +85°C). The new core design also has improved noise margins thus lowering radio frequency interference (RFI) generated noise levels.

Ideal applications for the new +3V products in mobile computing include the input interface for pen-based computers, PDA/personal communicators, keyboard control and peripherals control for green, laptop and notebook PCs. Intel is also targeting mobile communications, including cordless phones, cellular phones/systems and answering machines. Contact: Intel (0793) 696000.

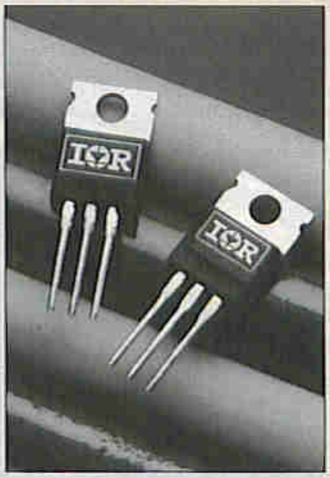
Radio TAG Licensing

British Technology Group (BTG) plan to commercialise the CSIR Supertag automatic identification system. Supertag is intended as an electronic replacement for bar codes.

Each Supertag is a single integrated circuit chip plus a printed flat aerial. Using radio links, Supertag readers are capable of multiple identification and counting at rapid speed. Devised by CSIR, the Supertag has a unique anti-clash communications function which enables a group of individually tagged objects to be separately identified and counted even though they are situated close together. At present 50 objects per second can be read up to a range of four metres. Performance is likely to increase.

Supertag has numerous potential applications in the storage, distribution and retailing of goods. In the long term the main opportunity is the possibility of self-service check-outs in retail stores. Other applications are likely to be parcel and airline baggage tagging, animal tagging, railway and bus season tickets, car parking and personnel access control.

British Technology Group and CSIR are now seeking collaborations with major semiconductor device suppliers and system integrators to establish a wide range of Supertag based products internationally. Contact: British Technology Group (071) 403 6666.



On-Resistance Reduction for TO-220 Packaged HEXFETs

International Rectifier has introduced two low on-resistance HEXFET power MOSFETs with a lower cost per amp ratio than any other comparable devices on the market.

The 30V IRL2203 and 50V IRL3705 N-channel devices are housed in the TO-220 package and achieve new low values for $R_{ds(on)}$ of 10 and 12 milliohms respectively. Both devices can operate from a logic-level +5V gate drive as well as the standard +10V. The IRL3705 is rated at +50V over the full operating temperature range, making it particularly suitable for automotive applications, where breakdown voltage at temperatures down to –40°C are important.

Both devices offer the designer a reduction in external components or size in comparison with devices with higher on-resistance. This is particularly true when designs require paralleled MOSFETs. As an example, twelve IRLZ44s can be replaced by only seven IRL3705s or, if the 30V rating is adequate, six IRL2203s.

The IRL2203 will also find applications in synchronous rectifiers in +5V power supplies as well as DC-to-AC inverters, +12V battery UPS systems and other +5 to +12V DC applications. The IRL3705 will be used in automotive applications and certain DC-to-DC converters where the +30V breakdown voltage of the IRL2203 is insufficient. Contact: International Rectifier (0883) 713215.

Discovery Card Highlights IRQ And DMA Conflicts

When installing PCs, networks or any kind of add-on card or PC adaptor, the most common problem is IRQ (Interrupt Request) and DMA (Direct Memory Access) channel conflicts. Hardware difficulties like these can now be avoided with the new Discovery Card available from Eurosoft.

The Discovery Card is a compact, single add-in card that connects into any BUS slot on the PC motherboard. It will detect conflicts and actual usage of any IRQ or DMA channel, by any adaptor, in any IBM-PC, compatible or EISA motherboard using ISA cards. The Discovery Card will capture the signal and inform the installer enabling easier and effective troubleshooting.

The alternative is to use ordinary logic probes, but these can add to hardware problems by causing short circuits and damaging slot connectors.

Time and efficiency also become paramount as this type of test takes two people to run effectively – one to insure the probe is on the right connector, and the other person to run the software and test the hardware. By contrast the Discovery Card allows tests to be executed by a single person. Contact: Eurosoft (0202) 297315.

Lighting the M1

When replacing the lighting at junctions 13 to 14 on the M1 motorway, a major consideration of the Department of Transport and Buckingham County Council was limitation of the stray light for the rural section of motorway. At the same time, lighting levels demanded by BS5489 for a widened four-lane dual carriageway had to be met.

The new ZX3 Curved Tempered Glass (CTG) lantern from Urbis lighting, offered a solution to these requirements, providing deep bowl photometry, whilst reducing light pollution to an absolute minimum.

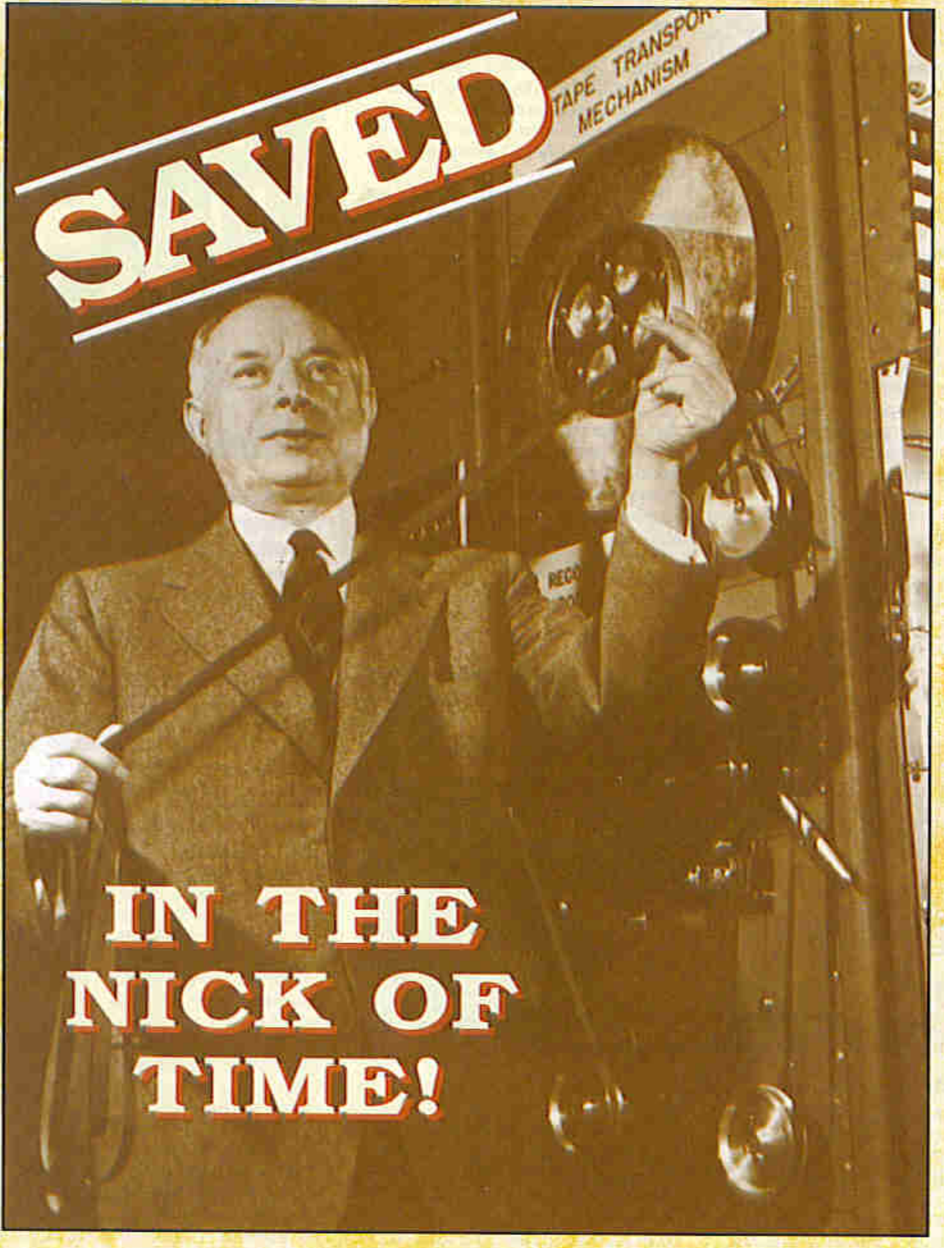
The IP66 tightness, coupled with a high performance optic in the patented Sealsafe system, guarantees lower maintenance costs, whilst offering better lighting control, thereby providing high energy efficiency. Contact: Urbis Tel: (0256) 54446.

Five-Way Video Splitter

Vine Micros, has announced the launch of its Splitter 550, a 5-way video distribution amplifier. The Splitter 550 handles VGA, SVGA and XGA input signals and provides up to five monitor outputs. The Splitter 550 joins Vine Micros' existing VGA Splitter which has been available for three years and allows three VGA connections.

"There is a rapidly growing market for wide audience computer display, particularly in the training and exhibition industries", said Ms. Amanda Mallett, Sales and Marketing Director at Vine Micros. "The Splitter 550 will certainly lead these markets and we also anticipate its extensive use in public display applications."

The Splitter 550 is available directly from Vine Micros or from suppliers nationwide and costs £149 + VAT, including VGA output connectors and mains adaptor. Connector packs for composite video, S-Video, RGB SCART and audio connection are also available, as is a Booster Cable which is recommended for distances greater than 15m. Contact: Vine Micros (0843) 225714.



SAVED IN THE NICK OF TIME!

Left: Video tape was a novelty back in 1956 when RCA demonstrated its first ½in. colour recording system. Finding a machine to play back these long-obsolete formats can be very difficult nowadays.

Andrew Emmerson investigates the people who recover rare recordings on lost formats

When David Bowie's record company wanted to release a video compilation of his early hits recently, they had a problem: some of the oldest material was on ¼in. reel-to-reel tape made on a long-forgotten Akai machine. The tape appeared to be in good condition, but where do you find a playback machine for a tape format that was obsolete when VHS was introduced in the late seventies?

Or take the case of the relatives of a deceased man who wanted to hear the sound of his voice again: all they had was an office dictation machine disc, again of an obsolete format. And how do you 'clean up' scratchy recordings, or make 'rescued' recordings from tapes and records that are damaged and cannot be played?

Simple – you call in an expert, to be precise, a recording consultant who specialises in recovering material on lost formats. It's a fascinating profession and one which is none too plentiful in Britain. Although they work for a living (and their fees are not excessive considering the specialised equipment they use), they also tend to be enthusiasts at heart. In fact most are passionately interested in the technologies they deal with – which is fortunate, since the advanced techniques used and the specialised hardware needed are virtually impossible to find elsewhere.

Horses for Courses

The techniques and hardware used to recover audio recordings are very different from those used with video, and most of the consultants tend to specialise in one field or the other. With the growing number of re-releases of archive material, they are kept pretty busy and even the public are much more conservation-minded nowadays, with old recordings being saved rather than consigned to a skip.

The techniques are neither simple nor cheap: 'means-to-an-end' items like the CEDAR machines (for removing crackles and hiss from old recordings) are essential equipment, but they don't come cheap. They work very well though and can achieve remarkable results for processing and 'cleaning up' old recordings which are still playable.

But what about the really troublesome recordings, the fragile or damaged discs and acutely dry and brittle tapes? And what about the tapes recorded on obsolete formats for which playback equipment is no longer made? This second problem is particularly acute in the video business, where line standards and recording formats have changed significantly, and is compounded by chemical changes in the tape itself which may render it unusable.

Sound Fellow

In the audio world there are a number of people who specialise in rescuing unplayable recordings and achieving the impossible. One such specialist is Philip Farlow, who has been operating independently for a number of years under the name 'Audio Services'.

"We specialise in the study and practice of achieving the best results in the transfer of material from mainly redundant formats, such as open reel tape of all sizes, speeds and track formats, also acetate discs up to 17¼in. in diameter at any speed and groove format. We use a studio of specialised tape and disc replay equipment to deal with the many and varied problems encountered in our attempts to retrieve all that remains on the tape or in the groove", he explained.

Once recovered, the audio can be transferred to the format of the customer's choice, whether compact cassette, or the new recordable compact disc (CD-R). If the recordings are particularly valuable then it may be worth

Although the original tapes have survived, many audio and video recordings made in the 1970s are no longer playable because of defects in the manufacturing process. Today tape manufacturers take no chances: here a high-powered microscope is used to examine tape surfaces at the 3M video tape plant in South Wales.

considering using one of the digital audio restoration processes currently available through the DAT format.

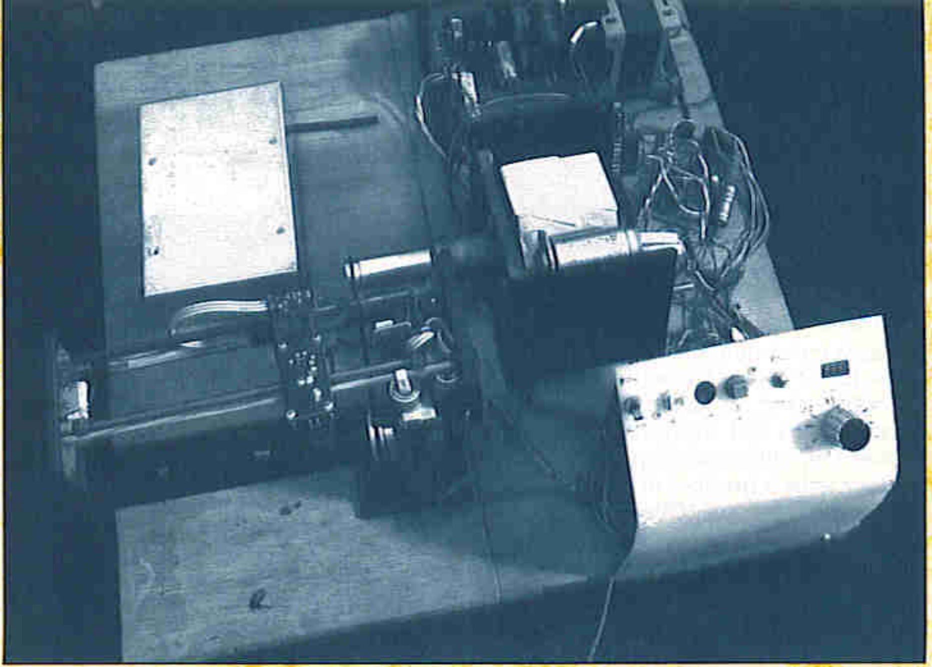
The expense of the equipment, and the specialist skills required, mean that there are only half a dozen or so people in the country able to carry out this work. Customers tend to be institutions such as the National Sound Archive, the Imperial War Museum and the BBC Sound Library, although some of the strangest commissions come from other professions and private individuals. All manner of odd jobs crop up, such as removing unwanted background noises from a muffled dictation machine tape, and compensating for variable tape speed caused by failing batteries!

Tedious Technicalities

Each recording format requires individual handling. Early reel-to-reel tapes tend to become brittle, and even with careful storage will probably be going out of shape beyond their ¼in. tolerance. To add to the difficulties of playing them will be past breakages that may have been joined (spliced) with sticky tape which has, over years of storage, oozed out on to adjacent layers. Sometimes too, due to curling, the tape will refuse to grip the head of the playback machine.

Other complications include determining the original recording head's alignment (azimuth), original recording speed (if identifiable), replay characteristics corresponding with the original machine (where known) and final overall sound conditions.

Records can pose problems too. Warping and off-centre holes are minor annoyances compared with discs that are covered in dust and dirt, even mould. Whilst shellac and vinyl discs can be washed clean, there are also some directly cut discs whose recording surface consists of a gelatine compound, which is prone to dissolve before your very eyes upon any attempt at washing the disc!

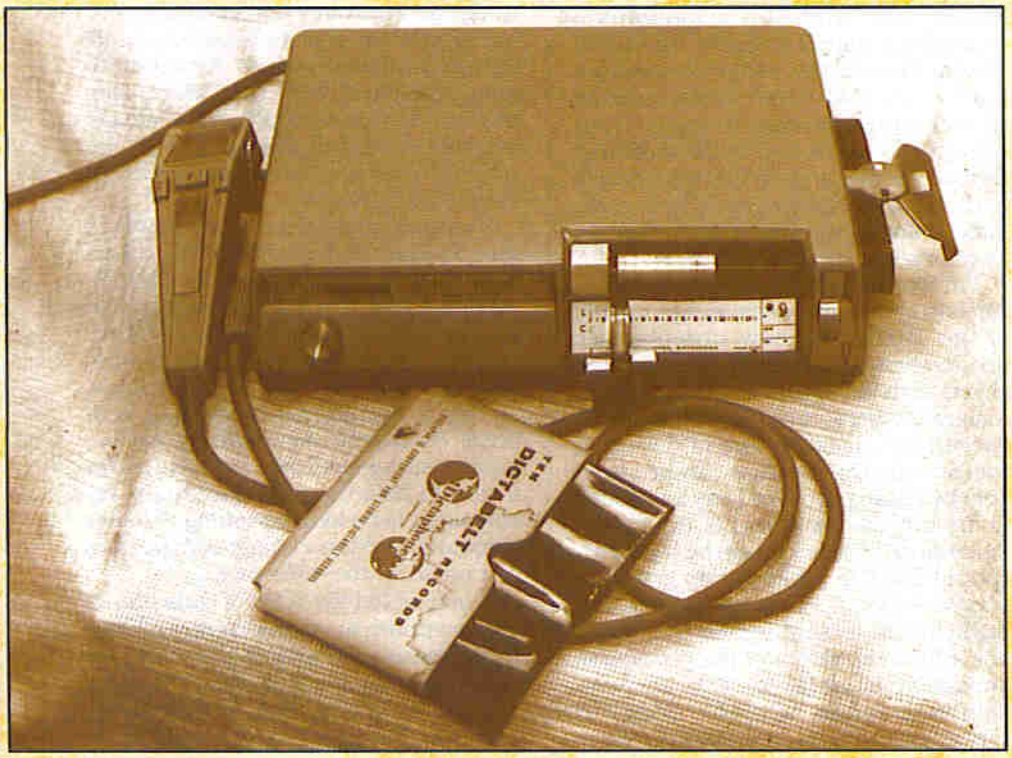


Above: The Sound Archive's 'Electronic Phonograph', custom-built specifically to recover obsolete cylinder recordings for transfer to a modern medium. At time of writing, this machine was being rebuilt to incorporate further improvements.

Directly cut discs present problems of their own. Their use was a popular means of preserving sound between 1934 to at least the early 1960s, when tape recording took over. Generally known as 'acetates', they were only ever intended to be played a certain number of times before wear set in, which then accelerated rapidly. Acetate is a misnomer really; the records were made on metal or glass blanks, and the surface is normally cellulose nitrate or a gelatine compound. They are easily recognised as they are often recorded on one side only, and have typewritten rather than printed labels. Most acetate or gelatine-coated discs will now be showing signs of decay as the compounds used in manufacture part company with the metal or glass base. Some will have become warped through bad storage, or else mouldy even with careful storage, and probably worn through being played many times under far from ideal conditions. Dealing with them needs a special kind of know-how, as well as variable speed turntables and a variety of pick-up styli and tracking conditions. With the right techniques, quite acceptable results can be achieved from even the most apparently ravaged recordings.

Laser Discs?

What do you do once the record surface is too delicate to use a stylus pick-up? Alan Ward, of the National Sound Library, explains that even when the lacquer has shrunk and cracked, the information in the grooves can be read using laser optics similar to those now commonplace in CD players. Working machines have been made, but unfortunately the laser, however well focused, has been unable to distinguish between wanted and unwanted information in the grooves, and so playback has been overwhelmed by a loud roar. A new, and hopefully more successful, solution was demonstrated at the Audio Engineering Society's convention last year. Scientists at the Swiss Institute of Technology at Lugano have built a playback mechanism based on a 124 micron thick, fibre-optic cable. This tracks around in the upper part of the groove, but is only a fraction of the weight of a normal stylus. The cable can be adjusted to pick-up wanted information only, and light emitted from the end of it is then processed using conventional CD circuitry.



Left: A Dictabelt 'Time Master' of 1960. In the foreground is a packet of plastic 'belt' records. Each is a simple flattened loop shape and is recorded by indentation rather than incision, hence no swarf. A belt can be seen half installed onto the rollers of the machine on the right.

It also makes a good job of replaying broken 78s that have been stuck together with sticky tape!

Archaic Archive Recordings

The recording formats mentioned so far are examples of fairly recent technologies, but what about wax cylinders, belt-driven dictation machines and wire recorders? Peter Copeland, of the National Sound Archive, takes these in his stride. "In fact we have the means to play four different cylinder formats together with a number of wire recording formats", he said. Obscure types of tape do not faze him either, and he can process most kinds of dictation machine cassettes, NAB cartridges and the Sony Elcaset. If necessary, tapes in cartridges and cassettes can be removed from these and replayed on an open-reel machine, he says.

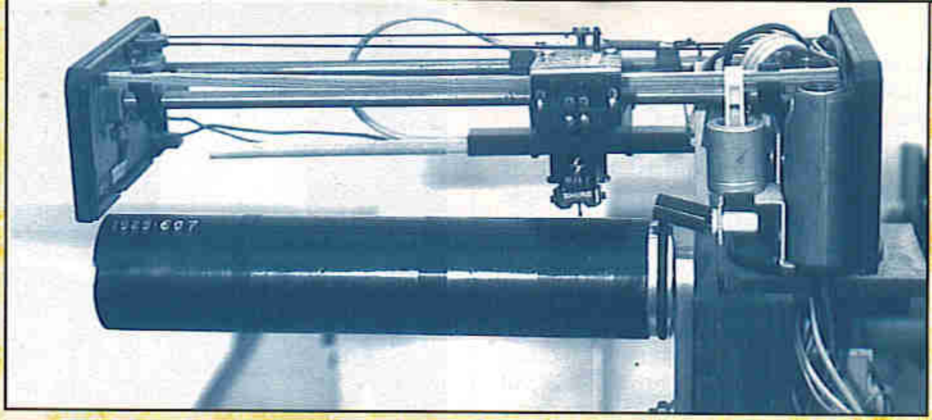
Although their transcription service is primarily for the Archive's own use, they do take on some outside jobs, both for commercial and private customers, with charges that reflect the customer's budget. Peter stressed that they are a sound archive, not a museum for audio equipment, however interesting, and their guiding remit is the storage and replay of sound recordings. If necessary, they can borrow equipment: they have access to a wartime German tape recorder, if required. There are also a few formats they have no means of handling, steel tape recordings for instance.

Video Matters

Television has been recorded in one form or another since the late 1920s (Baird produced the first videodiscs on 78rpm records) and this means that the potential problems are just as great when it comes to rescuing old material. People have joked that the best television recordings are made on cinematic film (16mm or 35mm). Film has proved to be a durable and constant format, independent of international TV line and field standards. And even when the base material shrinks or distorts, which is uncommon, broadcast film-to-video transfer equipment (telecine machines) can compensate for this.

Video formats, of both recording and transmission standards, have changed many times since the archiving of programmes and home recording started. An obvious bugbear is one where the recordings were made to an obsolete TV standard (generally 405 lines) or on an obsolete machine. The domestic video market has seen many formats come and go, and even in the industrial and broadcast sectors many formats are no longer with us. Tape widths range from ¼in., ½in. and ⅔in. to 1in. and 2in.

Converting from 405 to 625 lines can be done optically or electronically, but the key task is to recover the pictures and sound. There are no universal playback devices here, and the only solution is to find a machine of the original format. These can suffer from stretched drive belts and worn heads, and maintaining them can be problematic. Spares are obviously no longer made, and so the number of these machines dwindles as parts wear out and cannot be replaced.



Above: A close-up view of the 'Electronic Phonograph'. It uses a parallel tracking pick-up arm from a Revox transcription deck. The cylinder on the machine is a very early (c. 1888) Bell-Tainter type, longer and thinner than the more familiar Edison type. This one belongs to the Science Museum and carries obscure recordings, thought possibly to include the voice of Queen Victoria.

Nonetheless, a few hardy souls keep these dinosaurs going (most old videotape machines are pretty large). Some services are run as purely commercial enterprises but the job tends to be a labour of love, meaning that it appeals more to dedicated enthusiasts who carry across their professional skills to their spare time. With luck and good judgment, virtually any videotape format can be converted to any other. There are no set charges for these video rescuing operations: charges are determined by negotiation, generally on a no luck, no fee basis.

Tape Tribulations

Unlike cine film and gramophone records, the state of magnetic tape is not always obvious by visual inspection. Early video and audio tapes suffered from manufacturing defects, both noticed and unnoticed. Oxide shedding, leading to clogging of the tape heads with 'white powder', was generally noticed during use, but other problems took longer to be discovered.

Far worse is the 'sticky binder' problem and sadly, many recordings, mainly of the 1970s, are now unreplayable due to chemical changes. The 'disease' affects several brands of tape and, being a manufacturing defect, has nothing to do with the age of the tape or the way it was stored. The problem can be cured only by baking the tape (very carefully!) to dry out the stickiness of the binder material or by lubricating the tape with special fluid to make it slip past the playback head. Both techniques are highly intricate and expensive to carry out, whilst the extent of the problem is impossible to gauge (it often comes to light only when someone needs to replay an archive recording). Many recording companies and broadcasting organisations are extremely worried, particularly since, by the time the problem becomes apparent, it may be too late. Nobody, but nobody, can guarantee the long-term life of tape!

Keep it Clean!

With the sophistication of today's technology, are the recordings we are making ever likely to need recovery? Only time will tell, but it makes sense to protect your investment in tapes, discs and equipment. Avoid excessive humidity and extremes of temperature. Dust is an enemy, so keep recordings in their sleeves or cases. For different reasons, both vinyl discs and compact cassettes should always be stored vertically. If you follow these simple rules, you reduce the risk facing your precious recordings.

The sound on compact discs, using a digital recording and laser replay system, will not degrade with repeated replaying in the same way as a vinyl record does. On the other hand, problems have already appeared where CDs develop a brown colour due to internal oxidisation. It is caused by air trapped between the layers of the disc at the time of manufacture, or the air penetrates later through misuse. Either way it will render the disc unplayable eventually, and the more enlightened record companies will replace these 'diseased' CDs at their own expense. A more common problem is with CDs which skip tracks, and this is usually due to almost invisible specks of dust or dirt on the playing surface. Investing in a CD cleaner, is advisable.

Compact cassettes are vulnerable to tape stretch and creasing, but otherwise they do not generally deteriorate. You may find that you are losing high frequencies, or the sound has become muffled. The most common causes are dirty heads in your playback machine, so buy a cleaning kit or cleaning cassette! Or maybe the small phosphor-bronze spring and felt pad assembly, meant to hold the tape close to the replay head, is no longer working. A minor adjustment with non-magnetic tweezers can make all the difference.

If you would like a list of consultants who specialise in recovering rare recordings, please send a large (A4) stamped addressed envelope to Lost Formats, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex, SS6 8LR.

What's On?

Photographic Treasures at the Science Museum

Treasures of the National Museum of Photography, Film & Television (NMPFT) is a new exhibition which opened in February in the Picture Gallery of the Science Museum, London. The exhibition consists of thirty-nine photographs from the NMPFT and provides an unusual insight into the vast range of material collected by the National Museum of Science & Industry, the umbrella organisation incorporating the Science Museum, the National Museum of Photography, Film and Television in Bradford and the National Railway Museum in York.

The exhibition represents the personal choice of Colin Ford, who was the Head of the NMPFT until last autumn. It was assembled as part of the NMPFT's tenth birthday celebrations and is wide-ranging in terms of both its context and timespan; the earliest image dates from 1845 and the most recent was taken in 1989. Styles range from portrait studies through to social journalism. A photo-joiner of images of the NMPFT building, created by David Hockney, forms the centre-piece for this exhibition that also includes work from photographers such as Bill Brandt and Lewis Carroll.

Treasures of the National Museum of Photography, Film & Television runs until 2 May 1994. Contact: Science Museum (071) 938 8000.

DIARY DATES

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments contact event organisations to confirm details.

5 April. Equipment/Junk Sale – Bring your own items on the night, Sudbury and District Radio Amateurs, Wells Hall Old School, Great Cornard. Tel: (0787) 313212.

5 April. My Life in Space by Russian Cosmonaut Georgii Grechko, 6.15pm, The London Planetarium. Tickets £5.50 in advance. Tel: (071) 486 1121.

5 to 7 April. Storage & Recycling Systems '94, Institution of Electrical Engineers, University of Keele, Keele. Tel: (071) 240 1871.

11 to 13 April. Cable and Satellite '94, Olympia Grand Hall, London. Tel: (081) 948 9900.

11 to 14 April. Institute of Physics Congress, Brighton Metropole, Brighton. Tel: (071) 235 6111 ext 221.

12 to 24 April. Computation in Electromagnetics Conference, Institution of Electrical Engineers, University of Nottingham, Nottingham. Tel: (071) 240 1871.

16 April. Electronic and Construction Workshops, Crystal Palace & District Radio Club, All Saints Parish Church Rooms, Beulah Hill. Tel: (081) 699 5732.

16 April. Spring All Micro Show, Bingley Hall, Staffordshire County Showground, Stafford. Tel: (0473) 272002.

19 to 21 April. Communications Solutions Exhibition, National Exhibition Centre, Birmingham. Tel: (081) 948 9900.

19 to 21 April. Business Telecoms 1994, Olympia 2, London. Tel: (081) 742 2828.

19 to 21 April. Fifth Electrical Safety in Hazardous Areas Conference, Institution of Electrical Engineers, London. Tel: (071) 240 1871.

20 April. Trip to Smith Clayton Forge, Lincoln Short Wave Radio Club, Lincoln. Tel: (0427) 788256.

21 April. Lecture by Norman White of Nimbus Records on the making of the Nimbus 'Prima Voce' series of Opera CDs based on old 78rpm records. 6.45pm, National Sound Archive, 29 Museum Road, London. Free tickets by arrangement. Tel: (071) 323 7760.

22 to 24 April. MIDI & Electronic Music Show, Wembley, London. Tel: (0222) 512128.

23 April. International Marconi Day Exhibition, Wireless Museum, Puckpool Park, Seaview, Near Ryde, Isle of Wight. Tel: (0983) 567665.

26 to 28 April. Seventh Road Traffic Monitoring & Control Conference, Institution of Electrical Engineers, London. Tel: (071) 240 1871.

3 May. Magnetic Loop Aerials – Operating Evening and Talk, Sudbury and District Radio Amateurs. Tel: (0787) 313212.

5 to 6 May. International Conference on Adaptive Search and Optimisation in Engineering Design, Institution of Electrical Engineers, London. Tel: (071) 344 5446.

10 to 12 May. Expo-Lab 1994, Laboratory Technologies Exhibition, National Exhibition Centre. Tel: (081) 302 8585.

10 to 12 May. Control and Instrumentation Exhibition, National Exhibition Centre, Birmingham. Tel: (081) 302 8585.

11 May. Annual General Meeting, Lincoln Short Wave Radio Club, Lincoln. Tel: (0427) 788356.

15 May. Radio Society of Great Britain, National Exhibition Centre, Birmingham. Tel: (0707) 59015.

15 May. National Vintage Communications Fair, National Exhibition Centre, Birmingham. Tel: (0398) 331532.

15 May. Special Event Station, Sudbury and District Radio Amateurs. Tel: (0787) 313212.

19 May. Lecture on EMI's digital reissues on CD by Andrew Walter of Abbey Road Studios. 6.45pm, National Sound Archive, 29 Museum Road, London. Free tickets by arrangement. Tel: (071) 323 7760.

21 May. Fibre Optics by A. Ogden, Crystal Palace & District Radio Club, All Saints Parish Church Rooms, Beulah Hill. Tel: (081) 699 5732.

21 to 22 May. International Kite Festival with Kite Aerials, Wireless Museum, Puckpool Park, Seaview, Near Ryde, Isle of Wight. Tel: (0983) 567665.

25 May. Trip to Guildhall, Lincoln Short Wave Radio Club, Lincoln. Tel: (0427) 788356.

Institute of Physics Congress, Brighton Metropole

Leading edge science and the latest policy issues to be featured at the Institute of Physics Congress. Almost two hundred speakers from Britain and overseas will address participants at the second Institute of Physics Congress to be held at the Brighton Metropole in Brighton from 11 to 14 April. This year the Congress will feature an even wider range of topics from the latest developments in plasma and nuclear physics to the role of women in the scientific community.

The latest developments in pollution monitoring, image processing, semiconductors and micromechanics will be discussed alongside such issues as whether physics can be taught without mathematics, the ways to improve the present position of women in science, and the place of shared facilities in scientific research.

Plenary speakers for the Institute of Physics Congress have been drawn from industry, academia and the public sector, and include Dr. Peter Williams, newly-appointed chairman of the Particle Physics and Astronomy Research Council (PPARC), Professor Pat Lee from the Massachusetts Institute of Technology, Professor Michael Berry from the University of Bristol, Dr. Paul Williams, director of the Rutherford Appleton Laboratory, and the vice-chancellor of the University of Loughborough, Professor David Wallace. The President of the Institute of Physics, Mr Clive Foxell, will also be speaking.

In addition, the Physics World '94 Exhibition will be running alongside the meeting and conference programme providing a major opportunity to see the latest products, equipment and services on offer from high-tech physics-based industries and other companies.

The Institute of Physics Congress will open at 9am Monday 11 April and run until 4.30pm Thursday 14 April. The Physics World '94 Exhibition will open at 10am on Tuesday 12 April and run until 5pm Thursday 14 April.

For further information about the Institute of Physics Congress and Physics World '94. Contact: Lucy Bell (Congress Programme), Tel: (071) 235 6111 ext 243. Contact: Graham Balfour (Exhibition), Tel: (071) 235 6111 ext. 221.

Electronic Music

Now in its fifth year, The MIDI, Electronic Music and Recording Show comes to the Wembley Exhibition Centre during the three days 22 to 24 April.

Hailed as the industry showcase for new products and services relating to writing, performing and recording music, the Show provides a platform for the introduction into the UK of many of the products launched at NAMM in Germany.

Apart from exhibitors demonstrating their latest gear, a series of high profile seminars will run alongside the exhibition. These are free of charge to all visitors and cover topics such as copyright, sampling, state of the art equipment, audio media, multimedia and 'Question Time' type panels where industry experts line up to face questions on topics such as hardware and software.

Throughout the three day event, a series of lectures entitled 'World of MIDI' will explore and feature live demonstrations from different areas of MIDI, including drumming, keyboards and guitar synthesisers.

Admission on the door is £8 per day, but visitors booking tickets in advance on the ticket hotline pay only £5 per day or £10 for the Friday, Saturday and Sunday.

Further details and ticket hotline Tel: (0628) 664382.

My Life in Space

Twice awarded Hero of the Soviet Union, Russian Cosmonaut Georgii Grechko (ranked 34th) went into space three times – in 1975, 1978 and 1985. His personal experiments in space helped him to become a Doctor of Science.

My Life in Space by Russian Cosmonaut Georgii Grechko, The London Planetarium, 5 April at 6.15pm. Tickets £5.50 in advance. Tel: (071) 486 1121.

Please send details of events for inclusion in 'Diary Dates' to: The News Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

Part 7

by Graham Dixey
C.Eng., M.I.E.E.

POWER ELECTRONICS IN THEORY & PRACTICE

In Part 6 of this series, we looked at a number of circuits that made use of the SCR. Since this particular device has so many applications, it was impossible to cover them all. Therefore, this is a continuation of the previous article, allowing the reader to explore some more circuits; either to experiment with or just learn something about.

SCR RING COUNTERS

Normally ring counters are not associated with SCRs. The thought of ring counters brings to mind a chain of D flip-flops with the Q output of the last one coupled back to the D input of the first. Such a circuit is able to circulate data continuously in response to a series of clock pulses at the clock inputs of the flip-flops. We can use the word *data* in a very general sense here, since the logical ones and zeros circulated in such a circuit may actually be used as switching inputs to external circuits, as in the case of multiplexed 7-segment displays. In the case of SCR ring counters, we can also generalise by making each of the selected outputs energise some power device, which might be a lamp, solenoid, relay coil, etc. Since by definition the stages of a ring counter have to be coupled together, this dictates some form of coupling method. In fact there are two; these are known as *cathode coupling* and *anode coupling*.

THE CATHODE-COUPLED SCR RING COUNTER

Figure 1 shows a three-stage cathode-coupled ring counter, which is capable of driving high voltage (150V), low current (50mA) loads. The circuit can be extended to any number of stages, the principle being the same, of course. It can also be modified to work at a lower supply voltage. In fact, it is possible to construct ring counters to work over quite a wide range of supply voltages. It will be more difficult to employ it for switching *higher* load currents because of the difficulties inherent in commutating, that is turning off, SCRs that are conducting such high currents. The commutating capacitors may then have inconveniently high values.

As only one SCR can ever conduct at any instant; the logical starting point is to make the assumption that a particular SCR is conducting at that instant. Let us nominate SCR1 for this honour; SCR2 and SCR3 will, therefore, be off or *blocking* at this time. Capacitors C3 and C1 charge up to the supply voltage through R5 & RL2 and R1 & RL3, respectively; at the same time, capacitors C5 and C6 charge up to the supply voltage through RL2 and RL3, respectively. Because SCR1 is conducting, C2 and C4 cannot charge (the anode potential of SCR1 being very close to 0V).

When a shift pulse arrives on the shift line, only SCR2 is capable of being triggered, because its *gate steering diode* D2 is the only one that is not reverse-biased by a pre-charged capacitor. If you were to consider SCR3, for example, you would find that the cathode of its gate steering diode D3 is virtually at the positive supply potential (because of the potential across C5), while its anode can only rise by the amplitude of the shift pulse itself, probably only a few volts. It thus remains reverse-biased even in the presence of a shift pulse. In general, it will be found that only the SCR immediately following the conducting SCR will be able to trigger when a shift pulse is received, all others having their steering diode inputs inhibited in the manner just described. As SCR2 turns on, capacitor C5 is effectively connected

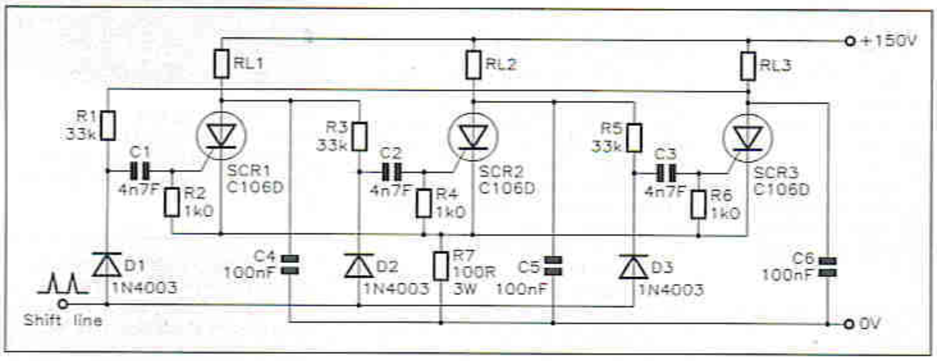


Figure 1. A circuit for a cathode-coupled SCR ring counter.

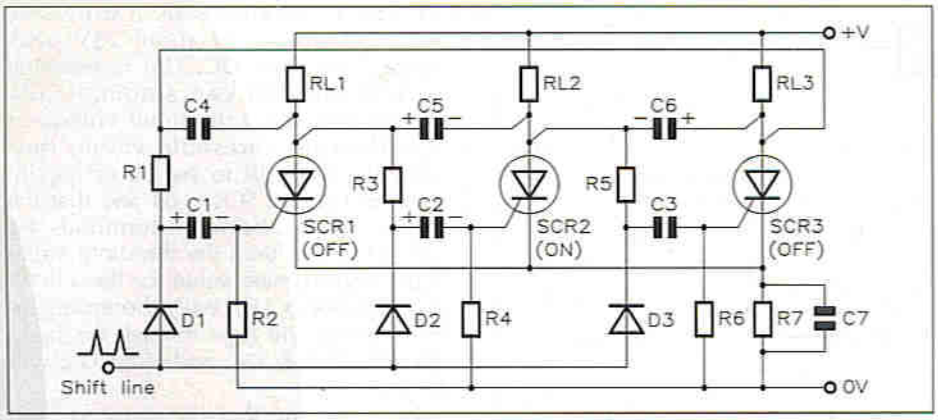


Figure 2. A circuit for an anode-coupled SCR ring counter.

across the common cathode resistor R7; this momentarily drives the common cathode voltage up to the supply potential (momentarily because C5 will quickly discharge through R7), reverse-biasing SCR1 and causing it to turn off. Remember that, when SCR1 was conducting, its anode voltage was very low and the voltage across C4 was similarly low. Consequently, the upper plate of C4 (connected to SCR1 anode) has a low potential so that, when SCR1's cathode rises briefly to supply potential, a large reverse voltage appears across SCR1, forcing its anode current to zero.

THE ANODE-COUPLED SCR RING COUNTER

For contrast, Figure 2 shows the anode-coupled version of the SCR ring counter. The differences include: returning the gate resistors R2, R4 & R6 to the 0V line rather than the common cathode line; removal of the three commutating capacitors C4, C5 & C6 (from Figure 1); coupling each pair of SCR anodes together with capacitors, these now being designated as C4, C5 & C6 in the diagram of Figure 2. This is a trickier circuit to get working than the previous one, primarily because the anode coupling makes the possibility of accidental triggering much more likely. However, a general circuit, without values, is included for comparison of methods. This type of circuit was used originally (with a ring of 10 SCRs) for driving decade read-out Nixie indicator tubes. In order to understand the circuit operation, again make the assumption that one SCR is on and the other two are off. We shall make the assumption this time that it is SCR2 that is on and the other two that are off.

Capacitors C5 and C6 are charged in the polarity shown to the supply voltage +V. The charging paths are through the load resistors, RL1 and RL3, respectively, and the common path to 0V through the anode-cathode path of SCR2 and the common-cathode resistor R7. Also, capacitors C1 and C2 charge, with the polarity shown, to the supply voltage +V through their series resistors (R1 & R2 and R3 & R4 respectively) and the appropriate load resistor (RL3 and RL1 respectively). As a result, the steering diodes, D1 and D2, are reverse-biased, since each has a large positive voltage on its cathode. A shift pulse input will, therefore, be steered to the gate of SCR3, turning it on. When this happens, SCR3's anode voltage will fall to a very low value. The capacitor C6, which is charged with the polarity shown, remember, is thus placed in parallel with the conducting SCR2 and commutates it into the off state. Now SCR1 and SCR2 are off and SCR3 is the conducting device. Until the arrival of the next shift pulse, of course, when conduction will move from SCR3 back to the beginning of the ring, when SCR1 is then turned on again.

A BRIDGE TYPE TEMPERATURE CONTROLLER

The circuit for this fairly simple controller is shown in Figure 3. It is based on a mercury-in-glass thermostat, which is an extremely sensitive measuring instrument, capable of responding to temperature changes as small as 0·1°C. However, to preserve the life of this device, it is essential that its contact current is limited to a very low value, less than 1mA.

The circuit is arranged as a full-wave rectifier bridge, the supply for which is taken directly from the 240V AC mains. The SCR is connected across the opposite arms of the bridge and thus receives a full-wave rectified anode voltage with a peak value of 340V. This voltage also appears across an RC phase-shift network, from the junction of which the gate voltage is tapped off.

When the thermostat contacts are open, the SCR triggers on every half-cycle, at a point in the half-cycles determined by the phase shift components C1 and R1. Power is thus delivered to the load. When the thermostat contacts close, the gate-cathode path of the SCR is shorted out and the SCR cannot trigger. No power is thus delivered to the load. Maximum contact current through the thermostat is restricted to 250µA rms. The control is essentially of the on/off or *bang bang* type, though the sensitivity of the thermostat ensures that variations in controlled temperature are minimised.

In the original design, the heater load was specified as 100W. However, I have substituted an SCR and rectifier diodes of a higher rating, so that the controlled power can be increased, if desired. The application is, essentially, for relatively low power, industrial uses rather than simple domestic control of heating appliances.

TOUCH SWITCH OR PROXIMITY DETECTOR

Figure 4 shows a simple circuit by means of which a load can be switched on by a human body merely coming into close proximity to the 'sensing electrode'. The sensitivity of the circuit is set, by adjustment of the 1MΩ preset potentiometer RV1. The amount of capacitance to ground from the sensing electrode will depend upon the proximity of an external body to that electrode. The circuit works as follows.

A 2N6027 (BRY39) PUT will switch into the on state when the anode voltage exceeds the anode gate voltage by the 'trigger voltage', typically about 0·5V. Both of these electrodes are returned through resistors (R1 and R3 respectively) to the same side of the alternating mains supply. Because both paths are resistive, the anode and anode gate potentials are in phase. As far as their magnitudes are concerned, the anode potential is clamped to a maximum value, dictated by the breakdown voltage of the ST2 diac, while the anode gate voltage is able to follow the full variation of the mains supply voltage. This makes it impossible for the anode voltage, under normal conditions, ever to exceed the anode gate voltage. The PUT is thus in the off state; naturally, the SCR is also off.

Now if we assume that a body is brought into close proximity to the sensing electrode, this creates a significant increase in the capacity between this electrode and ground. The path from supply through R3 and R4 to ground is no longer purely resistive, but comprises an RC circuit, which will shift the phase of the anode gate voltage relative to the instantaneous voltage on the anode. This phase shift between the instantaneous voltages on these two electrodes makes it possible for a difference of potential to exist between anode and anode gate, such that the trigger voltage of 0·5V can be realised. Once the PUT triggers into the on state, a potential is developed across

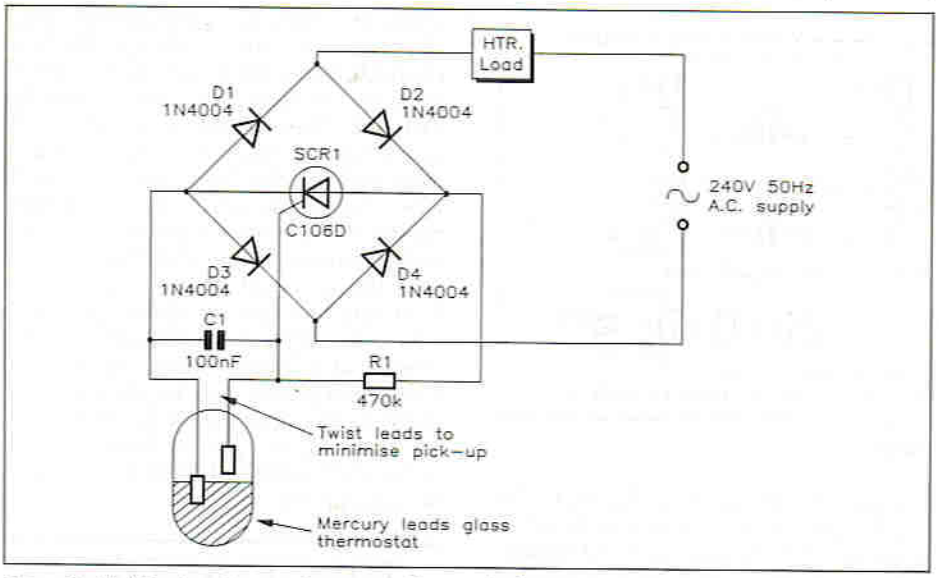


Figure 3. A bridge-type temperature controller employing an SCR.

R2 which triggers the SCR into conduction, thus energising the load.

Because the supply to the circuit is alternating, the SCR does not latch but is self-commutating. At the end of every positive half-cycle, the SCR will 'drop out'. However, as long as the capacitance to ground, caused by the external influence, remains, the SCR will automatically retrigger on the following positive half-cycle. In effect, the circuit remains on as long as the proximity of the external body is close enough. The nature of the load itself, here undefined, will have to take this behaviour into account.

For safety reasons it is important to note that the sensing electrode must not be touched directly; it must be enclosed in reinforced insulating material.

A VOLTAGE DETECTOR CIRCUIT

The circuit of Figure 5 can be used either to detect the presence of a voltage (providing that it exceeds some specified minimum value) or to respond to a threshold voltage (which will be the same as the minimum value just mentioned). The circuit response to an input voltage in excess of the threshold voltage is for lamp LP1 to light and for lamp LP2 to go out. The two uses described above are not necessarily the same thing! In case it might be thought that they are, let us take some arbitrary figures as an illustration.

Assume that the circuit responds to input voltages more than a minimum value of 3V. In the first case defined above; the circuit will clearly respond to an input voltage of, say, 5V. It has detected the presence of a 5V voltage (although we don't necessarily know that its magnitude is 5V). In the second case, assume that the input voltage increases gradually from some low value (even 0V perhaps) upwards, until eventually it reaches the threshold value of 3V; the circuit will then respond in the manner described. Alternatively, the circuit will respond if the input voltage falls below the threshold value; LP1 will go out and LP2 will light. The circuit has detected the very *instant* at which the input voltage has passed through the threshold value. Perhaps this makes the distinction between the two modes clear.

The circuit is energised between the #1 and #2 terminals by a full-wave rectified voltage of about 25V peak value – not pure DC. This is essential so that the SCR can automatically commutate when the input voltage is less than the threshold value, thus allowing the SCR to switch off again. Assume that the SCR is off and that the input voltage, between terminals #3 and #4 is less than the threshold value – the approximate value for this circuit is 2·8V; lamp LP1 will, therefore, be off. Current will flow through the path: R4, LP2, D3 & D4, and lamp LP2 will be lit.

Now assume that the input voltage between terminals #3 and #4 exceeds the threshold voltage; the SCR will switch on and lamp LP1 will be lit. Under these conditions, the voltage across LP2 will be limited to the sum of the forward volt drops of SCR1 and D2, about 2·6V or less. If the lamps used are rated at 6V 0·25A (1·5W) or thereabouts, then the lamp LP2 will have insufficient voltage to produce any significant light output.

The threshold voltage is determined by the sum of the forward volt drops of the diodes D1, D3 & D4 (as well as the volt drop across resistors R1 and R3). The threshold voltage can, therefore, be increased by adding further diodes in this path or by replacing D3 and D4 with a Zener diode of the required breakdown voltage.

Possible applications for this circuit include detecting the voltage across a switching device such as another SCR (hence determining its state of conduction or otherwise) or indicating the output state of an operational amplifier.

AN EMERGENCY LIGHTING SYSTEM

Emergency lighting systems provide a valuable source of illumination in the event of a mains failure, especially under hazardous conditions, such as a fire in a building. The principle is that a secondary source of power – a rechargeable battery – together with its own low power lamp, is automatically switched into

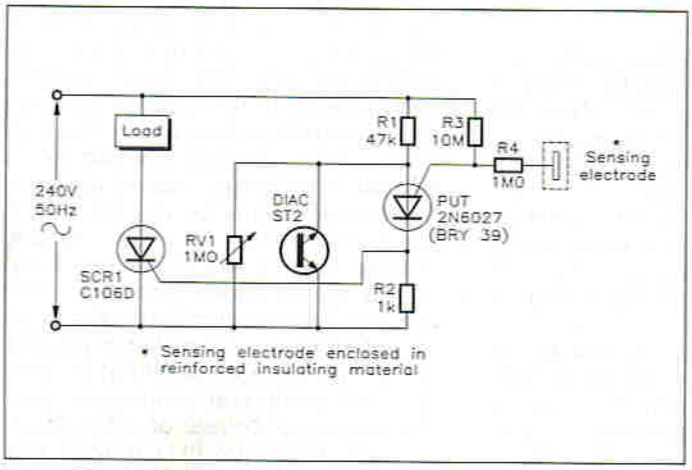


Figure 4. Proximity detector circuit.

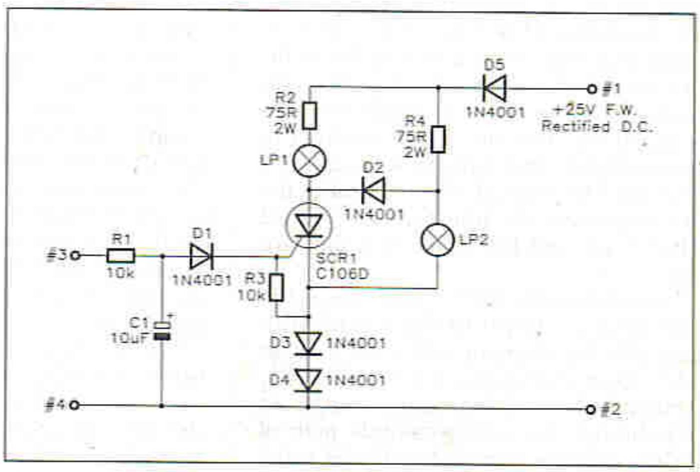


Figure 5. A voltage detector or voltage threshold circuit.

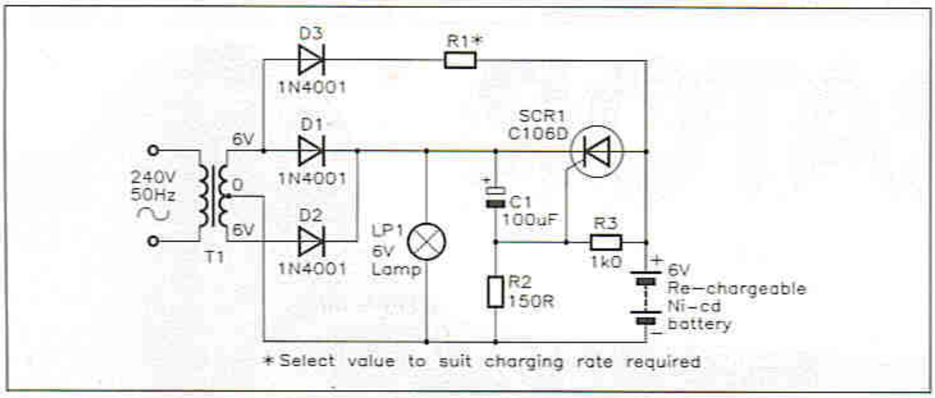


Figure 6. A single power source emergency lighting circuit.

circuit in the event of mains power being lost. Thus, the circuit used for this purpose must constantly monitor the mains supply and act accordingly when it fails. Figure 6 shows a circuit – using an SCR – that is able to do this. However, this circuit has been simplified to the extent that there is only one lamp, a low power type that is on all the time. It is either energised from the mains or, in the event of a mains failure, is switched over to the alternative battery supply. This switching is carried out by an SCR.

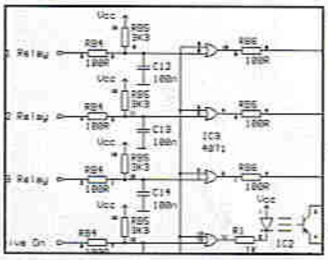
The circuit of Figure 6 works as follows. Transformer T1 together with diodes D1 and D2 form a full-wave rectifier which supplies a pulsating DC supply to the lamp LP1 and the series RC path C1 and R2. Capacitor C1 charges in the polarity shown. Both the anode and gate of SCR1 are taken to the same potential, that of the positive terminal of the battery.

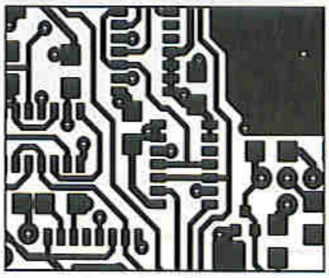
The cathode of the SCR is taken to a higher potential, that of the positive terminal of capacitor C1. As a result, the gate-cathode path of the SCR is reverse-biased and the SCR is, therefore, non-conducting. In the event of an interruption of the mains supply, the cathode voltage will fall below that of the battery. The gate of the SCR will receive a bias current through resistor R3 and the SCR will switch on, supplying power to the lamp.

The battery is kept fully charged under normal conditions by the trickle charge path via diode D3 and resistor R1. The value of the latter must be chosen to suit the charging requirements of the Ni-Cd battery being used. When the AC mains supply is restored, the SCR switches off automatically (being commutated by the fact that its anode supply is pulsating rather than steady DC) and the battery is put into the charging mode, with AC power again energising the lamp.

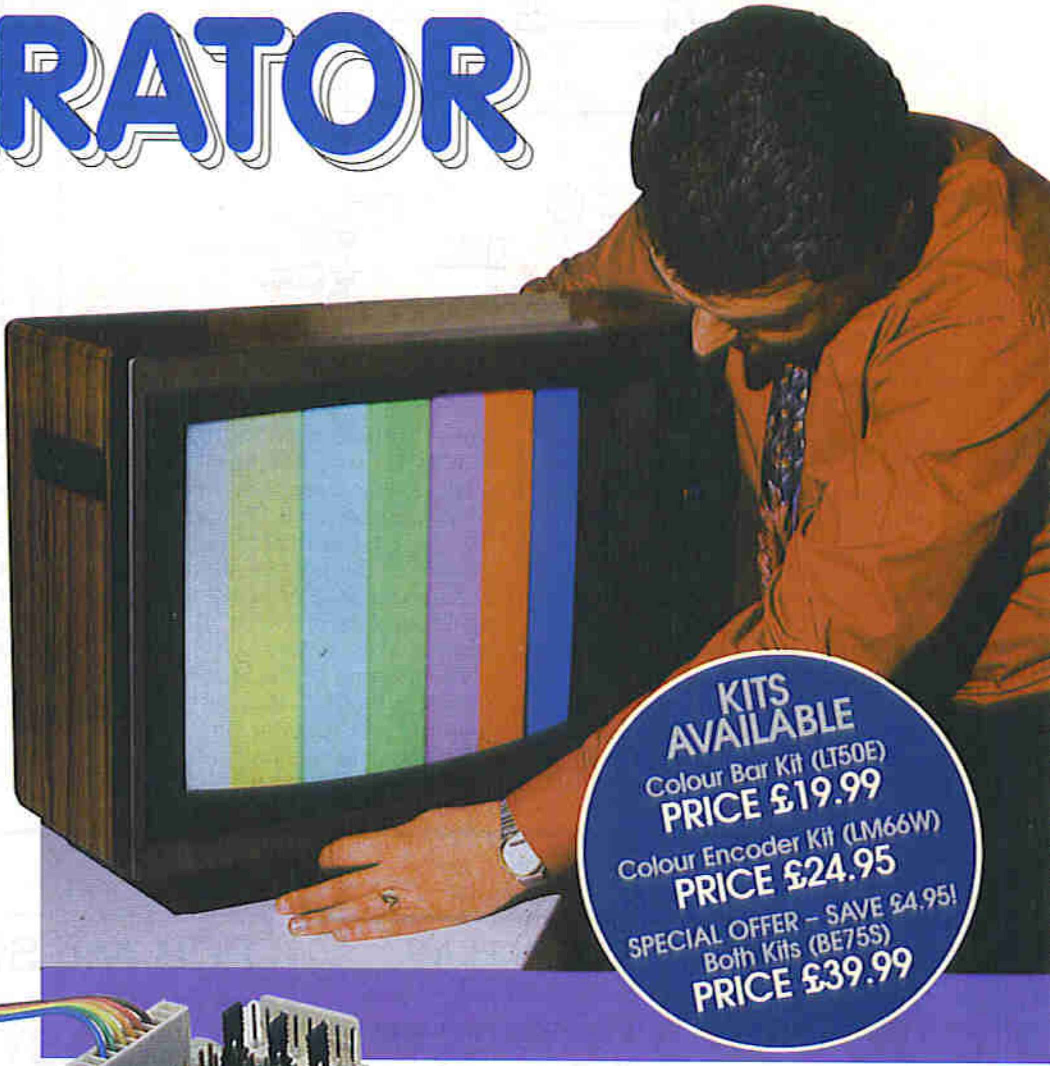
Obviously such a circuit can have wider applications, to any situation where an uninterrupted supply to a piece of equipment is essential, whether mains power is on or off. The 6V rechargeable Ni-Cd battery specified in this instance can be replaced by any other rechargeable source, according to the nature of the load.

Next month we shall look at some uses for another member of the thyristor family, the triac.





TV COLOUR BAR GENERATOR



Design by Ian Berry and Chris Barlow
Text by Ian Berry and Robert Ball

If you are involved in sending television pictures up and down cables, or to and from VTRs and monitors, it is really necessary to be able to check if the pictures at the far end are being displayed correctly. Whilst the black and white test stripe that some VTRs give out in their 'test mode' is useful, it is not normally possible to properly adjust a TV or monitor to *exactly* the right settings to display correct colour pictures.

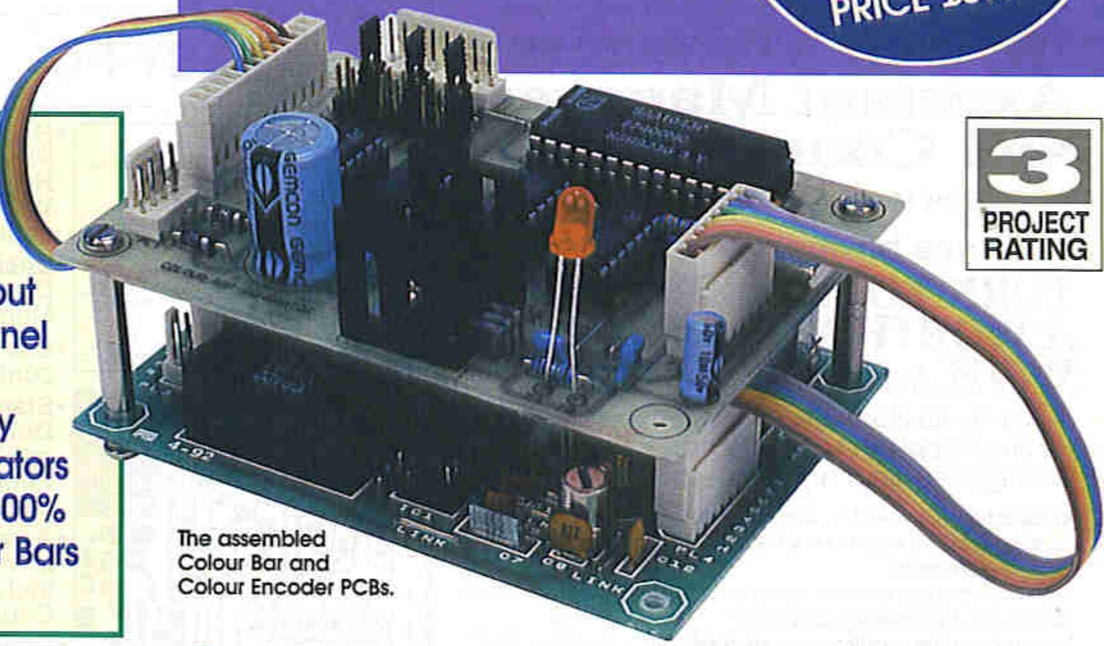
3 PROJECT RATING

FEATURES

* PAL Composite Video Output
* PAL UHF RF Output
* RF Output Channel Adjustable
* AC or DC supply
* Onboard Regulators
* Produces EBU, 100% and 75% Colour Bars
* Easy to Build

APPLICATIONS

* TV/Monitor Servicing
* Video Servicing
* Workshop and Field Use
* TV Outside Broadcasts
* TV Studio



The assembled Colour Bar and Colour Encoder PCBs.

SIMILARLY, when servicing TVs, monitors, VTRs or other video equipment it is necessary to have a constant and stable colour test signal to be able to accurately set up the various preset controls. Over the last decade, the previously familiar colour test card has vanished from our TV screens much to the chagrin of TV and video engineers the length and breadth of the country. The younger readers of this magazine may not remember the days before the 'Breakfast TV' and '24hr TV' revolutions, prior to these it was easy to find at least one channel displaying a 'test card'. Originally, the test card was literally placed in front of a camera, the most popular (famous?) being the BBCs 'Test Card F' shown in Photo 1. Modern test cards are entirely electronically generated and usually personalised so that the signal can be identified.

Photo 1. Test Card F. © Copyright BBC Engineering.

Specifications of Colour Bar Generator

Power supply voltage range:	15V to 25V AC or DC
Power supply current:	105mA at 15V DC
Colour system:	PAL
Colour bar standards:	100%, EBU and 75%
Composite video output:	1V Pk-to-Pk into 75Ω (EBU Bars)
UHF RF output:	591·5MHz (Channel 36)
UHF RF output connector:	Phono
PCB Dimensions (WDH)	
Colour Bar PCB:	99 x 73 x 31mm
Colour Encoder PCB:	99 x 73 x 20mm
Mounting holes:	M3 clear

Test Signals On Tap

For the engineer or technician an 'on tap' colour test signal is needed, units to generate such a signal vary in complexity from an expensive broadcast standard electronic test card generator costing several thousand pounds to a much simpler and cheaper colour bar generator. Broadcast standard equipment is designed to the highest standards possible – after all the test equipment has to be better than the system under test.

A simple colour bar generator is more than adequate for most general setting up procedures, and when aligning video equipment a full test card provides *too much* information. Often servicing information specifies a standard colour bar test signal. This type of test signal is widely used by broadcasters for checking and setting up all manner of equipment which is required to operate with colour pictures. Colour bars are also the test signal used when timing colour pictures together for use in any situation where sources need to be switched or mixed; a studio vision mixer for example. In this case the pictures need to appear in the same relative time (horizontal phase) and also the same relative colour phase (subcarrier phase) – controls normally being provided on the source equipment to vary these two parameters. Correct subcarrier phase is important because if two sources are switched, which are not in the same phase, then the monitor or video equipment will be required

Important Safety Note:

Because of the wide range of possible final construction methods, ultimately determined by the constructor, full details of mains wiring connections are not shown in this article. However for safety reasons it is essential that a suitably rated mains fuse and switch is fitted if a mains power supply is to be constructed. Whilst by no means exhaustive, the following recommendations are made:

If the final unit is housed in a plastic case and a mains supply is integral, Class II (double insulated) construction techniques must be employed and the mains transformer must comply with class II requirements.

If the final unit is housed in a metal case with integral mains supply, Class I construction techniques must be employed; the case and metalwork of the mains transformer must be earthed.

Other precautions and steps necessary to comply with published safety standards must be employed to ensure safety of the user and servicing personnel.

Every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit. Safe construction of the unit is entirely dependent on the skill of the constructor.

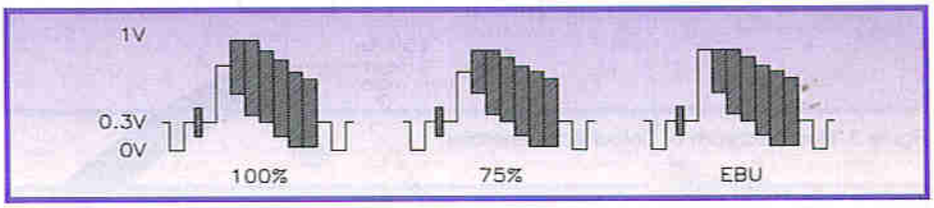


Figure 1. Idealised colour bar video waveforms.

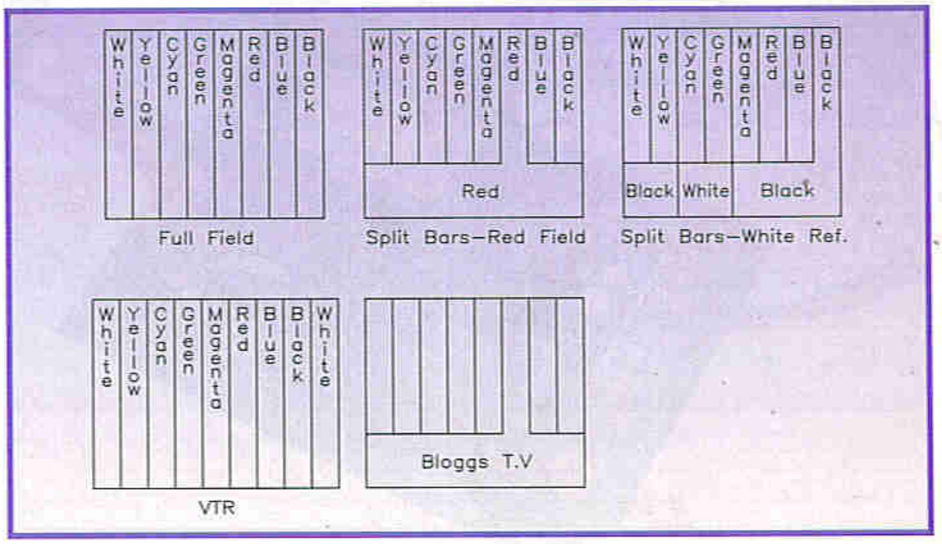


Figure 2. Various colour bar screen displays.

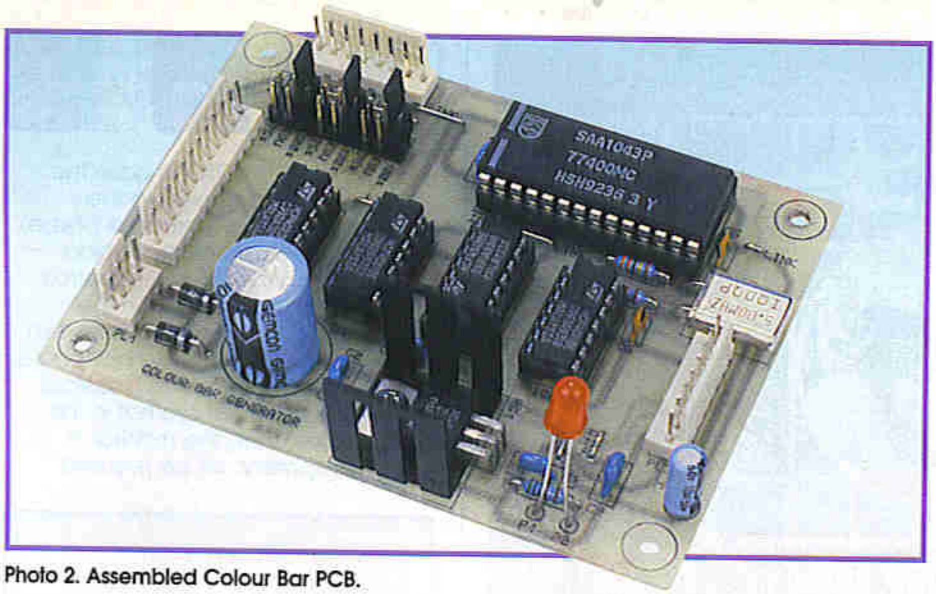


Photo 2. Assembled Colour Bar PCB.

to relock its colour decoder, the effect will be at best, a colour flash, and at worst, complete picture breakup.

Variations

There are several different styles of colour bars in use around the world, each suited to a particular task. They are all based on eight vertical coloured stripes, which can sometimes be seen when the vision mixer at the TV studio pushes the wrong button!

The first variation lies in the amplitude of the various parts of the waveform. The bars are actually made up of a series of black and white steps reducing in amplitude from right to left. This is the luminance (brightness) part of the signal and as

a reference signal is used to set the overall gain of the signal path. 1V Pk-to-Pk from the bottom of the sync pulse to the top of the white bar is the normal level. Superimposed on this luminance signal is the chrominance (colour) signal, a suppressed carrier quadrature amplitude modulated signal based on a reference frequency of 4·43361875MHz. The amplitude and phase of this signal indicates the colour (hue) and amount of colour (saturation). There is also a quick burst of the subcarrier at reference level and phase in the line blanking interval just before the picture starts, this is the colour burst and is used to synchronise colour decoding circuitry and provide automatic level adjustment. The finer technical points of the colour encoding and decoding process have been omitted here and the reader is referred to one of the many books written on the subject.

In the old days of television the amplitude of colour bars was specified by the maximum height of the luminance signal, 1V, and the maximum amount of colour modulation allowed, 100%. While there was only the one system of colour bars this was fine. But then it was found that for some uses 100% colour modulation was a little excessive. Setting up of radio links became difficult, and the fact that the chrominance signal extended well above the maximum white level, was also a problem. So engineers began to use another set of colour bars with the amplitude reduced to 75%. The original bars were then referred to as 100% bars.

This cured the problem of too much chrominance but the white bar was also reduced to 75% and this brought its own problems. Many an engineer has seen 100% bars, thought they were 75% bars and proceeded to increase the video level accordingly, thus producing 125% pictures with disastrous results!

Important Note about Servicing Mains Equipment

It is important to note that servicing mains powered equipment, such as TVs, video monitors, VTRs, etc. is potentially dangerous. Mains voltage and EHT voltage are potentially lethal. Live working should not be undertaken except where absolutely necessary; in such cases suitable safety precautions must be taken as described in published safety standards and legislative acts, e.g. use of isolation transformer, RCD, correct working procedures, etc. Manufacturers instructions to servicing personnel with regard to servicing methods, necessary equipment, spare parts (especially safety critical components), etc., must be followed. If in any doubt as to the correct way to proceed, seek advice from a suitably qualified engineer.

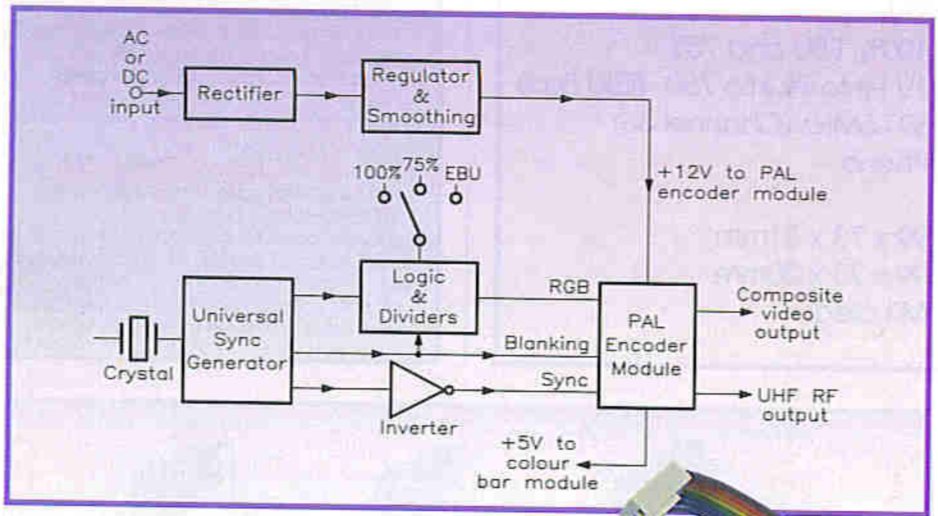


Figure 3. Block diagram of Colour Bar Generator.

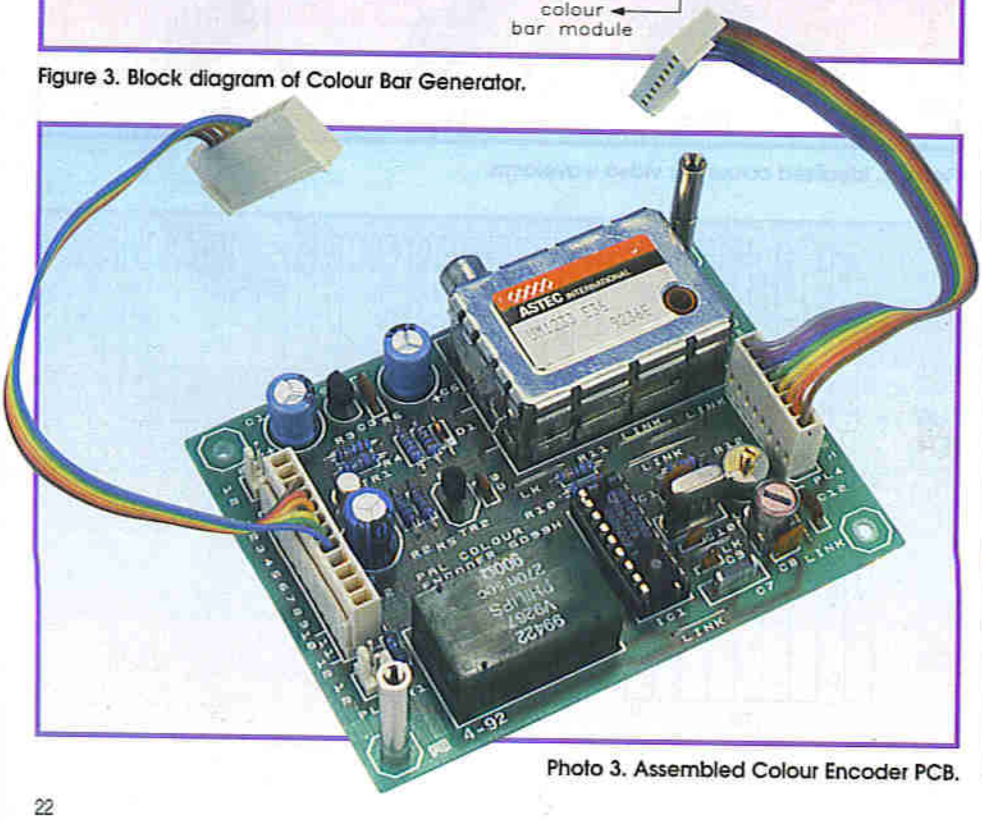


Photo 3. Assembled Colour Encoder PCB.

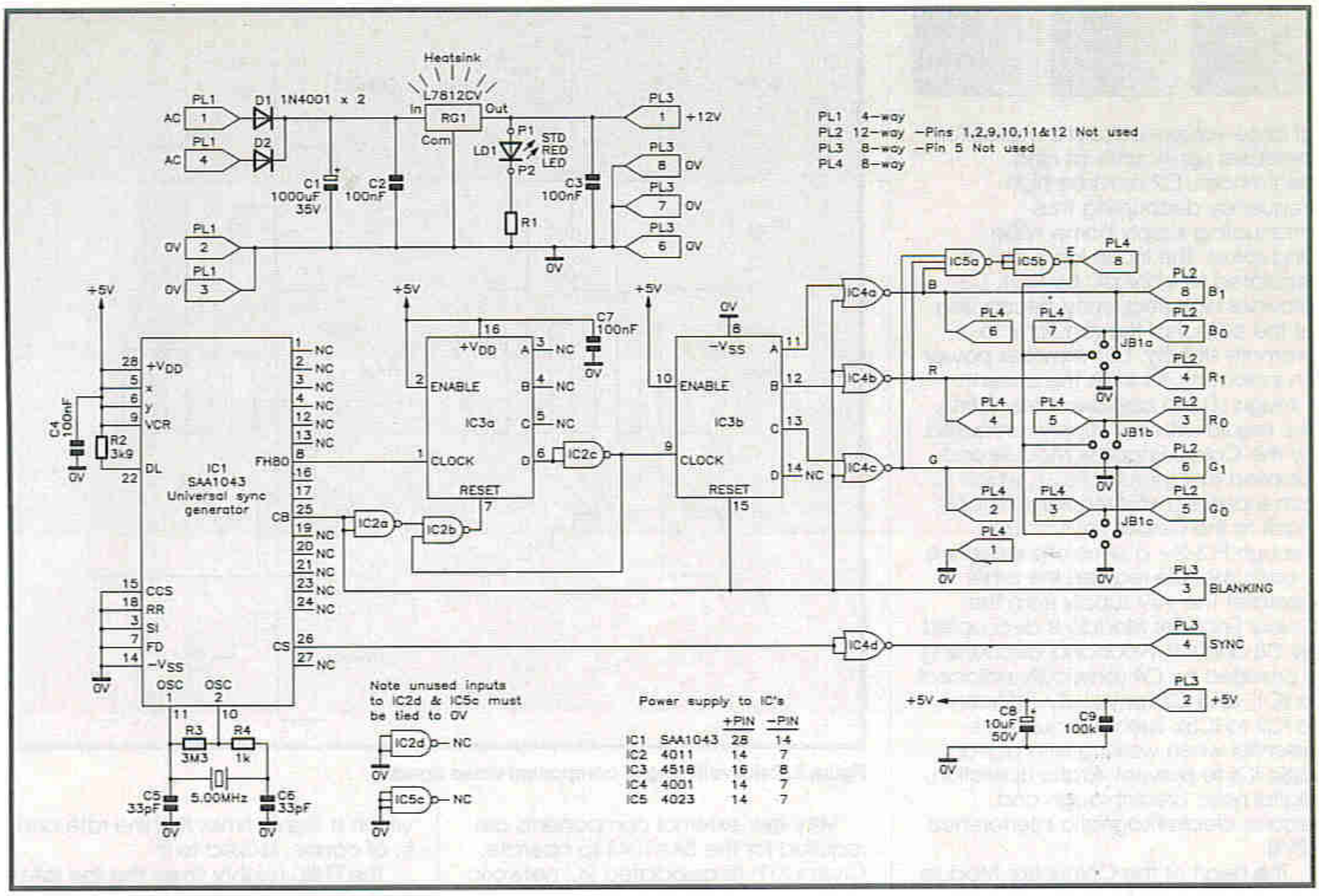


Figure 4. Circuit diagram of Colour Bar Module.

To get over the problem of the 75% bars looking the same as the 100% bars, the European Broadcasting Union (EBU) designed another set of bars, known as EBU bars, having the same specifications as 75% bars except that the white bar is increased in level to 100%. The video waveforms for all three colour bar standards are shown in Figure 1.

With EBU standard bars the first step is bigger than the rest, but this is far outweighed by the fact that now there is a set of bars which has 100% luminance and 75% chrominance which seems to suit just about everybody.

More Variations

The second variation is how the bars are combined with other signals.

In some cases the bars are divided horizontally about two thirds of the way down the frame, normal bars appearing in the top section but other signals appearing in the bottom section. These are known as split bars and can contain various signals in their bottom section. The most common of these is a red field to the same specification as the red bar in the upper section. This is used to check for various distortions and non-linearity in the chrominance information. It also has the effect of making the dots in the red boxes on a vectorscope display larger than the rest thus making it possible to set up correct chroma phase without a colour monitor which can sometimes be useful.

A variation of the split bars has the lower section at black level with a bar inset into it at white level. This allows full 75% bars to be used in the upper section as a 100% white reference is contained in the lower section. It is also possible to observe the low frequency response of the system under test and to check for distortions such as overshoot or ringing which are normally masked by the chroma information. This type of colour bars is normally found on Philips (now BTS) equipment but this is not always the case.

One exception to the normal eight bar sequence is a nine stripe design which has a white bar at the right as well as at the left. The purpose of this is to define the right-hand edge of the picture so that the picture can be accurately centred within the line blanking period when using timebase correctors or anything else where the picture is movable sideways. Due to their widespread use in video recording areas these are usually known as VTR Bars.

These days it is common practice among the broadcast companies and others communications companies such as BT and satellite link providers to use split bars and insert a name or logo into the bottom section. It is easy to see how useful this is, if you think for a moment of the situation at Telecom Tower for example where incoming circuits number in the hundreds – most of them inactive most of the time and so showing colour bars as a standby signal. Just which bars are which!

Examples of all the colour bars mentioned are shown in Figure 2.

Colour Bar Generator

The Colour Bar Generator project presented here is of the simplest configuration, that of full field bars. Any of the three 100%, EBU, or 75% standard levels can be generated – the choice is either set by jumpers or by an off-board switch. The project is based on two PCBs: the first contains power supply circuitry and generates the necessary video and timing signals – this is referred to as the Colour Bar Module. The second is encodes the colour video signals to the PAL TV standard and provides composite video and modulated UHF RF outputs – referred to as the Colour Encoder Module.

To help understand operation of the Colour Bar Generator, Figure 3 shows a block diagram of the overall project.

Circuit Descriptions

Colour Bar Module

The circuit of the Colour Bar Module is shown in Figure 4.

Either an AC or DC extra low voltage supply can be applied to the power connector PL1; in the case of an AC supply D1 and D2 form a bi-phase full wave rectifier, in the case of a DC supply the same diodes provide reverse polarity protection. C1 is the main reservoir capacitor. Since the equivalent series resistance (ESR)

of large value electrolytic capacitors increases significantly at high frequencies, C2 provides high frequency decoupling thus attenuating supply borne noise and spikes. The incoming supply is regulated to +12V DC by RG1. C3 provides high frequency decoupling at the output of the regulator to promote stability. LD1 provides power on indication; R1 limits the current through LD1 to approximately 20mA. The regulated +12V supply is required by the Colour Encoder Module and supplied to it through PL3-1, which in turn supplies a +5V regulated supply back to the Colour Bar Module through PL3-2 – a symbiotic existence – each module requires the other to operate! The +5V supply from the Colour Encoder Module is decoupled by C8 and C9. Additional decoupling is provided by C4 (physically adjacent to IC1) and C7 (physically adjacent to IC2 to IC5). Such decoupling is essential when working with digital logic ICs to prevent erratic operation, digital noise breakthrough and reduce electromagnetic interference (EMI).

The heart of the Colour Bar Module is IC1 which is an SAA1043 Universal Sync Generator IC, this device generates all the required timing signals for a television picture. Before such devices were developed, a whole board of logic ICs would be necessary to generate the required timing signals. The IC does not, however, generate the colour subcarrier which is generated by the Colour Encoder Module. IC1 has several programming pins which define its operating parameters such as the TV standard it is to be used on. These are tied either high or low as shown in the circuit diagram.

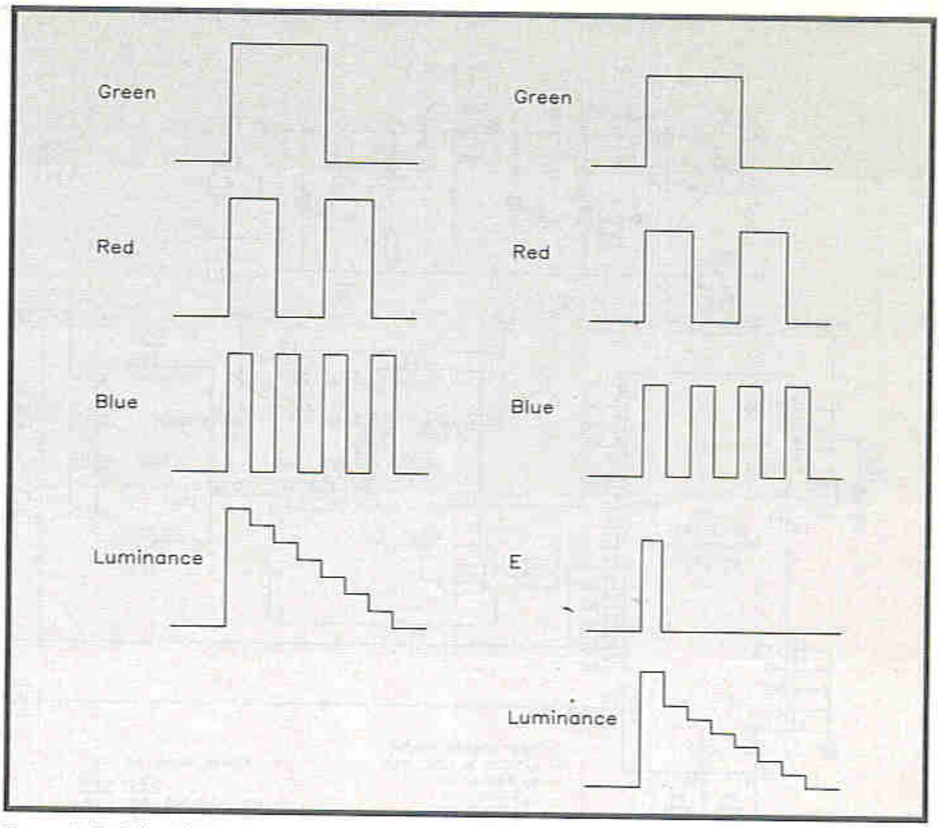


Figure 5. Relative timing of component video signals.

Very few external components are required for the SAA1043 to operate. Crystal XT1, its associated RC network comprising R3 & C5 and R4 & C6, and circuitry within the IC form an accurate 5MHz oscillator. This oscillator provides the master reference for all system timing. The only other component is a single pull up resistor on the DL input.

One problem often encountered when generating timing signals electronically is finding a locked source of correctly timed pulses at a much higher frequency than the normal line and frame rate, so that the picture area can be split into various vertical segments. Fortunately the SAA1043 has an output of 1·25MHz which is eighty times the line rate and is, of course, locked to it.

The FH80 (eighty times the line rate) output signal is passed to the clock input of IC3A, a 4518 dual BCD counter. The D output from IC3A is now FH80 divided by eight, which gives ten times the line rate (FH10). This would give ten bars, not eight, but most of the unwanted two bars are contained within the line blanking period and as such are gated off by the $\overline{CB}$ (negative going composite blanking) signal from IC2A. IC2A (used as an inverter) provides CB from the CB output of IC1. This is NANDed with the $\overline{D}$ output from IC2C (also used as an inverter), to reset IC3A. The input to IC3B is a series of eight normal

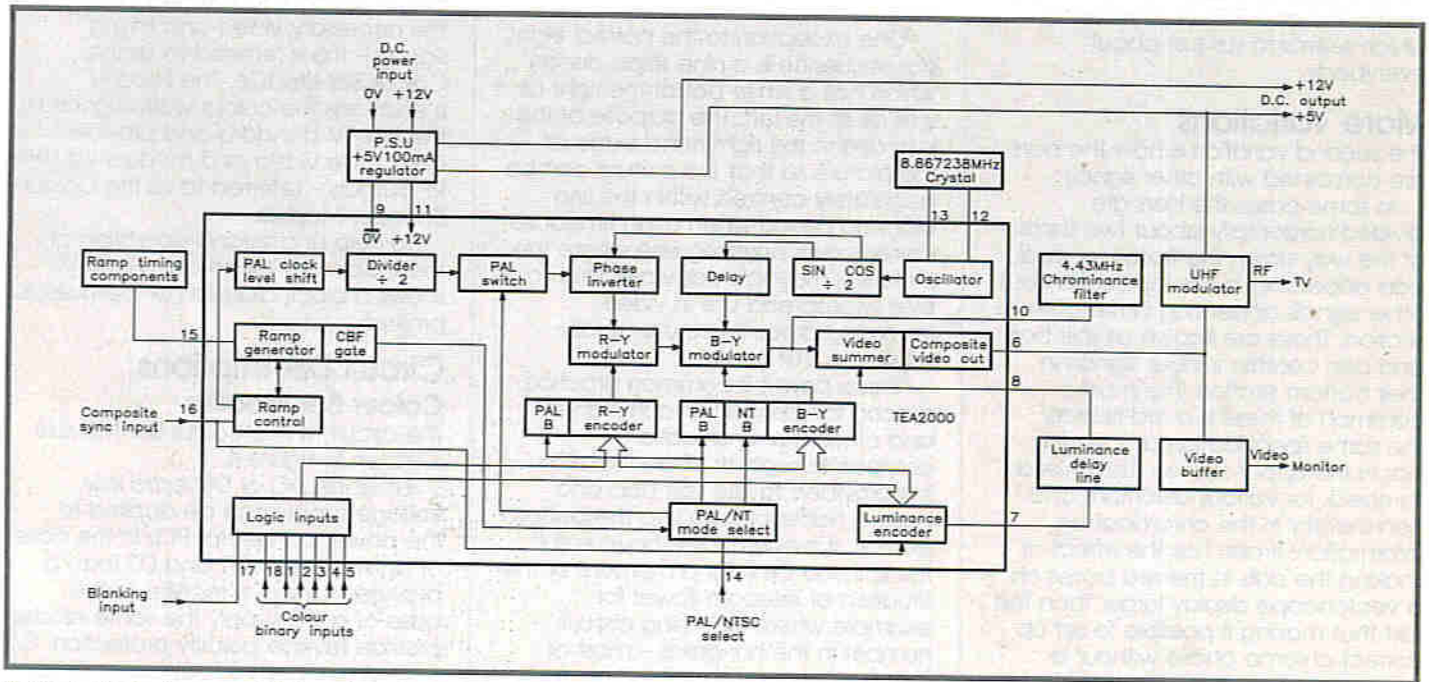


Figure 6. Block diagram of Colour Encoder Module.

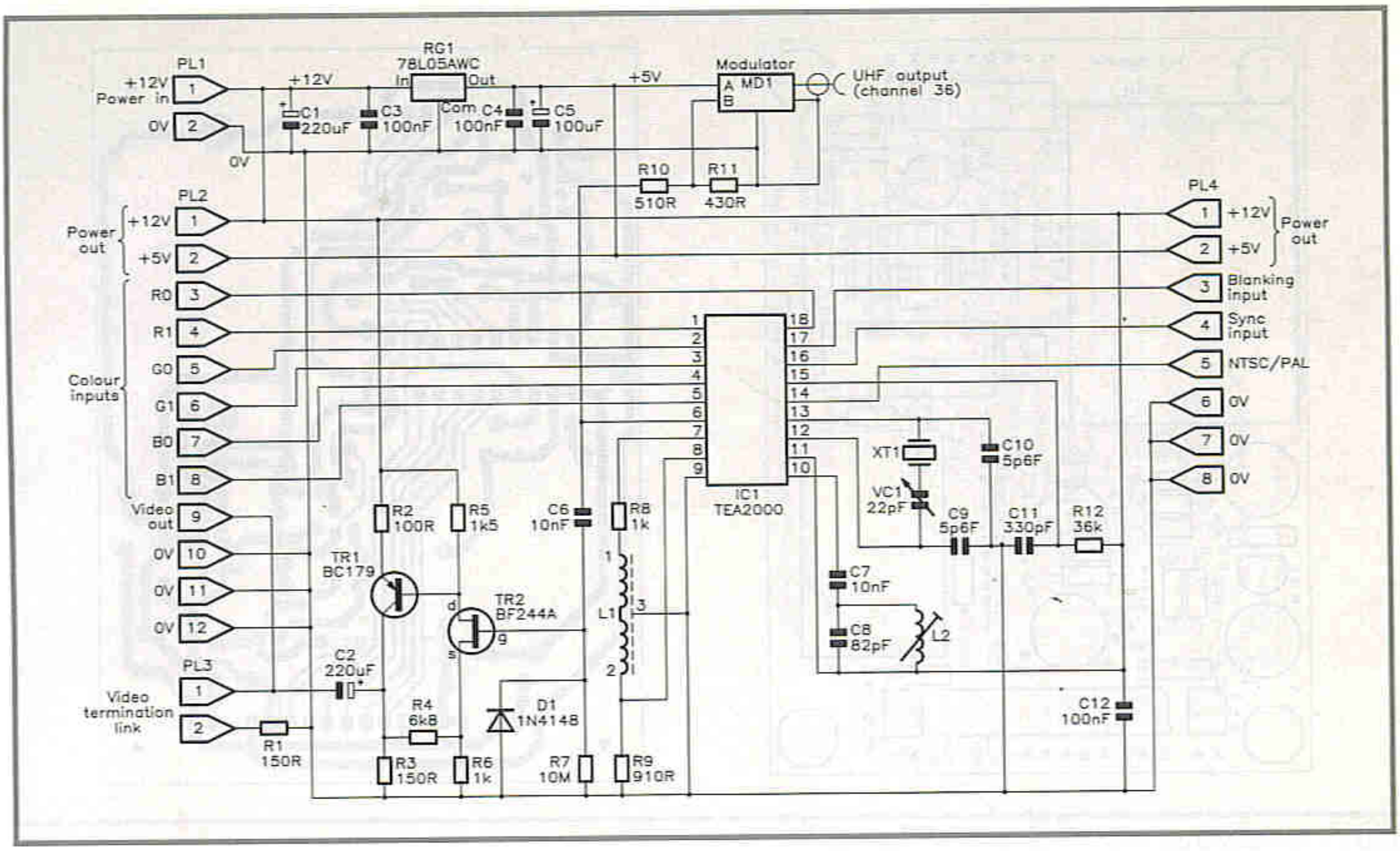


Figure 7. Circuit diagram of Colour Encoder Module.

width pulses and a final narrow pulse giving nine in total. From this it will be seen that the colour bars produced will have nine bars, not eight, the final right hand bar being a narrow white bar. This will actually give a form of VTR Bars; for most, if not all, applications this will be an advantage not a disadvantage. The CB output signal from IC1 is fed to the Colour Encoder Module's blanking input through PL3-3.

The Colour Encoder Module requires RGB (Red, Green and Blue) component video signals. The combinations and relative timing of RGB signals to produce familiar staircase luminance waveform are shown in Figure 5. The encoder sums the RGB signals at the correct levels to generate the luminance signal, superimposes the chrominance information and colour burst, and adds the synchronising signals resulting in the waveforms shown in Figure 1.

To provide the $\overline{RGB}$ signals, the FH10 signal from IC2C needs to be divided by two, four and eight to give $\overline{B}$, $\overline{R}$ and $\overline{G}$ signals respectively. This is achieved by IC3B. IC4A to IC4C invert the $\overline{RGB}$ signals to provide RGB signals for the inputs of the Colour Encoder Module. These three gates, by means of the CB signal fed to the second input of each gate, remove any signals outside the active picture area.

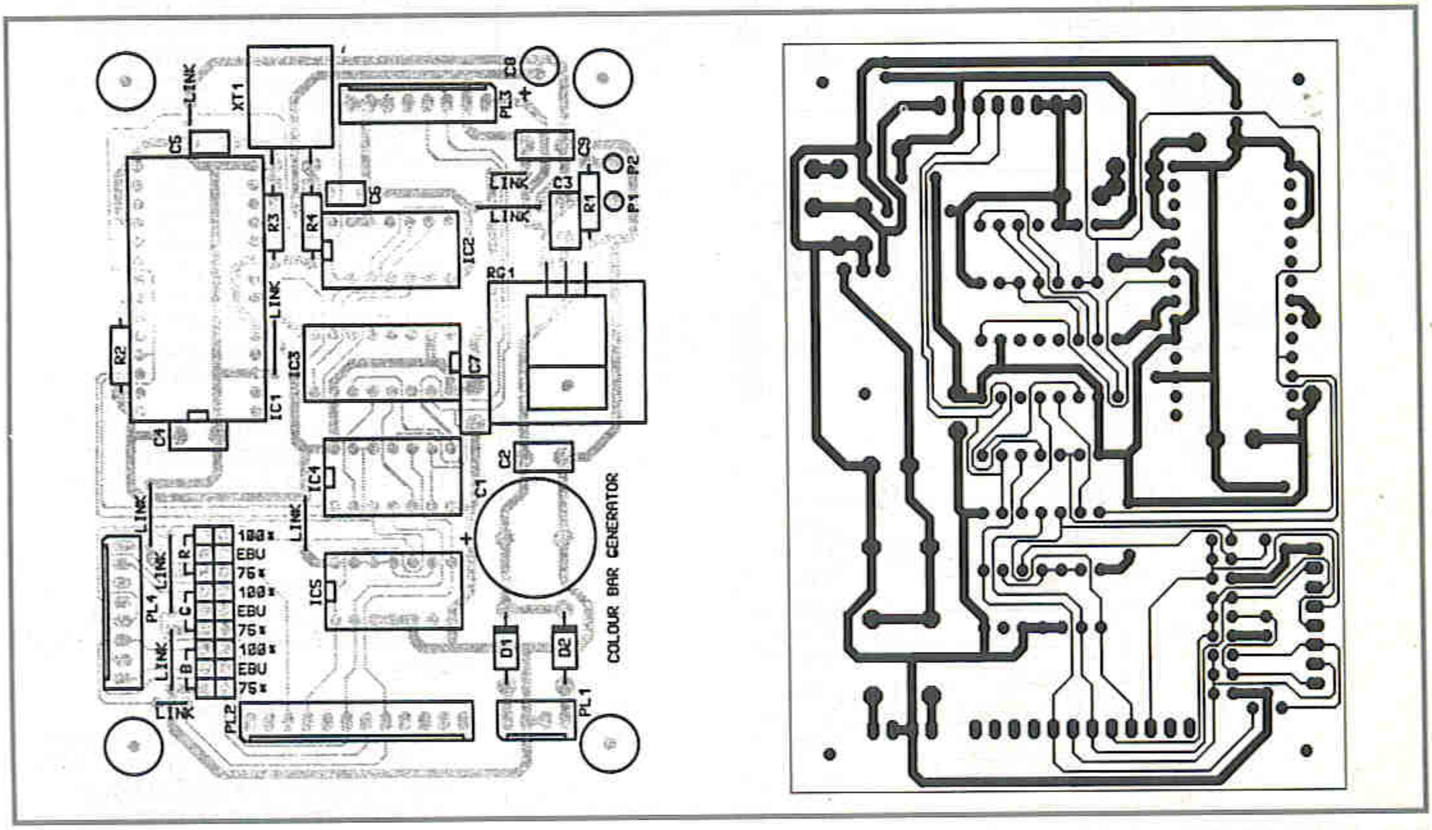


Figure 8. PCB legend and track for Colour Bar Module.

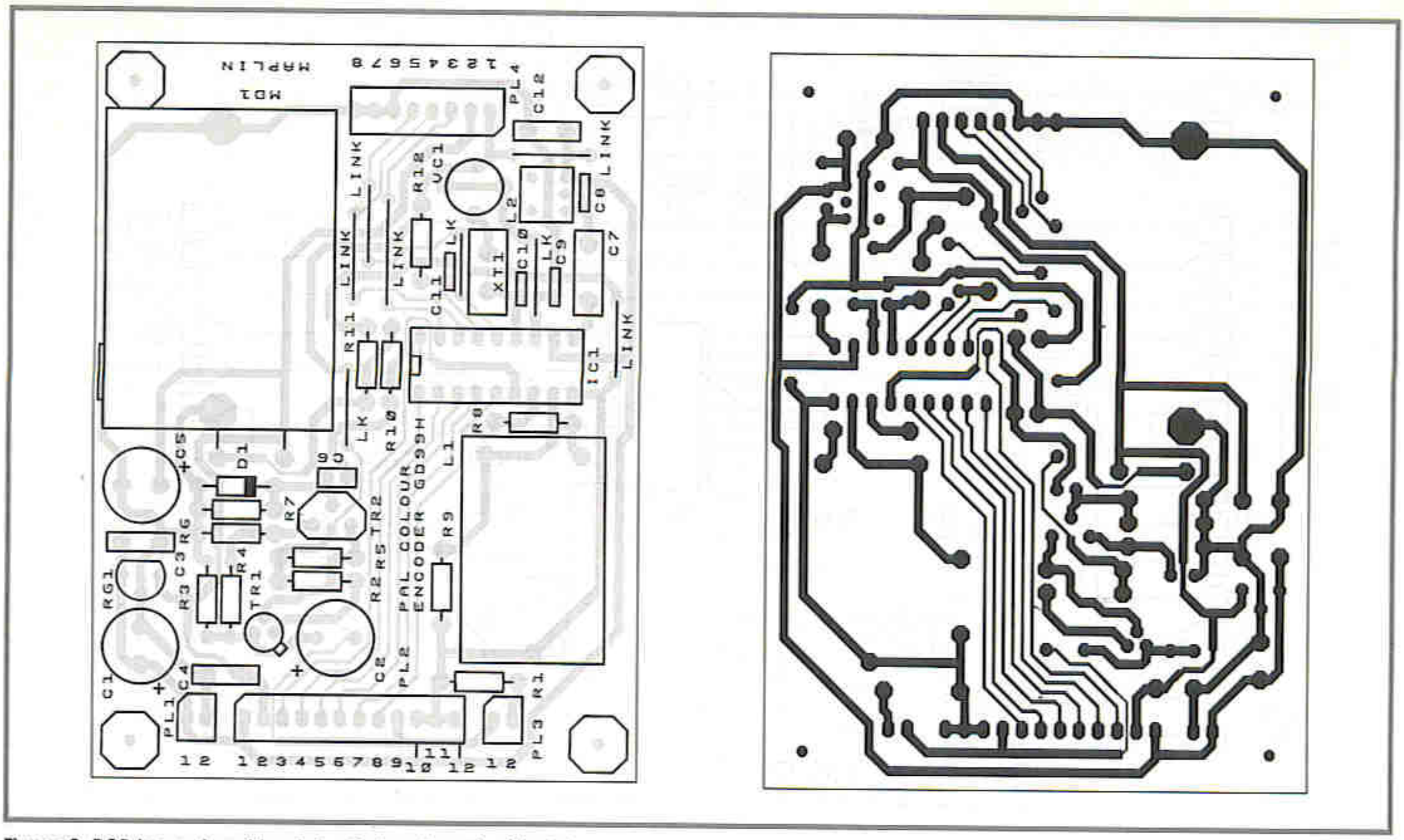


Figure 9. PCB legend and track for Colour Encoder Module.

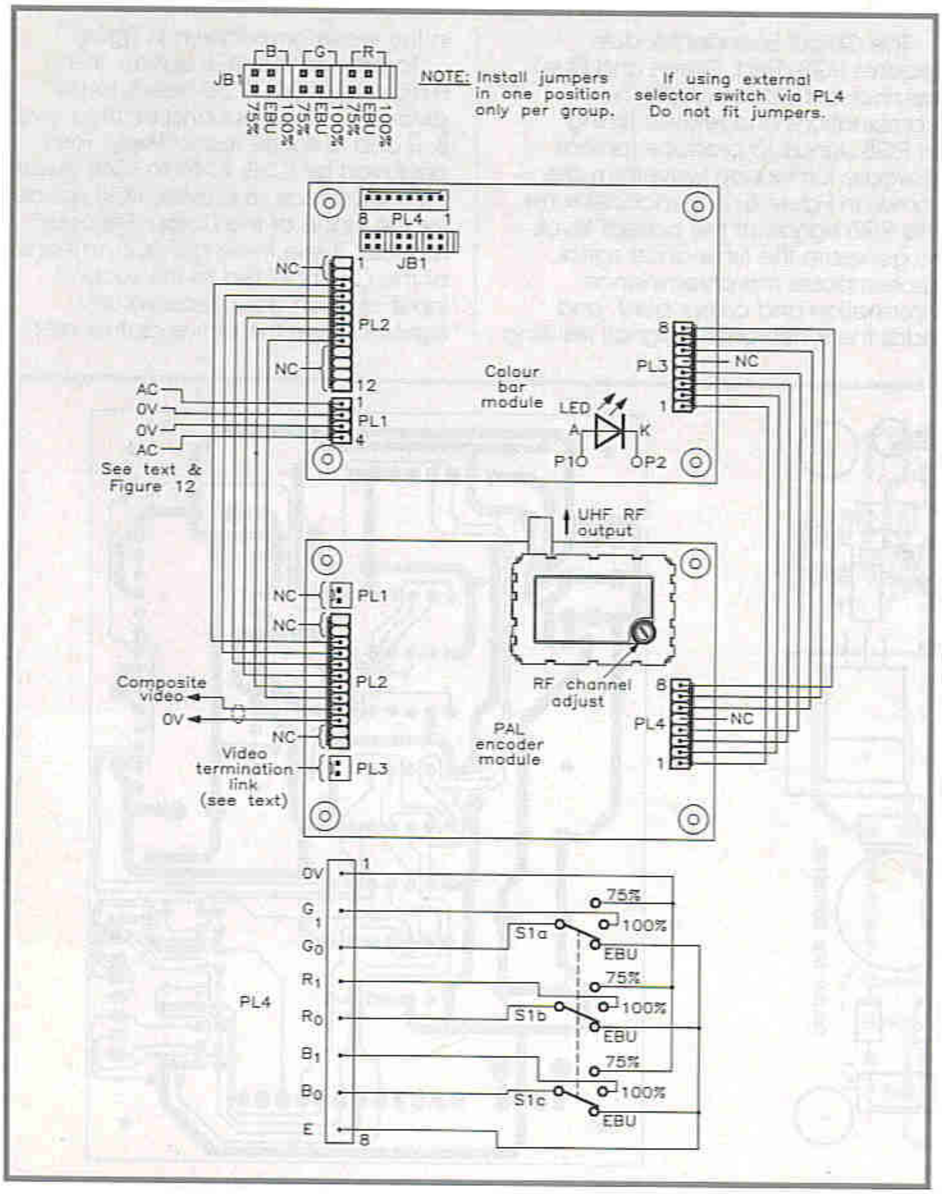


Figure 10. Wiring diagram and jumper selection.

IC5 detects when all the three bar outputs are high, which is only during the white bar period, and generates a peak white bar signal, sometimes called the E bar. This is added to the three colour outputs in the Colour Encoder Module to give a true EBU level output. Figure 5 indicates how the E bar is used to achieve this.

The inputs to the Colour Encoder Module are in the form of a two bit per colour TTL compatible port. The RGB signals are input into the MSB inputs (R1, G1 and B1). What is input into the LSB inputs (R0, G0 and B0) determines the final form of the Colour Bar output. Connecting all three LSB bits to ground will give 75% bars with a 75% white reference. Connecting all three LSB bits to the output from IC5 (E signal) will increase the level during the white bar giving 75% colour and 100% white reference, that is to say EBU bars. Connecting each LSB to its associated MSB will produce 100% bars with 100% white reference. The RGB signals are to the Colour Encoder Module through PL2-3 ti PL2-8.

Selection of the required colour bar standard is achieved by a jumper block, JB1a to JB1c, on the PCB or a three pole switch connected to PL4.

The CS (composite sync) output signal from IC1 is inverted by IC4D to give $\overline{CS}$ (negative going composite sync) which is fed to the Colour Encoder Module's sync input through PL3-4.

Colour Encoder Module

The Colour Encoder Module is shown in block diagram form in Figure 6; the circuit diagram is shown in Figure 7. The following circuit description is a shortened extract from the article originally published in the December 1988-January 1989 issue of *Electronics*.

The +12V supply for the Colour Encoder Module is provided by the Colour Bar Module as previously explained and is supplied through connector PL4-1. The +12V supply feeds the video buffer and the TEA2000 colour encoder IC. C1 provides supply decoupling, additional high frequency decoupling is provided by C3 and C12. The RF Modulator, MD1, requires a +5V supply which is provided by RG1, the output of which is decoupled by C4 and C5. The +5V supply is also fed back to the Colour Bar Module through PL4-2.

IC1, a TEA2000, is a colour encoder and video summer which has an internal oscillator from which R-Y and B-Y colour difference signals are produced. As can be seen from the block diagram shown in Figure 6, the chip has a complex internal structure and requires very few additional components. The frequency of the internal oscillator is set by XT1 an 8·867238MHz crystal (twice the colour subcarrier frequency). The output of the ICs oscillator stage is divided to provide the four sub-carrier phases required in the encoder.

The combined luminance and sync signal appearing at pin 7 of IC1 is coupled to pin 8 via a 270ns delay line.

Chrominance filtering is accomplished with a parallel tuned circuit comprising C8 and L2 AC coupled to pin 10 of IC1 by C7. The filter is set to resonate at 4·433MHz.

The timing information for the colour burst and PAL switching is controlled by the ramp timing components, C11 and R12.

The composite video signal from pin 6 of IC1 is supplied to the UHF modulator, MD1, by a potential divider formed by R10 and R11. This signal is also capacitively coupled, by C6, to the input of the video buffer.

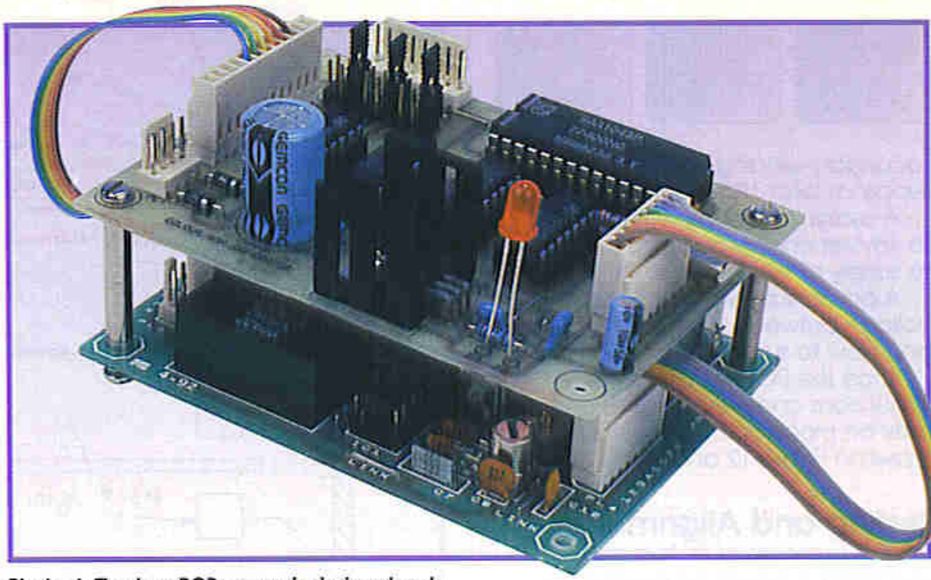


Photo 4. The two PCBs mounted piggyback

The input impedance at the gate of TR2 is approximately 10MΩ, whilst the output impedance of TR1 is much lower, approximately 100Ω. The buffered video signal is supplied by C2 to the video output on PL2-9. When using a video monitor with a high input impedance the termination resistor, R1, must be placed in circuit by linking PL3-1 and PL3-2.

Construction

Assembly of the two PCBs should prove straightforward providing a logical assembly sequence is followed. Double check component type, value and polarity before soldering as subsequent component removal may damage PCB tracks unless great care is taken. It is recommended that the smallest components are fitted first (wire links, diodes, resistors, etc.), working up to the largest components (large electrolytic capacitors, modulator, regulator and heatsink, etc.). It is a good idea to leave fitting the ICs into their sockets until last; precautions should be taken to prevent electrostatic discharge as this may permanently damage the ICs or cause premature failure in service. For further information on general construction techniques and component identification, please refer to the Constructors' Guide (XH79L) which is included in the kits. Figures 8 and 9 show the PCB legend and track for the Colour Bar Module and the Colour Encoder Module respectively. After the PCBs have been assembled, remove excess flux from the board using an environmentally friendly PCB cleaner and double check for misplaced components, solder splashes, etc. Photos 2 and 3 show the assembled PCBs (see page 3).

The PCBs are interconnected by means of ribbon cable and Minicon connectors. Connections should be made as indicated in the wiring diagram shown in Figure 10. Selection of the colour bar standard is by means of PCB jumpers or an off-board switch. Jumper positions and wiring for the switch are also shown in Figure 10. Do not fit more than one jumper per group. If the off-board switch is to be used, do not fit any jumpers. The switch chosen should have break before make contacts.

Figure 11 shows three possible power supply options; these are:

A mains transformer with a centre-tapped 12-0-12V to 15-0-15V

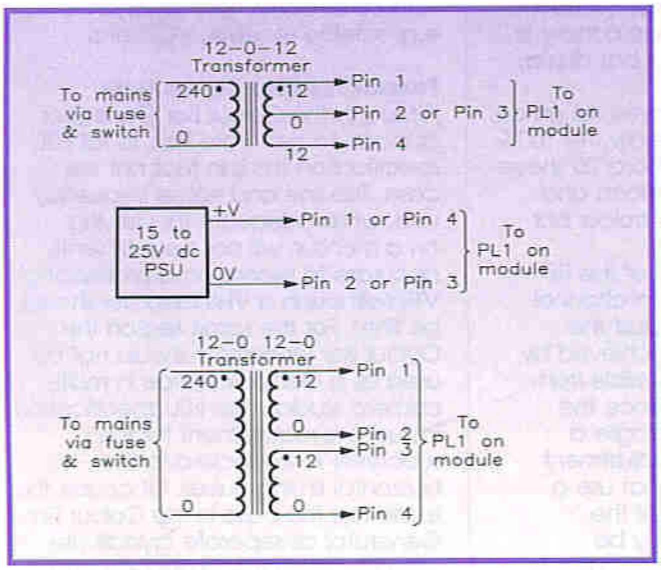


Figure 11. Power supply options.

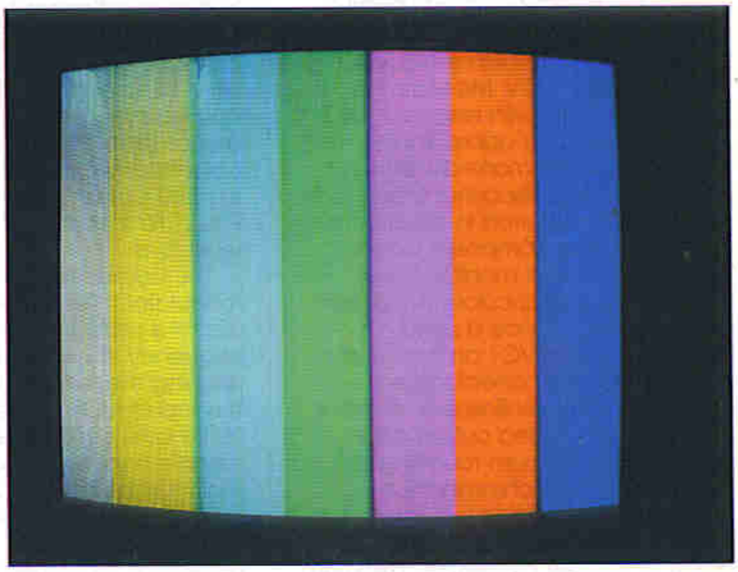


Photo 5. Colour Bars displayed on a TV screen.

secondary winding and able to supply at least 150mA.

A mains transformer with twin 12V to 15V secondary windings and able to supply at least 150mA.

A power supply with an output voltage between +12V and +25V DC and able to supply at least 150mA.

Since the PCBs have the same dimensions and fixing centres, they may be piggy back mounted as shown in Figure 12 and Photo 5.

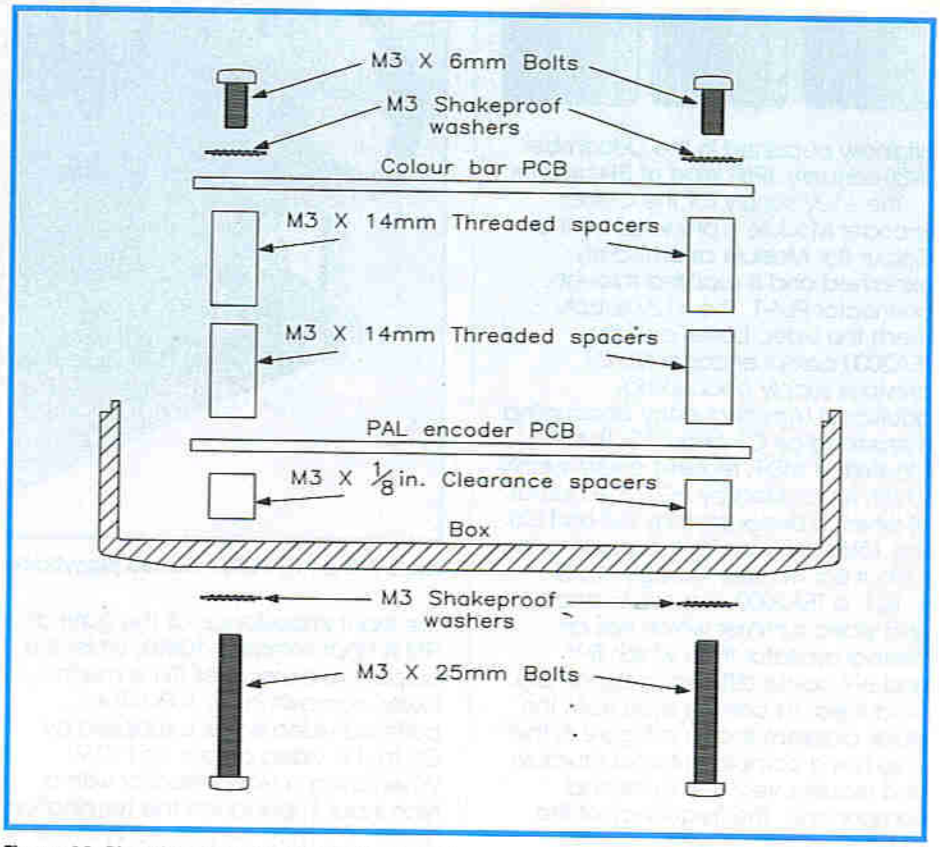


Figure 12. Piggyback mounting arrangement.

Testing and Alignment

For the purposes of testing and alignment a power supply able to supply between +15V and +25V DC is required.

Connect the supply to the Colour Bar Generator as shown in Figure 11 with a multimeter set to read DC mA on a 250mA or higher range in series with the positive supply. Measure the current, which should be approximately 100mA.

Remove the multimeter from the supply, set it to read DC V on a 15V or higher range and reconnect the supply. On the Colour Bar Module measure the voltage on PL3-1 with respect to PL3-8, which should be approximately +12V. Measure the voltage on PL3-2 with respect to PL3-8, which should be approximately +5V.

If readings are markedly different from those listed, disconnect the supply and recheck for errors in construction.

Connect the composite video output to a colour monitor or the UHF RF output to a colour TV (TV will require tuning). Once a picture is displayed, adjust VC1 on the Colour Encoder PCB for correct locked colour. Using an oscilloscope monitor the composite video output and adjust L2 for minimum rounding or overshoot on the chrominance envelope of the video waveform. If an oscilloscope is not available, adjust L2 for best picture, i.e. minimum colour bleed between adjacent bars and minimum colour variation between adjacent TV lines (venetian blind effect). Photos 5 and 6 show a correctly adjusted colour bar display on a TV screen and the corresponding video waveform on an oscilloscope. Photo 7a show the 100% colour bar waveform, Photo 7b shows the EBU colour bar waveform and Photo 7c shows the 75% colour bar waveform.

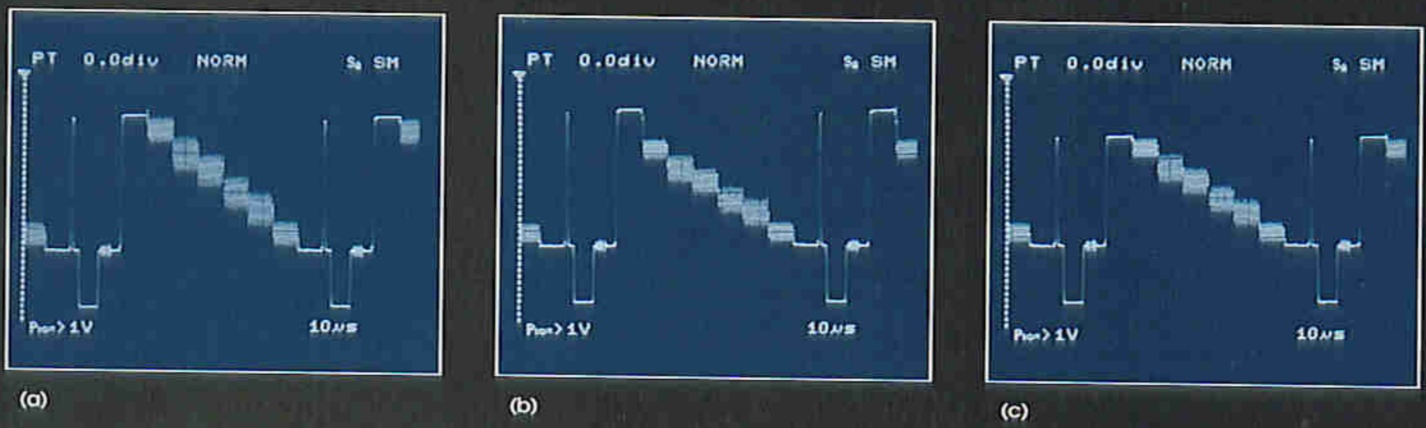
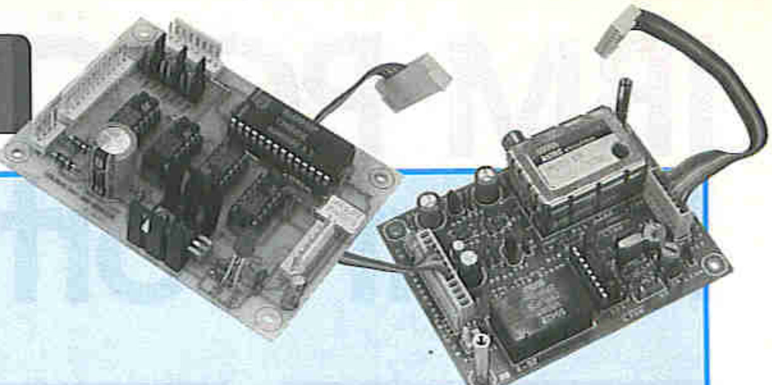


Photo 6. Colour Bar waveforms on an oscilloscope: (a) 100%, (b) EBU, (c) 75%.

The output frequency of the RF modulator is factory set to channel 36. If it is necessary to adjust the frequency, this can be achieved by retuning the ferrite core visible from the top of MD1's case. Since the ferrite core is extremely fragile a suitable non-magnetic adjustment tool must be used – Do not use a screwdriver. Adjustment of the modulator frequency may be necessary, e.g. when adding the RF signal into a TV distribution amplifier in a TV repair workshop to avoid clashing with other equipment on channel 36, e.g. satellite receiver, VCR, etc.

Professional Users Please Note

Although the Colour Bar Generator appears to generate Bars to full EBU specification this is in fact not the case. The line and frame frequency rate, while adequate for viewing on a monitor, will not be sufficiently accurate to record on a professional VTR (although a VHS recorder should be fine). For the same reason the Colour Bar Generator should not be used as a Genlock source in multi-camera studios. The EBU specification includes a requirement for the subcarrier to be locked to the horizontal timing pulses. Of course this is also not the case in the Colour Bar Generator as separate crystals are used to obtain the luminance and chrominance parts of the output.



PARTS LISTS

COLOUR BAR MODULE

RESISTORS: All 0·6W 1% Metal Film			
R1	560Ω	1	(M560R)
R2	3k9	1	(M3K9)
R3	3M3	1	(M3M3)
R4	1kΩ	1	(M1K)
CAPACITORS			
C1	1,000µF 35V PC Elect	1	(FF18U)
C2,3,4,7,9	100nF Monolithic Ceramic	5	(RA49D)
C5,6	33pF Ceramic	2	(WX50E)
C8	10µF 50V PC Elect	1	(FF04E)
SEMICONDUCTORS			
D1,2	1N4001	2	(QL73Q)
RG1	L7812CV	1	(QL32K)
LD1	5mm Red LED	1	(WL27E)
IC1	SAA1043	1	(UK85G)
IC2	4011BE	1	(QX05F)
IC3	4518BE	1	(QX32K)
IC4	4001BE	1	(QX01B)
IC5	4023BE	1	(QX12N)
MISCELLANEOUS			
XT1	5MHz Crystal	1	(UL51F)
	28 pin DIL IC socket	1	(BL21X)
	16 pin DIL IC socket	1	(BL19V)
	14 pin DIL IC socket	3	(BL18U)
PL1	4-way Minicon Plug	1	(YW11M)
PL2	12-way Minicon Plug	1	(YW14Q)
PL3,4	8-way Minicon Plug	2	(YW13P)
	4-way Minicon Socket	1	(HB58N)
	12-way Minicon Socket	1	(YW24B)
	8-way Minicon Socket	2	(YW23A)
	Minicon Terminal Strip	3	(YW25C)
JB1	2x36 Pin Strip	1	(JW62S)
	Mini Pin Jumper	3	(UL70M)
	1mm Vero Pin	1 Pkt	(FL24B)
	Slotted Heatsink	1	(FL58N)
	M3 x 10mm Bolt	1 Pkt	(JY22Y)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 Nut	1 Pkt	(JD61R)
	PCB	1	(GH67X)
	Instruction Leaflet	1	(XU60Q)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	3-pole 4-way Rotary Switch	1	(FF75S)
	10-way Ribbon Cable	1m	(XR06G)
	Miniature Coax	As Req.	(XR88V)
	Red 1·4A Wire	As Req.	(BL07H)
	Black 1·4A Wire	As Req.	(BL00A)
	Phono to Coax Cable	1	(FV90X)
	M3 x 25mm Bolt	1 Pkt	(JY26D)
	M3 x 6mm Bolt	1 Pkt	(JY21X)
	M3 Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 x 14mm Threaded Spacer	1 Pkt	(FG38R)
	M3 x ⅛in. Clearance Spacer	1 Pkt	(FG32K)

PAL COLOUR ENCODER

RESISTORS: All 0·6W 1% Metal Film			
R1, 3	150Ω	2	(M150R)
R2	100Ω	1	(M100R)
R4	6k8	1	(MK6K8)
R5	1k5	1	(M1K5)
R6,8	1k	2	(M1K)
R7	10M	1	(M10M)
R9	910Ω	1	(M910R)
R10	510Ω	1	(M510R)
R11	430Ω	1	(M430R)
R12	36k	1	(M36K)
CAPACITORS			
C1,2,5	22µF 16V PC Electrolytic	3	(FF13P)
C3,4,12	100nF Minidisc	3	(YR75S)
C6	10nF Minidisc	1	(YR73Q)
C7	10nF Poly Layer	1	(WW29G)
C8	82pF Ceramic	1	(WX55K)
C9,10	5p6F Ceramic	2	(WX41U)
C11	330pF Ceramic	1	(WX62S)
VC1	22pF Trimmer	1	(WL70M)
SEMICONDUCTORS			
IC1	TEA2000	1	(UH66W)
RG1	µA78L5AWC	1	(QL26D)
TR1	BC179	1	(QB54J)
TR2	BF244D	1	(QF16S)
D1	1N4148	1	(QL80B)
MISCELLANEOUS			
L1	Delay line	1	(UH84F)
L2	15µH Adjustable Coil	1	(UH86T)
XT1	Crystal 8·867238MHz	1	(UH85G)
MD1	UHF Modulator UM1233	1	(FT30H)
PL1,3	2-way Minicon Latch Plug	2	(RK65V)
PL2	12-way Minicon Latch Plug	1	(YW14Q)
PL4	8-way Minicon Latch Plug	1	(YW13P)
	18 pin DIL IC Socket	1	(HQ76H)
	2-way Minicon Latch Housing	2	(HB59P)
	12-way Minicon Latch Housing	1	(YW24B)
	8-way Minicon Latch Housing	1	(YW23A)
	Minicon Terminal	3 Pkts	(YW25C)
	PCB	1	(GD99H)
OPTIONAL (Not in Kit)			
	Trim Tool	1	(BR51F)
	Video Lead 6	1	(FV90X)
	M3 x 14mm Threaded Spacer	1 Pkt	(FG38R)
	M3 x 6mm Bolt	1 Pkt	(BF51F)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 Nut	1 Pkt	(BF58N)

The Maplin 'Get-You-Working' service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as kits, which offers a saving over buying the parts separately.

Order As LT50E (Colour Bar Kit) Price £19.99.

Order As LM66W (Colour Encoder Kit) Price £24.95.

Both of these kits are available at further discount if purchased together.

Order As BE75S (Colour Bar & Colour Encoder Kits) Price £39.99.

Please note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following items (which are included in the kits) are also available separately.

Colour Bar PCB Order As GH67X Price £3.45.

Colour Encoder PCB Order As GD99H Price £4.25.

IBM PC Centronics Input Port

by Andrew Odell

PROJECT RATING 1

FEATURES
* Easy to build
* Simple to interface
* Used with Maplin IBM PC I/O Card

APPLICATIONS
* Transfer data via parallel port

A few months ago I purchased an IBM PC compatible computer because it offered vastly greater storage and speed over my archaic home computer. Due to the unavailability of useful software for my home computer, I had written a simple database program to keep track of my sheet music (more than 1,500 items!). I didn't feel like retyping this data into the PC as it would have taken rather a long time. The task now facing me, was how to get the database data transferred to my PC, and if this could be achieved without too much problem in doing so?

Most home computers can transfer data by a serial communication link via the serial port. My old computer has not got a serial port, so the only way I could see of outputting the data was to the printer port, which employed a crude form of Centronics protocol. What I really needed to do was to make the PC emulate a centronics printer. This would mean that I could then output the data as normal as if printing from my original computer, but instead of outputting data to paper, the data would transfer to the screen and to a disk file on the PC.

Working on the problem I noticed that the Maplin IBM PC I/O Card (LP12N) could provide up to 24 I/O lines as it used an 8255 IC, which could easily be configured to interface with Centronics protocol.

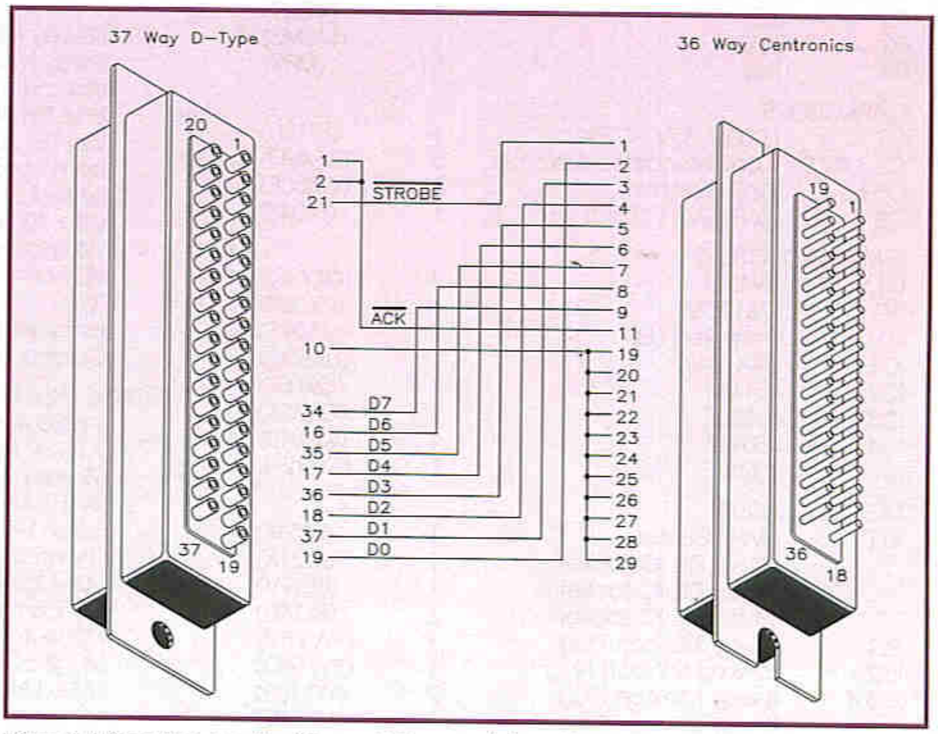


Figure 1. Wiring between the 37-way D-Type socket and the 36-way Centronics socket.

```
Listing 1.

'This program will read data in from the I/O card
'and output the data to an ASCII disk file
'Received data is also displayed on the screen

START:
        CLS
        FILES
        PRINT
        PRINT
        INPUT "Name for disk file ":A$
        PRINT
        PRINT
        PRINT "Press 'Space' to Quit and close all files."
        PRINT
        PRINT
        OPEN"O",#1,A$              'Open disk file for serial write
        LOCATE,,1                  'Turn cursor on
        BASEADD%=&H0300            'Set Base address for I/O Card
        OUT BASEADD%+3,191         'Set 8255 to Mode 1, all pins inputs

GETDATA:
        IF INKEY$=" " THEN QUIT    'If Space pressed, goto Quit
        A%=INP(BASEADD&+2)         'Read pin to see if data present
        B%=A% AND 128              'If no data, goto Getdata
        IF B%<>128 THEN GETDATA
        A%=INP(BASEADD%)           'Read data from port
        B$=CHR$(A%)                '
        PRINT B$;                  'Write data to screen
        PRINT #1,B$;               'Write data to disk file
        GOTO GETDATA               'Return to Getdata

QUIT:
        CLOSE #1                   'Close disk file

END
```

Listing 1. Turbo Basic Program.

This was the ideal solution, so all that was required was a simple interface from my home computer using the printer port to the Maplin IBM PC I/O Card in my PC, and a suitable program.

Figure 1 shows how a 37-way female D-type to 36-way centronics socket should be wired, converting the 37-way connector of the PC I/O card to a standard 36-way centronics connector. Use multi-colour cable and colour code the connections – this is the best way of keeping track of the work done. Also use a fine soldering iron bit as the distance between connections, especially the centronics connector, are very close.

Normal printer leads, as used between computers and printers, are kept fairly short: usually not more than 2m, this is to make sure that data is not corrupted by noise spikes. The length of cable used between the computers should be of similar length, but if need be it can be extended, but be aware that problems might happen if the cable is too long.

Next, a short program written in Turbo Basic (with minor modifications, it will work with most versions of BASIC) is needed to grab bytes of data from the PC I/O card and output them to a disk file. I have put comments in the listing which will assist in understanding how the program works.

The Maplin IBM PC I/O Card is put into one of the PC slots. The base address is normally set up for location 0300_{HEX}. This is the address for prototype cards, although it is possible to change it if there is a conflict with another card using the same address (remember that the address in the program will need to be changed as well).

On running up the system, it worked a treat; the data was transferred to the PC, showing me the data on the screen and at the same time saving to disk. The data saved is now the basis of my new data base on the PC, and it has certainly saved me many hours work. I am sure that there are other applications that might benefit from this method of transferring data. I am certainly pleased that I was able to transfer my data as it worried me that my hard work might have been lost. My old home computer is now packed away, maybe one day it might become a valuable museum piece.

IBM PC CENTRONICS INPUT PORT PARTS LIST

37-Way D-Type Socket	1	(FV72P)
36-Way Centronics Socket	1	(FV87U)
12-Core Multi-Core Screened Cable	As Req.	(XS20W)
IBM PC I/O Card	1	

The Maplin 'Get-You-Working' Service is not available for this project.
The above items are not available as a kit.

IBM PC I/O CARD

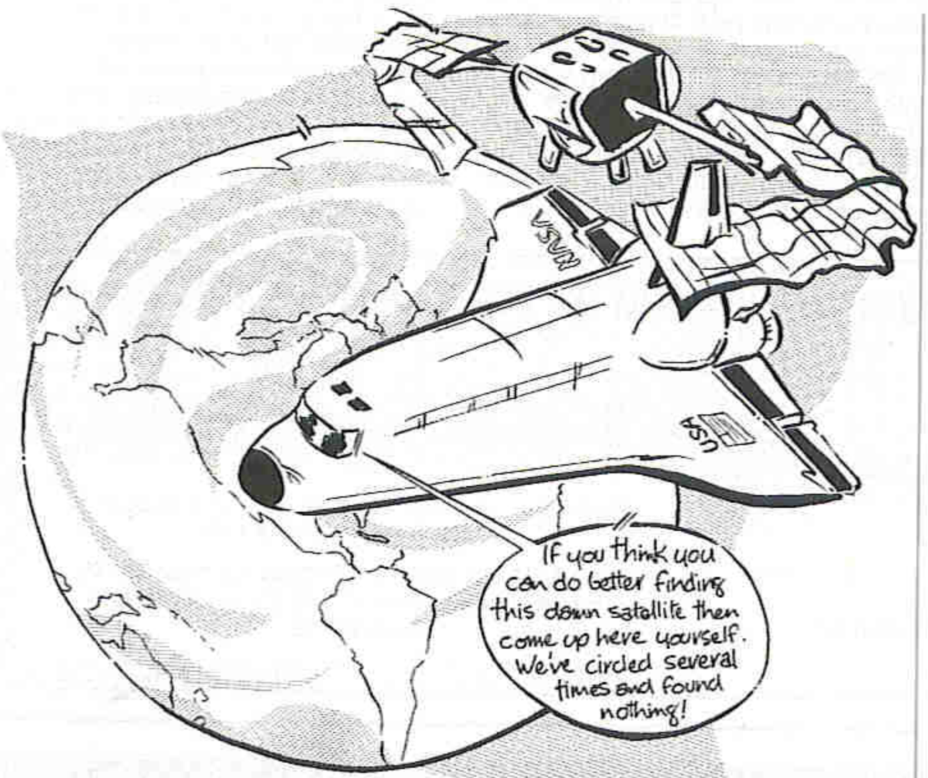
	IBM PC I/O Card Kit	1	(LP12N)
or	IBM PC I/O Card Assembled	1	(AM11M)

The Maplin 'Get-You-Working' Service is available for the IBM PC I/O Card Kit.

Order As LP12N (IBM PC I/O Card Kit) Price £21.95.
Order As AM11M (IBM PC I/O Card Assembled) Price £29.95.

Stray Signals

by Point Contact



Caveat emptor – let the buyer beware: especially when what he purchases is access to an outside computer network. Such a network is exceedingly useful, enabling electronic mail, data files and a thousand other items to be rapidly exchanged between users, facilitating the interchange of information and generally oiling the wheels of business. Last year, however, some hackers in the USA intruded into the Internet network and planted a 'trojan horse' program, which then monitored all network activity. It recorded password information in a secret file, which its creators subsequently accessed. This gave them details of the passwords for thousands of US government, corporate and university networks connected to the Internet system.

It is not known how many computer systems have been compromised, or whether any data has been stolen or damaged (and if so, how much). With network-borne logic bombs, trojan horses, viruses, bacteria and worms all potentially infesting the unwary computer, my ancient but trusty PC, used mainly as a word processor, is connected to nothing beyond a printer and a PROM programmer, certainly not to any outside network, thank you very much! Not that that is necessarily a guarantee of continued computer health. Be very wary of apparently cheap software, possibly pirated from legitimate sources, offered on disk – or even accepting software from a friend: it may be dubious without him realising it! (Very easily done, so it's a good idea to invest in some anti-virus software – Ed.)

Staying with news from across the other side of the pond for the moment, on 8th October last year, officials at the NOAA (National Oceanic and Atmospheric Administration), at Silver Spring, Maryland, said they had given up hope of finding Landsat 6, a 220 million dollar earth observation satellite, with which all contact was lost after its launch three days earlier. (I hope it was insured – I wouldn't like to be in the insurance business.) At about the same time as the launch, the U.S. Justice Department had just reached a 25 million dollar settlement (on behalf of NASA) with the makers of the Hubble Space Telescope, whose faulty mirror made performing some of its tasks impossible.

Meanwhile, across the globe, the Ukrainian Parliament decided that electricity production at Chernobyl should continue, reversing an earlier decision that the nuclear plant should shut by the end of 1993. This was part of a policy, said officials, to develop indigenous energy production and reduce reliance on its major supplier and big neighbour Russia.

Readers of this magazine include both electronics hobbyists and professional electronic engineers – not that these two categories are by any means mutually exclusive! Most readers, and certainly those in the second category, will know that components are cheaper when bought in bulk, the 100-up unit price often being half that of the 1 off price, and the 10,000-up unit price peanuts by comparison. Yes, well that's certainly so – isn't it?

Not always, as PC found out many years ago. At the time he worked for a company which manufactured RF bridges, among other things. Each of these used two large Muirhead slow-motion drives of the type which had been fitted to various MOD receivers, etc. during WWII, which we usually bought by the ten or twenty at a time and which, strangely enough, the manufacturer was still willing to make and supply in such small quantities. Then, while chasing a potentially lucrative overseas order (which in fact never materialised) for 100 bridges, we requested a quotation for 200 of the drives, expecting a useful if not huge reduction in price.

In fact the very reverse was the case; the prospect of an order of that size had prompted the manufacturer to reappraise his cost of production, which had not been done since decades before! As a result the firm realised that for years they had been supplying these items at a considerable loss on each one, so not only was the quoted price per unit at 200 off much higher, but also, from then on, our normal order size price was higher still – a clear case of the advisability of letting sleeping dogs lie!

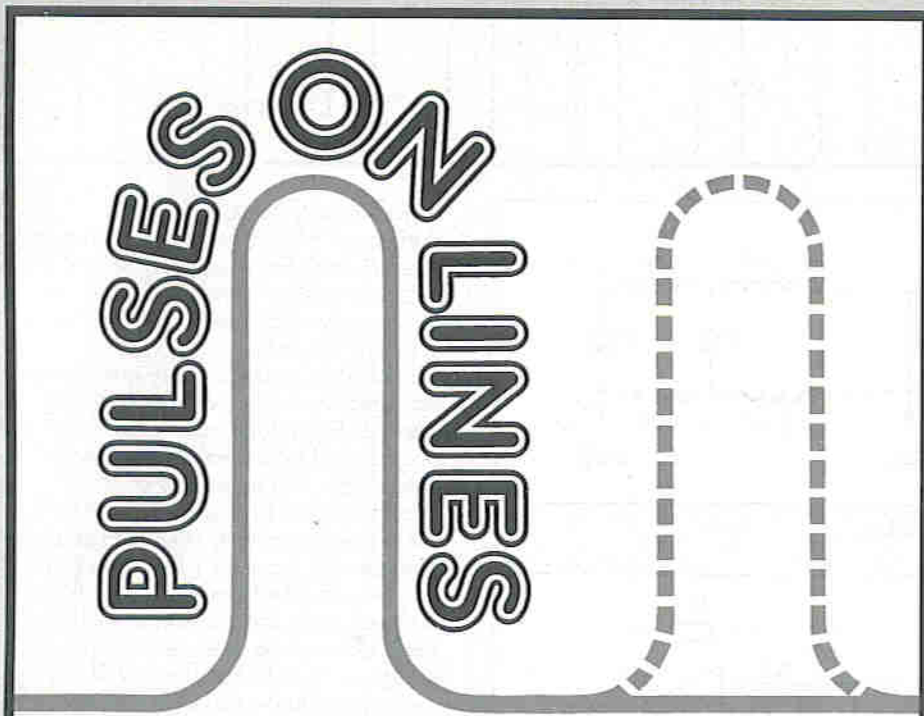
Tailpiece: Last November the University of Southern California, Los Angeles, announced that the virus era was now ten years old, the program for the very first virus having been written by a USC college student in 1983. That student is now a computer security consultant: it would be difficult to think of a better qualification for the job!

Yours sincerely,

Point Contact

The opinions expressed by the author are not necessarily those of the publisher or the editor.

Pulses on Lines



A Beginner's Guide

by Bryan Hart **PART ONE**

A Circuit Around the Fields

IMAGINE a child's skipping rope lying in a straight line on a level wooden floor. The near-end, shown as 'A' in Figure 1, is left free but the far-end, 'B', is attached to a fixed post. If A is moved upwards to position A_1, then moved slowly back again to its original position, all points on the rope change position simultaneously by amounts dependent on their distances from B.

Each frame of a filmed record of the change would be indistinguishable from that obtained if the rope were to be held stationary in that position, e.g., A_2B. Suppose, however, that instead of being moved slowly the end A is jerked upwards and then down. Then, all points on the rope do not change position simultaneously. A bell-shaped disturbance travels along the rope from A towards B, as shown in Figure 2, with a velocity that depends on the elastic properties of the rope material.

Figure 1 illustrates a mechanical analogue of a 'lumped' electrical system, a familiar example being a potentiometer network comprising of two ordinary resistors.

In contrast, Figure 2 depicts a mechanical analogue of a 'distributed' system – a 'transmission line' used for sending fast pulses over appreciable distances – that is the subject of this introductory article. The words 'fast' and 'appreciable' are, of course, vague and one aim is to formulate a numerical relationship between them that can be used in design work.

As this area of electronics seems, traditionally, to present problems not only to the beginner but also to the practising engineer, we digress briefly to examine further the nature of the problem.

In both free space and solids, electrical

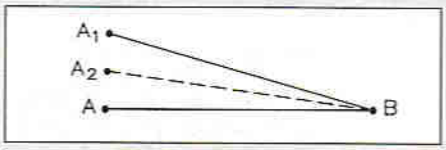


Figure 1. Skipping rope profile. End A is moved up and down slowly while end B is fixed.

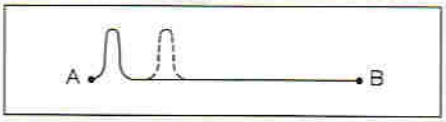


Figure 2. Rope profile when A is jerked up and down.

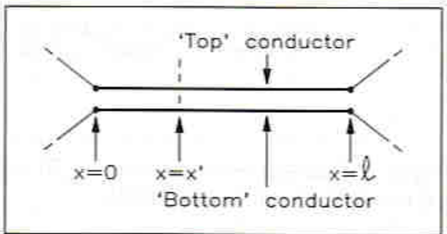


Figure 3. Two closely-spaced parallel conductors comprise a transmission line.

signals are electromagnetic in nature. In free space, radio waves travel at the velocity of light in air (3×10^{10} cm.s^{-1}, or 186,000 miles per second); in a conductor, the effects of a changing electrical charge pattern are transmitted with a velocity close to that of light.

If you were to press a switch to start up the operation of a robot arm situated on the ground, 6 feet in front of you, the only significant delay (a few milliseconds) would be due to the contact time of the switch. For most practical purposes, the actions – the switch being pressed, and the robot arm starting to move – could be regarded as simultaneous.

If, however, the same switch controlled, via a radio link, the same robot arm but this time located on the moon, and you observed the movement of the arm via a suitably positioned camera and TV link, there would be a delay of some 2·5 seconds. This would be the time required for the command signal to travel the 240,000 miles to the moon, and for the picture to be transmitted back to earth. The delay would not necessarily matter in the case of the robot arm, but it would limit the speed at which you might talk if, as an earth-based observer, you wanted to have an intelligible conversation with a moon-based astronaut.

This introduces the important point – that any delay in a transmission path must be considered in relation to the proposed operating speed of a system.

Note, in passing, that the time delay experienced when an electromagnetic wave is transmitted to earth, via a satellite in orbit around it, is put to advantage in the design of accurate global positioning systems.

Transmission Lines – Ideal and Real

Figure 3 shows two closely-spaced parallel conductors, of constant circular cross-section, stretching between points x = 0, x = ℓ. The conductors are assumed to have negligible resistance and to be perfectly insulated from each other. They comprise an ideal transmission line with predictable and reproducible characteristics, suitable for sending fast digital pulses from one logic unit to another.

The properties of the line can be described in terms of electromagnetic field theory, which is basically concerned with the fields around the conductors – and

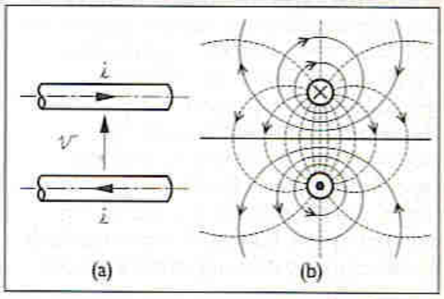


Figure 4a. Line currents and voltage at x = x'. Figure 4b. Field patterns corresponding to (a). Magnetic flux (H) lines shown full, electric flux (E) lines shown dotted. $L = L_T/2n$; $C = C_T/n$, L_T, C_T defined in text.

conventional circuit theory, which deals with the voltages and currents associated with them. The circuit theory approach is favoured by engineers, and is the one we will follow, because it is an extension of familiar ideas. However, it helps to keep the field approach in mind because it gives added physical insight.

Figure 4a shows the voltage and currents

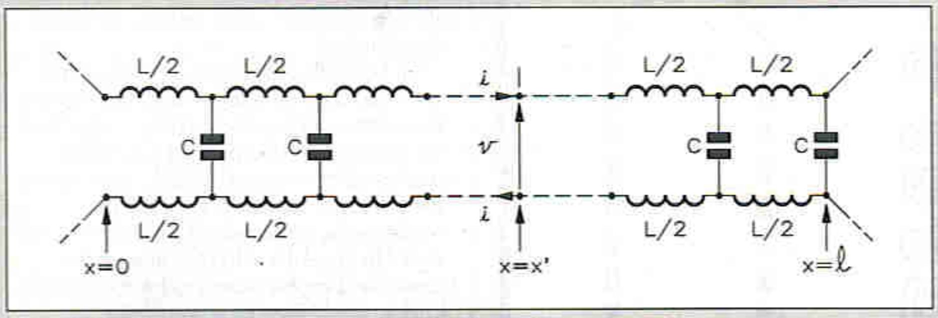


Figure 5. Ladder network approximation for Figure 3.

at a point, x', along the line. The 'return' current in the lower conductor must be equal in magnitude to the 'go' current in the upper conductor because electric charge must be conserved; it cannot just disappear. Figure 4b shows the related field distribution patterns. These apply for both DC and transient conditions. The lines of magnetic flux, H, are perpendicular to the lines of electric flux, E, and both are at right angles to the direction of travel of the electromagnetic wavefront for this transverse electromagnetic (TEM) wave.

The direction is that of the current in the top conductor, which is indicated by the arrow-tail.

For circuit analysis, we can approximate the electrical behaviour of the line by considering it to be a ladder network of *n* sections, as shown in Figure 5 (artificial transmission lines using a similar ladder structure were used, in fact, as long ago as World War II, in the design of radar modulators).

Each section comprises two inductors, each of value $L_T/2n$, that take into account the effects of the magnetic field, and a capacitor C_T/n that accounts for the electric field. L_T and C_T are the total line inductance and capacitance respectively, as might be determined using a suitable measurement bridge. The larger the value of *n*, the closer the performance of the network approaches that of an 'ideal' line. As *n* approaches infinity, L_T and C_T must be uniformly distributed, and it is necessary to characterize the line in terms of the inductance per unit length, L_o, and the capacitance per unit length, C_o. The 'unit length' can be whatever we choose, e.g., in inches or feet, but there is a trend towards the use of metric units, i.e. centimetres and metres.

The construction of buildings provides a useful analogy for the approximation process. If the individual steps in a staircase connecting two vertically adjacent floors in a building are reduced in height by a factor of one thousand, and the number of steps is increased by the same factor, the staircase becomes, for most purposes, a ramp. It is then necessary to specify the slope, i.e. the amount of height change per unit of horizontal run, instead of the rise at each step.

From a mathematical analysis, the key features in line operation that emerge for a signal launched on to it, are as follows:

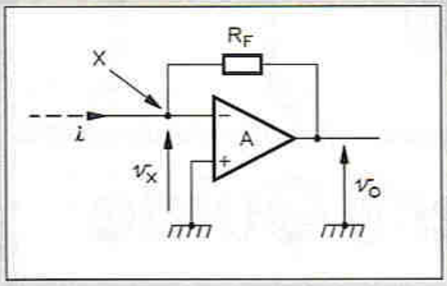


Figure 6. Amplifier circuit analogy used in clarifying meaning of R_o ('characteristic resistance').

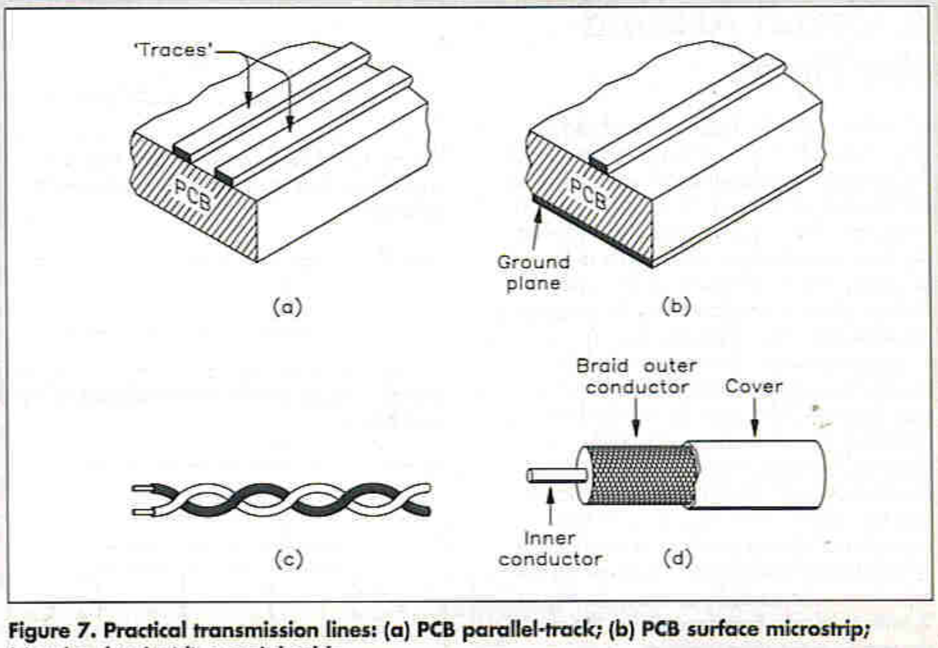


Figure 7. Practical transmission lines: (a) PCB parallel-track; (b) PCB surface microstrip; (c) twisted-pair; (d) co-axial cable.

1. The signal travels along the line with a constant velocity

$$u = \frac{1}{\sqrt{L_o C_o}}$$

There is no change in shape or amplitude in its passage along the line from $x = 0$ to $x = \ell$, only a time delay t_d. t_d is often referred to as the 'electrical length' of the line. It is usually more convenient to write $t_d = \ell\, t_u$, $t_u = \sqrt{L_o C_o}$ being the time-delay per unit length.

2. The instantaneous ratio of signal voltage charge to signal current charge, at a point reached by a signal is a constant, R_o, known as the 'characteristic resistance'. Furthermore, $R_o = \sqrt{L_o \div C_o}$.

R_o is often a source of confusion for beginners, and therefore deserves clarification. Although expressed in ohms, it does not mean that energy is dissipated as heat, as would be the case with the familiar component we call a resistor. Appearing to be one thing while being, in reality, something else is not uncommon in electronics. An illustrative example occurs in amplifier theory. In Figure 6, the operational amplifier A is assumed to be ideal, with an infinite voltage gain. This means that point X appears to be at earth potential, and for this reason is commonly referred to as a 'virtual earth'. A current, *i*, flowing to X from an input circuit (not shown) does not flow to chassis earth, but passes through the feedback resistor to produce the output voltage, v_o. The ideal op amp circuit configuration forces the circuit condition $v_x = 0$. In our case, the ideal line forces the condition $v = i\,R_o$. It is immaterial whether *i* is the stimulus and V the response, or vice versa.

From the point of view of conventional circuit theory, R_o governs the rate at which energy can be supplied to the line from an applied source, and stored in the line as the signal travels along it. Thus, R_o is associated with the rate of energy transfer or storage – not the rate of energy dissipated. It can be shown that the energy is shared equally between the E and H fields.

From the point of view of field theory, an electromagnetic wave is guided down the line by the conductors. The 'spiders-web' field pattern of Figure 4b expands and contracts in scale, in step with the profile of the signal applied to the line, but does not change its shape. R_o is a time-independent factor of proportionality relating the strength of the E field at any point near the conductors, to the strength of the H field there.

Continued on page 44.

Last month we took a detailed look at essential LCD Digital Panel Meter (DPM) basics and general application information, and showed some simple ways of using DPM modules. This part goes one step further, and presents essential 'application' details of the two specific LCD DPM modules.

THE MAPLIN LCD DPMS

The current Maplin Catalogue lists two types of LCD DPMs, categorised by their display digit height of 10mm (Order Code FD89W), and 12·5mm (Order Code FD88V) respectively. Electronically, the two units are fairly typical of modern types, designed around a subminiature 44-pin, flat-pack version of the ICL7136, which drives an LCD that carries a good range of annunciators. Figure 17 shows the appearance of the LCD with all segments and annunciators activated.

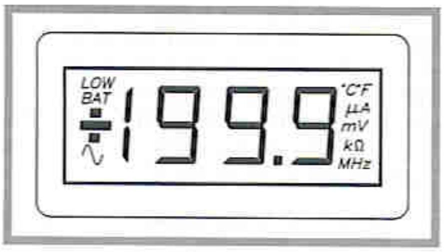


Figure 17. Appearance of the Maplin DPM LCD display, with all segments and annunciators activated.

Both DPMs have the normal basic features of Auto-Zero, Auto-Polarity and 200mV full-scale sensitivity, plus Automatic Low-Battery Indication, Programmable Decimal Points, etc. Figure 18 shows the basic specification that is common to both units. Both versions typically consume a total operating current of 150µA, each from a 9V supply.

Although the two DPMs are fairly ordinary electronically, they are very unusual regarding their physical structure. The 10mm model is, for example, exceptionally compact, being only 40.5mm wide, 20.4mm high, and 10.6mm in total depth of body. The 12.5mm model is larger, and measures 52 x 24.8 x 10.7mm. Also, each DPM is provided with connecting pins rather than more usual solder pads, enabling it to be plugged directly into a standard DIL IC socket. The 10mm model uses a 28-pin DIL format, while the 12.5mm model uses a 40-pin DIL format. Each unit can be mounted into a fascia panel by adding a snap-in bezel that is provided with the module. Another unusual feature is that the rear surface of each unit has a number of special 'split' solder pads that can be used to directly 'program' the DPM. By either cutting or solder-bridging the pads, dedicated DPM applications are possible, thus minimising the number of external connections required to the unit.

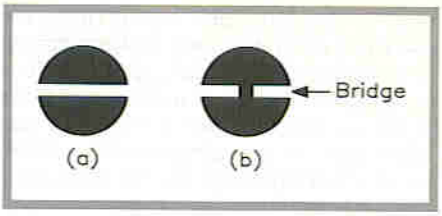


Figure 20. Magnified views of the normally open (a) and normally closed (b) 'round' versions of the 'split' PCB solder pads.

The two 'Maplin' LCD DPMs are, therefore, modern units of unusual construction. The 10mm unit is ultra-compact; it carries 24 user-available pins, and offers good application versatility and a good range of available annunciators. The 12.5mm model is a larger unit, with 36 user-available pins, offering even greater versatility, and a larger number of user-available annunciators. Figure 19 shows the character annunciators that are available from each DPM. Individual annunciators (and Decimal Points) can be activated by connecting them to the unit's XDP pin. Note that unwanted annunciators can (unless otherwise stated) be fully disabled by shorting them to the BP pin, or can be temporarily disabled (so that they can be turned on and off) by connecting them to BP with a 1M resistor. They must never be connected directly to XDP and BP at the same time!

If you look on the back of one of these DPMs you will find several numbered 'split' solder pads, that can be used to 'program' the unit. On the 10mm type the pads are rectangular and there are seven of them, but only three are intended for normal customer use. On the 12.5mm type

Specification	Min	Typ	Max	Unit
Accuracy (±1 count)		0·05	0·1	%
Linearity			±1	Count
Sample Rate		3		per sec
Temp Stability		100		ppm/°C
Temp Range	0		50	°C
Supply Voltage (V+ to V–)	7·5	9	15	V
Supply Current		150		µA
Max DC Input Voltage			±20	V
Input Leakage Current (V_{in} = 0V)		1	10	pA
Low Battery Threshold		7·5		V

Figure 18. Basic specification that is common to the two Maplin LCD DPMs.

DPM Model	°C	°F	µ	A	m	V	k	Ω	M	Hz	–	:	–
10mm (DPM 400)	√	–	√	√	√	√	√	√	√	–	√	√	–
12·5mm (DPM 500)	√	√	√	√	√	√	√	√	√	√	√	√	√

Figure 19. Range of character annunciators available from the Maplin DPMs.

most of the pads are round. There are eleven of them, but only five are meant for normal (non-specialist) use. If you look at the pads through a magnifying glass, you'll see that they are of either the normally open or the normally closed types, as shown in Figure 20. The normally open types can be closed by bridging the gap with a spot of solder. The normally closed type can be opened by cutting away the PCB shorting link with a sharp knife, taking great care not to damage any adjacent tracks!

MECHANICAL CONSIDERATIONS

If you buy one of these units, the box contains the basic DPM, a panel-mounting bezel and stick-on face plate. The manufacturer's instruction leaflet is included, this gives a complete circuit diagram as well as useful application notes and dimensions. The units are manufactured by Lascar Electronics Ltd. who call the 10mm model the 'DPM 400', and the 12·5mm model the 'DPM 500'. If you decide to use the bezel, etc., proceed as follows:–

Cut a suitable hole in the panel (45 x 22mm for the DPM 400, 57 x 27mm for the DPM 500) and clip the bezel into place from the front. Remove the pull-off protective film from the face of the ready-tested DPM, and slide the DPM into the bezel from the rear until it clicks into place. Now remove the rear protection from the face plate (to expose its sticky surface) and stick it onto the front of the bezel. Finally, peel off the protective film on the front of the face plate.

The following two sections give individual application information on the two different models of DPM.

USING THE 10mm (DPM 400) DPM

Figure 21 shows the basic application diagram of the 10mm DPM. All annunciator control terminals are shown on the right. Note the 'backwards' numbering of the DP1 to DP3 decimal point control terminals, which – like the annunciators – can be activated from the XDP terminal. All input control terminals and pads are shown on the left of the diagram.

Note that REF LO is normally shorted to COM via Pad 3, IN LO can be joined to COM by shorting Pad 2, and that REF HI is normally joined to an internal 100mV reference via Pad 1. The CLK (CLOCK) terminal allows the unit's internal clock signals to be externally accessible, but can also be used as an input point to override the internal oscillator. This terminal should be treated with caution.

The TEST terminal can be activated from the positive supply line, and should not be used for longer than 5 seconds at a time. If all is well, it produces a '–1888' display. The module's supply terminals are numbered 24 (V+) and 25 (V–).

Figure 22 shows the unit's rear panel connections available to the user. Ideally, access to the control pins should be made via a 28-pin DIL socket. Soldered connections can, however, be made directly to the pins, but only at the user's own risk. Figure 23 shows the LCD display obtained when the unit's TEST terminal is activated.

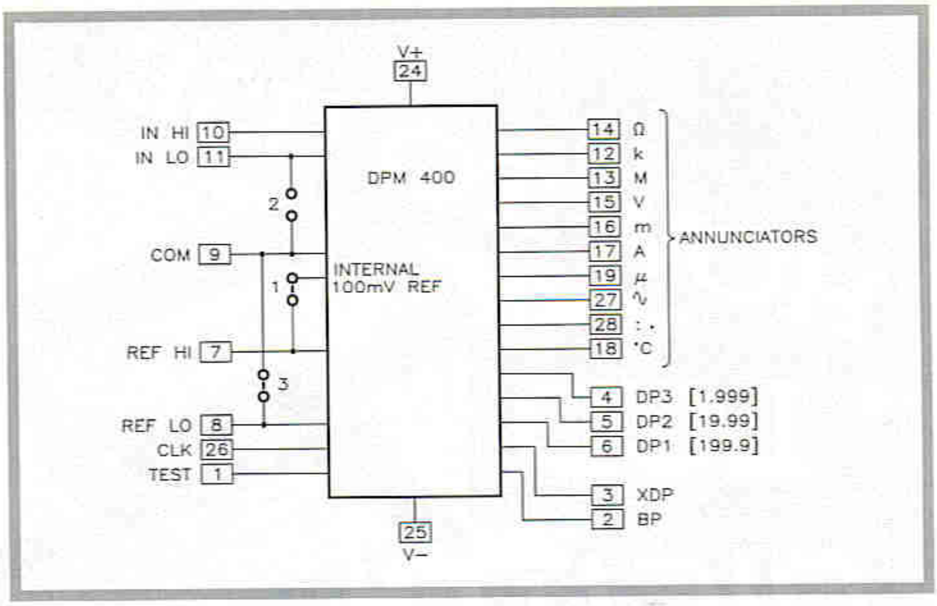


Figure 21. Basic application diagram of the 10mm DPM (DPM 400).

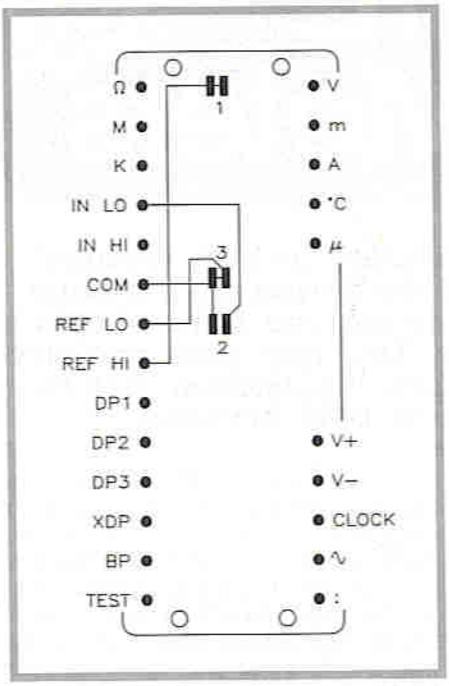


Figure 22. Rear panel connections of the DPM 400.

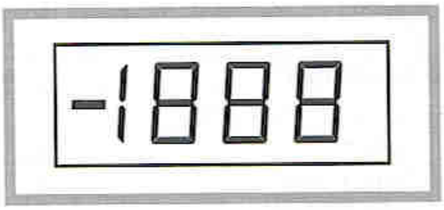


Figure 23. 'TEST' display of the DPM 400.

WHAT TO DO FIRST

The first thing that you should do on obtaining one of these modules is to give it a functional test as a 200mV FSD meter, Figure 24 shows the connections to use. Wire this circuit to a 28-pin DIL socket, with flying leads connected to pins 1 (TEST), 3 (XDP) and 10 (IN HI). Plug the module into place in the socket and connect a 9V supply (for example, a PP3 battery). Initially, the meter should read '000', which changes to '–1888' if you touch the TEST flying lead to pin 24. With the IN HI lead connected to pin 7 (REF HI), the display should read '1000', ±1 digit. If the supply voltage is reduced below 7·5V nominal, the display's 'battery' sign should activate. Once these tests are complete, use the XDP flying lead to activate and test the various DP and annunciator symbols. These may be slow to turn off again if they are not provided with a static-discharge path to BP (pin 2, the back-plane).

Note that in most DPM application diagrams, the use of the TEST, XDP, DP, and annunciation pins is left to the common sense of the user. The basic circuit of Figure 24 (which acts as a 200mV FSD meter with a 1MΩ input impedance) can thus be simplified to that of Figure 25. This in turn can be scaled to read alternative FSD values of DC voltage or current by using the 'R_a' and 'R_b' connections and values shown in Figure 8 last month. Working on this 'simplified circuit' principle, Figures 26 to 28 show various other basic ways of using the DPM 400.

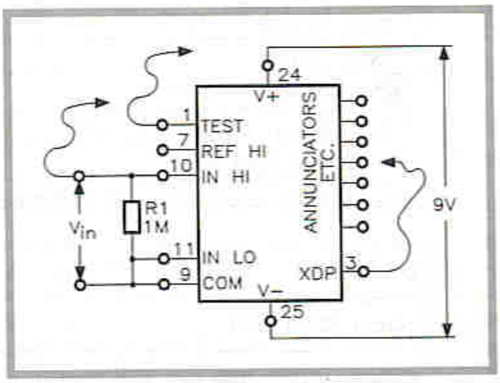


Figure 24. Basic DPM 400 functional test circuit as a 200mV FSD meter.

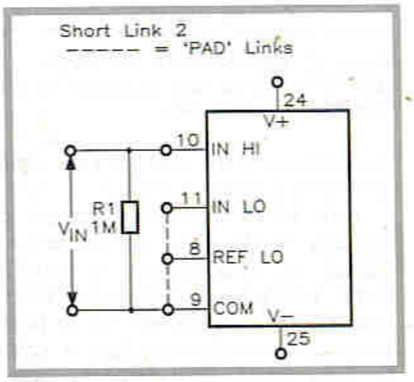


Figure 25. Basic 200mV meter using the DPM 400.

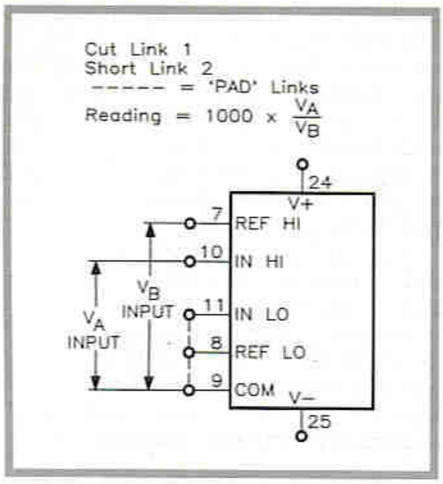


Figure 26. Basic DPM 400 ratiometric voltmeter, with common 'LO' inputs.

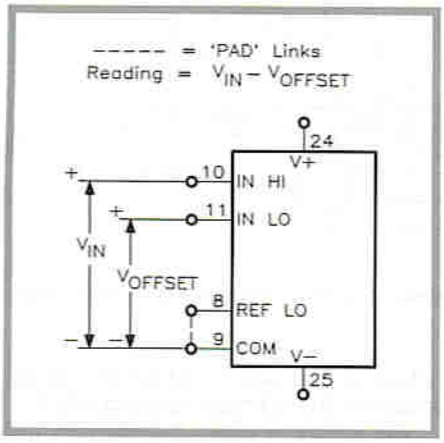


Figure 27. Method of applying zero-offset to the DPM 400 200mV meter.

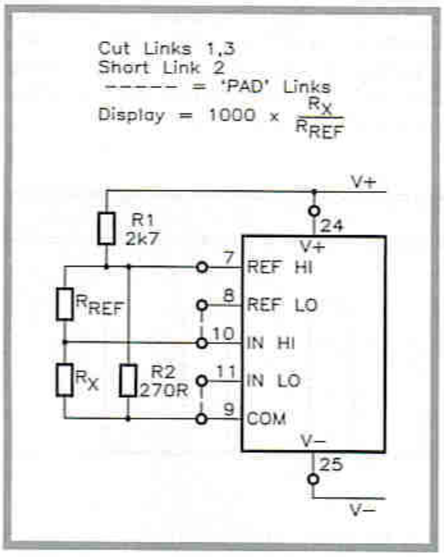


Figure 28. DPM 400 precision resistance meter, using ratiometric technique.

USING THE 12·5mm (DPM 500) DPM

Figure 29 shows the basic application diagram of the 12·5mm DPM. All annunciator control and auxiliary output terminals are shown on the right, and the rear panel connections in Figure 30. Again note the 'backwards' numbering of the DP1 to DP3 decimal point control terminals, which – like the annunciators – can be activated from the XDP terminal. Note that the (–) (pin 15) terminal is shorted to the POL terminal via Pad 11. To use it, cut the link in Pad 11, but note that this

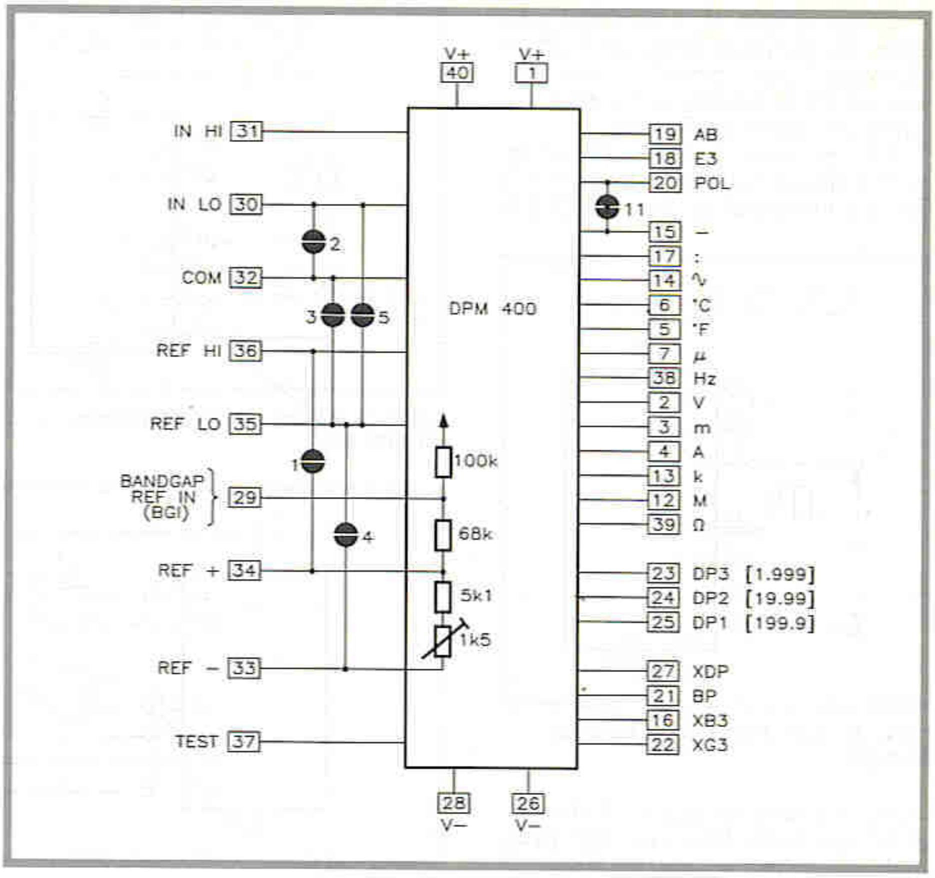


Figure 29. Basic application diagram of the 12·5mm DPM (DPM 500).

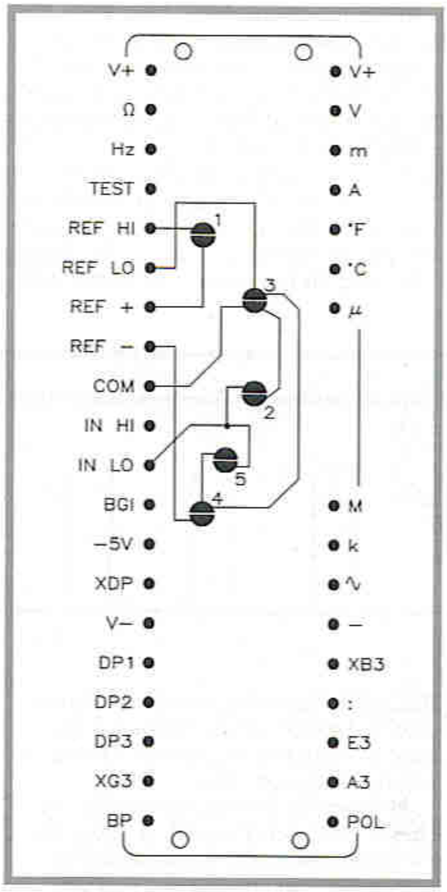


Figure 30. Rear panel connections of the DPM 500.

Figure 31. 'TEST' display of the DPM 500.

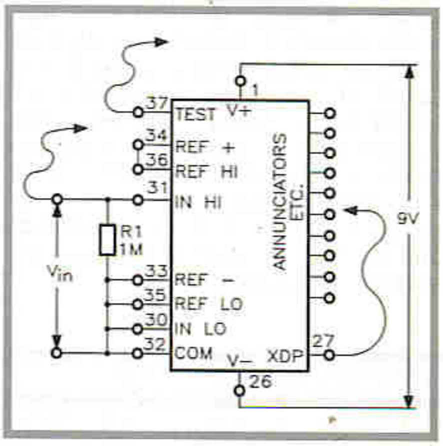


Figure 32. Basic DPM 500 functional test circuit as 200mV FSD meter.

action disables the unit's auto-polarity indication. The AB, E3, XB3, and XG3 outputs are activated by the display's two left-hand digits, and are useful in auto-ranging circuits. Note that although the unit is shown as having two sets of 'supply' pins, only pins 1 (V+) and 26 (V–) should normally be used.

All input control terminals and pads are shown on the left of Figure 29. Note here that the unit's internal reference only becomes active when pin 33 (REF–) is shorted to COM (which is biased to 2·8V below V+). Under this condition 100mV is generated between 'REF+' and 'REF–' from the internal voltage divider network. Also note that this internal reference can be overridden by connecting a suitable bandgap reference network externally between pins 29 and 33, as shown later (see Figure 34). The TEST terminal can be activated from the positive supply line, but should not be used for longer than 5 seconds at a time, and should produce the display shown in Figure 31.

Ideally, access to the control pins (Figure 30) should be made via a 40-pin DIL socket. Solder connections can, however, be made directly to the pins, but only at the operator's own risk.

The first thing that you should do upon obtaining one of these modules is to give it a functional test as a 200mV FSD

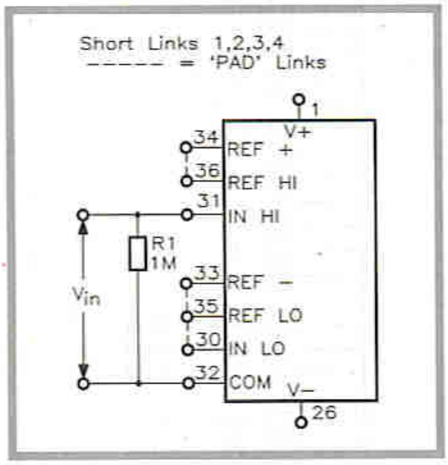


Figure 33. Basic 200mV meter using the DPM 500.

meter, connected as Figure 32. Wire this circuit to a 40-pin DIL socket, with flying leads connected to pins 37 (TEST), 27 (XDP) and 31 (IN HI). Plug the module into place and connect a 9V supply. Initially, the meter should display '000', which changes to that of Figure 31 if you touch the TEST flying lead to pin 1. With the IN HI flying lead connected to pin 34 (REF HI), the display should read '1000', ±1 digit. If the supply voltage is reduced below 7·5V nominal, the display's 'battery' sign should appear. Once these tests are complete, use the XDP lead to activate and test the various DP and annunciator symbols, as already described.

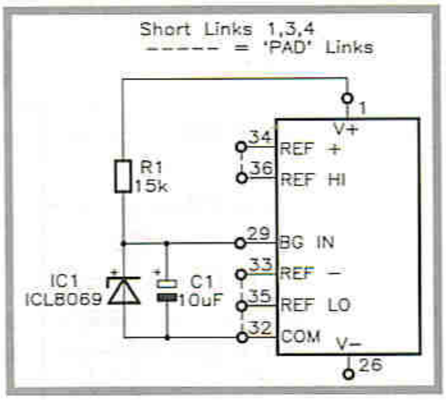


Figure 34. Adding a bandgap reference to the DPM 500.

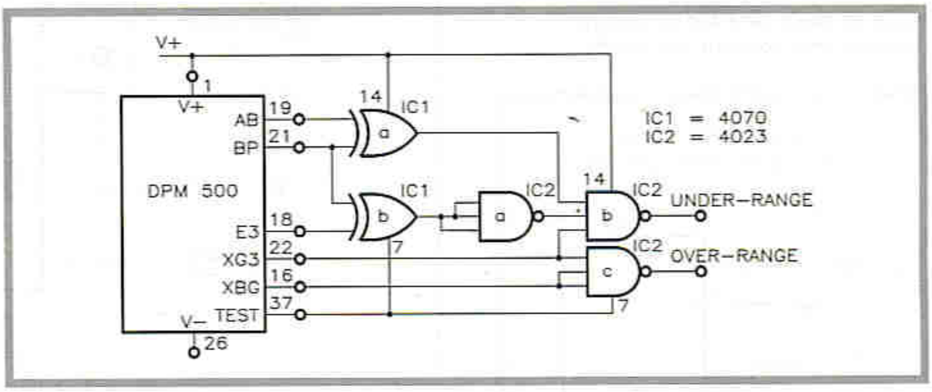


Figure 35. Adding auto-ranging outputs.

While the connection of the TEST, XDP, DP, and annunciation pins is left to the common sense of the user, the basic circuit of Figure 32 (which acts as a 200mV FSD meter with a 1MΩ input impedance) is simplified to that of Figure 33. This in turn can be scaled to read alternative FSD values of DC voltage or current by using the same 'R_a' and 'R_b' connections and values shown in last month's Figure 8. Working on this 'simplified circuit' principle, Figure 34 shows how an external bandgap reference can be added to the circuit. Similarly, Figure 35 shows how the auxiliary output terminals can be decoded to provide over-range and under-range control signals via a couple of external CMOS ICs, which are powered by connecting them between the V+ and TEST terminals.

Next month, we shall see various practical applications that can be used with any of the modern LCD DPMs. In these, 'conventional' terminal notations are used, in which the notations RFH, RFL, ROH, and ROL correspond to the Maplin notations 'REF HI', 'REF LO', 'REF +', and 'REF –' respectively. Similarly, 'conventional' DP notations are used, in which DP1 corresponds to the left-hand decimal point.

The reader is asked to note that this mini-series is based on Chapter 7 of the author's *Instrumentation and Test Gear Circuits Manual* (published by Butterworth-Heinemann Ltd.), with extra material, derived from data sheets supplied by Lascar Electronics Ltd., added. The book is available from Maplin, Order As AA37S Price £16.95*NV*

Pulses on Lines *continued from page 40*

Although the two conductors comprising a line have to be parallel and uniform, they need not be circular in cross-section. In principle, any shape is allowed. That chosen in practice is dictated by the application. R_o is determined by cross-sectional geometry, but it emerges that u is independent of this, and is a function only of the velocity of light in air and the dielectric constant of the line insulation.

Figure 7 shows, schematically, the mechanical arrangements of some popularly used lines. Over lengths of some metres, the energy loss in these, due to finite conductor resistance and dielectric loss, is normally quite small compared with the transmitted signal energy – so they can be assumed 'ideal' or 'lossless' for many applications.

Figures 7a and 7b apply to connections between high-speed units on a particular PCB, while those of Figures 7c and 7d are used for interconnections between PCBs, some of which may be remotely located with respect to each other.

In Figure 7a, the line is formed by two parallel PCB tracks ('traces'); in Figure 7b, the 'surface microstrip' line is formed by a single track on one side of a PCB and a common ground plane on the other. Formulae, given in the literature (consult, for example, the references to be given at the end of this series) specify R_o (Ω) in terms of mechanical dimensions and the dielectric constant of the PCB material. Sometimes this data is displayed graphically for ease of use in design work.

Generally, R_o lies in the range 20Ω to 120Ω, whilst $t_u \approx 1{\cdot}75$ns/ft.

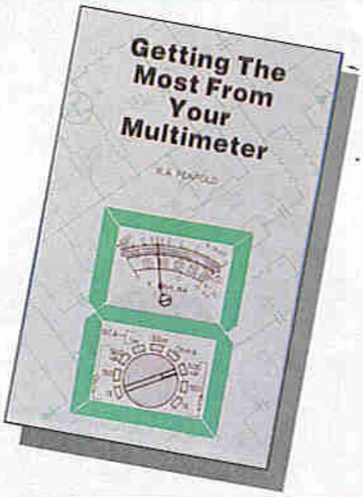
In Figure 7c, two insulated wires, twisted together continuously in a uniform manner over their lengths, make a low-cost, flexible 'twisted-pair' line having $R_o \approx 100\Omega$ and $t_u \approx 1{\cdot}8$ns/ft. Such a line can be purchased commercially, but short lengths (e.g., 1m) are easily made up by a user. Figure 7d shows the familiar co-axial cable. This is used where minimum loss, maximum preservation of pulse shape and maximum screening is required. Typically $R_o = 50\Omega$, but $R_o = 75\Omega$ and $R_o = 93\Omega$ are also used in video and data transmission; $t_u \approx 1{\cdot}5\text{ns.ft}^{-1}$.

In Part Two of this series, we will discuss pulse transmission on a line and show, in three illustrative examples, how pulse-edge shape at $x = 0$ and $x = \ell$ can be calculated by simple arithmetic.

These are our top twenty best selling books based on mail order and shop sales during February '94.
Our own magazines and publications are not included in the chart below.

The Maplin order code of each book is shown together with page numbers for our 1994 catalogue. We stock over 250 different titles, covering a wide range of electronics and computing topics.

Number ONE



Getting The Most From Your Multimeter
by R.A. Penfold
A unique and very useful book, showing you how to best use your multimeter.
(WP94C) Cat. P746.
Previous Position: 1.
Price £2.95.

2

Home VCR Repair Illustrated, by Richard Wilkins & Cheryl Hubbard. *(WZ32K) Cat. P755.* Previous Position: 3. **Price £13.95** A1.

3

IC555 Projects, by E.A. Parr. *(LY04E) Cat. P751.* Previous Position: 2. **Price £2.95.**

16

Remote Control Handbook, by Owen Bishop *(WS23A) Cat. P747.* Previous Position: 12. **Price £3.95.**

17

NO CHANGE

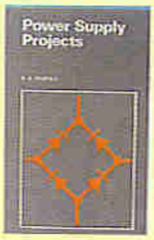
Electronic Projects for Guitar, by R.A. Penfold *(WZ61R) Cat. P723.* Previous Position: 17. **Price £8.95.**

4

NO CHANGE

Loudspeaker Enclosure Design and Construction. *(WM82D) Cat. P721.* Previous Position: 4. **Price £9.95.**

7



Power Supply Projects, by R.A. Penfold *(XW52G) Cat. P748.* Previous Position: 9. **Price £2.50.**

10

RE-ENTRY

The Washing Machine Manual, by Graham Dixon. *(WS98G) Cat. P755.* Previous Position: Re-Entry. **Price £12.95.**

13

RE-ENTRY

Servicing TV and Video Equipment, by Eugene Trundle *(WS76H) Cat. P755.* Previous Position: Re-Entry. **Price £25.00.**

18

50 Simple LED Circuits Book 2, by R.N. Soar. *(WG43W) Cat. P752.* Previous Position: 14. **Price £1.95.**

5

NO CHANGE

An Introduction to Loudspeakers and Enclosure Design, by V. Capel. *(WS31J) Cat. P720.* Previous Position: 5. **Price £2.95.**

8

How to Use Oscilloscopes and Other Test Equipment, by R.A. Penfold. *(WS65V) Cat. P746.* Previous Position: 7. **Price £3.50.**

11

RE-ENTRY

How to use Op Amps, by E.A. Parr. *(WA29G) Cat. P734.* Previous Position: Re-Entry. **Price £2.95.**

14

NEW ENTRY

Electronic Projects for Your PC, by R.A. Penfold. *(WZ76H) Cat. P741.* Previous Position: New Entry. **Price £3.95.**

19

RE-ENTRY

Electronic Music Projects, by R.A. Penhold. *(XW40T) Cat. P722.* Previous Position: Re-Entry. **Price £2.95.**

6

International Transistor Equivalents Guide, by Adrian Michaels. *(WG30H) Cat. P745.* Previous Position: 8. **Price £3.95.**

9

How to Expand, Modify and Repair PCs and Compatibles, by R.A. Penfold. *(WS95D) Cat. P729.* Previous Position: 6. **Price £5.95.**

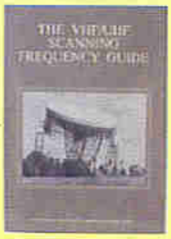
12

50 Projects Using Relays, SCR's and Triacs, by F.G. Rayer. *(RH30H) Cat. P747.* Previous Position: 16. **Price £2.95.**

15

50 Simple LED Circuits, by R.N. Soar. *(RF12N) Cat. P752.* Previous Position: 18. **Price £1.95.**

20



The VHF/UHF Scanning Frequency Guide, by B. Laver. *(WT70M) Cat. P719.* Previous Position: 10. **Price £9.95.**

PROJECT RATING 2

Design by Jerry Sims
Text by Jerry Sims and Robin Hall

Simple MIDI Merge Unit

KIT AVAILABLE (LT52G) Price £14.99

The assembled Simple MIDI Merge Unit ready for use.

FEATURES

- Active design maintains galvanic isolation between units
- Operates up to 6 months from a PP3 battery
- Compact design
- Easy to construct

APPLICATIONS

- Controls a sound module from two sources
- Sequencer set ups

Photo 1. Close-up of assembled MIDI Merge PCB.

The concept of MIDI (Musical Instrument Digital Interface) came from the American manufacturer Sequential Circuits in the early '80s. The idea was to establish a hardware and software specification which would make it possible to exchange information between different musical instruments (or other devices, such as sequencers, lighting controllers, mixers, etc.) regardless of manufacturer. The first commercially produced instrument to include MIDI was the Prophet 600, launched in December 1982. Although originally conceived for live performances, subsequent developments had an enormous impact in recording studios and audio/video production. In fact, such was the impact of MIDI on the recording industry, that there are now very few studios, in this country, devoid of any MIDI equipment.

As mentioned earlier, MIDI is both a software and hardware specification. The software protocol defines the MIDI 'instruction set', whereas the hardware specification is responsible for the actual transmitting and receiving of the MIDI data.

The hardware MIDI interface operates at 31·25k BAUD, with one start bit, eight data bits, and one stop bit. This makes a total of ten bits, the transmission of which takes 320µs.

WHAT ACTUALLY IS A MIDI MERGE UNIT?

The easiest way to describe the operation of the MIDI merge unit is to start by describing a MIDI thru' box. This is designed to take a single MIDI signal and provide two or more buffered outputs. A MIDI merge unit, however, provides the opposite function and combines two (or more) MIDI signals into one. Figure 1 shows a block diagram with some typical system connections.

A sophisticated MIDI merge unit can function with simultaneous input signals. Signals from one input are passed through to the output, whilst the other signals are stored in a buffer until the output is free and can be transmitted. As long as the MIDI sources do not provide so much information that the buffer becomes full, good results are obtained with little significant time-shifting of the MIDI data. However, a merge unit of this kind is complex and expensive, as a microprocessor is required to control the data flow. In most instances, all that is required is a unit that simply mixes two inputs direct into one output. The advantage of a unit like this, is that it can be small and cheap. The only drawback is that simultaneous operation on both inputs must be avoided otherwise the output signal will be scrambled and meaningless. In fact, it is perhaps more truthful to think of a simple MIDI merge unit as an automatic MIDI switch.

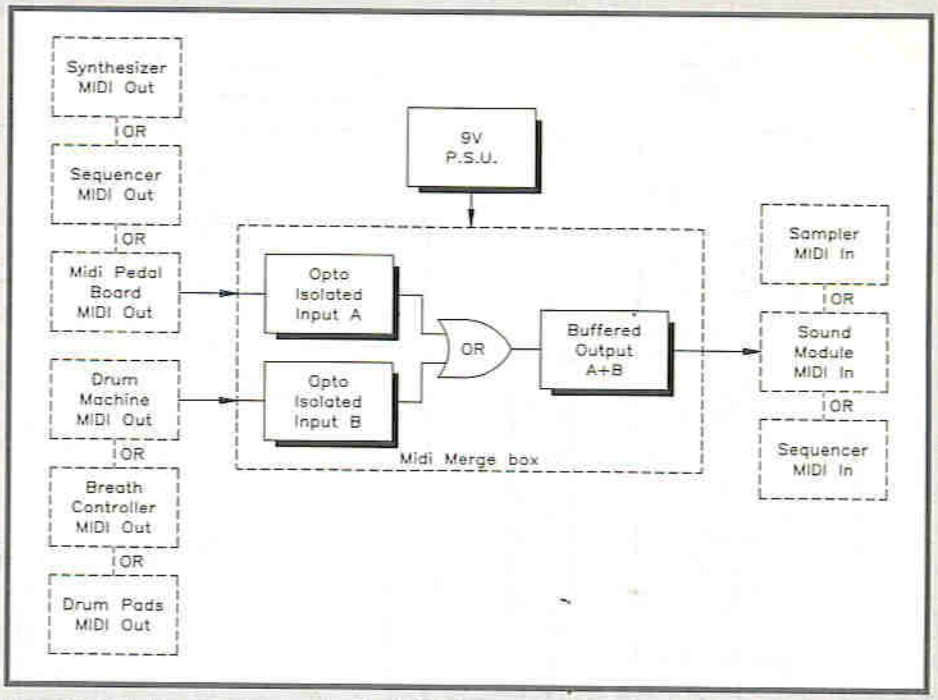


Figure 1. Block diagram showing the Simple MIDI Merge and typical system connections.

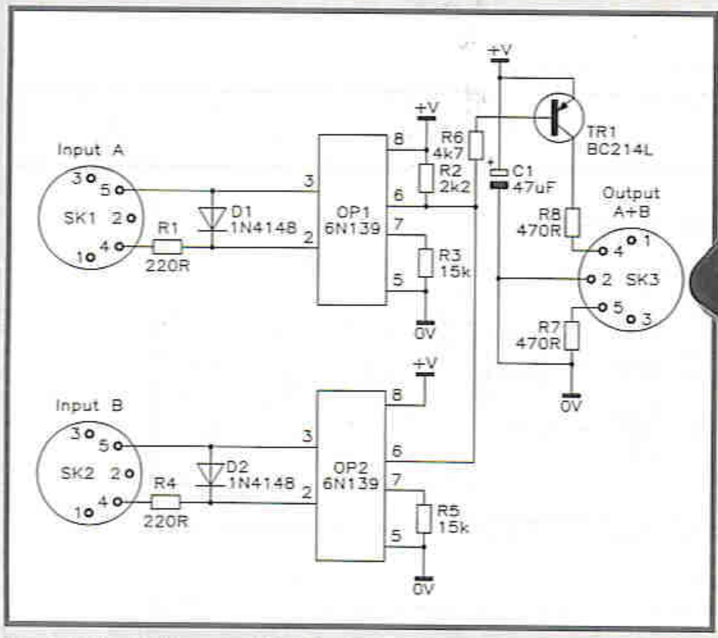


Figure 2. Circuit diagram of the Simple MIDI Merge.

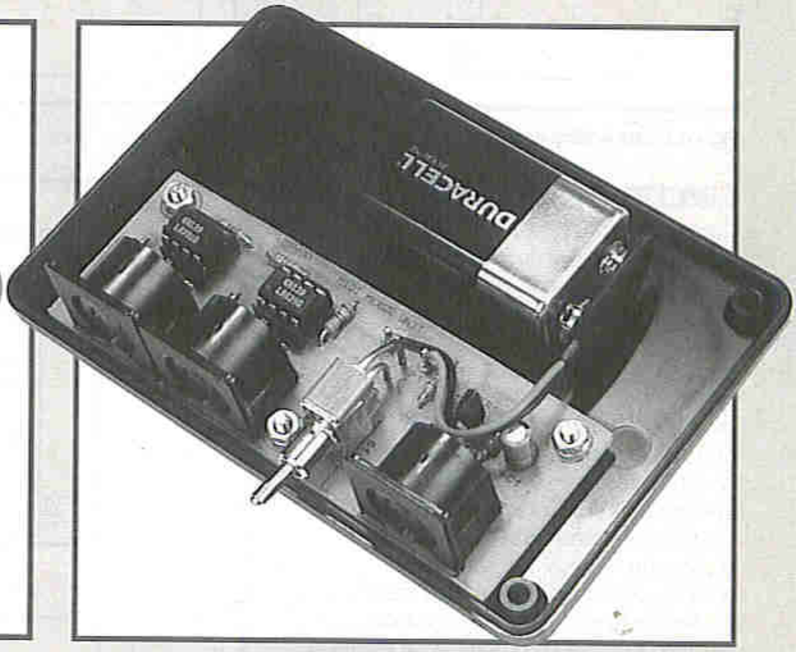


Photo 2. Assembled Simple MIDI Merge Unit in its box.

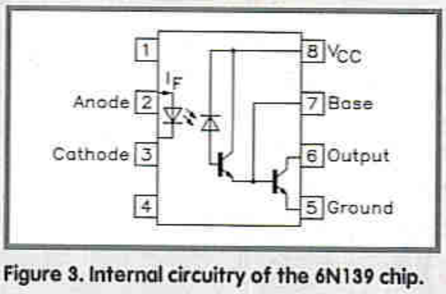


Figure 3. Internal circuitry of the 6N139 chip.

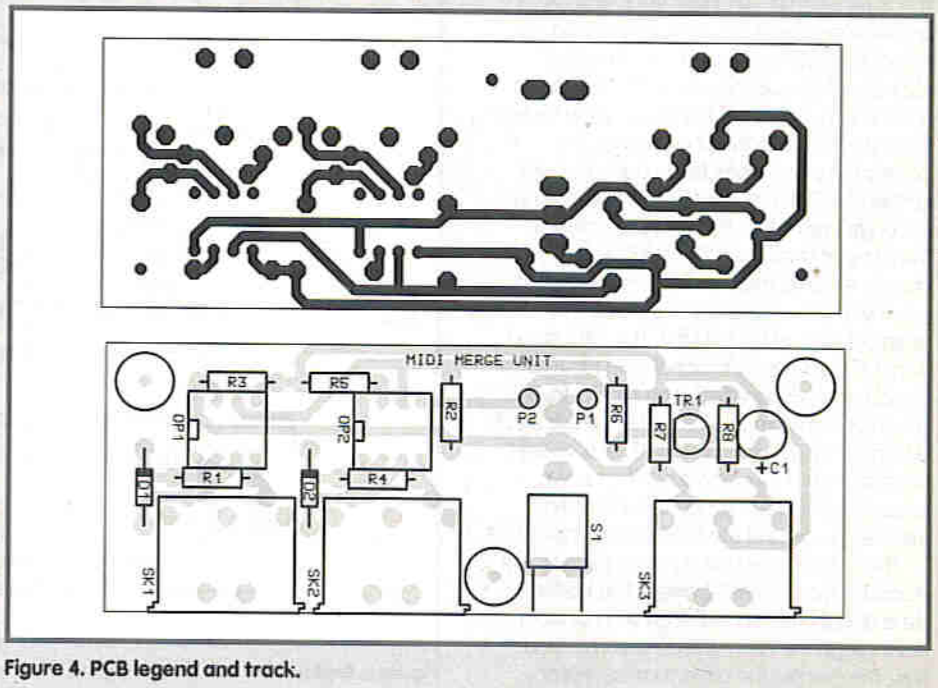
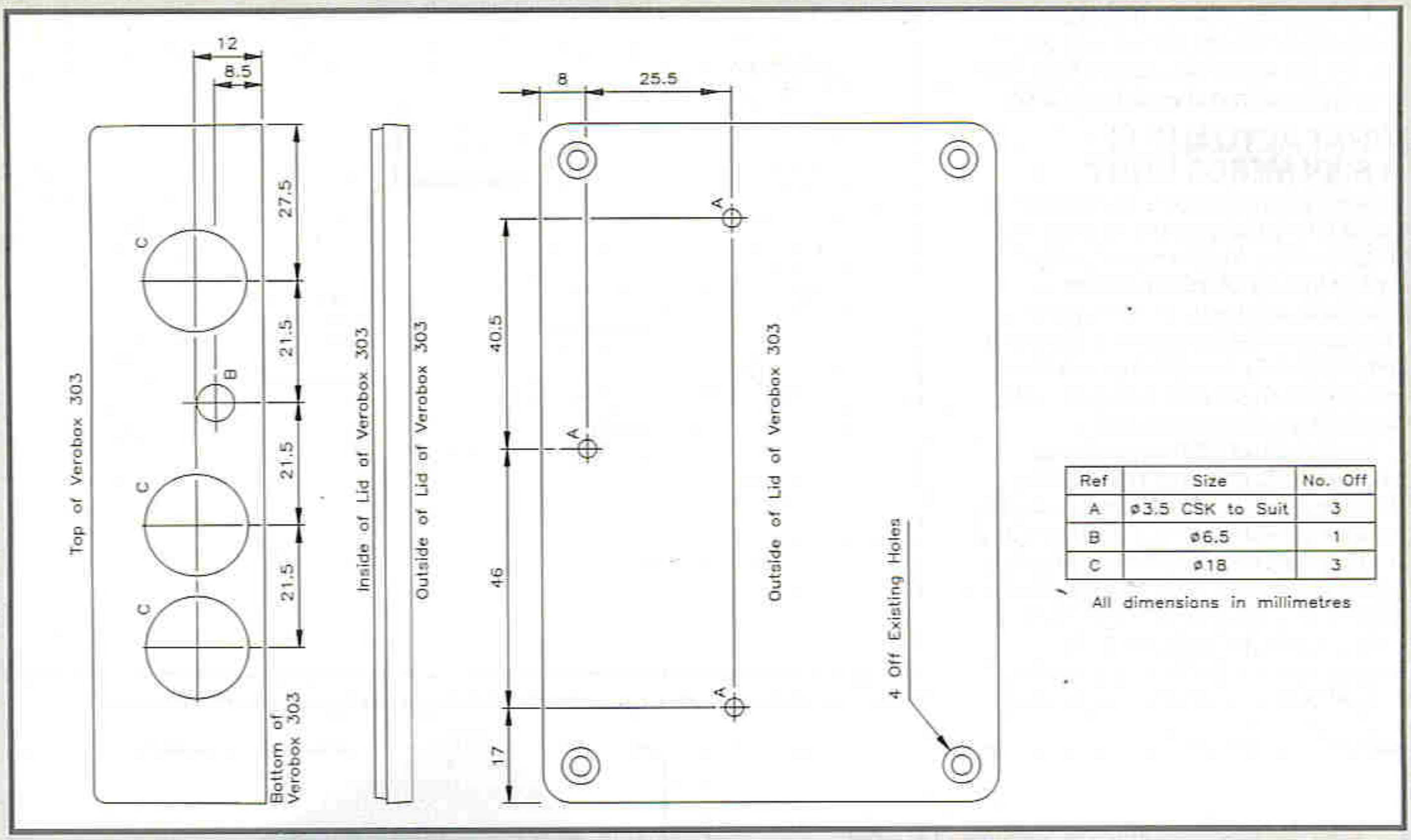


Figure 4. PCB legend and track.



Ref	Size	No. Off
A	ø3.5 CSK to Suit	3
B	ø6.5	1
C	ø18	3

Figure 5. Box drilling details.

CIRCUIT DESCRIPTION

The circuit diagram for the Simple MIDI Merge Unit is shown in Figure 2. As the MIDI input circuitry for inputs A and B are identical, only input A will be described below.

The MIDI signals from SK1 pass through R1, a current limiting resistor to OP1. D1 affords reverse bias protection for the internal LED of the optoisolator (OP1, a 6N139, was specifically chosen because of its high sensitivity and capability to handle the high MIDI data rate of 31·25K BAUD. The internal operation of the 6N139 chip is shown in Figure 3. The optoisolator isolates (well, what else did you expect?) the transmitting and receiving devices, ensuring that there is absolutely no electrical connection between transmitter and receiver. This is required to eliminate the possibility of ground loops from the system, as these can introduce a 50Hz audible hum. The serial MIDI signal causes the LED in OP1 to turn on and off and, when on, the LED emits infra-red light which falls on the photodiode. This causes the photodiode to conduct and turn on the split Darlington transistor pair, pulling the output pin 6 low. R3 serves to optimise the transfer characteristic of OP1 – the value chosen ensures fast rise/fall time and good sensitivity. R2 is the collector load for the open collector output of OP1. The MIDI signal from OP1 is 'OR'ed (or mixed) with the MIDI signal from OP2 and fed, through R6, to TR1. The MIDI output (in the form of a current loop) is formed by TR1, R7 and R8. R7 and R8 limit the maximum current that can be drawn under possible fault conditions, protecting the Merge unit and the MIDI device driven.

The MIDI Merge Unit is powered by a standard type 9V 'PP3' battery. The battery life is directly related to the quantity of data fed through the unit – the greater the data flow, the greater the current consumption.

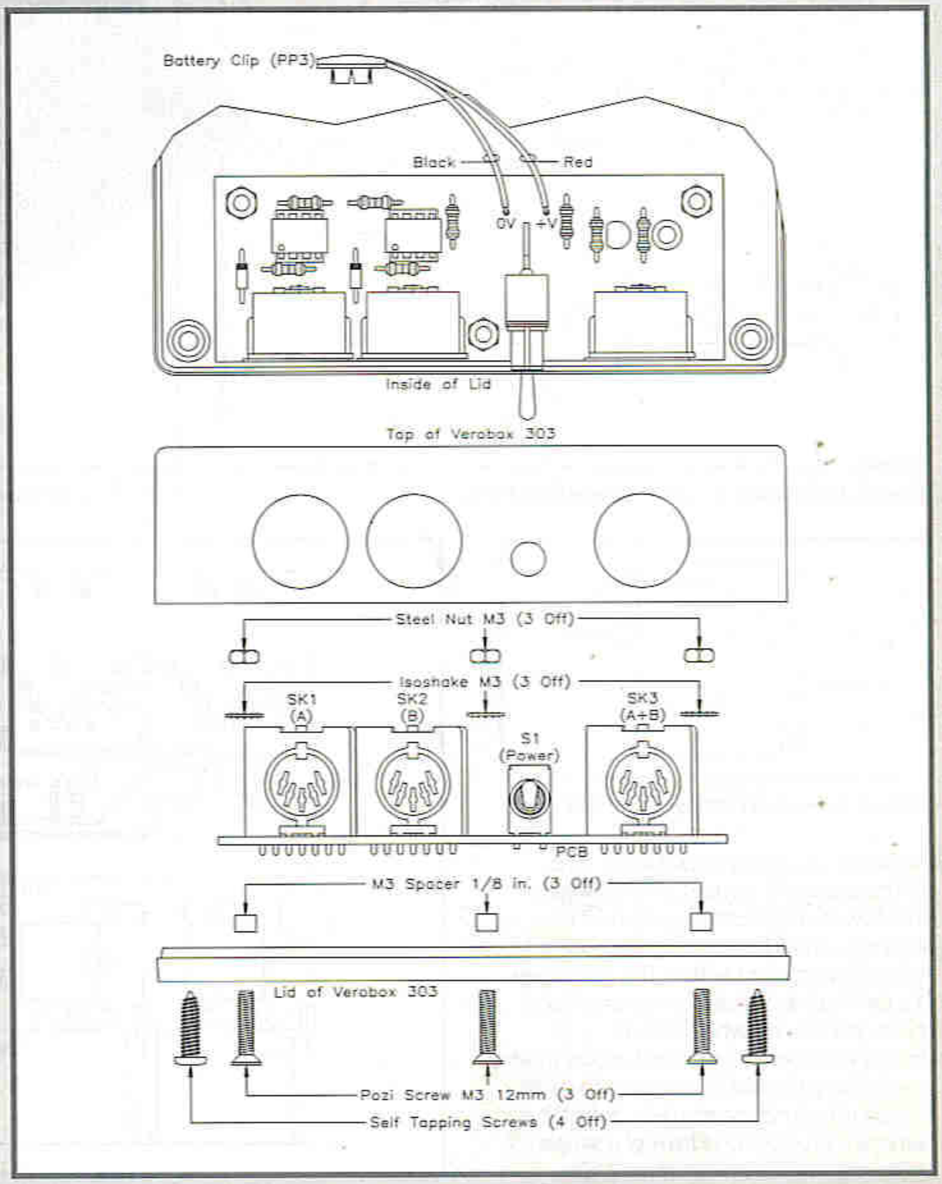


Figure 6. Exploded assembly of Simple MIDI Merge.

However, the battery should give a long operating life as the maximum current consumption (with a continuous stream of data) is only about 7mA, and the current consumption under quiescent conditions is likely to be no more than a couple of microamps.

CONSTRUCTION

As all of the components are mounted on the PCB, assembly of the project is very simple. The MIDI Merge PCB is of the high quality, single-sided glass fibre type, chosen for maximum reliability and electrical stability. Figure 4 shows PCB legend and track. The sequence in which the components are fitted is not critical; however, removal of a misplaced component is quite difficult so please double-check each component type, value and polarity where appropriate, before soldering! Photo 1 shows the assembled MIDI Merge PCB. For further information on component identification and soldering technique please refer to the Constructors' Guide (XH79L) included with the kit.

Insert the PCB pins using a hot soldering iron. If the pins are heated in this way, very little pressure is required to press them into position. Once in place, the pins may then be soldered. It is now easier to start with the smaller components, such as the resistors, and work upwards in size until the sockets SK1 to SK3 are fitted last.

The diodes should be inserted such that the band at one end of the diode corresponds with the white block on the PCB legend. When fitting the electrolytic capacitor C1, it is essential that the correct polarity is observed. The negative lead of the capacitor, which is usually marked by a full length stripe and a negative (–) symbol, should be inserted away from the hole marked with a positive (+) sign on the PCB legend. Insert and solder the transistor, matching the shape of its case to the outline on the legend. Note that both optoisolators are fitted into 8-pin IC sockets; these sockets should be soldered into the PCB and allowed to cool *before* OP1 and OP2 are inserted.

Lastly, solder the PP3 battery clip to the pins marked P1 (+9V, red wire) and P2 (0V, black wire).

BOXING CLEVER

A suitable case for this project is LH50E (included with the kit), drilling details for which are given in Figure 5. Before marking out the holes, place something hard and flat along the side of the box, for example a piece of plywood or stripboard. This will give you a reference point to measure from; these steps are necessary because the box has bevelled edges. It is advisable to use a sharp point to make indentations at the marked positions as this will prevent the drill from slipping. The next stage is to assemble the PCB into the box using the M3 screws, nuts, spacers and washers, as shown in Figure 6. After fitting the countersunk screws and spacers into the box, the PCB can be mounted on top of the spacers and secured in place using the M3 nuts and shakeproof washers. All that is left to do now is to attach a PP3 battery and stick it in place using the supplied self-adhesive pad. Photo 2 shows the assembled MIDI Merge unit in its box.

Figure 7. Box label.

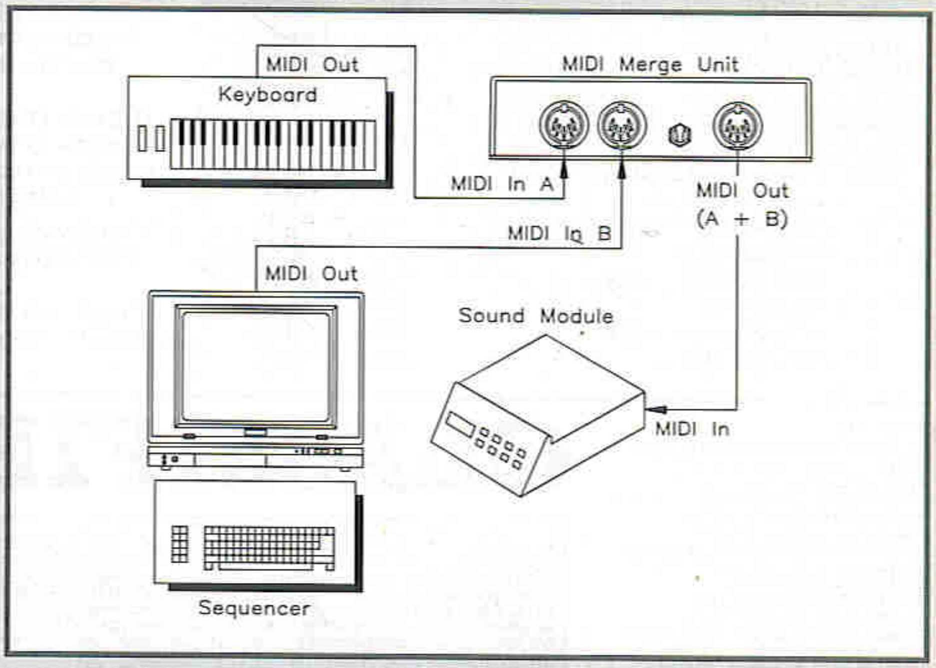


Figure 8. A typical application for the MIDI Merge Unit.

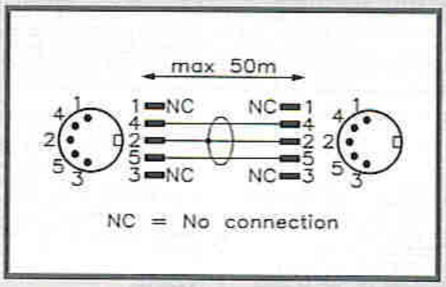


Figure 9. MIDI lead wiring.

There is a box label included and this can be stuck in position, see Figure 7, making sure that the holes align properly before doing so. Photo 3 (below) shows the completed MIDI Merge Unit in box including the label.

IN USE

Figure 8 shows how the simple MIDI Merge Unit can be used. In this example a keyboard and sound sequencer are connected into the MIDI Merge Unit. Here, a sound module can be played from a MIDI keyboard and receive MIDI data from the sequencer (but, not at the same time!). In this example, if it were not for the MIDI Merge Unit, much plugging and unplugging would be required to feed signals from the desired source to the sound module.

The wiring of a suitable cable with two 5-pin 180° plugs is shown in Figure 9, with the shield to pin 2 and the two conductors to pins 4 and 5. There are no connections to pins 1 and 3.

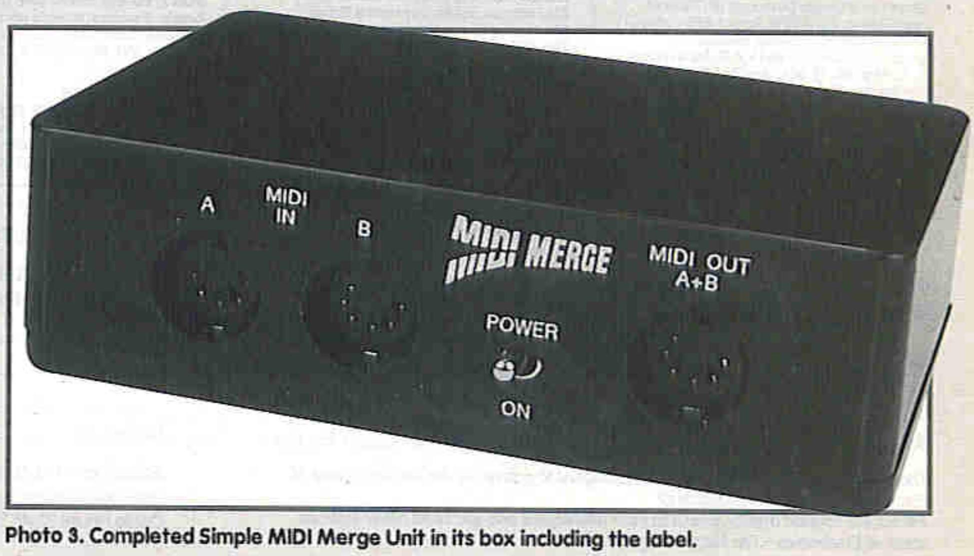


Photo 3. Completed Simple MIDI Merge Unit in its box including the label.

SIMPLE MIDI MERGE PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1,4	220Ω	2	(M220R)
R2	2k2	1	(M2K2)
R3,5	15k	2	(M15K)
R6	4k7	1	(M4K7)
R7,8	470Ω	2	(M470R)
CAPACITORS			
C1	47μF 16V Sub-Miniature Radial Electrolytic	1	(YY37S)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
TR1	BC558	1	(QQ17T)
OP1,2	6N139 Hi Gain Optoisolator	2	(RA59P)
MISCELLANEOUS			
S1	R/A Toggle Switch SPST Up/down	1	(FA70M)
SK1-3	5-pin PCB DIN Socket Type A 180°	3	(YX91Y)
	Vero Box Type 303	1	(LH50E)
	Single-ended PCB Pin 1mm (0·4in.)	1 Pkt	(FL24B)
	PP3 Battery Clip	1	(HF28F)
	M3 x 12mm Pozi Screw	1 Pkt	(BF37S)
	M3 Steel Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 x ⅛in. Spacer	1 Pkt	(FG32K)
	Front Panel Label	1	(KP64U)
	PCB	1	(GH69A)
	Instruction Leaflet	1	(XU57M)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
	5-pin DIN Plug Type A 180°	As Req.	(HH27E)
	Twin Overall Braided Screen Microphone Cable	As Req.	(XR98G)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit, which offers a saving over buying the parts separately.

Order As LT52G (Simple MIDI Merge Kit) Price £14.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1994 Maplin Catalogue.

Simple MIDI Merge PCB **Order As GH69A Price £2.48**

Simple MIDI Merge Front Panel **Order As KP64U Price £1.49**

CLASSIFIED

Placing an advertisement in this section of *Electronics* is your chance to tell the readers of Britain's Best Selling Electronics Magazine what you want to buy or sell, or tell them about your club's activities-Absolutely Free of Charge! We will publish as many advertisements as we have space for. To give a fair share of the limited space, we will print 30 words free, and thereafter the charge is 10p per word.

Placing an advertisement is easy! Simply write your advertisement clearly in capital letters, on a post-card or sealed-down envelope. Then send it, with any necessary payment, to: Classifieds *Electronics–The Maplin Magazine.* P.O. Box 3, Rayleigh, Essex SS6 8LR. Advertisements will be published as soon as possible, space allowing. No responsibility is accepted for delayed publication or non-inclusion of advertisements.

Private individuals only are permitted to advertise in this section; commercial or trade advertising of any kind is strictly prohibited by law. Advertisements are only accepted by the Publisher on this proviso. Readers who have reasonable grounds to believe they have been misled as to the nature of an advertisement are advised to contact the Publisher and their local Trading Standards Office.

VARIOUS

COMPLETE MULTI-SATELLITE. Salora XLE 144 Channels, stereo sound and many features. Echo Star 1-2m dish unit actuator, feed/polariser and LNB. Complete with video crypt and D2MAC decoder. £300 (buyer collects). Tel: Martin (0702) 603557.

COMPONENTS FOR SALE! All brand new, unused and at very low prices. To obtain a list please Tel: (081) 842 3862.

NEW COMPONENTS plus free PCB Mounting Ni-Cd, assorted Resistors, Capacitors, Diodes, ICs etc., £10.00 per bag inclusive of postage and package. Mr. D.I. Brown, 2 Glentworth Avenue, Whitmore Park, Coventry, West Midlands CV6 2HW.

RETIRED ENGINEER SELLING UP 1950/1993. Test Gear to parts. Audio to logic. Valves to LSI. Cossor/Telequipment/ Leader Scopes. Ferrograph recorder test set. EX-BBC bits. Tel: (0926) 817531 (anytime).

GLOBAL 6001 Professional Counter-Timer. Will measure positive or negative pulse widths from 0·1 microsecond to 3 years, frequency 0 to 110 MHz, etc. With manual and as new, £115 including carriage. Tel: (0981) 240616.

HARRY MOSS remote car alarm (MS705) circuit diagram £7.00. Write for details to: 83 Avenue Vivian, Fence Houses, Tyne & Wear DH4 6HZ.

FOR SALE 70 copies of Practical Wireless spanning Jan 51 to Aug 61. 10p each £5 the lot. Buyer collects. Tel:(0865) 777178 (Oxford).

TOPWARD 7021, 20MHz Triple Trace Oscilloscope with leads. £225 o.n.o. Tel: Steve (081) 592 9584 (after 6pm).

SCANNER, YUPITURU MVT7000, hardly used, still in box waiting for a buyer. Must sell! Call (0860) 906950, price £300 (free p&p).

OLD MAPLIN PROJECTS, built and working – inc. Partylight; Message Panel; Z80-A Development System (all chips & boxes) with experimental EPROM Programmer; Z80-B CPU; Infra-Red TX/RX; Ultrasonic Intruder Detector; 16 Channel Logic Tester; Dual 15W Amp + PSU in box. Also *Everyday Electronics* microlab; & Spectrum I/O port. Send S.A.E. for details to: Mr A. Morrell, 12 Boscobel Road, Winchester, Hants, SO22 6RY.

WANTED

FOR PROJECT. Vintage valve amplifier and tuner, i.e. Leak, Roger, etc., Working or not. Also Garrard 301 and SME 309 Tonearm. Tel: (0533) 835821.

LEAK TL25 plus valve amplifier. Tel: (0702) 202556.

PC 286 or above, or any PC parts at a reasonable price. Edinburgh area only, write with details to: D.Price,6 Marchbank Grove, Balerno, Edinburgh EH14 7ES.

DESPERATELY NEEDED. GD04E Motherboard and LM02C 6x8 port kit, or GD06G PCB. All from discontinued Amstrad kits. Tel: (0702) 540967.

INTERAK COMPUTER CARDS, especially the FDC-1 floppy disk drive and VDU-2K video cards. Tel: Peter (0795) 661560.

COMPUTERS

EXCHANGE YOUR MAC for my IBM. I would like to exchange my Metadyne (i.e. Technomatic) IBM/XT compatible, 10MHz, 704K RAM, 20MB hard disk (before doubling), Hercules hi-res mono monitor, mouse, manuals and software for best Mac offered,preferably model IIci or IIfx. Cash adjustment as necessary. Tel: (0981) 240616.

ATARI 1040STFM, 100MB hard drive, external drive, clock, original software, magazines, joystick, accessories, £600 o.n.o. Will split. Tel: (0223) 412535.

ATARI-ST Software and Books. Metacomco Pascal, Prospero-C, PC-Dito, NeoDesk-3, Flight Sim II, Assempro, Graphix. 3D Graphics and GEM Programmers Reference. Offers. Tel: (0562) 740876.

APPLE IIE COMPUTER, Pre-Mac, 8-bit, monochrome reliability! 80-column green-screen display. Two external 5¼in. drives. Some software, but no manuals. For a dedicated enthusiast. Only £60. Tel: Paul (0243) 786585 or (0703) 592771 (Answer phone).

AUDIO

MULLARD VALVE CIRCUITS available, '5-10' and '3-3' power amplifiers, 2 and 3 valve preamps, high quality tape recorder amplifier. Send A4 S.A.E. to: R. J. Abraham, 15 Fiona Close, Winchester, Hampshire SO23 8HB.

PAIR PEERLESS 140W loudspeakers containing 10in. Polypropylene bass, 5in. midrange, 1in. dome tweeter. Kit cost £270, sell for £135. Tel: P. W. Swinson (0889) 564021.

SONY TC-645 reel-to-reel tape deck, 3 heads, 3 motors, superb performance, many facilities. Excellent condition, £75 o.n.o. plus postage. Tel: Martin (0702) 603557.

CLUB CORNER

ELECTRONIC ORGAN CONSTRUCTORS SOCIETY. For details of meetings. Tel: (081) 902 3390 or write 87 Oakington Manor Drive, Wembley, Middlesex HA9 6LX.

SOUTHEND & DISTRICT RADIO SOCIETY. Meets at the Rocheway Centre, Rochford, Essex every Friday at 8pm. Details F. Jensen (G1HQQ) P.O. Box 88, Rayleigh, Essex SS6 8NZ.

THE LINCOLN SHORT WAVE CLUB meets every Wednesday night at the City Engineers' Club, Waterside South, Lincoln at 8pm. All welcome. Further details from Pam, G4STO (Secretary) Tel: (0427) 788356.

WIRRAL AND DISTRICT AMATEUR RADIO SOCIETY meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson (G0JZP) on (051) 648 5892.

CRYSTAL PALACE & DISTRICT RADIO CLUB. Meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, G3DSC. Tel: (081) 699 5732.

WIRRAL AMATEUR RADIO SOCIETY meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the 1st and 3rd Wednesday of every month. Details: A. Seed (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

TESUG (The European Satellite User Group) for all satellite TV enthusiasts! Totally independent. TESUG provides the most up-to-date news available (through its monthly 'Footprint' newsletter, and a teletext service on the pan-European 'Super Channel'). It also provides a wide variety of help and information, contact: Eric W. Wiltsher, TESUG, Rio House, Stafford Close, Ashford, Kent TN23 2TT. England.

THE BRITISH AMATEUR ELECTRONICS CLUB (founded in 1966), for all interested in electronics. Four newsletters a year, help for members and more! UK subscription £8 a year (Junior members £4, overseas members £13.50). For further details send S.A.E. to: The Secretary, Mr. J.F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.

MODEL RAILWAY ENTHUSIAST? How about joining 'MERG', the Model Electronic Railway Group. For more details contact: Mr. Eric Turner, Treasurer MERG, 38 North Drive, Orpington, Kent BR6 9PQ.

CLUBS. Want to make your PC or Z80 based machine do things, move things? Control lighting/heating, play music! Endless things to do. Join INTERFACE-UG, the interface group for you! Contact: Mel Saunders, 7 Drumcliff Road, Thumby Lodge, Leicester LE5 2LH.

- ★ Do you have difficulty in getting hold of your copy of *Electronics – The Maplin Magazine?*
- ★ Does your Newsagent always sell out before you can get your copy?
- ★ Are you fed up with braving the onslaught of wind, rain and keep fit fanatics in your ceaseless quest to find a copy of your favourite electronics magazine?
- ★ Do you say to your family and friends, "I'm just going outside, I may be gone a little while. . ."?
- ★ Does your dog hide when you return empty handed?
- ★ Do you resort to reading the Beano, Dandy, Viz or other well known 'comics'?

Then why not ask your friendly local Newsagent to reserve or deliver each issue of Electronics – The Maplin Magazine?

Fill out the coupon (right), hand it to your Newsagent and you need never miss an issue of Electronics – The Maplin Magazine.

Dear Newsagent

Please reserve/deliver (delete as applicable) each issue of *Electronics – The Maplin Magazine* for me.

Name ____________________

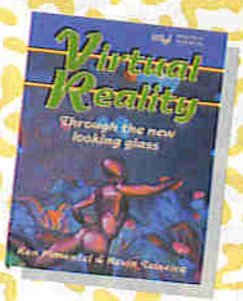
Address ____________________

____

Signature ____________________

Electronics – The Maplin Magazine is published monthly and is distributed through your wholesaler by: United Magazine Distribution Ltd., Castle House 37-45 Paul Street, London EC2A 4PB. Tel: 071-490 2020.

NEW BOOKS



Editor's Choice

MS-DOS 6 Explained

by N. Kantaris & P. R. M. Oliver

This book deals with the latest version of the PC operating system MS-DOS version 6 and includes the very latest 6.2 update. No previous knowledge of DOS is assumed, and each section is self-contained, so that the more experienced user will also find this book very useful. The book is not intended to replace the documentation that is supplied with MS-DOS 6 but to supplement and explain it. Additionally, the book covers the enhancements to be found in versions 6.0 and 6.2 of MS-DOS, several aspects of which are new. There is the *DoubleSpace* program which can double the capacity of your hard disk, and the *DoubleGuard* program (new to version 6.2) which tests the integrity of the *DoubleSpace* data. Additionally, there is the *Scan Disk* program, again new to version 6.2, which can detect and repair errors on your hard disk whether compressed or uncompressed. The *MemMaker* program will configure your system automatically to give you maximum conventional memory, and the *Anti-Virus* program which detects and removes computer viruses.

As with other books in this series, it is not necessary to read several hundred pages that cover every aspect of the subject, when a few selected pages are more than adequate. The book seeks to highlight the simplicity of the MS-DOS operating system by presenting with examples, the principle of what you need to know, when you need to know it.

This book is written such that it can equally be used as a reference guide, as a summary of the commands supported by the MS-DOS operating system, are included at the back of the book.

1993. 209 pages. 197 x 128mm, illustrated.

Order As AA57M
(MSDOS 6 Explained) £5.95 NV

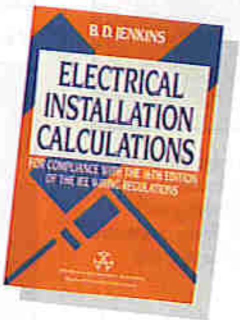
Electrical Installation Calculations

by B. D. Jenkins

The recently introduced *16th Edition of the Wiring Regulations from the IEE* has been accompanied by many supplementary guidance materials and numerous books explaining the 16th Edition. However, very few, if any, deal with the calculations involved in circuit design for compliance with the IEE Wiring Regulations. This book is intended to fill the gap, and includes worked examples with the minimum discussion of theory.

There are chapters devoted to cross-sectional areas of circuit live conductors; voltage drop under normal load conditions; earth fault loop impedances; protective conductor cross-sectional areas; short circuit conditions. The final chapter combines all the calculations from the previous chapters which will help the reader to design a complete circuit. An appendix on 'touch voltages' has been included that should be of interest to many in the electrical industry.

The Wiring Regulations can offer certain options such as when calculating voltage drop as either an approximate method or a more accurate one can be used. The author has attempted to show when the more accurate method may be preferable, which should make this book attractive to a wider circle of readers.



The extensive use of worked examples and avoidance of unnecessary theory, will make invaluable reading for all electrical contractors, as well as students and plant engineers.

1991. 200 pages. 234 x 155mm, illustrated.

Order As AA54J
(Elect Installat Calcs) £22.50 NV A1

All About VHF Amateur Radio

by William Orr

Some of the early experiments of Hertz and Marconi operated in the VHF band, in fact, the world's first radio transmitter and receiver, built by Hertz in 1884, operated around 100MHz. Marconi was operating at 500MHz when he was sending signals between his yacht and land base, a distance of about 169 miles. However, it was not until about the mid-1930s that interest in VHF took off. After the World War II, there was a major reallocation of the frequency bands, and the modem amateur VHF bands were created.

This handy, inexpensive VHF handbook has been written for the non-technical and ham enthusiast who wants to work on the 6m and above bands. The text, illustrations and general information is presented in an enjoyable and easily understood style, and provides valuable information covering all aspects of VHF radio. The book covers VHF bands and propagation; VHF repeaters; VHF moonbounce communication; amateur satellite communication; coaxial lines; VHF vertical and mobile antennas; VHF beam antennas; VHF interference. There are many suggestions for the

DIYer for building vertical, mobile and beam antennas.

The book offers exceptional value-for-money and is highly recommended for the non-technical beginner and serious enthusiast.

1988. 162 pages. 228 x 125mm, illustrated. American book.

Order As AA58N
(VHF Amateur Handbook) £7.50 NV

Virtual Reality

by Ken Pimentel and Kevin Teixeira

What is Virtual Reality (VR)? – is it just another science fiction gimmick or a major breakthrough in computer technology and something that eventually we can all experience. This book sets out to answer these questions and explores the technology that allows you to experience worlds generated entirely by computer. An explanation of Virtual Reality is given along with how it works and how it evolved. An insight is given into how Virtual Reality is having an important impact on the fields of medicine, science, business, architecture and entertainment.

Virtual Reality is a major technological breakthrough that allows you to step through the computer screen into a 3-D artificial world. In the last few years, VR has gone from being an unknown scientific exercise to what many believe will be the future of computing.

This book is designed to provide a guide to VR and is filled with numerous photographs and illustrations. It is divided into three parts aptly titled 'Stepping through the new looking glass', '21st century tools' and 'Brave new worlds'. The first part defines VR and provides an overview along with the developments in the VR field. Part two is a layman's guide to VR technology, and part three gives an insight into what can be done with VR and the future.

This well researched and illustrated book will prove to be compulsive reading for those who are interested in the possible future of computers.

1993. 323 pages. 234 x 186mm, illustrated. American book.

Order As AA60Q
(Virtual Reality) £19.95 NV

Windows For Dummies

by Andy Rathbone

Windows is the modem way to use your PC, but this does not mean that it is easy to use, as the idea of using boxes, bars and PIF options can be unnerving to many users. In many instances, if you buy a PC it will come with Windows already installed, and once mastered it is certainly more friendly to work with than DOS. Also, the latest software is often only available for operating in a Windows environment.

This book, like others in the 'Dummies' series, is aimed primarily at those people who are more concerned at getting the work done, than becoming computer supremos. The book has no difficult technical computer jargon, and there is nothing to learn or memorise. The comprehensive index allows the reader to find a particular topic, that will easily show how to solve your problem – it is not necessary to read the book from cover to cover. It is divided into six self-contained parts, the first being a very basic introduction, followed by using Windows, and others that discuss using Windows applications, working with DOS and DOS based programs and help! Part six provides a useful list of tips etc.

The use of icons indicates to the reader either very useful tips, or technical stuff that can be ignored, or important points that are worth noting, or a warning of an operation that should be carried out with care, such as 'delete'. A book well worth having on the bookshelf, be it for the computer enthusiast or the computer user.

1992. 350 pages. 234 x 188mm, illustrated. American book.

Order As AA61R
(Windows For Dummies) £14.99 NV

NEW PRODUCTS from Maplin

The new products featured on these pages are not shown in the 1994 Maplin Catalogue. If you would like to see new products featured in *Electronics* on a regular basis please write to: 'New Products', The Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR. To purchase any of the items featured on this page call the Credit Card Hotline, Tel: 0702 554161 or use the order coupon on page 34. Regional Maplin Stores do not currently stock these new products, however, they may be ordered from Maplin Stores. Export customers call Maplin Export, Tel: +44 702 554155 extension 326 or 351, or contact your nearest Overseas Maplin Agent, see page 57 for details.

Frequency Counters
Optoelectrics

Two frequency counters from the American firm that have put high quality test equipment into the pockets of thousands of engineers.

Opto-3300 1MHz to 2·4GHz

Impedance:	50Ω
Sensitivity:	300μV @ 150MHz
Resolution:	1Hz
Accuracy:	1PPM @10MHz
Gate times:	4 (0·01 to 10 sec.)
Size:	85 x 65 x 29mm
Supply:	Internal Ni-Cds

Opto-M1 10Hz to 2·8GHz

Impedance:	50Ω/1MΩ
Sensitivity:	300μV @ 150MHz
Resolution:	10Hz
Accuracy:	1PPM @ 10MHz
Gates times:	6 (·001 to 10 sec.)
Memories:	3
Size:	122 x 65 x 40mm
Supply:	Internal Ni-Cds

These units are supplied with AC charger, Aerial and Ni-Cds.

Order Code	Type	Price each
JM38R	Opto-3300	£169.95 A2
JM39N	Opto-M1	£259.95 A2

XLR-Type Chassis Mounting Connectors
Neutrik

A range of high quality professional XLR plugs and sockets for chassis and panel mounting. Suitable for audio applications such as cable connectors, microphone stage boxes, professional public address systems, recording studio applications and audio mixer connections. The range includes 3, 4 and 5 pin plugs and sockets. The shell of the connector is of rugged die cast Zn/Al/Cu alloy construction with CU/Sn alloy contacts and a contact surface of Ag/Au hard alloy.

The 'SktR' and 'PlR' series has a raised edge surrounding the connector allowing mounting on the inside of a panel chassis, reducing the amount of panel finishing work required. Also this series is RF protected. These connectors will mate with the Neutrik series of XLR line plug and socket connectors.

Order Code	Type	Price each
CW64U	3-pin XLR Chass Skt	£3.11
CW65V	4-pin XLR Chass Skt	£4.29
CX52G	5-pin XLR Chass Skt	£6.47
CX56L	3-pin XLR Chass SktR	£2.41
CX57M	4-pin XLR Chass SktR	£3.47
CX58N	5-pin XLR Chass SktR	£5.35
CX53H	3-pin XLR Chass Pl	£1.98
CX54J	4-pin XLR Chass Pl	£3.18
CX55K	5-pin XLR Chass Pl	£3.98
CX59P	3-pin XLR Chass PlR	£2.21
CX60Q	4-pin XLR Chass PlR	£2.82
CX61R	5-pin XLR Chass PlR	£4.21

XLR-Type Line Connectors
Neutrik

A range of high quality professional XLR plugs and sockets for in-line cable connection. Suitable for audio applications such as microphone cable connectors and audio mixer connections. The range includes 3, 4 and 5 pin plugs and sockets. Assembling the line plugs and sockets does not require a screwdriver. The connectors contain four easy to assemble parts including the chuck type strain relief assembly. The shell of the connector is of rugged die cast Zn/Al/Cu alloy construction with Cu/Sn contacts that comply with solderability specification

IEC 68-2-20 and can accommodate wire sizes up to 16AWG (1·29mm). These connectors will also mate with the Neutrik series of XLR chassis mounting plug and socket connectors.

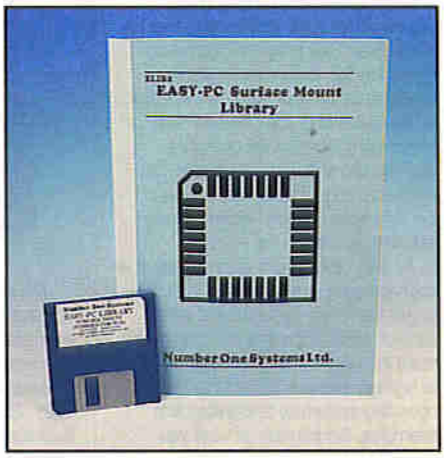
Order Code	Type	Price each
CW58N	3-pin XLR Line Plug	£2.82
CW59P	4-pin XLR Line Plug	£3.82
CW60Q	5-pin XLR Line Plug	£6.41
CW61R	3-pin XLR Line Plug	£2.33
CW62S	4-pin XLR Line Plug	£2.77
CW63T	5-pin XLR Line Plug	£4.29

Professional Diecast Jack Plugs
Neutrik

¼in. professional diecast, jack plugs with Neutrik chuck-type strain relief. The item easily disassembles into four separate parts to facilitate soldering.

Order Code	Type	Price each
CC69A	Neutrik Mono Jack	£1.86
CC70M	Neutrik Stereo Jack	£2.68

Easy-PC Schematic (ELIB 1) and Surface-Mount (ELIB 2) Libraries
Number One Systems



These two Easy-PC libraries contain between them over 1,500 Schematic and PCB layout symbols that can be used with the Easy-PC program. The Schematic program (ELIB 1) contains a collection of over a thousand drawing symbols covering thirteen logic families and a range of popular microprocessors, memories and support chips. It also has board layout symbols for single and double Eurocards. The Surface-Mount program (ELIB 2) contains over 500 PCB component land patterns from simple two-pin passive devices through DILS, Quads, Flat-packs, Ceramic and Plastic Chip Carriers, to a 244-pin PLCC. All the symbols in both libraries are fully compatible with Easy-PC, and may be used freely alongside symbols from Easy-PC's own library.

Order Code	Type	Price each
GK87U	ELIB 1 Software	£44.99
GK88V	ELIB 2 Software	£54.99

Easy-PC Professional
Number One Systems

Easy-PC Professional is a powerful, yet easy to use, second-generation software package for the production of quality Printed Circuit Board Layouts and Schematic Circuit Diagrams. It is a development of the British Design Award-winning Easy-PC. The Professional has the automatic schematic to PCB translation, checking and simulation facilities which do not appear in its predecessor. The Easy-PC Professional will run on any industry standard PC under MS-DOS version 3 or later. A Hard Disk, a VGA or EGA screen and 640K of RAM are required. Easy-PC Professional will accept drawing files from Easy-PC for updating and maintenance purposes.

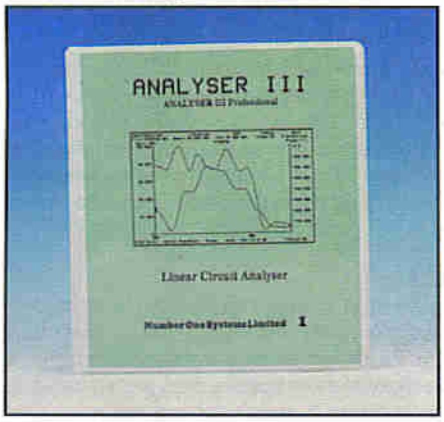
Order Code	Type	Price each
GK57M	Easy PC Pro Software	£229.00

Easy-PC Professional Surface Mount Library
Number One Systems

Over 230 complete Surface-Mount components covering the popular 74LS and 4000 series parts are available in this library. It also provides over 260 generic pad patterns for use when creating your own Surface-Mount components. Other Easy-PC Professional Libraries are fully compatible and components from all libraries can be freely mixed in a single design. All the symbols in this library conform fully to ANSI/IPC-SM782. Package types, DIL or SOL are selectable whenever a 74LS or 4000 series parts selected and called into a schematic. On translation to PCB, the appropriate Surface-Mount Symbol from this Library will be linked in automatically.

Order Code	Type	Price each
GK58N	PC Pro S/Mt S/Ware	£54.99

Analyser Linear Circuit Analysis Programs
Number One Systems



Analyser III and Analyser III Professional programs facilitate analysing the characteristics of Filters, Amplifiers, Crossover Networks, Wideband Amplifiers, Aerial Matching Networks, Radio and TV IF Amplifiers, Chroma Filters, Linear Integrated Circuits without soldering a single component. Band-pass, frequency gain and centre frequencies of filters are some of the characteristics that can be analysed and displayed. The Programs are driven using Menus and Help Windows which enables quick learning and ease of use. Fast, analysis libraries containing over 500 device models, coupled with the easy to read display of the analysed results make Analyser III and Analyser III Professional advanced Linear Circuit Analysis Programs.

General requirements
VGA or EGA colour Monitor
Hard Disk Drive with MS-DOS 3 or later
Mouse or Trackerball (Recommended)
Epsom/IBM Graphics Dot Matrix Printer or Laserjet II or compatible printer (optional)

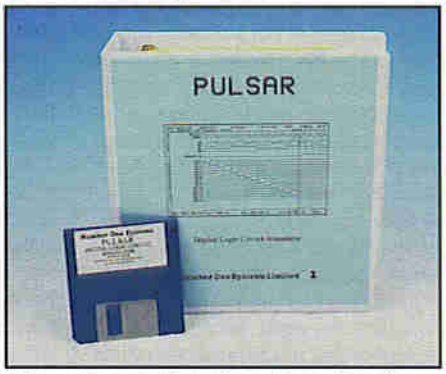
Order Code	Type	Price each
CC92A	AN3 Software	£114.99
CC93B	AN3 Pro Software	£229.00

Analyser III Library 1
Number One Systems

This library is intended to complement the existing library supplied with Analyser III and Analyser III Pro (CC92A and CC93B). It contains a selection of 'real' Analyser III models for over 500 devices including Biopolar Transistors, Field Effect Transistors and Operational Amplifiers.

Order Code	Type	Price each
GK89W	AN3Lib1 Software	£54.99

Advanced Digital Circuit Simulator Programs
Number One Systems



Pulsar and Pulsar Professional are advanced Digital Logic Circuit Simulator programs. They allow testing of designs without soldering a single component, and without the need of expensive test equipment. The Programs are driven using Menus and Help Windows which enables quick learning and ease of use.

Specifications

Maximum circuit complexity:	Over 1500 Gate equivalents (Pulsar) Over 10,000 (16MB) (Pulsar Professional)
Maximum simulated events:	Over 40,000 Gate State changes (Pulsar) Over 1 meg (16MB) (Pulsar Professional)

Order Code	Type	Price each
CC94C	Puls Software	£114.99
CC95D	Puls Pro Software	£229.00

Pulsar 74HC and 74HCT Devices Libraries
Number One Systems

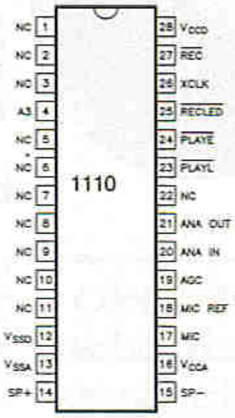
Complements the libraries of the Pulsar and Pulsar Professional programs. (CC94C and CC95D).

Order Code	Type	Price each
CC96E	PLIB 1 Software 74HC	£54.99
CC84F	PLIB 2 Software 74HCT	£54.99

ISD1110P 10-Second Voice Record/Playback IC
ISD

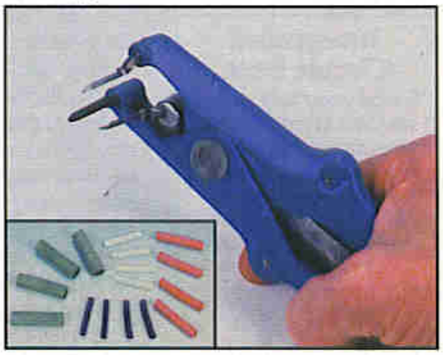
A high quality, single-chip record/playback device for short duration messaging applications. The device includes an on-chip oscillator, microphone preamplifier, AGC, anti-aliasing filter, smoothing filter, and speaker amplifier. A minimum system can be configured with a microphone, a speaker, a few passive components, two push-button switches and a power source. Recordings are stored in non-voltatile memory cells requiring no power.

This unique solution is made possible through new technology whereby voice and audio signals are stored directly, in their natural analogue form, into an EEPROM memory. Such direct analogue storage allows natural voice reproduction in a single IC. The device is supplied in a 28-pin DIL package.



Order Code	Type	Price each
KU92A	ISD1110P	£12.99
DS00A	ISD110P Data Sheet	80p

Hellermann Sleeve Fitting Tools



The tool for applying sleeving to cable ends. It uses three fixed prongs to open the sleeve. It is used in conjunction with the sleeve oil. The tool is available in two sizes, type SS (CC80B) for sleeving up to 2·0mm and type S(CJ02C) for sleeving up to 5·0mm diameter.

Hellermann Sleeve Oil

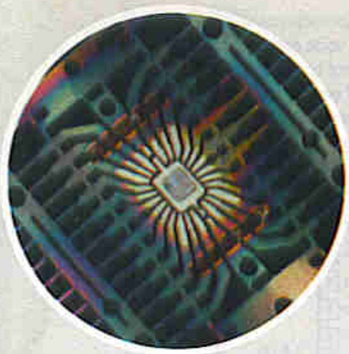
This Oil is used with the Sleeve Fitting Tool and the Binding Sleeves.

Hellermann Binding Sleeves

Helsyn binding sleeves for uses including insulating wire joints, pin connections soldered to wires and insulating the screen on coaxial cables. The sleeves are available in four different colours: black, white, pink and green and in four sizes. Sold in packs of 100.

Int. Dia mm:	1·5	2·0	3·0	5·0
Length mm:	20	20	25	25

Order Code	Type	Price each
CC80B	Sleeve Fit Tool 2mm	£16.44
CJ02C	Sleeve Fit Tool 5mm	£16.44
CJ01B	Sleeve Oil	£2.65
CC97F	Sleeving Black 1·5mm	£1.34
CC98G	Sleeving Black 2mm	£1.49
CC99H	Sleeving Black 3mm	£1.65
CJ00A	Sleeving Black 5mm	£2.81
CJ45Y	Sleeving White 1·5mm	£1.34
CJ46A	Sleeving White 2mm	£1.49
CJ47B	Sleeving White 3mm	£1.65
CJ48C	Sleeving White 5mm	£2.81
CJ76H	Sleeving Pink 1·5mm	£1.34
CJ93B	Sleeving Pink 2mm	£1.49
CR50E	Sleeving Pink 3mm	£1.65
CW06G	Sleeving Pink 5mm	£2.81
CW46A	Sleeving Green 1·5mm	£1.34
CW47B	Sleeving Green 2mm	£1.49
CW48C	Sleeving Green 3mm	£1.65
CW49D	Sleeving Green 5mm	£2.81



SEMICONDUCTOR PROCESSING

by Stephen Waddington BEng(Hons)., M.I.E.E.E, A.I.E.E, A.I.T.S.C.

PART TWO Production Techniques

Last month we looked at methods of refining semiconductor substances into the materials that form the basis of transistors and integrated circuits. Our starting point this month is a pure single crystal wafer, from which a manufacturer will produce several hundred integrated circuits. As we are working on a subatomic scale, the initial purity and quality of the starting material is essential. The wafer will already have been lightly doped during the growth process to achieve a desirable resistivity – typically 50Ωcm.

Doping

In order to produce devices with useful electrical characteristics, we must form a series of PN junctions within the semiconductor wafer. The PN junction is the basic building block for integrated circuit design. By applying varying degrees of doping and controlling the size of the junctions, designers are able to form diodes, transistors, capacitors and resistors. This means that almost every electrical circuit conceivable could be fabricated on an integrated circuit. Indeed, a quick scan through the semiconductor section of the Maplin Catalogue will reveal numerous devices which, until a few years ago, had to be constructed from individual components.

Introducing dopants into the wafer on such a small scale is difficult. It is essential that the crystallinity of the wafer is maintained and damage prevented. Care must also be taken when positioning dopants. Impurities placed in the wrong location will render the wafer useless, destroying the intended electrical function.

Integrated Circuit Fact

Typical integrated circuit devices currently being manufactured, such as the recently introduced Pentium processor from Intel, consist of up to twenty million PN junctions.

Diffusion

Consider a piece of single-crystal silicon on an atomic scale. At absolute zero, the wafer will consist of a rigid array of silicon atoms interspersed with impurity atoms (introduced during the growth process) in interstitial locations. Each atom will be static, and will have a fixed position in the lattice as illustrated in Figure 1. As we progress up the temperature scale, atoms within the wafer will have a thermal motion, an oscillation about a mean position, which will increase with temperature. At higher temperatures the probability of atoms moving from one lattice position to another, or from one interstitial position to another increases. This results in a random dispersion where atomic movement in all directions is equally probable.

Diffusion Fact

Diffusions in silicon are usually undertaken in the temperature range 900 to 1300°C – dose quantities range from 10^{12} to $10^{16}cm^{-2}$.

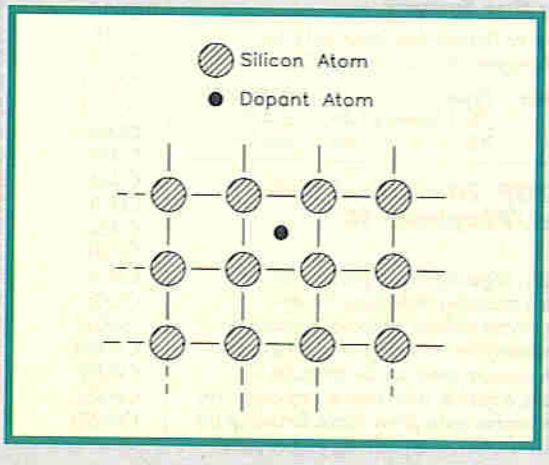


Figure 1. Silicon atoms in fixed lattice positions with impurity atoms interspersed.

If, at any position within the lattice, there is a larger concentration of impurities than elsewhere, then there will be a net movement of impurities in the direction of the concentration gradient. All directions are equally probable for each atom, but since there are more atoms in one place, it is more likely that atoms will move away from that place rather than towards it. This process is called *diffusion,* and the number of impurity atoms and the distance travelled at any one time is defined according to Fick's Law. From now on the subject becomes steeped in mathematics, which we will ignore to concentrate on the practical implications!

Diffusion is used to introduce dopant materials into a semiconductor wafer. The semiconductor manufacturer must be aware of the diffusion mechanisms so as to make a reasoned estimate of doping times and temperatures. In order to form a diffused junction within a wafer, a defined doping profile has to be achieved.

In a practical situation, the semiconductor is heated to a predetermined temperature in a gaseous atmosphere of the desired impurity, as shown in Figure 2. Impurity atoms condense on the surface of the wafers and diffuse into the semiconductor material in both horizontal and vertical directions. We have seen that control of the doping profile is important to achieve the required degree of doping. Equally, control must be exercised over the precise areas of the wafer that are to be diffused, otherwise the characteristics of the whole of the wafer will be altered.

The Planar Process

Selective diffusion is achieved using a lithographic technique called the *planar process,* as shown in Figure 3, similar to that used when etching printed circuit boards. Here, silicon dioxide is grown on the surface of the wafer. This forms naturally on the surface of a silicon wafer when it is exposed to the air. To speed up the process, the silicon is usually heated slightly in oxygen or water vapour. Next, the wafer is coated with a photoresist. The solution is allowed to dry, and then exposed to light, or near ultraviolet radiation, through a mask. The detail definition of the mask is limited by the wavelength of the exposing light source; the minimum feature dimension on the mask is confined to a single wavelength. Thus, where very high definition is required, far ultra violet exposure is used, allowing a feature size in the order of 500nm.

Masking

A mask may be used to image a complete wafer at one exposure, but this means that in many cases, the mask features must be identical in size and duplicity to those required on the wafer. As feature sizes are reduced, it is easiest to produce a reticle whose image can be reduced onto the wafer using optical means.

The image may be of one chip or a few chips only. In this instance, the image must be stepped across the wafer and exposures repeated to produce the desired pattern over the whole area of the wafer. Alignment must of course be very precise, and sophisticated interferometry techniques are often used to ensure an alignment accuracy of less that 1µm.

A reticle for *step-and-repeat* use must be defect-free, since any imperfections will then be repeated for every chip, and the whole wafer will be ruined. However, a mask which images the whole wafer need not be perfect, since any imperfection will effect only one chip, and not all the chips.

Research is continuing on the best lithographic method to succeed optical lithography for high wafer throughput with smaller feature size. Candidates are X-rays, ion beams or possibly electron proximity printing. It is not possible to predict yet which is likely to be most successful. At present resists are needed for all forms of lithography. As higher resolutions are needed, resists and indeed lithography may disappear – it will then be combined with processing.

After exposure, the photo-resist is developed and the exposed area of the silicon dioxide mask removed chemically, leaving clean areas of silicon where diffusion is able to take place.

Several diffusions can be carried out in succession. Usually a final layer of oxide is grown to encapsulate the entire chip (except for contact areas) in order to provide a stable surface and minimise surface leakage effects. The characteristics of early junction transistors tended to be dominated by surface leakage effects, and the planar process proved to be one of the most important single advances in semiconductor technology. A transistor formed by diffusion and the planar process is illustrated in Figure 4.

Ion Beam Doping

With the advent of Very Large Scale (VLSI) and Extra Large Scale (ELSI) Integrated circuits, chip surface features are becoming progressively smaller. The necessity then arises for more precise control over dopant dimensions, including width, depth and concentration. Since diffusion takes place in all directions, it is not possible to prevent some dopant spreading into undesirable areas of the wafer. This makes precise control of shallow dopant depths difficult.

Ion implantation offers some solution to the disadvantages of diffusion, although it does have plenty of drawbacks of its own. Instead of allowing atoms to make their own way into the semiconductor gradually, ion implantation relies on atoms being fired at high energy and lodging within the semiconductor. All processing must be carried out under high vacuum conditions to prevent contamination, and damage introduced into the wafer by this technique must be annealed out at a later stage.

The Ion Source

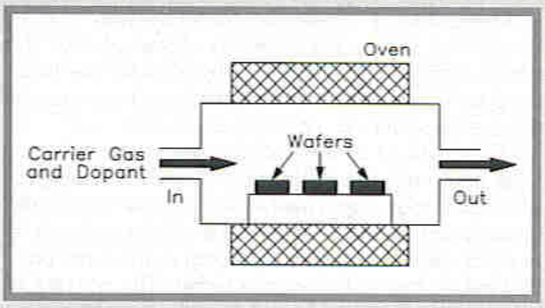
Figure 5 shows a schematic diagram of a Lintott 2 ion implantation system. The ion source, in the middle of the implanter section of the machine, is biased up to a potential of +80kV with respect to earth. Figure 6 shows the ion source in more detail. The required dopant elements can be introduced into the arc chamber via the gas line or from the furnace. Electrons are liberated from the hot tungsten filament and accelerated through a voltage of approximately 50V. This creates a plasma (a region of positive ions, electrons and neutral gas atoms) that glow with a colour, characteristic of the ionised gas or substance.

The whole source is at a positive potential with respect to earth, so that positive ions are extracted from the plasma and accelerated towards the analysing magnet. The source magnet tends to combine the plasma and intensify the ionisation. The –5kV and 0V extractor plate configuration helps to limit the spread of the ion beam due to electrostatic repulsion.

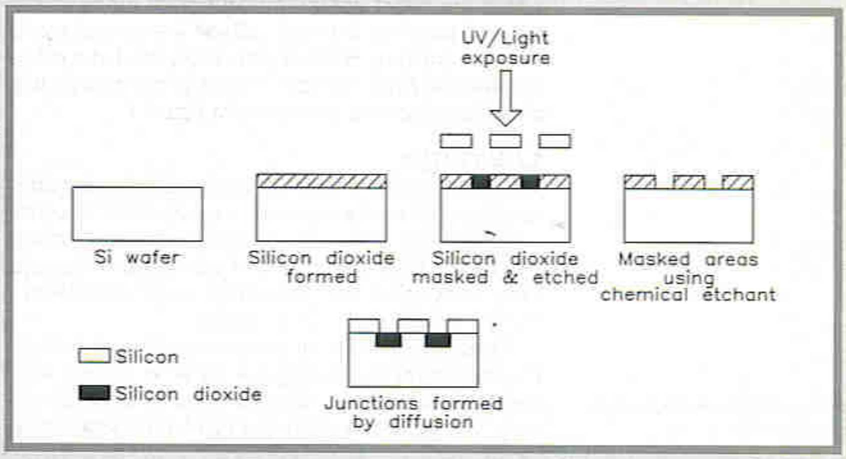
Magnetic Analysis

Positive ions extracted from the source are accelerated to energies up to +80keV. The extracted ion beam diverges and is then bent through an angle of 60° by a large electromagnet. Magnetic analysis ensures that the ion beam is formed solely from the desired dopant ions. Lighter or heavier impurity ion contaminants (left in the machine from a previous processing) are deflected. The divergent beam is converged again and a sharp focus achieved. The ion beam cross section is a vertical ribbon; fringe magnetic fields effect a focus in both the horizontal and vertical planes.

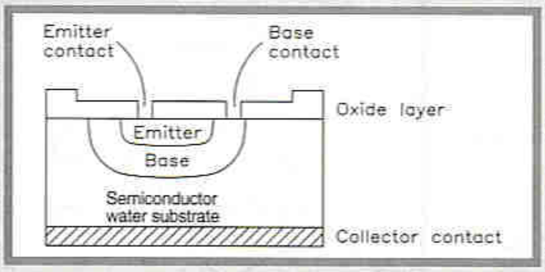
The now pure ion beam passes into the process unit, which can also be biased up to a potential of +120kV with respect to earth. This enables singly-charged ions up to 200keV to be used for implantation.



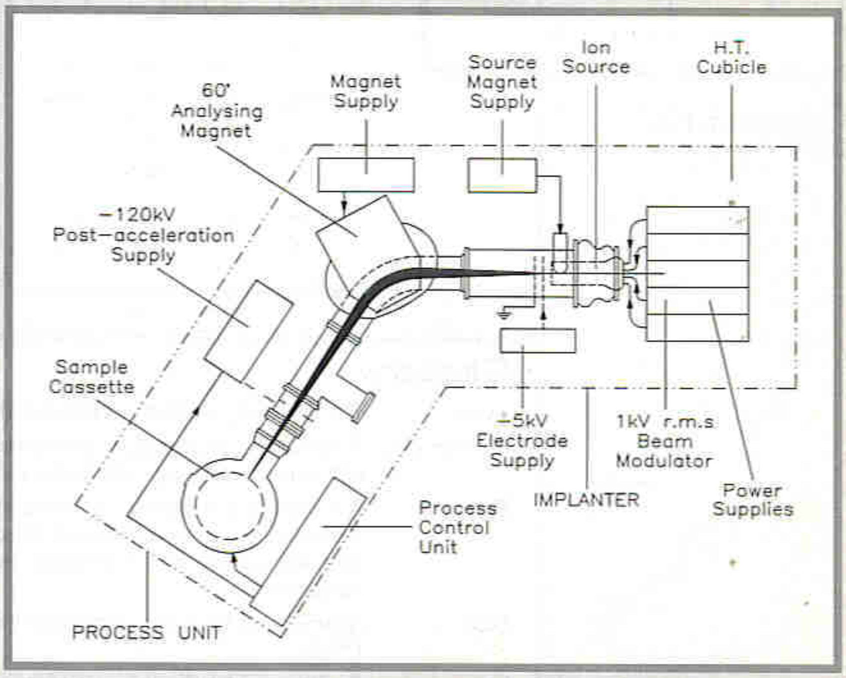
Left: Figure 2. Practical diffusion system.



Below: Figure 3. The planar process.



Left: Figure 4. Planar transistor. Note base and emitter have been formed using sequential diffusion.



Above: Figure 5. Schematic diagram of a Lintott 2 ion implantation system.

Ion Beam Fact

Implantation energies in use range from 1keV to 10Mev, resulting in ion range distributions with projected ranges of 100Å to 10μm (10^{-8} to 10^{-5}m). Implantation doses vary from 10^{12} to 10^{18}cm^{-2}.

Precautions are taken in the processing unit to ensure that wafers are uniformly implanted over the whole surface. This is achieved by scanning the beam using an AC modulator at the source, and by physically moving the wafers in the implantation unit.

The depth of an implantation depends on the ion mass implanted, the target material and the energy of the implantation. Again mathematics is used to describe implantation depths, but we shall avoid this and stick to practical details. Ions do not all stop at the same position below the surface of the target. The process of slowing down is one of multiple collisions with atoms within the target wafer. The path taken by implanted atoms depends on the initial collision with surface atoms and the structure of the crystal. Every ion has a different path and (within certain limits) a different range; two possible trajectories are shown in Figure 7.

Damage

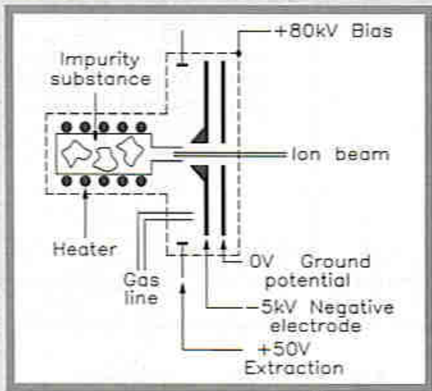
The major problem with ion implantation is that damage is caused to the crystal as a result of the displacement of target atoms. These atoms (called *recoil atoms*) may have substantial energy and cause further damage. Thus, point defects and dislocations are produced which cannot be tolerated in VLSI devices.

There are several methods for repairing the damage. During thermal annealing, the wafer is heated, after implantation, to temperatures of around 700°C (for silicon). This promotes restructuring of the crystal lattice, but, unfortunately, this may cause in-diffusion of the dopant. Care must be taken when working with shallow depths.

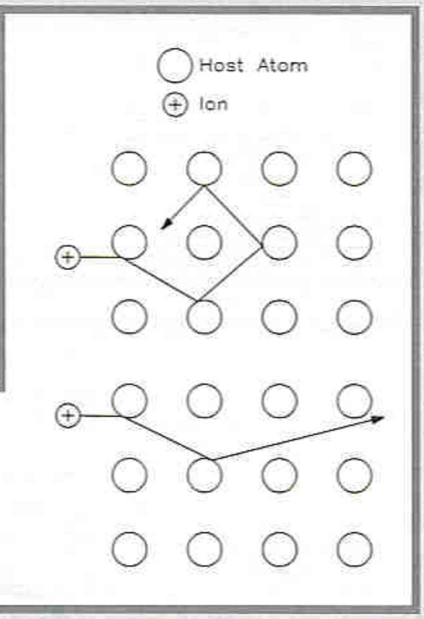
Flash or laser-annealing is currently the subject of a number of research programs. The wafer is more conveniently maintained at room temperature, and is subjected to an intense light or laser beam of about 2Jcm^{-2} for between 100μs and 1ms duration. This encourages localised melting and regrowth close to the surface of the wafer, and, because the light or laser beam is fired for only a brief period, this prevents modification of the doping profile. That is what happens in theory; in practice, if conditions are not correct, the process can result in total disorder of atoms within the semiconductor wafer!

Ion beam annealing shows promise. If this technique were to become established, it would reduce processing costs, since all work could be undertaken using the ion implanter. A high energy (100keV to 1Mev) light ion beam is implanted following the dopant implant. The wafer temperature is maintained at 200 to 400°C so that in-diffusion is not likely. Restructuring takes place due to the energy transferred to the semiconductor atoms on the atomic scale. The energy of the implant is much higher than the dopant implant, and so these ions stop much deeper, away from the junction region.

Below: Figure 6. Ion source details.



Right: Figure 7. Two possible trajectories.



Contacts and Interconnections

During the manufacture of integrated circuits it is often necessary to deposit a thin layer of metal upon a semiconductor. This may be to form interconnections between the various layers within the integrated circuit, or contacts for a dual-in-line package. Metallic connections are made using vacuum technology in an arrangement of the type shown in Figure 8. The semiconductor wafers are placed face down in a bell jar with the metal source in the centre. The bell jar is evacuated to below 5 x 10^{-6}Torr before deposition can commence.

The semiconductor wafers are heated to between 100 and 300°C for silicon, allowing the metal to adhere and diffuse to a thickness of up to 1micron. The thickness is monitored by a quartz crystal oscillator mounted next to the wafer, whose frequency changes in sympathy with the amount of metal deposited on its surface. The wafer is masked off, so that only the contact areas are metallised.

The metal source must have a large area. Shadowing effects can arise from point sources, which would result in weaknesses in the metal film. There are two ways of heating the metal source. It can be wrapped as a wire around a resistance heated tungsten filament. This is an inexpensive method but does have the risk of contamination due to evaporation of the heater metal.

Glossary

Atom:	The smallest particle of an element that cannot be subdivided without destroying its identity.
Electron gun:	A device that produces an electron beam; forms an essential part of many electronic instruments including cathode-ray tubes and electron microscopes.
Element:	A substance that consists of atoms of the same periodic number. Over a hundred different elements have been discovered that cannot be broken down into simpler substances. Elements are the basic substances from which compounds are built up by chemical combination.
ELSI:	Abbreviation for Extra Large Scale Integration. Describes a device with a capability over 1M-bit.
Ion:	An atom, molecule, or group of atoms or molecules that has electric charge.
PN junction:	The region at which two semiconductors of opposite polarity meet. A simple PN junction (a homojunction) is formed of the same material, in which doping levels lead to two different conductivity types.
Resistivity:	A material property equal to the resistance per unit length. Resistivity is the reciprocal of conductivity; the lower the resistivity of a material, the better it is as a conductor. In semiconductors, the higher the doping level, the lower the resistivity.
VLSI:	Abbreviation for Very Large Scale Integration. Describes a device with a capability between 16k-bit and 1M-bit.

A cleaner solution is to use electron beam evaporation. Here, the metal is placed in a 'boat' which acts as the anode of an electron gun. High energy electrons striking the source cause it to evaporate and deposit on the surrounding semiconductor wafers.

After evaporation it is usual to heat the wafers to about 500°C in an inert atmosphere. This causes the metal to alloy with the semiconductor surface so that the interface between the two has a low resistance. This is known as an ohmic contact joint.

Next Month

Having looked at the different production techniques, next month we can go on to examine how all the pieces fit together to form a complete, finished integrated circuit.

References

A. Barlev, Semiconductors and Electronic Devices.
B. Tuck and C. Christopoulos, Physical Electronics.
G. Farrell, University of Salford, Integrated Circuit Fabrication & Design – An Engineering Perspective.

Sincere thanks are due to Dr G. Farrell of the University of Salford, who taught the author almost all he knows about the subject of Integrated Circuit Fabrication & Design.

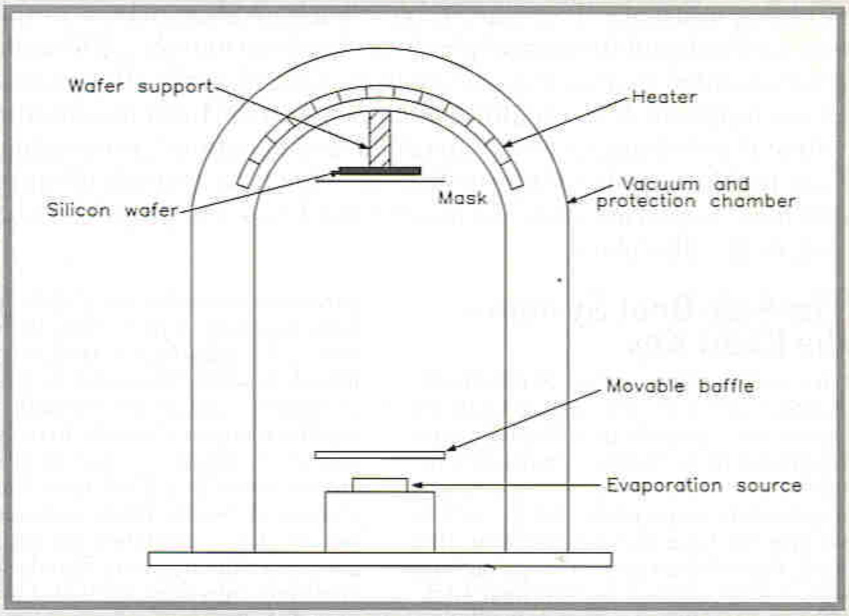


Figure 8. Metal evaporation equipment.

A Boot-up Protection System for the PC

Reviewed by Frank Booty

A PC boot-up protection system is a means whereby a PC's hard disk is rendered unusable *unless* the PC has been booted-up using a proprietary disk product, and the correct password has been entered. Although it has to be admitted that such a scheme has a limited application in a domestic environment, it is, of course, of more use in the business environment where it will deny access to unauthorized personnel, preventing them from reading sensitive information, altering it or 'ripping off' programs and files. To gain access to the internal hard disk, the proprietary boot-up disk works like a key.

The Safe Boot System – the Right Key

One such system is the 'SafeBoot PC Access Control System' which includes 'SmartDisk', available from SmartDiskette Limited of Hove, Sussex. Compared with other PC boot protection systems, which usually store the cryptographic key which secures the hard disk on the hard disk itself, the SafeBoot system keeps the key, password protected, on the SmartDisk. The beauty of this approach is that it prevents an unauthorized person from discovering the key by using low level disk accessing tools, such as Norton Disk Editor, to explore the hard disk, because it simply isn't there.

Instead the key is stored on the SmartDisk. This very clever gadget is not a floppy disk at all (whereas the SafeBoot System disk *is* a real 3·5in. disk). Rather it is very similar to a 'smart card', and contains microcontroller based circuitry, with built-in battery, which 'talks' to the computer's disk drive head via inductive couplings located in the positions where the read/write head would normally rest on the disk surfaces. The disk drive hub does nothing of course, as there is no disk to spin in SmartDisk. Each time SmartDisk is inserted into the drive, its internal battery supply is switched on and, when accessed, the magnetic signals fool the computer into thinking that it is a spinning diskette.

The user can select whether he wants full or partial disk encryption during SafeBoot installation. Partial disk encryption encrypts only the areas of the hard disk which store the information which MS-DOS uses to locate file data. Normally this will, in most cases be sufficient, because SafeBoot makes it impossible for the unauthorized user to read the files on the hard disk by the normal means. The only other option is to search for the data using low level disk access tools. Alternatively, full disk encryption encrypts *all* the data on the hard disk, making it impossible for the unauthorized user to read any data from the hard disk by any means.

The partial disk encryption is very quick to install, whereas of course full disk encryption takes rather longer, about two minutes per 10 Megabytes depending on the speed of the PC. However, once SafeBoot is installed on the PC there is no noticeable difference in the operation of the machine, other than having to 'log on' using the SmartDisk. This works in exactly the same way as does a normal system boot-up from a floppy in drive A: to override the hard drive system boot.

Installation

In order to use the SafeBoot system the IBM or compatible PC needs a 3·5in. floppy disk drive as the system default drive (A:), and be running either MS-DOS or PC-DOS version 3·0 or higher. Before installing SafeBoot it is necessary to check that there is both a SmartDisk and a SafeBoot System Diskette to hand. The hard disk should preferably be backed up (if power is lost during the installation then the data on the hard disk could be lost). You should also have a bootable 3·5in. floppy disk as a system boot-up disk (use the DOS 'SYS' command, 'SYS C:\ A:' to make a system disk, or 'FORMAT A:/S/U/F:720 or 1.44' (DOS 5 and over)), which may be needed in the event of loss or damage of the SmartDisk in order to be able to recover the hard disk.

The final check is to ensure that there is no disk cache program installed (DOS 'SMARTDRV', etc.) on the PC which is configured to cache the *floppy disk* drive. Most disk caches operate only on the PC's hard disk drive(s), and should therefore be compatible with SafeBoot. Some, may be configured to cache data from the *floppy disk* drive(s). Such caches must be reconfigured not to cache the floppy diskette drive, or be disabled completely, in order for the SmartDisk to operate properly.

It is important to note that SafeBoot should not be installed with Microsoft Windows running. While SafeBoot is compatible with Windows, *SafeBoot must be the only program running while it is encrypting the hard disk.* Should another program attempt to read or write to a partially encrypted disk, the hard disk may be corrupted. Even if there are no other applications active under Windows, Windows itself may still attempt to write to the hard disk.

The SafeBoot System as supplied; the Smart Disk itself is on the right of the photograph.

Starting the installation and loading SafeBoot is straightforward. The software first checks that the PC has been backed up, and performs compatibility checks to understand the types of partitions on the PCs hard disk. It checks the level of encryption required, copies the password information to the hard disk, then configures the SmartDisk (which is inserted when required) for use with SafeBoot, and copies the SafeBoot software to the SmartDisk. It loads the SafeBoot key for the PC onto the SmartDisk and the system boot-up diskette that you made earlier, and lastly, protects the PCs hard disk. The latter command enciphers all or part of the PCs hard disk (depending on your options) using the SafeBoot key such that it can only be accessed using the SmartDisk. On completion, the user is reminded to store the SafeBoot system diskette in a secure place and reboot the computer.

Once the system has been installed, booting the PC – without the SmartDisk inserted – will cause the SafeBoot log-on screen to be displayed with the message: 'Please insert your SmartDisk, press any key to continue.' Doing this results in a prompt to enter the (user defined) password, and then to press '[Enter]' to continue booting in the normal way. The SmartDisk must then be removed to conserve its battery power (don't forget!).

Order of the Boot

With most PCs it is possible to insert the SmartDisk *before* booting. Here, SmartDisk initially behaves like a system boot-up floppy and the PC will not display the message to insert SmartDisk, but will proceed directly to the password prompt. (Some PCs – notably some Compaq systems – are unable to boot directly from the SmartDisk. It is actually better to boot directly from the SmartDisk, as the SafeBoot software stored on the PC can be verified before running is commenced.)

With SafeBoot installed on the hard disk, it is still possible to use the PC using a bootable floppy diskette – that is one which has a PC operating system installed on it. The protected hard disk will not be recognised by the operating system and will not be usable when the computer is booted in this way. But the machine can still be used in the normal way, albeit with only floppy drives available for use. SmartDiskette Ltd have warned, however, that if booting is done from a floppy diskette and an attempt is made to recover the hard disk using any disk tools, *it will no longer be possible to boot from the SmartDisk and the information on the hard disk will be lost.*

The battery life of the SmartDisk is claimed to be at least 20 hours of continuous use. SmartDiskette Ltd claims that the disk should be able to boot the computer over 1,000 times before needing a new battery. Current is drawn from the battery as long as it remains inserted in the disk drive, so removal is therefore advised as soon as booting is finished.

Should any problems arise while trying to boot the PC, a selection of error messages is catalogued with full information provided in the manual. It is also possible to remove SafeBoot protection from the PC, provided you've got the key, of course.

The password can be changed, but obviously only if the existing one is known. The system can also be used to protect several computers, by using the *same* SmartDisk and SafeBoot system diskette, making sure that the same SafeBoot key is used for all computers.

SafeBoot can also be installed on PCs having disk compression software installed, provided that there is at least 8K of free, *uncompressed* space on drive C of the PC's hard disk, and that the compressed space is *not* assigned to drive C. If there is sufficient uncompressed disk space available but the compressed drive is assigned as drive C, then SafeBoot may be installed after booting the PC using a bootable floppy diskette. This gets around the swapping of the drive letters that usually occurs while compression drivers are installing themselves.

Conclusion

In today's professional climate, the appearance of such a product as the SafeBoot SmartDisk can only be welcomed. Anyone looking for a means of setting up security – particularly restricting access to a PC's hard disk – could do no worse than give this product a trial run.

The package has recently been updated with improved installation options. It is priced at £175 + VAT, and can be obtained directly from SmartDiskette Limited, Gemini Business Centre, 136/140 Old Shoreham Road, Hove, East Sussex BN3 7BD. Tel:(0273) 773002. Fax: (0273) 737133.

READERS' SURVEY PRIZE DRAW WINNERS

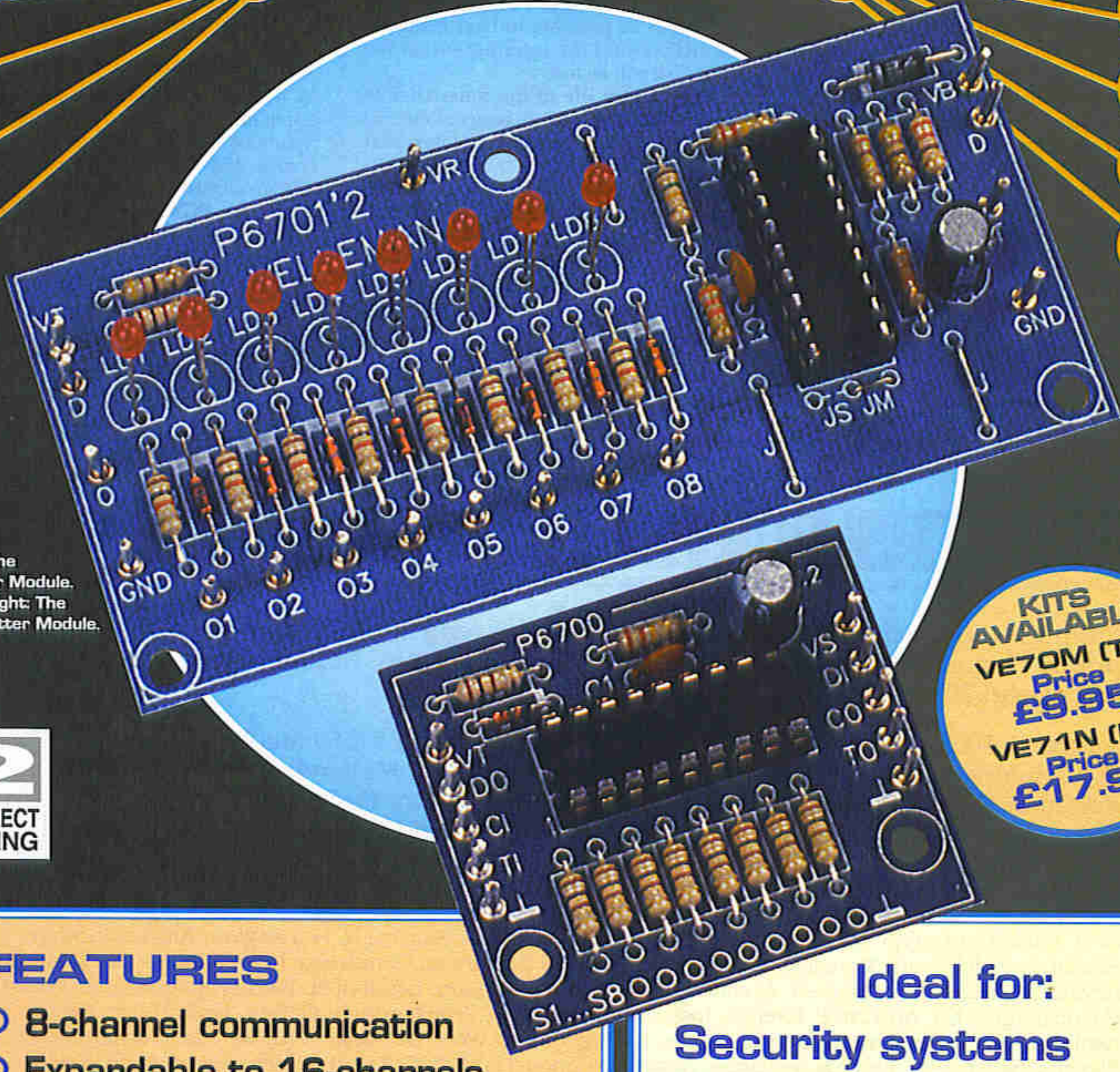
From the 2,811 readership survey questionnaires returned, a total of 61 were drawn for prizes. First out of the pile was Mr. P. A. Rosser, of Hitchin, Hertfordshire, who wins a very useful 7045 dual-trace 40MHz oscilloscope.

A further 10 second prize runners up, who each received a £10 Maplin gift token, were: D. F. Spinney, Bromley, Kent; T. Ratcliffe, Solihull, West Midlands; A. J. Denniss, Romford, Essex; J. Chappell, Stafford; Ian Soaft, Bedford; G. Scothern, Bicester, Oxon; Sean Ripley, Wokingham, Berkshire; D. Goodchild, Ayelsbury, Buckinghamshire; P. Montgomery, Slough; R. Stevenson, Calne, Wiltshire.

An additional 50 third prize winners received a new Maplin Catalogue: G. B. Hall, Esher, Surrey; A. D. Lake, Banbury, Oxon; L. F. Smart, Bexhill-on-Sea, East Sussex; N. H. Langton, Kincardineshire, Scotland; P. Johnson, Mansfield, Nottinghamshire; M. S. Barrett, Cambridge University; G. Gudgonsson, Reykjavik, Iceland; S. Lovelass, Aycliffe, Co. Durham; R. Knapp, London; N. Worthy, Durham; R. Yeung, Carrickfergus, Co. Antrim; P. Everett, Ipswich; D. V. Dolby, Peterborough; G. Salt, Hull; H. Matthews, Ashton-under-Lyne, Lancashire; R. C. Lee, Ryton, Tyne & Wear; J. Foster, Peterlee, Co. Durham; F. P. Stevens, Sevenoaks, Kent; S. Williams, Newcastle-upon-Tyne; C. C. Lee, Buckley, Clwyd; C. E. Naylor, Colchester; D. C. Popely, Banbury, Oxon; N. Dobson, Carrville, Durham; D. Roberts, Liverpool; R. W. Catch, London; D. Furnell, Huntingdon, Cambridgeshire; G. Barlow, Greenfield, Oldham; J. J. Stead, Wanniassa, Australia; J. T. Knights, Newport Pagnell, Buckinghamshire; S. Smith, Paddock Wood, Kent; R. Mason, Bognor Regis, West Sussex; J. Francis, Bognor Regis, West Sussex; N. Doody, Co. Waterford, Ireland; P. Creevy, Co. Kildare, Ireland; A. Lake, Edenbridge, Kent; P. Bennett, Sheffield; C. Bannister, Reading; B. P. Wilmott, Essex; John Mills, Corby, Northamptonshire; K. Duncan, Road, Dundee; R. Cook, Ruislip; P. D. Miller, Aylestone, Leicester; M. B. Hayes, Tonbridge Wells, Kent; J. G. Hunt, Stourport-on-Severn, Worcestershire; E. B. Woods, Guildford, Surrey; F. Wilson, Scarborough; R. Hardy, Carrickfergus, Co. Antrim; I. M. Tasker, Grantham, Lincolnshire; G. Green, Basildon, Essex; G. Manning, Edgware, Middlesex.

2-wire 8-Channel Communication Transmitter + Receiver

Text by Alan Williamson and Robin Hall



Right: The Receiver Module. Below right: The Transmitter Module.

KITS AVAILABLE
VE70M (Tx) Price £9.95
VE71N (Rx) Price £17.95

2
PROJECT RATING

FEATURES

- 8-channel communication
- Expandable to 16-channels
- Power supply through data line
- 2-wire communication between transmitter and receiver
- LED status indication of each output

Ideal for:

Security systems
Signal and control systems
Railway modelling
Data logging

Specification

Power supply:	+9 to +16V DC
Quiescent current :	80mA
Maximum current (full load):	480mA
Channels:	8-channels expandable to 16

These kits open up a wide range of possibilities, such as security, model railways, remote signalling, and other applications where a number of switching connections are required. These modules enable up to eight individual switching devices to be operated from a distance of 50m or more. Further expansion using more modules is also possible. There are only two connecting wires between the transmitter and receiver, with power for the transmitter obtained from the data line. It is also possible to connect several receivers to one transmitter, to receive switching connections in several places.

Circuit Description and Overview

The modules operate by scanning the transmitter(s) switch inputs, then converting the controlling switches 'ON or OFF data' into a digital code; the 'data' is then transmitted serially through a two wire cable.

The receiver decodes the sequential data and then turns on the appropriate transistors. Light emitting diodes (LEDs) indicate which channels have been turned on.

The basic configuration is one transmitter and one receiver, but as shown in Figure 1, the system can be extended by the addition of a slave transmitter and receiver.

Transmitter

Refer to Figure 2a for the transmitter circuit. The power for the transmitter is obtained from the data-line, using D1 and smoothed by capacitor C2.

Resistors R1 to R8 are pulled down to ground by switches. IC1 generates a signal that shows the state of each channel. The signal is sent down a two wire cable to a receiver.

Note that ground is denoted as (⊥) on the transmitter.

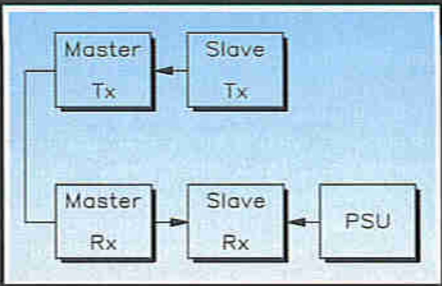


Figure 1. Block diagram of system.

Receiver

Figure 2b shows the receiver circuit. Power is connected to VB and this should be in the range +9 to +16V DC. The board consumption with the LEDs off and the transmitter not connected should be around 1·5mA.

Reverse polarity protection is provided by D9. Pins 6 and 13 on the 6052 IC are for setting Master or Slave operation. For Master operation, pins 6 and 13 are taken high through R9. For Slave operation pin 6 is pulled down to ground.

Diodes D1 to D8 are provided to protect IC1 from induced emf produced by relays de-energising (if connected). LD1 to LD8 are used to give a visual indication of switch states at the transmitter end.

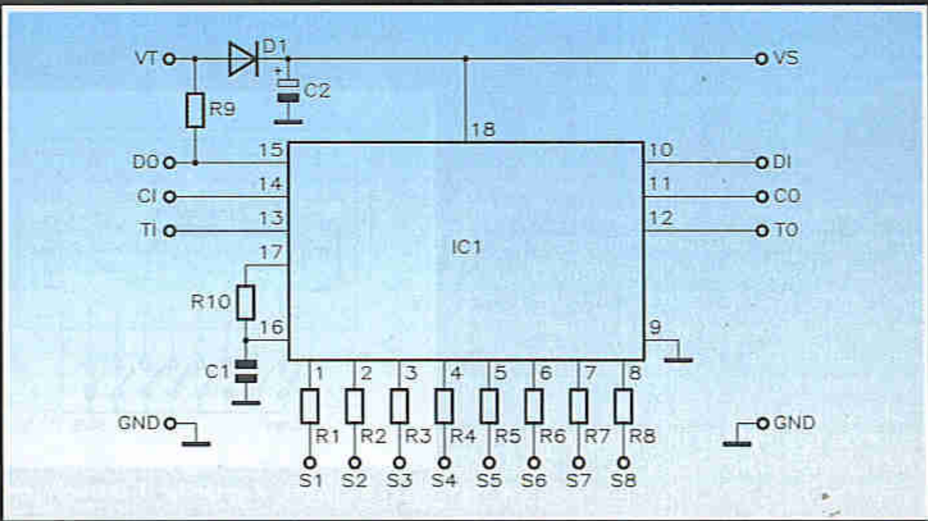


Figure 2a. Circuit diagram of transmitter.

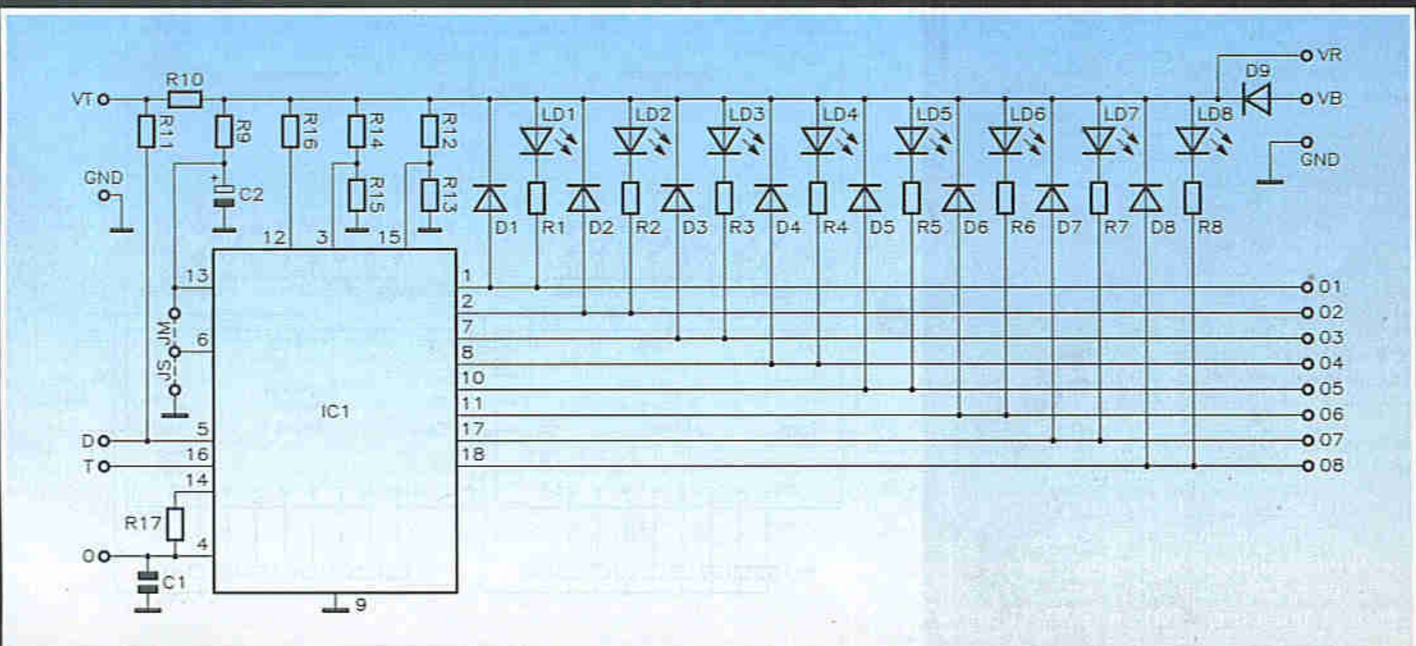


Figure 2b. Circuit diagram of receiver.

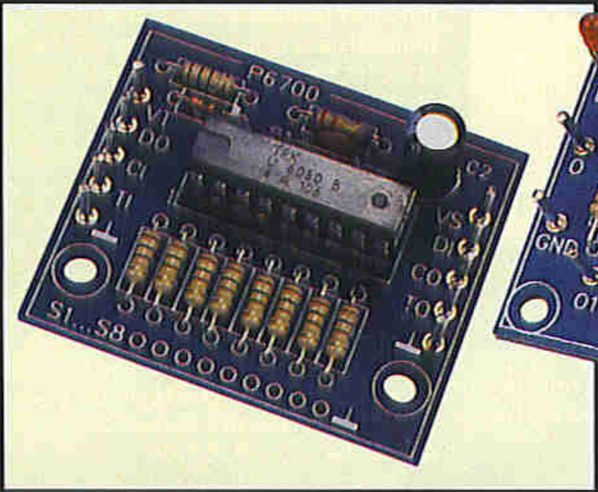


Photo 1. Assembled transmitter PCB.

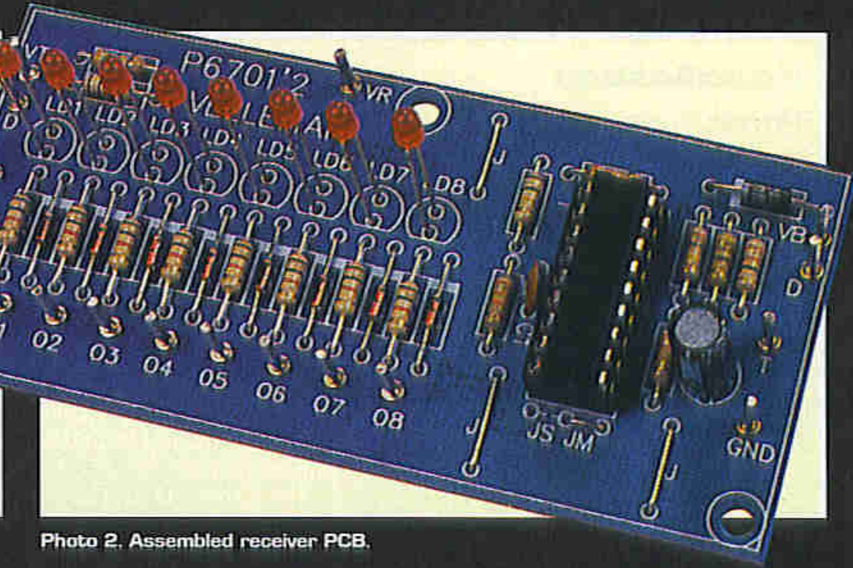


Photo 2. Assembled receiver PCB.

These LEDs are protected by current limiting resistors R1 to R8. Note that ground is denoted as 'GND' on the receiver.

Construction

Fit the resistors according to the legend on the PCB. Next fit the diodes making sure that the polarity is correct, and that the band on the diode is located in the same position as on the board. When fitting the LEDs LD1 to LD8, make sure that the shortest leg of the LED is positioned in the hole nearest to the flat part on the PCB legend.

Fit the capacitors next, making sure that electrolytics are fitted the correct way round. The polarity for an electrolytic capacitor is shown by a plus (+) sign on the PCB legend; the longer lead is normally positive on the capacitor, with the negative lead designated by a negative symbol (–). Next fit the 18-pin DIL sockets, making sure that the orientation mark on the PCB is matched with the notch on the socket.

Fit the PCB pins into the relevant holes. Finally fit the ICs, making sure that it is correctly orientated, with the notch matching that on the socket. Photo 1 shows the assembled transmitter PCB, and Photo 2 the assembled receiver circuit.

If the receiver board is being used as a Master module then construction should be in the same manner as before. Additionally place wire links made up from offcuts from the resistors in the positions marked as 'J', and fit a link in position 'JM' see Figure 3a. For Slave operation replace R10 by a link and do not fit R11, R17 and C1. Fit a wire link in position 'JS' instead of position 'JM' see Figure 3b.

If using several receivers with one transmitter remember not to fit R11 on the additional receivers.

Connect the power supply to the receiver in the usual way, and connect positions GND to GND, D to D, etc. between receivers.

NOTE: in each receiver configuration the maximum collector current should not be greater than 50mA.

If the unit or units are to be interfaced with devices that draw more than 50mA, then relays must be used. The relays can be directly connected, as protection diodes have been included on the PCB, as shown in Figures 3a and 3b, making sure that the common point for the relays are taken to position VR. A supply current of 480mA will be required.

Suitable relays for the project are given in the Optional Parts List.

Testing and Set Up

Referring to Figure 3a connect the K6700 and K6701 as shown. Link C1 and TI to ground on the Master transmitter and connect to the GND terminal on the receiver. Connect VT on the receiver to VT on the transmitter; the length of the wires determined by the user. Using a correctly rated power

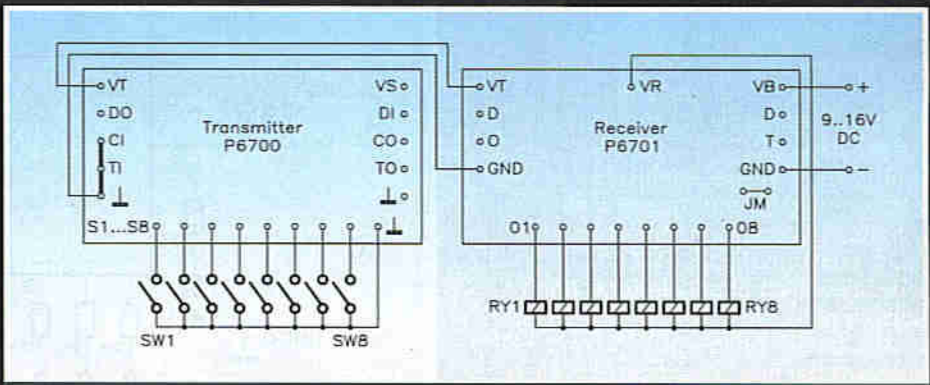


Figure 3a. Wiring diagram for 8-channel operation.

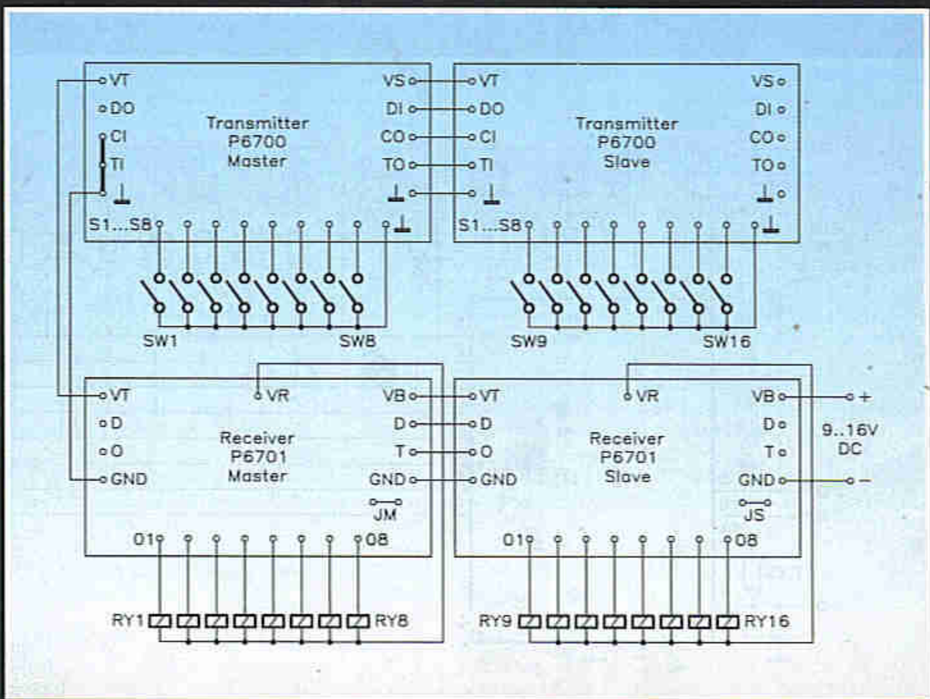


Figure 3b. Wiring diagram for 16-channel operation.

supply connect the positive to VB and negative to GND. If all has been wired up correctly then shorting positions SW1 to SW8 to GND will result in the appropriate LEDs lighting up. An oscilloscope can be used to check the data signals on the two wires; these should be seen to change when the appropriate position is shorted to GND.

If further modules are required for 16-channel use, referring to Figure 3b connect positions VT to VS, DO to DI, CI to CO and ⊥ to ⊥ from the transmitter slave to transmitter master. Connect VT to VT, and CI, TI and ⊥ to GND from the transmitter master to the receiver master. Connect from the receiver master to receiver slave, VB to VT, D to D, T to O and GND to GND. The power supply is connected to the receiver slave, with positive to VB and negative to GND. All being wired up correctly, then shorting positions SW1 to SW8 and SW9 to SW16 to GND will result in the appropriate LEDs lighting up.

Input Combinations

Figure 4 shows a selection of 'switches' that are shown on the same board for demonstration purposes only. In practice the switches would be of a similar type and connected to S1 to S8 on the transmit module; as can be seen they need not be limited to just simple 'ON OFF' switches. Some applications may include relays that are switched on by a separate supply. These are particularly favoured in automobile circuits. Reed switches can be used in hobbies such as model railways. Using a magnet in the engine or carriage, or even the magnetism from the engine's motor, and with a reed switch embedded between the tracks, a train passing over the contacts will close the reed switch and activate one of the channels on the transmitter. This in turn activates one of the receiver channels, which can then be used for signalling or position information, such as when the locomotive has reached the centre of a tunnel, or a certain part of the layout, such as at a station.

'ON OFF' momentary action security switches (either Normally Open (NO) or Normally Closed (NC) contacts) can be positioned in locations such as, outhouses, summerhouses or greenhouses, where the remoteness from the main building may be a problem. Existing burglar systems may be extended into other areas where individual security switches on windows, floor mats, and doors, when triggered can, close or open the appropriate contact and the information fed from the transmitter back to the receiver module. The

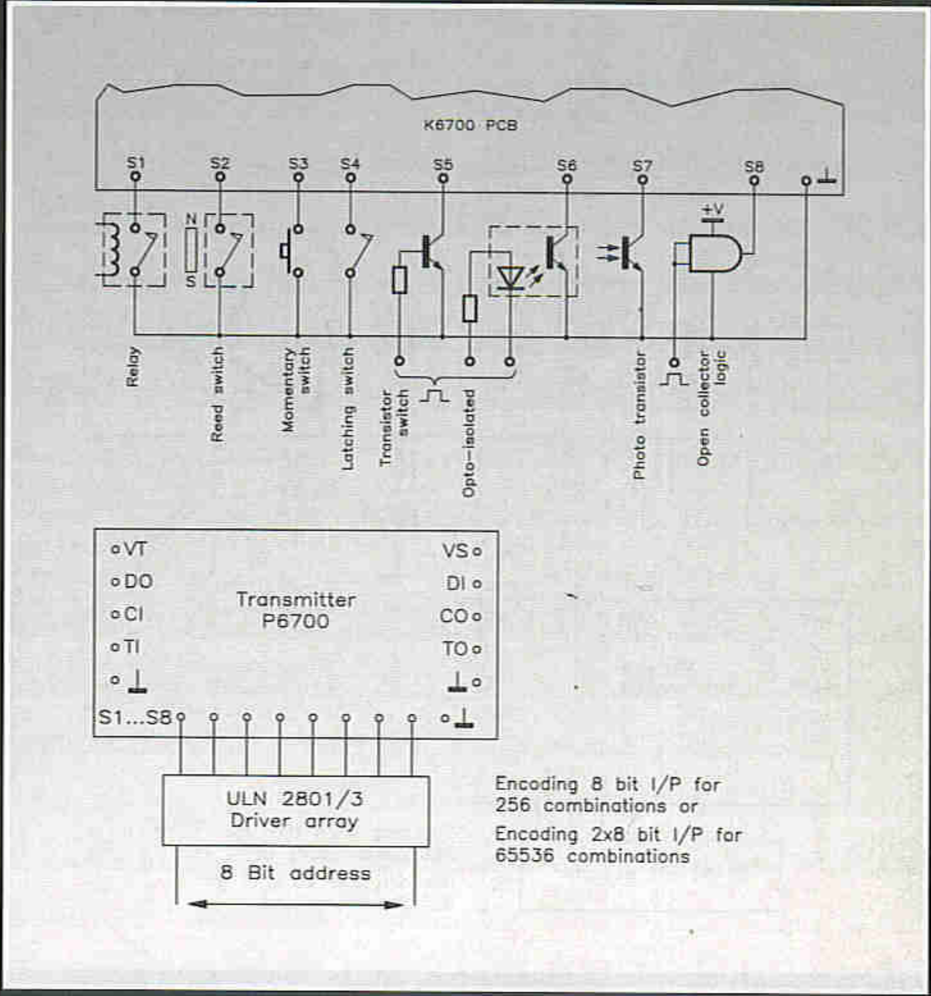


Figure 4. Input 'switch' combinations.

LEDs might be used on a mimic panel to indicate which door or window has opened.

Another method of switching is to have transistor collectors connected to positions S1 to S8 on the transmitter board, and have the transistors switched on via their bases. The same for optoisolators, which the output of each again connected to S1 to S8 on the transmit board. Other forms of devices such as photo-transistors could indicate whether an area was lit or not, or with suitable biasing, activate on a particular level.

Open collector logic devices are another possibility for input switching, where circuitry using logic levels, individually switch the devices, the integrated output transistor then acts as an electronic switch.

Up to eight switching devices may be used on the transmit module but this can be extended to a total of sixteen by the addition of a slave transmitter, and connected as mentioned in the Testing and Set Up section.

There is the possibility of interfacing the modules to an 8-bit, or with an extra slave module, 16-bit port on a computer. Use a suitable 8-bit open collector driver array such as ULN 2801/3 as shown in Figure 4. The advantage here is that with an 8-bit address there would be 256 possible combinations, or with 16-bit 65536 combinations.

Output Interface Combinations

Figure 5 shows a selection of devices that can be connected to the receiver board. Relays as covered earlier in the text, these can be used in many applications, where higher switching currents or isolation between input and output are required.

Solenoids can operate mechanical linkages and in conjunction with a pair of channels open or close remote doors; this would have a security aspect. Alternatively the solenoids can be used to activate mechanical signals such as on a railway layout, or points or turntables.

CMOS logic gates can be switched on or off, the correct supply voltage levels would have to be applied, i.e. same supply as receiver. The applications for logic switches are numerous.

The receive board could use the switched channel to activate an optoisolator or a high power transistor. This would then act as an electronic switch. A channel could be used with a level shifter to interface with TTL logic.

Using an 8-bit decoder for one module for 256 combinations or 2 x 8-bit decoders for 65536 combinations is another possibility,

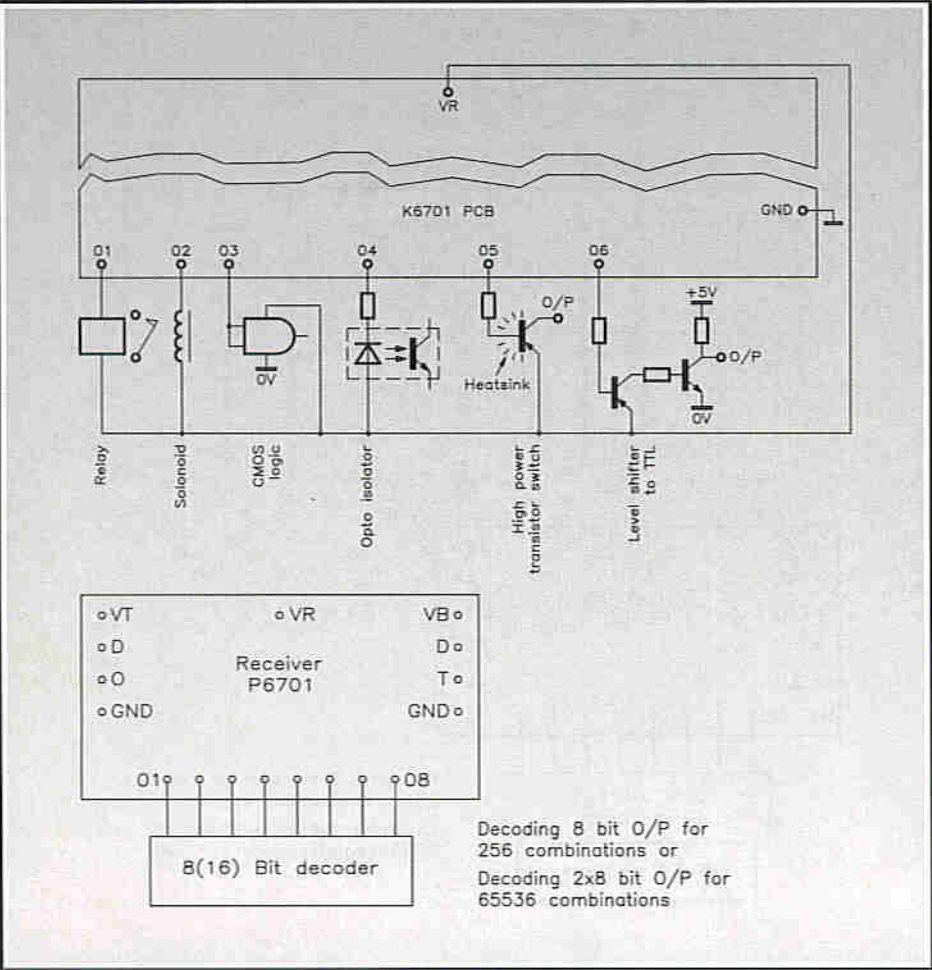


Figure 5. Output interface combinations.

as shown in Figure 5. This would be useful with a computer, although the switching speed would not be particularly fast.

Further Suggestions

There are many more uses for this project, using a combination of switching devices for controlling models, lighting, motors, alarms, locks, various theatrical on-stage applications, status indication wiring in cars and caravans.

For the hobbyist, controlling lighting in individual rooms in a doll's house, or houses and street lighting in a model village, where the houses may be situated remotely. Model train enthusiasts with pairs of transmitters and receivers to cut down on the wiring between the control panel and the layout.

Data logging applications may be used where contacts embedded in remote machinery can be checked to see if the particular piece of equipment is on. Similarly, machinery interfaced, with suitable switching arrangements, such as heavy duty relays, could be switched on remotely.

Do not think that it must only be two *wires* that the signal is to travel down. Other possibilities might be to use conductive tracks or the frame or chassis acting as one of the conductors (GND).

2-WIRE 8-CHANNEL COMMUNICATION TRANSMITTER

RESISTORS: All 0·6W 1% Metal Film		
R1 to 9	100Ω	9
R10	220k	1
CAPACITORS		
C1	680pF	1
C2	100μF 25V	1
SEMICONDUCTORS		
D1	1N4148	1
IC1	6050	1
MISCELLANEOUS		
	PCB	1
	18-pin DIL IC Socket	1
	PCB Pins	10

2 WIRE 8-CHANNEL COMMUNICATION RECEIVER

RESISTORS: All 0·6W 1% Metal Film		
R1 to R8	1k	8
R9,10	470Ω	2
R11	100Ω	1
R12	270k	1
R13	22k	1
R14	150k	1
R15	33k	1
R16	220Ω	1
R17	220k	1
CAPACITORS		
C1	120pF	1
C2	100μF 25V	1
SEMICONDUCTORS		
D1 to D8	1N4148	8
D9	1N400x	1
LD1 to LD8	3mm Red LED	8
IC1	6052	1
MISCELLANEOUS		
	PCB	1
	18-pin DIL IC Socket	1
	PCB Pins	17

OPTIONAL (Not in Kit)

Suitable Relays:		
Micro-Min Relay 12V	As Req.	(BK47B)
12V Micro-Min 1A 200mW	As Req.	(DC52G)
Ultra-Min Relay 12V SPDT	As Req.	(YX94C)
Ultra-Min Relay 12V DPDT	As Req.	(JX55K)
12V DPDT BT Relay	As Req.	(DC77J)
12V BT47W/6 Relay	As Req.	(DC80B)
3A Min Relay	As Req.	(YX96E)
12V/5A Min Relay	As Req.	(JM18U)
12V/10A Min Relay	As Req.	(JM67X)
10A Mains Relay	As Req.	(YX97F)
12V 16A Relay	As Req.	(YX99H)
12V 6A Min Relay	As Req.	(FJ43W)
Relay Flat 12V	As Req.	(HY20W)
Relay 16A 250V AC	As Req.	(JG22Y)
Low current consumption relays:		
Reed Relay 12V SPDT	As Req.	(JH13P)
Reed Relay 12V DPST	As Req.	(JH16S)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
The above items (excluding Optional) are available as a kit only.
Order As VE70M (2-Wire 8-Channel Communication Tx) Price £9.95.
Order As VE71N (2-Wire 8-Channel Communication Rx) Price £17.95.
Please Note: Some parts, which are specific to this project (e.g., ICs, PCBs) are not available separately.

A readers forum for your views and comments. If you want to contribute, write to:

The Editor, 'Electronics – The Maplin Magazine' P.O. Box 3, Rayleigh, Essex, SS6 8LR.

Air Your Views

Using Up Spare 'Bottles'

Dear Editor,
As a subscriber to your excellent (creep, creep) magazine, may I say that as one of the old valve fanatics, how much I have enjoyed reading the articles by Graham Dixey. They certainly have brought back old memories for me. My main reason for writing is to ask whether anyone has ever considered using TV line output valves for audio amplifiers?
I pose this question because I (and, I suspect, many other 'valve wallers') have several of the old TV valves left from the days when I used to dabble with tellies. I particularly have in mind the PL81, PL36 and PL500/504. This is an alternative due to the prohibitive cost of conventional output 'bottles' such as EL34, KT66/88, etc., assuming one could find a source of supply in the first place.
The heater voltages may be a slight problem, but possibly a series supply arrangement might be feasible. All such valves have heaters standardised at 300mA, which equates with the ECC81/2/3 current. Some experimentation will be required to find the optimum bias and transformer ratios.
R. J. Abraham, Winchester.

While this might sound feasible, after thinking about it for a short while one can see a few possible snags with this idea. For example, matching transformers to pentode valves is actually rather critical, more so than for triodes. Also L.O.P.T. valves naturally have a fast response and are designed for optimum performance at ultrasonic frequencies, so HF instability may be persistent. Also, what do you do when your specialised TV valves finally expire and you have no more spares, nor are you able to obtain any? Although an interesting exercise, and it might seem a shame for such valves to go to waste, I wonder whether saving a few pounds is worth all the aggravation, but that's only my opinion. You suggest that EL34 audio output valves are difficult to obtain, which is simply not the case – you can buy them from Maplin!

Why No Coils?

Dear Electronics,
Thanks for the recent articles on sub-woofers. I would, however, like the following points clarified if possible:
1. I am used to seeing RCL crossovers in loudspeakers. Why are there no inductors in the active crossovers of Part 3 (Figure 19, page 50, March issue)?
2. I would like to build this crossover, but I am not sure of the power supply needed. Should it be split or single rail? Will a PCB be available?
On a different topic, I would like a remote volume control for my amplifier. As I have a pre and power amp combination it could go between them, but in an integrated amp it could go in a 'tape loop'. I have no experience of this sort of thing, and it could prove an interesting and simple introduction, to myself and other readers.
David Thorne, Essex.

John Woodgate replies:
The active filters do not need inductors because the same frequency responses as with LC filters can be obtained with just resistors, capacitors and op amps.
As I often mention in my articles, circuit details are normally sufficient for an experienced constructor, but full constructional details are not given, nor are such details as power supplies, unless there are special points to be made. In this case, the type of power supply depends on which op amps you choose, but where I have mentioned type numbers, they require split rails, although you can often use two resistors and one or two electrolytic capacitors, or even a spare op amp, to make a centre-tap on a single rail supply. Don't forget, however, that the input and output terminals will be at half rail volts above 0V if you do this. I expect you could use single-rail op amps, but you would need to ensure that they were operated as the manufacturer directs.
With regard to the remote control, you could use the SSM2120P (UL78K) IC as a stereo electronic gain control, so that your remote lines need carry only DC. Information on how to use this device is in Electronics Issue 47. Another possibility is the LM1035N (QY19V). However, the peripheral circuits would need quite a bit of design work.

S·T·A·R L·E·T·T·E·R

This issue Mr. Gerry Bates of Sheffield, wins the Star Letter Award of a Maplin £5 Gift Token for his comments on constructional notes in projects.

We are Not Children

Dear Sir,
I would like to throw my weight behind the argument put forward by Dr. Manning in Issue 75, regarding the balance between circuit description and constructional details in project articles. The latter, largely common sense and applicable to most projects, could be left out of the articles and issued as an additional general sheet with each kit, or even as a basic (cheap!) general construction booklet.
The article on the AR-1 AM VHF Receiver in the same issue is a case in point. The constructional details take up most of a column, are *very* basic and, apart from a reference to a slight difference in the order of assembly, could refer to *any* kit!
Apart from this I will say many thanks for an otherwise most stimulating magazine.

We have had very few letters of this kind from readers who have been irritated by the repeating of 'apparently basic' construction information. As we have said before, the magazine article forms the basis of the kit construction leaflet, hence it is convenient to include the constructional information at time of writing. Apart from these instructions, there is also a general construction booklet (the Constructors' Guide), which is included in every kit. And yet in spite of all this, the greatest majority of kits returned to our servicing department, taking advantage of our 'Get You Working' service, have bad solder joints, or misplaced components, or diodes or ICs inserted the wrong way round. What's more, this state of affairs has not improved at all over several years! Since the customer is charged for the repair (if their error), which is proportional to the cost of the kit (£17 minimum – see page 2 of this issue), such simple mistakes can be expensive. So no, we will not *stop including the construction information, as it appears to be desperately needed! We do not shorten any of the other information so don't worry you are not missing out!*

Automotive Amnesia

Dear Sirs,
As a technician in the 'motor trade', I was drawn into the field of electronics by necessity as vehicles became more and more complex, and I find the subject fascinating. Although admittedly I am a comparative novice, I look

forward to reading *Electronics* every month, and of course take a special interest in anything automotive related.
After reading the Wiper Controller project, and very relevant safety warning (regarding disconnecting the vehicle's battery), I thought your readers may be interested in the following points. Firstly, a large number of vehicles are fitted with security coded radio cassette players, and obviously you will need the security code after you have reconnected the battery!
Secondly, and more important, is the fact that some modern fuel injection/engine management systems have data, usually relating to engine settings, stored in the control unit's volatile RAM. Disconnecting the battery will lose this data and it will take some expensive diagnostic equipment (and a garage proprietor with a knowing smile) to get your pride and joy running normally again, and lighten your wallet at the same time!
All is not lost, however, as a PP3 9V battery connected to the cigarette lighter socket with a suitable plug (watch polarity!) should act as a 'memory saver', but make sure that there is no load switched on (interior light, etc.). Finally, if your vehicle is fitted with central door locking, or an alarm which locks the doors, make sure you have the keys in your pocket when you reconnect the battery, or you may find yourself locked out!
Ken Adams, Wakefield, West Yorkshire.

All of which seems to greatly increase the problems you may have from even something as simple as a flat battery. Does this imply that of the few modern motor cars that one occasionally sees abandoned on the roadside, some of them may have nothing more wrong with them than erased memory chips? Furthermore, is this a deliberate attempt by motor manufacturers to catch out unsuspecting motorists and rake in a few extra pounds – why not include a memory back-up battery in the design, as with most computers. Here, the critical system set up information is held in volatile CMOS RAM, powered by the memory back-up batteries when the PC is switched off. Alternatively, EEPROMs could be used. If anyone knows any more on this, please write in, and perhaps other readers might like to comment. However, the advice 'if in doubt, seek qualified advice' is a good maxim to adopt.

All About Catalogues

Dear Sir,
Just a short note to say that I agree with the views of Dr. J. R. Barker of Chester ('Air Your Views', March issue) in that I think the layout of the current Maplin Catalogue is a disaster. Please bring back the original alphabetic listings for the next edition. At present, the only way that I can find anything is to constantly keep referring to the index at the back. It's such a shame to have such a fine catalogue marred by a simple clerical 'error'. I look forward to the 'all-new' 1995 edition in September, and hope that my comments have been noted.
I also have a query regarding one of the audio circuits featured in Ray Marston's article also in the March issue. I have built the audio compressor as in Figure 37 (page 23), and have found that it has a fixed compression ratio of 2:1, and I was wondering how to alter the circuit so as to give a fully variable compression ratio of up to 30:1.
Rodney Neill, County Armagh.

John Mosely replies:
We are sorry that you are unhappy with the layout of the current catalogue. When we decided to go for colour we took the opportunity of changing the layout too, hopefully to increase the interest value, especially for the non-technical user. This was the main reason for placing the less technical, ready-made items at the front. We hoped that by the colour coded six main sections, numbered sub-sections and comprehensive index that users would not experience too many difficulties. Your comments have been noted, though.
To get the most accurate and complete information about a particular device you really need to look at the manufacturer's data. Data sheets for any of the ICs stocked by Maplin can be obtained by ordering as DS00A, with the description 'Data sheet for' followed by the IC's device number, price 80p. Of course there is always the possibility that you are asking too much of the device. The NE570/571 ICs were predominantly developed for noise reduction techniques for tape recording, etc. Outside of these limits you need to either find a different device or design something to do the job.

Noisy Buildings

Dear Sir,
Your introduction, about Intelligent Buildings, to the article 'Networking Intelligence', page 54 of issue 76 (April) started me thinking.
Many of us with a long experience (I started my career as an Army Apprentice in Electronics in 1968) of telecommunications will know how long the expression 'Intelligent Building' has been used.
Most of the younger generation have grown up in a world where most problems are believed to have been solved, and it's just a matter of accessing the right data bank to obtain all the information you need.
Unfortunately this is not always the case. Many will have seen 'Tomorrow's World' and suchlike programmes, and how the operations of word processors and computer networks within a building can be monitored, showing how insecure systems can be, and prone to 'eavesdropping'. They also highlight how we should be investing in buildings capable of reducing internal electrical emissions, as well as preventing internal systems from being interfered with externally.
Time and again I have heard so called 'experts' stating "you do not need RF screening at HF levels of the spectrum". This completely neglects the fact that the lower the frequency, the further you can transmit, even with only 1 watt of RF output. The argument is always the same, people fail to appreciate that even a computer can generate an electromagnetic output in the form of RF.
How, for instance, do you suppose that a TV detector van operates? Without proper attention being paid to screening, you will find all sorts of spurious signals and intermittent faults plaguing your equipment. Why do modern office buildings not include adequate RF screened ducting as part of their basic structure? Not only would this make data exchange in LANs and WANs more reliable, but will prevent illegal eavedropping. I hope this letter wakes some people up to the fact that the young do not possess all the answers, and that with age comes experience.
J. C. E. Moore, Essex.

Are there any young electronic students who would like to defend themselves? Have you been told that every long length of conductor can act as an aerial, and have you been taught your Fleming's right and left hand rules? Answers, please.

CAD for Sub-Woofers

Dear Sir,
Many thanks for the very interesting series of articles on the Sub-Woofer, which contain some excellent experimental and theoretical work. I include a short Basic program for the circuit in Figure 6, page 59, Issue 74, for impedance and frequency response.
Ken Hughes, Berkshire.

Judging by Maplin sales, books about building loudspeakers are as popular, if not slightly more so, than the actual speaker drive units themselves. Would anyone welcome more computer-aided speaker design programs?

```
10 REM 61 Vented box L/S program (modified to run in DOS
5 QBASIC)
15 CLS
20 FOR f = 20 TO 100
30 x = 1: y = 1: fm = 47
40 q1 = 3.54: q2 = 6.55: qt = q1 * q2 / (q1 + q2): r3
= 18.86: rd = r3 * qt / q1
50 ra = 3.84: rb = rd * SQR(f / fm): c1 = 552.8 *
.000001: l1 = 15.7 * .001: c2 = x * 528 * .000001: l2
= y * 28.7 * .001
60 w = 2 * 3.14159 * f
70 g = 1 / rb: b = w * c1 - 1 / (w * l1) - 1 / (w * l2
 - 1 / (w * c2))
80 a = (ra * (g * g + b * b) + g) / (g * g + b * b):
b1 = -b / (g * g + b * b)
90 zi = SQR(a * a + b1 * b1)
100 r = ra * rb / (ra + rb)
110 c = 1 / (w * l2) * (w * l2 - 1 / (w * c2) - l2 /
(w * l1 * c1) + 1 / (w * w * w * l1 * c1 * c2) - 1 /
(w * c1)): d = -1 / (w * l2) * (l2 / (c1 * r) - 1 / (w
* w * r * c1 * c2))
120 e = SQR(c * c + d * d): h = LOG(1 / e) * 8.8
130 PRINT f, (100 * zi + .5) / 100, (100 * (180 /
3.14159 * ATN(b1 / a)) + .5) / 100, (100 * h + .5) / 100
140 NEXT f
150 END
```

The Godfrey MANNING Aircraft Museum

Reported by MARTIN PIPE

Aircraft museums! To many people, these words conjure up images of renovated World War II aircraft hangars, the aviation display at the Science Museum, and the RAF Museum. In other words big spaces, big aircraft, big business. Yet, in the leafy suburbs of Edgware, north-west London, one man seeks to disprove all that.

Dr. Godfrey Manning, a NHS doctor by profession, has been interested in aviation from a tender age. Now 37 years old and just (if not more!) as devoted to his subject, a spare bedroom and parts of his garden are allocated to his own aircraft museum. The decision to start a museum dates back to the well-publicised breaking up of obsolete VC-10 aircraft in the mid-seventies, but nearly ten years were to elapse until the Godfrey Manning Aircraft Museum was finally ready – it opened its doors for the first time on 20th March 1984. Since then, the museum – open by appointment, but free to get in – concentrates on the instrumentation and equipment side of aircraft – clearly, giving a home to even a light aircraft would present severe practical problems, given the present accommodation! Usually dealing with members of the public on an individual basis, Godfrey communicates an incredible amount of enthusiasm through his remarkable hobby. Interested parties generally leave the Museum knowing considerably more about aircraft than they did upon entering – this was certainly the case with your roving reporter!

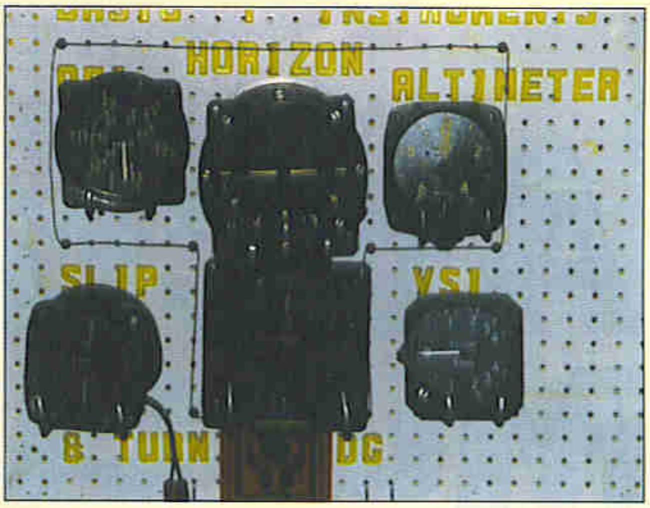
Apart from his activities as a museum curator, Godfrey, also a radio amateur, writes a regular column, 'Airband', for *Practical Wireless*. Pointing to an array of cockpit radio control units, he makes a few recommendations for those considering the purchase of a radio suitable for airband reception: "It should provide coverage over a range of 108MHz to 137MHz without gaps, an AM mode and 12·5kHz channel spacing."

Who Goes?

The Museum, says Godfrey, caters for two main categories of people. Of course, there is the enthusiast – typically the kind of person who visits Farnborough or the Southend Airshow each year– and of course those who may well have been involved professionally with flying. The other group of people who tend to visit the Museum are those who have holidayed abroad or are about to, but find they know little about the aircraft or what keeps them airborne, and want to learn more. As the visitors' book demonstrates, people have literally come from all over the world (presumably by air) – one entry seen was from an ex-serviceman currently residing in Australia. A considerable amount of interest has been shown in this tiny museum – it has even been listed in *Time Out* magazine.

So what can you expect to find out?

Below left: A wide variety of instruments are on show.
Below right: Godfrey shows us the rudder from a Cessna 3-10 light aircraft.



Of course, each tour of the Museum will be tailored to the particular interests of the visitor – in my case, the workings of the essential instruments, as well as their relation to the act of flying the craft, were discussed in considerable depth. All of this is demonstrated with working items salvaged from redundant aircraft, which have been simplified so that their workings become easier to understand. "There is at least one example of each major cockpit instrument", says Godfrey.

For those who have not flown before, but are considering journeying abroad at some time in the future, Godfrey's talk includes much on practical air safety. After all, the popular press is responsible for fuelling many misconceptions – like those relating to the likelihood of a crash – which leads to nervousness on the part of the traveller. If you understand a little about how the aircraft operates, then you are less likely to worry. For example, a major cause of worry amongst unseasoned air travellers is that of 'go-around'. This, says Godfrey, is where the plane starts to land, but then suddenly starts climbing again. Novices, perhaps understandably, assume the worst when this happens! In fact, there are normally two simple explanations for this – another aircraft is blocking the runway and so has to be moved; your pilot will simply circle the airport until it is clear. If your plane does not have 'all-weather' landing capability and conditions are poor, the pilot will pull away if he cannot see the runway at a height of 200ft, and then attempt landing at another airport. This manifests itself as "... that horrible coach journey you had to undergo between Manchester and London on your return to England, which spoilt that otherwise wonderful Spanish holiday ...". The important thing to realise, though, is that when seemingly strange things happen, your air crew is in control, and so you shouldn't panic!

If you haven't flown yet, Godfrey is a mine of useful practical advice – even those who often travel by air often forget the 'essentials'. Get immunised – and a supply of malaria tablets – before you travel, even for the diseases encountered at refuelling stops, and consult your doctor if you have health problems and are contemplating flying. A less obvious point is that of dehydration. Since the air at 30,000ft. is somewhat drier than it is at ground level, there is a real risk of dehydration – particularly for those long flights. Godfrey recommends that you drink – and not necessarily that of the alcoholic variety! Always wear your seat-belt if you are sitting down – after all, you never know if you'll encounter turbulence, and you might end up with a sore head, where it has come into contact with the roof of the cabin! Finally, read the safety card – many don't!

Hands-On Instruments

When you visit the Museum, you will be bewildered by the variety of cockpit instruments on show. Altimeters, artificial horizons, air speed indicators; they're all here, and much else besides. What's more, Godfrey is able to tell you how the instrument works, who manufactured it, and even about the aircraft from whence it came. Although wonderfully intricate, the basic operation of many of these items will be familiar to any *Electronics* readers with a grasp of 'O'/GCSE level physics.

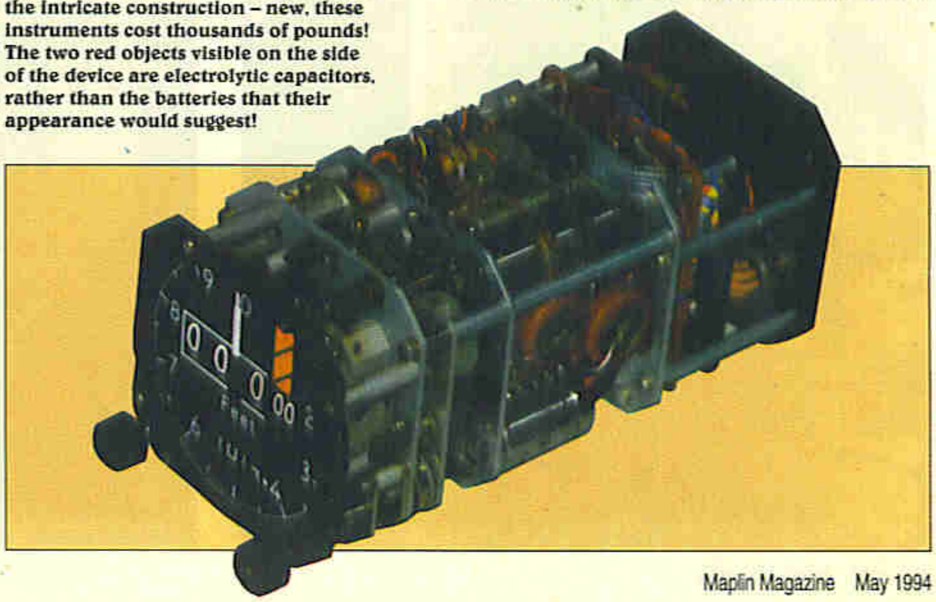
Electronic flight decks excepted, there are four main cockpit instruments, which are usually arranged in the so-called 'Basic T'. At the centre, we have the artificial horizon (also known as an 'attitude indicator'). To the left of this resides the air speed indicator, to its right can be found the altimeter. The fourth instrument is the gyroscopic compass, which sits below the artificial horizon. All current civil aircraft use this same basic layout, although the location of ancillary components – such as the turn/slip indicator at bottom left (used when steering), and the vacuum flask-clad vertical speedindicator at bottom right – can vary from aircraft to aircraft.

Top left: Instrument panels from a Vulcan bomber.
Top right: The 'Basic T' instrument configuration.
Left: A Smiths artificial horizon – out of interest, the first item in the Museum's collection. The orange flags indicate the absence of power to the unit.

Gyroscopes ('gyros') play an important part in aviation, forming the basis of the artificial horizon, as well as the gyroscopic compass. In the artificial horizon, a fixed symbol, representing the wings of the aircraft, is embossed on the glass. The gyroscope, which may be powered by air (turned into rotational motion by a turbine) or an electric motor, is turned on its axis; on the ground, a knob on the front of the instrument calibrates the axis so that it corresponds with the fixed symbol. When the craft is airborne, the gyro keeps spinning along its axis, regardless of the pitching and banking of the plane. Thus, it is the fixed symbol which moves, with reference to the artificial horizon.

Using a compressor, Godfrey demonstrated a turbine-powered gyroscopic compass – even when the power had been disconnected, the inertia of the gyro was such that it kept working for several minutes. This is

Below: A Smiths servo altimeter – this would be used with an Air Data Computer. Note the intricate construction – new, these instruments cost thousands of pounds! The two red objects visible on the side of the device are electrolytic capacitors, rather than the batteries that their appearance would suggest!



particularly important for motor-driven gyros, where the loss of power is a potential problem. Out of interest, most instruments have a spring-loaded orange 'flag' that comes into view in the event of power loss, so that appropriate evasive action can be taken by the pilot. The gyroscopic compass works along similar lines to the artificial horizon, except that the gyro spins in a vertical plane – corresponding to north – and is preset on the ground using a magnetic compass and a table of magnetic deviation (which allows for errors introduced by steel components in the aircraft).

Under Pressure

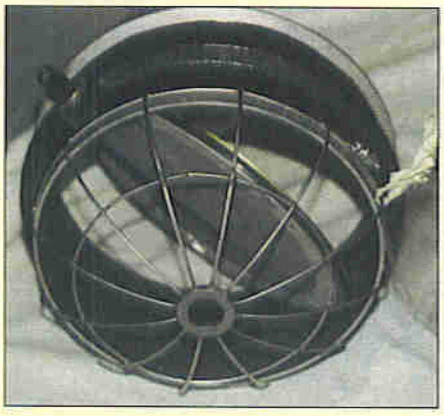
Many readers at home will have a barometer, which relies upon the changes in atmospheric pressure that are responsible for weather patterns. Its primary working component is a partially-evacuated 'pressure chamber', which is basically a tin box. As the atmospheric pressure acts on the chamber, it 'squashes' it; a pointer coupled to one side of the box indicates the relative amount of pressure to which it is being subjected. An altimeter works in exactly the same way – the higher you are, the smaller the volume of air above you, and hence the atmospheric pressure is lower. In another of his grassroots practical demonstrations, Godfrey blew into the device's input tube to simulate increased atmospheric pressure.

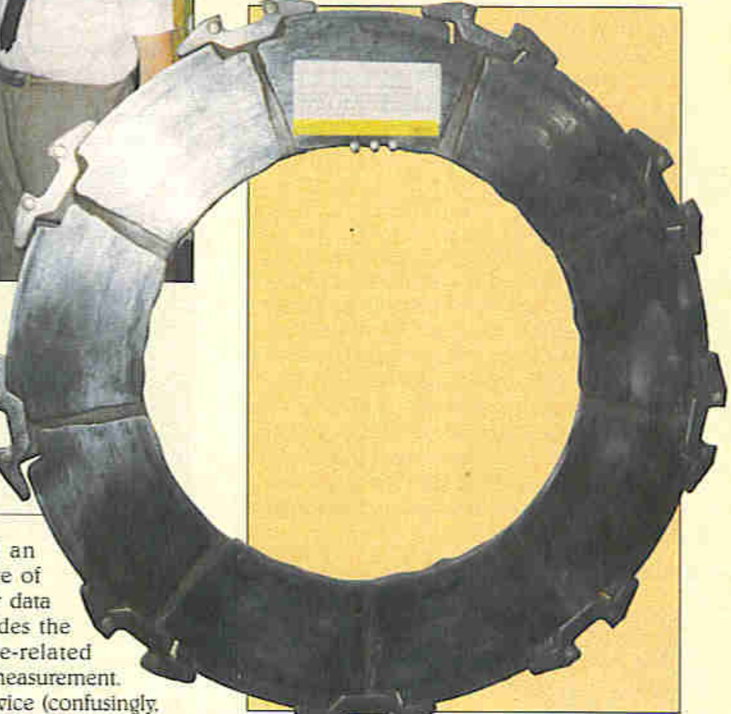
Another barometric device, known as the 'cabin altimeter', is installed in high-flying aircraft – rather than measuring the pressure outside the craft, this one, as its name suggests, measures that inside the cabin. If the cabin pressure falls below that corresponding to a height of 10,000ft, the device triggers the release of oxygen masks for the aircrew. In commercial aircraft, passenger oxygen masks are only released if the cabin altitude rises above 14,000ft. – clearly, the aircrew are given priority since the fate of the aircraft is in their hands!

Provision is made such that each person on board has half an hour of oxygen – more than enough time for the pilot to reduce height. Talking of oxygen masks, Godfrey has some more down-to-earth advice. When the masks drop down (the Museum even has a real-life example to demonstrate this!), most people panic, which tends to result in the cabin's oxygen supplies being depleted still further. So you should keep calm, and put your mask on as soon as possible. "It might appear selfish at first", says Godfrey, "but you should put your mask on quickly, regardless of whether you see others struggling. If you have your supply, then you are in a better position to help others!"

In larger aircraft, most of the instruments are located in the so-called avionics bay, along with the radio/radar equipment and computers.

Below: The butterfly valve, which is mounted on the exterior of the aircraft. It is used to regulate cabin air pressure.





Above: Godfrey duly demonstrates the positioning system of the Ekco cloud radar dish.
Right: A disc brake pad from a Boeing 737-200 passenger aircraft.

Godfrey demonstrated an extremely intricate piece of equipment called the 'air data computer', which includes the sensors for the pressure-related functions and air speed measurement. The outputs from this device (confusingly, the acronym is ADC, perhaps better known to *Electronics* readers as standing for 'Analogue-to-Digital Converter'!) are used to drive the displays in the cockpit. Although digital and computer displays are becoming more common, old-fashioned analogue displays are the norm, particularly for smaller aircraft. Rather than using a moving coil meter, most remotely-controlled instruments are driven by suitably-geared three-phase motors; compatible generators are located within the ADC. In the (demonstrated) example of the tachometer, a three-phase generator is powered from the engine's auxiliary gearbox. In the cockpit-mounted display, a 'magnetic clutch' is used; the motor is used to power a magnet, which is coupled to a copper disc (and hence the pointer) through the action of eddy currents – similar techniques are used in your domestic electricity meter.

Powered Up

One of the interesting points to be raised during the visit was that of an aircraft's power supply. An AC power supply is used (115V), but a frequency of 400Hz (rather than the 50Hz of our mains) is employed; a bulky converter unit has to be used. The reasoning behind 400Hz is simple; the higher frequency means that the physical bulk of electromagnetic components (e.g., transformers) can be reduced – it is clearly of great practical value to reduce the weight and size of the aircraft wherever possible. But why use AC at all? Much aeronautical equipment still requires it, and in any case it has evolved into a standard. Some areas are still familiar, though, like the use of a current transformer (the heart of every clamp meter) for assessing the load on an aircraft's alternator.

Talking about the power requirements brings us neatly onto safety, which is important since much of the equipment operates from a 115V supply – still potentially lethal. Earth leakage circuit breakers are used throughout, and there are no exposed mains connections – heatshrink sleeving and perspex panelling are liberally used – the latter so that you can see what's going on without the risk of electrocution.

Instruments apart, there is much to see at the Godfrey Manning Aircraft Museum. Mounted on the wall is an Ekco cloud radar dish, which was originally fitted in the fibreglass nose cone ('radome') of a VC-10 aircraft, and fed a tiny cockpit-mounted CRT display. On the same wall hangs one of the brake pads from a Boeing 737-200 passenger aircraft, several of which are required for each wheel – somewhat different in scale (but not in principle) to those fitted to your Ford Fiesta! On the floor, next to the 115V converter unit, lie two instrument panels from a Vulcan, a bomber from the Cold War era. Posters adorn the walls, and operations' manuals and airline handbooks pack the shelves.

The Great Outdoors

In the garden rests the somewhat bulkier remains of dismembered aircraft. The torn rudder from a Cessna 3-10 twin-engine 6-seater light aircraft lies propped against an outside wall, while the battered vertical fin from a single-engined AA-5 Cheetah – a crash victim – nestles unexpectedly amongst the foliage at the bottom of the garden. Other items add to the surrealism, waiting to be transformed into displays of airframe design. Surprisingly, this presents one of Godfrey's biggest challenges yet; removing the aluminium skin to reveal the skeleton underneath – removing the numerous rivets has proved somewhat expensive in drill bits.

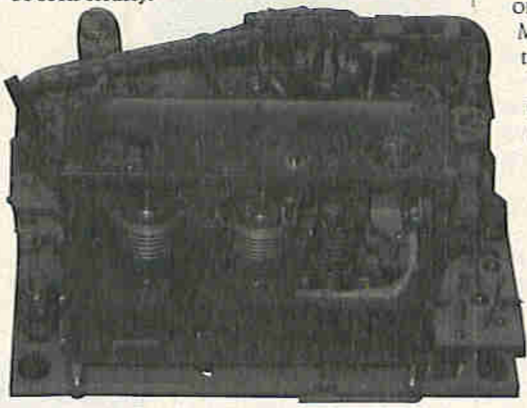
While the Museum's garden-based items await attention, much is afoot inside. At the time of my visit, Godfrey was planning a full-sized model of a cockpit, much evidenced by the intriguing mound of boxes and apparatus that dominates one side of the room. This display will draw on the experience and components of three medium-sized twin-engined passenger aircraft – the BAC 111, the Boeing 737-200 and the DC9. Of course, in line with Godfrey's educational aims, most (if not all) of the instruments will function as they would in a real aircraft, and so he is currently designing control circuits, based largely around Maplin components – a plentiful array of Maplin-supplied hardware is already apparent in other exhibits. In Godfrey's words, "no other electronics company has the range of equipment that Maplin sells". He would like to see a range of PTFE-covered wire, though!

So where do the exhibits originate from? At this point, Godfrey picks up an air speed indicator and reveals that he paid £15 for it at the summer Flying Association Rally. Similar finds can be found at other rallies – for example, the cloud radar was picked up at an amateur radio show. The most significant sources, though, tend to be airlines and aircraft maintenance organisations, who will supply equipment on the sole proviso that it will not be used in a serviceable aircraft. Sometimes, Godfrey hears that an aircraft has crash-landed and is allowed to scavenge amongst the wreckage for anything of interest. Occasionally, equipment turns up as private donations.

Any Offers?

The Museum's collection is growing at such a pace that Godfrey is considering moving it elsewhere in north-west London, to a building more accessible to the public. So, if somebody knows of somewhere, please do give Godfrey a call. The owner of such premises is likely to be an aviation enthusiast – someone who wants to do it out of love rather than financial incentive; at a time when many museums in London are introducing the turnstiles to keep afloat, Godfrey wants free admission to remain a feature.

Above: All you see here will shortly be transformed into a replica cockpit!
Below: An Air Data Computer (ADC). The pressure chambers and air inlet tubes can be seen clearly.



The best aspect of the Museum must surely be that a member of the public is sharing his hobby with others. Godfrey puts considerable time and money into the project, and expects only interest from the visitor. The Godfrey Manning Aircraft Museum is an example to us all.

If you're enthusiastic about a certain hobby, why not consider opening a museum devoted to it? Others dotted around the country include those featuring vintage television sets, model railways and china dolls, operated by a wide variety of people, both hobbyists and retired tradespeople. But they all share one thing in common – they enjoy what they are doing!

Admission to the Godfrey Manning Aircraft Museum is by appointment only – Tel: (081) 958 5113 for further details.

NEXT issue

In next month's super issue of *Electronics – The Maplin Magazine*, there are yet more terrific projects and features for you to enjoy. These include:

PROJECTS

12V DC/230V AC INVERTER

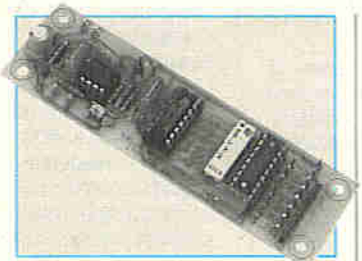
Enables mains operated equipment, with a power consumption of 250W or less, to be powered from a high current +12V DC power source such as a car battery or generator. Very useful should you need 230V AC mains in the event of a power cut, maintaining electric pumps and the timer circuit for gas central heating, or domestic electric lighting. It can even be used as a backup supply for important computer equipment in the event of a power cut, or to provide mains power where it is not normally available, such as in your car, caravan, outhouse or boat.

CAR BATTERY CHARGE/DISCHARGE INDICATOR

A form of current monitor to augment the ignition warning light normally found on the dashboard of the modern family car. Traditionally this task was performed by an ammeter, but this project gives a visual indication of current flowing into and out from the battery. An optional 'ammeter' can be added if there is enough room on the dashboard.

LIVE WIRE GAME

An improvement on the traditional live-wire game often found at fairs and fêtes, where an awkwardly shaped length of 'live' wire has to be traversed from beginning to end with a loop attached to a handle. In this project, simple electronics is added to overcome contact resistance problems which may lead to arguments as to whether the loop actually touched or not. In addition a number of 'lives' (from 1 to 5) can be provided, in true arcade game style, which are counted off by indicators as they are lost.



PACKET RADIO MODEM

Packet Radio is fast becoming one of the more popular of the 'Data' type modes available for the radio amateur enthusiast, and it enables two hobbies, amateur radio and computing, to be enjoyed at once. Most radio amateurs and enthusiasts today have at least one computer in the home, and the IBM PC/AT is mainly covered here. This project is ideally suited to the beginner wanting to learn more about packet radio, and is also useful to the radio amateur already using an expensive terminal node controller (TNC), who might like to monitor another packet frequency.

TTL TEST UNIT

A project consisting of up to nine separate circuits which can be put together to form one test unit, all powered from an external 5V supply. Apart from testing existing logic systems, its other useful role is as an aid to developing experimental logic circuits to explore TTL digital logic, and can be extremely helpful. The modules include noise-free logic level switches, pulse generators and various logic level testers.

FEATURES

Your favourite features continue with more about Digital Panel Meters, Power Electronics, Silicon IC Manufacturing and Transmission Lines, with special features describing the 'Paknet' communications system, while 'Outsourcing and Facilities Management' reveals that many businesses are increasingly contracting out for their in-house computing needs. All this plus all the usual regulars too!

ELECTRONICS - THE MAPLIN MAGAZINE

BRITAIN'S BEST SELLING ELECTRONICS MAGAZINE

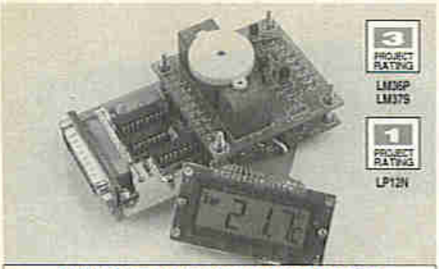
These descriptions are necessarily short. Ensure that you know exactly what the kit is and what it comprises before ordering, by checking the issue of *Electronics* referred to in the list.
The referenced back-numbers of *Electronics* can be obtained, subject to availability, at £1.95 per copy.
Carriage Codes – Add, A: £1.45, B: £2.10, C: £2.65, D: £3.15, E: £3.70, F: £4.25, G: £5.10, H: £5.70.

DID YOU MISS THESE PROJECTS?

The Maplin 'Get-You-Working' Service is available on ALL of these projects.

To order Project Kits or Back-numbers of *Electronics*, 'phone Credit Card Sales on (0702) 554161. Alternatively, send off the Order Form in this issue, or visit your local Maplin Store.
See advertisement elsewhere in this issue for locations of Maplin Stores.

Maplin: The Positive Force In Electronics
All items subject to availability. Prices include VAT.

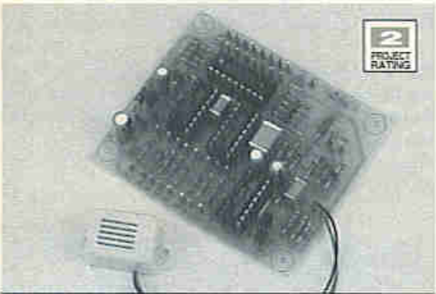


USING TEMPERATURE MODULES

This very practical *Electronics* article details the use of the following projects which, when used in conjunction with the range of temperature modules available from Maplin, can provide some extremely versatile environmental control functions.
Order as: LM37S (Relay Interface Card Kit), **Price £12.45**; LM36P (Serial/Parallel Converter Kit), **Price £14.95**; LP12N (24-line PC I/O Card), **Price £21.95**. Details in *Electronics* No. 71 (XA71N).

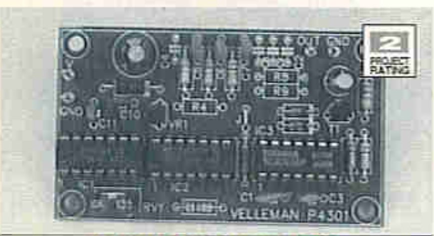
10-BAND GRAPHIC EQUALISER MODULE

This easy to build equaliser project has ten frequency bands that allow you to adjust audio response to your particular preference.
Order as: VE44X, **Price £34.95**. Details in *Electronics* No. 71 (XA71N).



PRIORITY QUIZ BUZZER

No more arguments about who got the answer first! This versatile system allows up to eight contestants to battle it out without altercation, and can be expanded in blocks of eight by simply adding more units. Order as: LT41U, **Price £9.95**. Details in *Electronics* No. 72 (XA72P).

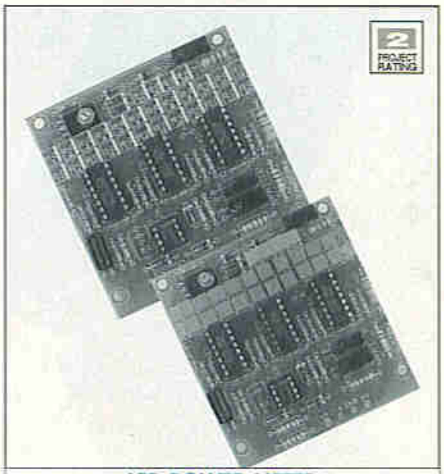


PINK NOISE GENERATOR

This easy to build pink noise generator employs a pseudo-random digital noise source and can be easily adapted to produce white noise if required.
Order as: VE43W, **Price £11.95**. Details in *Electronics* No. 72 (XA72P).

DIGITAL MODEL TRAIN CONTROLLER

This versatile project allows you to control up to fourteen locomotives on a single layout, with up to four locomotives being active at any one time. The basis of the system is a Common/PSU board, to which one controller is added for each active locomotive. All locomotives require a receiver. To complete the project, a smart, pre-drilled case is available.
Order as: LW61R (Common/PSU), **Price £39.95** C4; LW62S (Controller), **Price £9.95**; LT29G (Receiver), **Price £12.95**; XG09K (Case), **Price £24.95**. Details in *Electronics* No. 71 (XA71N).



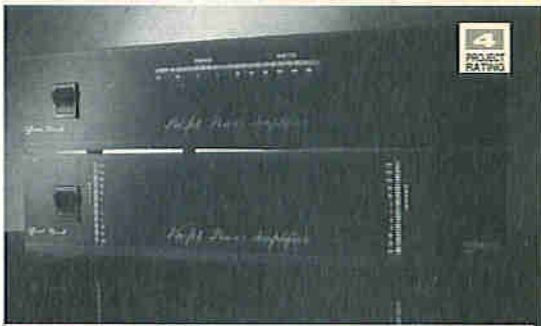
LED POWER METER

A pair of LED power meters for the Velleman Stereo MOSFET Amplifier, VF17T. The meters can be used in either stereo or mono configuration. Order as: VF18U, **Price £34.95**. Details in *Electronics* No. 72 (XA72P).

You'll find a variety of projects at Maplin for the beginner, intermediate and advanced hobbyist

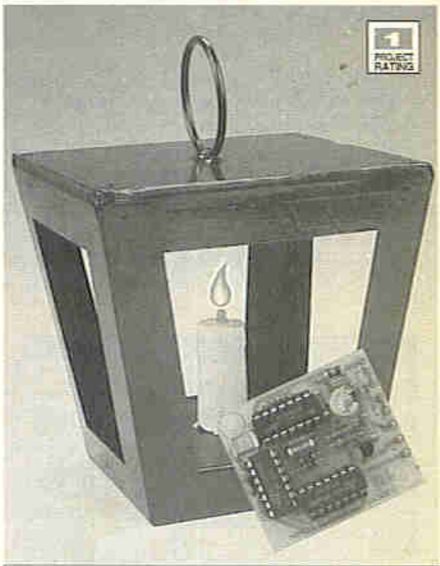
INFRA-RED SWITCH

Look, no hands! This versatile remote control switch can operate a multitude of electrical or electronic equipment without you even touching it.
Order as: LT38R, **Price £9.95**. Details in *Electronics* No. 71 (XA71N).



STEREO MOSFET AMPLIFIER

A superb high power stereo amplifier that sounds as good as it looks. Bridged configuration transforms the unit into a 600W (music power) mono amplifier.
Order as: VF17T, **Price £299.95** H29. Details in *Electronics* No. 71 (XA71N).



TWINKLING CHRISTMAS CANDLE

This simple to build, high tech electronic candle has a realistic pseudo-random flicker, but won't burn a hole in your pocket—or anything else for that matter. Ideal for decorations or plays, as there is no danger of fire, or of the flame being blown out. The kit includes constructional details of a suitable cardboard lantern for the festive season. Order as: LT40T, **Price £6.95**. Details in *Electronics* No. 72 (XA72P).

These descriptions are necessarily short. Ensure that you know exactly what the kit is and what it comprises before ordering, by checking the issue of *Electronics* referred to in the list.
The referenced back-numbers of *Electronics* can be obtained, subject to availability, at £1.95 per copy.
Carriage Codes – Add; A: £1.45, B: £2.10, C: £2.65, D: £3.15, E: £3.70, F: £4.25, G: £5.10, H: £5.70.

DID YOU MISS THESE PROJECTS?

The Maplin 'Get-You-Working' Service is available on ALL of these projects.

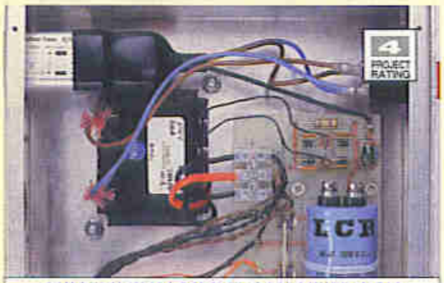
To order Project Kits or Back-numbers of *Electronics*, 'phone Credit Card Sales on (0702) 554161. Alternatively, send off the Order Form in this issue, or visit your local Maplin Store.
See advertisement elsewhere in this issue for locations of Maplin Stores.

Maplin: The Positive Force In Electronics
All items subject to availability. Prices include VAT.

MILLENNIUM 4-20 VALVE POWER AMPLIFIER

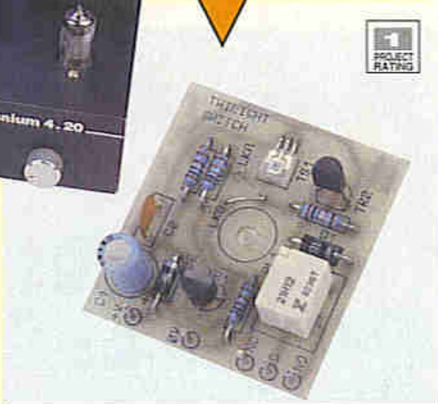
A superb 4-valve, non-hybrid, class AB1 push-pull amplifier with an output of 20W r.m.s. and low output distortion, producing that characteristic valve sound. Construction is simplified by the use of printed circuit boards and no setting up is required.
Order as: LT45Y, **Price £74.95** C6. Details in *Electronics* No. 74 (XA74R).

SAVE MONEY by buying these combined Millennium Amplifier kits:
Save £10! Complete Millennium Monobloc Amplifier Kit (1 x PSU & 1 x Amplifier kit)
Order as: LT71N, **Price £114.90** H12.
SAVE £20! Complete Millennium Stereo Amplifier Kit (1 x PSU & 2 x Amplifier kits)
Order as: LT72P, Price **£179.85** H18.



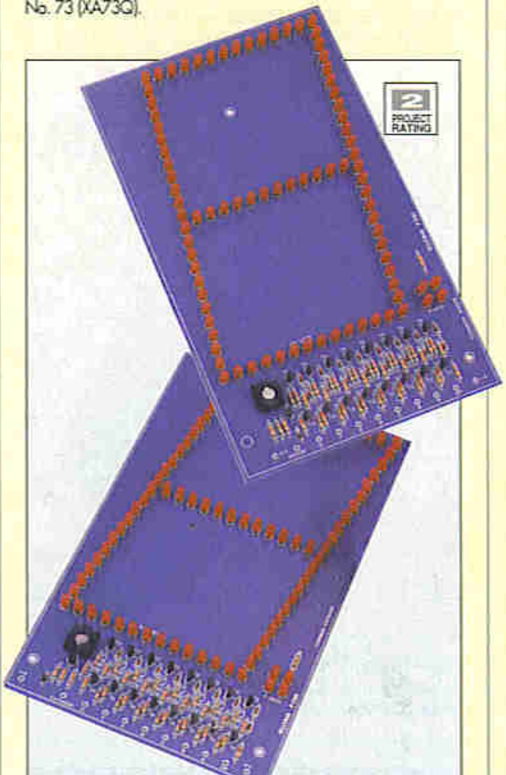
MILLENNIUM VALVE AMPLIFIER PSU

A Power Supply kit for the Millennium 20W Valve Power Amplifier. The supply is capable of powering up to two amplifier modules for a stereo system, or alternatively you could use two PSU kits and two amplifier modules to produce a pair of 'monobloc' amplifiers.
Order as: LT44X, **Price £49.95** C6. Details in *Electronics* No. 73 (XA73Q).



TWILIGHT SWITCH

Using the ULN3390T opto-electronic switch, this versatile project senses the ambient light level and operates the built-in relay at dawn and dusk. Typical applications are automatic control of lighting, night-time security or anywhere that daylight related switching is required.
Order as: LT47B, **Price £5.95**. Details in *Electronics* No. 73 (XA73Q).

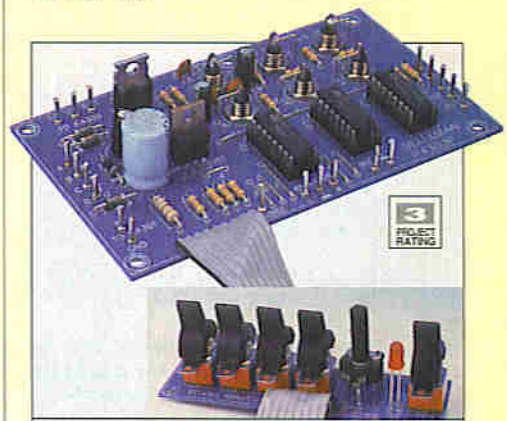


EXTRA LARGE LED DISPLAY

A choice of two 20cm (7½in.) 7-segment LED displays, catering for open-collector and open-anode circuits. Ideal for educational equipment, public displays, exhibitions, demonstrations, clocks etc. Connects to existing 7-segment display drivers. Operating voltage: 22 to 26V DC, maximum supply current: 400mA.
Order as: VF01B, Common Cathode Version, **Price £32.95,** or: VE63T, Common Anode Version, **Price £32.95**. Details in *Electronics* No. 74 (XA74R).

MODULAR GRAPHIC EQUALISER FRONT PANEL

A pre-drilled front panel and pre-printed foil to give a professional look to your completed equaliser project. The panel is suitable for a standard 19in. housing having a height of 2 units (2U).
Order as: VE41U, **Price £32.95** A1. Details in *Electronics* No. 74 (XA74R).



GRAPHIC EQUALISER PSU & SWITCHING UNIT

Part of the Modular Graphic Equaliser System. This project provides a regulated power supply for various of the other units in the system, a front panel mounted line input sensitivity control and also provides all of the necessary switching functions.
Order as: VE45Y, **Price £32.95**. Details in *Electronics* No. 73 (XA73Q).

AUTOMATIC REAR WIPER CONTROL UNIT

At last! Comprehensive control for rear window wipers, tied into the operation of the front windscreen wipers and gearbox. Facilities include: Single shot (when front wipers turned on), Intermittent operation (when front wipers on), and Auto wipe (Reverse gear selected and front wipers on).
Order as: LT46A, **Price £9.95.** Details in *Electronics* No. 74 (XA74R).

These descriptions are necessarily short. Ensure that you know exactly what the kit is and what it comprises before ordering, by checking the issue of *Electronics* referred to in the list.
The referenced back-numbers of *Electronics* can be obtained, subject to availability, at £1.95 per copy.
Carriage Codes – Add; A: £1.45, B: £2.10, C: £2.65, D: £3.15, E: £3.70, F: £4.25, G: £5.10, H: £5.70.

DID YOU MISS THESE PROJECTS?

The Maplin 'Get-You-Working' Service is available on ALL of these projects.

To order Project Kits or Back-numbers of *Electronics*, 'phone Credit Card Sales on (0702) 554161. Alternatively, send off the Order Form in this issue, or visit your local Maplin Store.
See advertisement elsewhere in this issue for locations of Maplin Stores.

Maplin: The Positive Force In Electronics

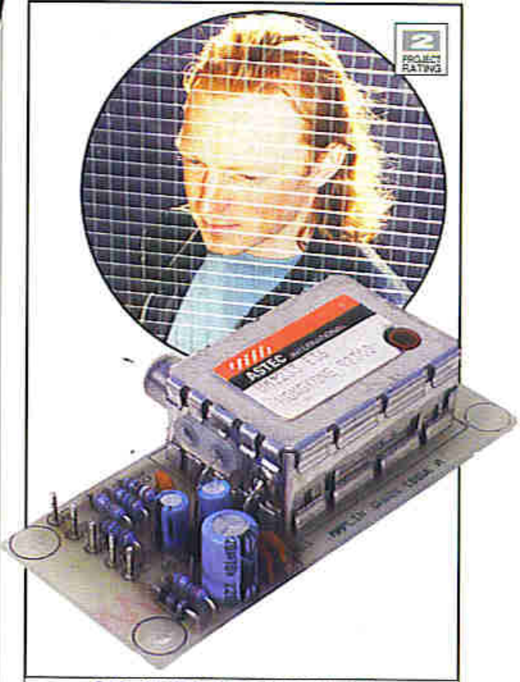
All items subject to availability. Prices include VAT.

CAR INTERMITTENT WIPER CONTROLLER

An essential device for those of us with older cars and classics, that weren't built with anything more sophisticated than an on/off switch on the wipers! This simple to build project produces three delay periods, and has an LED indicator which lights during the delay period, reminding you that the unit is operating.
Order as: VE03D, **£12.95**. Details in *Electronics* No. 75 (XA75S).

AIRCRAFT BAND RADIO RECEIVER

Listen in on pilot and control tower communications with this super AM airband receiver. The kit is simple to build and requires little alignment. Frequency range is 118 to 135MHz and the receiver operating voltage is 9V. (Optional case not included.)
Order as: CP17T, **£29.95**. Details in *Electronics* No. 75 (XA75S).



CCD CAMERA TV MODULATOR

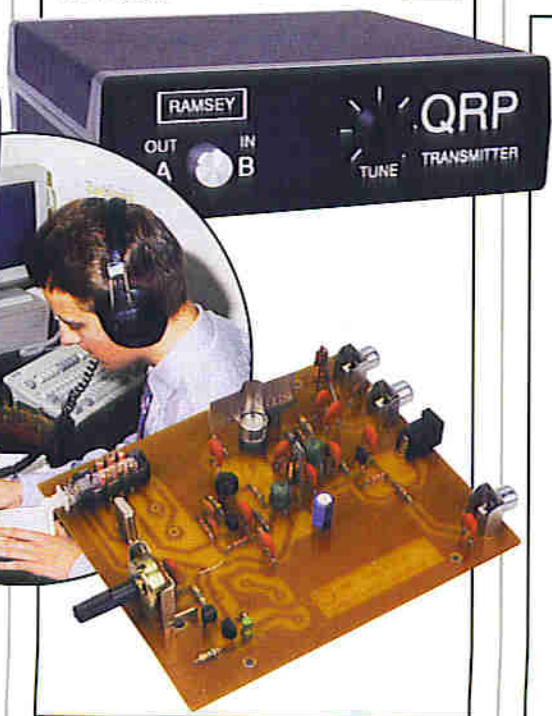
A low-cost unit which allows the Maplin colour and black & white CCD Camera Modules to be linked to any normal domestic TV with UHF aerial input. Applications include closed-circuit security systems, and interfacing equipment that only has video outputs to a normal TV receiver.
Order as: LT37S, **£9.99**. Details in *Electronics* No. 75 (XA75S).

The assembled receiver in its optional case (not included).

20 METRE ALL MODE RECEIVER

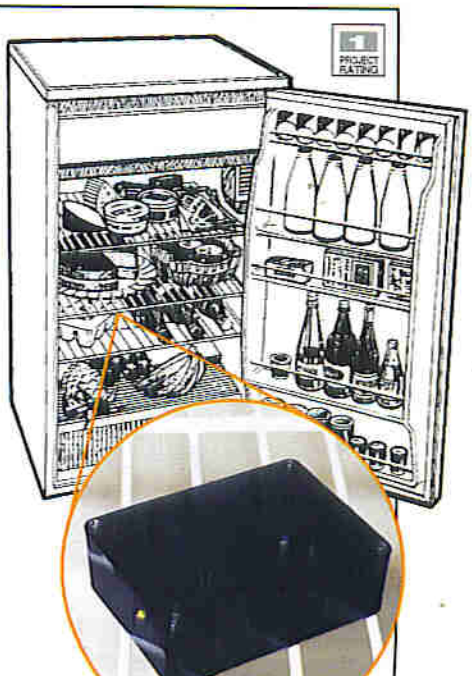
A 'direct conversion' 'DC' type receiver that is both simple-to-build and easy-to-use as there is no 'intermediate frequency' (IF). Frequency range is 13·85 to 14·50MHz and the receiver operates from a standard 9V PP3 battery (not supplied).
Order as: CP13P, **£31.95**. Details in *Electronics* No. 76 (XA76H).

The assembled transmitter in its optional case (not included).



20 METRE CW TRANSMITTER

A crystal controlled CW transmitter operating on the 20m band. The crystal frequency can be shifted by up to 5kHz by the VXO control. The transmitter operates from a +12 to +15V DC supply and has an RF output of 1W. Note: To operate this transmitter legally, either a full Class A Amateur Radio Licence or a restricted Novice Licence is required.
Order as: CP09K, **£31.95**. Details in *Electronics* No. 76 (XA76H).



FRIDGE CHECK

Is your fridge always as cold as it should be? This easy-to-build unit constantly monitors the temperature inside your fridge. If it exceeds a preset limit the alarm sounds, alerting you to the potential dangers of bacterial growth and food poisoning.
Order as: LT53H, **£8.49**. Details in *Electronics* No. 76 (XA76H).

Electronics –The Maplin Magazine January 1994 Issue	(XA73Q)	**Price £1.95** *NV*
Electronics –The Maplin Magazine February 1994 Issue	(XA74P)	**Price £1.95** *NV*
Power Supply Kit Only	(LT44X)	**Price £49.95** [C]
Amplifier Kit Only	(LT45Y)	**Price £74.95** [C]
Complete Monobloc Amplifier Kit [1 x Power Supply Kit + 1 x Amplifier Kit]	(LT71N)	**Price £114.90** [H] **Save £10!**
Complete Stereo Amplifier Kit [1 x Power Supply Kit + 2 x Amplifier Kit]	(LT72P)	**Price £179.85** [H] **Save £20!**

Carriage: kits marked [C] add £2.65, kits marked [H] add £5.70. If ordering several kits maximum total carriage is £5.70. Handling: add £1.40 to each order. Please note: carriage and handling charges apply to Mail Order only – you do not pay carriage or handling if you purchase these kits from Maplin Regional Stores.

Photograph shows Stereo Millennium 4-20 Amplifier (LT72P). The Millennium 4-20 Amplifier is not available ready built. The kits listed are rated 4 (Advanced) on the 1 to 5 Maplin Construction Rating Scale.

Maplin Electronics plc., PO Box 3, Rayleigh, Essex, SS6 8LR. Tel: (0702) 554161. Fax (0702) 553935.
For details of your nearest Maplin Regional Store Tel: (0702) 552911.

Prices include VAT at 17·5% except items marked *NV* which are rated at 0%.
All items subject to availability. Prices are correct at time of going to press (errors and omissions excluded), but may be subject to change.