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No. 60

ELECTRONICS
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EDITORIAL

Merry Christmas! And welcome to this special, seasonally flavoured, issue of 'Electronics'!
The backroom boys thought long and hard about this year's festive project (don't worry, it isn't another twinkling flashing thingumy wotsit to put on your defoliating Christmas tree!). Seasonal projects (of any kind) are not without their problems when it comes to development. Since the pages of 'Electronics' are prepared several months before publication (with the exception of News Report, Air Your Views, etc., which are compiled at the last possible moment) a Christmas project requires development in May/June/July – have you ever tried buying 'fairy lights' in the middle of summer! This year the 'Electronics' festive project is called the 'Fest-O-Meter', which supposedly indicates the degree with which you have entered into the 'Spirit of Christmas' (and I don't mean the Scotch!); between you and me it just measures skin resistance but don't tell Granny that! The Fest-O-Meter displays on an LED bargraph whether you rate as 'Scrooge', 'Turkey', 'Pudding', 'Jolly', 'Merry' or 'Cracker' – reaching 'Cracker' is accompanied by a medley of festive tunes. All jolly good fun!
Of course, there are plenty of other projects to build and features to read, but I'll leave you to 'unwrap' them for yourself – I've got the Editorial Office Christmas Party to go to!
So until the New Year's issue next month, all that remains for me to say is don't eat too much turkey and I hope that you enjoy reading this issue a great deal more than watching the same boring old TV movies that are screened every Christmas!

R. Ball

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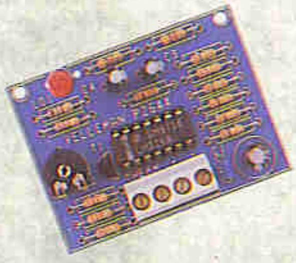
PROJECTS



FEATURES

REGULARS

Prices shown in this issue include VAT at 17.5% (except items marked NV which are rated at 0%) and are valid between 6th November 1992 and 28th February 1993.

NEWS Report

Dial Premium Rate for God

The British Telecom premium line services have been the subject of outrage for sometime now. By following the gutter sheet press and calling up the 0898... numbers described throughout, it's possible – so they tell us – to explore areas of sexual perversion. Aside from providing cheap thrills, the lines, charged at 48 pence per minute during peak time, are favoured by a host of organisations; it's possible to obtain cricket scores, cookery recipes and even technical information from Alan Sugar's Amstrad consumer support lines. Now someone at the BBC has caught on with Thoughtline, described as a 'prayerful and devotional experience' – divine intervention in the form of a computerised answering machine. The Church of England and the Catholic Church have yet to comment.

Snap-Happy Computer

Canon's new computer-controlled EOS-5 SLR compact camera has a unique focusing system. When a scene is viewed your eyes automatically focus on the part of the subject which catches your attention. The innovative Canon does the same. Simply look at the subject through the viewfinder and the camera lens will automatically select the focus point, which is closest to the subject.

When the camera's 'Eye Select' function is used, an infra-red LED illuminates the photographer's eye. The light reflected back to the camera from the eye is captured by CCD sensors. The camera then analyses the pattern of the reflection to determine where the eye is looking. (Not a lot of people know that!) Every eye is different. The Eye Select operation can be calibrated to the specific requirements of each user and the values stored in the camera's memory. But don't expect an EOS-5 in your Xmas stocking. This level of high tech does not come cheap – yet! The suggested guide price is £499.99, with another £249.99 on top if you want a zoom lens.

Satellite TV News and Views

The Independent Television Commission has revealed that 50% of homes will have multi-channel television, either directly from satellite, or via cable by the end of the decade. This fact is encouraging the BBC and ITV to have celestial ambitions. Already the BBC and Thames TV (which lost its franchise in the Government's blatantly ridiculous franchise auction) are co-operating with a large American cable company, Cox Enterprises Inc., on a new 'oldies but goldies' channel to be distributed via the Astra satellite, known as 'UK Gold'. Highlights include repeats of Dr Who, The Bill, The Young Ones, EastEnders and Not the Nine O'clock News. The planned launch date for the new channel, intended for a "slightly more up-market (English? – Ed) audience than that of Sky" was sometime in September but, due to disputes with actors' unions over repeat fees for their somewhat avaricious members, it has been postponed till November 1st. For its first year, the advertisement-funded UK Gold will be soft-scrambled in Videocrypt – that is to say a decoder will be required, but a card won't. After that, a subscription fee (hopefully not too much!) will be required – which brings us to an ironic situation – paying to see repeats! Also ironic are the rumours that these subscriptions, for economy reasons, may have to be collected by competitor BSkyB. There is probably more truth to this than meets the eye – BSkyB may want to introduce a mini-subscription package for its remaining 'free' channels, Sky News and Sky One. Including UK Gold in the package makes it far more attractive to potential subscribers.

Of course the real loser (apart from the recession-ravaged UK viewers) of subscription will be British expatriates and English-speaking Europeans, who rely upon the (arguably excellent) Sky News to know what's going on in Britain – it is unlikely that subscriptions to the package will be offered overseas. Subscriptions to UK Gold will almost certainly not be offered overseas, unless ludicrously expensive pan-European broadcast rights are obtained. Actors unions (sorry, 'associations') are very influential – remember the Comedy Channel met its demise after less than a year, thanks to disputes with Equity that forced it to replace its most popular programmes with American cast-offs from Sky One. As a result, its ratings fell dramatically, which is why the channel was recently replaced with Sky Movies Gold (was that name chosen deliberately?). Superchannel (currently to be found on Eutelsat IIF1, 13°E) originally started in early 1987 as a 'best of British' service – but a fortnight after starting, Equity intervened and the relevant programmes were taken off the air. The real losers are the viewers; surely, these examples illustrate a case in which unions do have too much power?

One company which have been doing particularly well out of satellite broadcasting however (despite a supposed shortage of receiving equipment in the shops), are BSkyB themselves who are heading for their one millionth home subscriber for the (now hard-encrypted) Sky Sports channel. Interestingly, Sky Sports was scrambled to recoup the costs (over £300 million) of Premier League football. If you don't like football, you've still got to pay for a service that is otherwise unchanged. Why don't Sky just hard-scramble the football matches – or, better still, introduce pay-per-view (a comment levelled also at the two film channels). Videocrypt has provision for such a system (as evidenced by the 'authorise' button on all Videocrypt decoders).

Out of interest, a third Astra satellite (1C) will be launched by Arianespace next May. This will increase transmission capacity from 32 channels today (30 are already rented) to 48. Broadcasters interested in renting transponders include several Spanish channels and the excellent documentary channel Discovery, which can currently be found unencrypted on Intelsat VI-F1 (27·5°W). Astra-delivered TV and radio programmes today already reach more than 37 million households in Europe, with ten million households receiving programming through their individual or communal dishes.

On the subject of Astra satellite radio (in the UK, a generally undiscovered delight), a new station called Euronet seems well worth a listen. Proclaiming itself as 'a radio station for an united Europe (?? – Ed)', Euronet, which can be found on the 7·56MHz subcarrier of Sky Sport's transponder, is broadcasting much of interest to a wide variety of people. Apart from a show by none other than Screaming Lord Sutch, there is 'Ian Johnston's Tender Trip', billed as 'DX news and offshore memories' (One for the anoraks! – Ed), a 'chat' show called 'England's England' and religion with Brother R Stair ('The Overcomer Broadcast') – in addition to Radio Dublin International, and programmes targeted at wrestling fans, the Jewish and gay communities. Weekends are devoted to non-stop disco mixes and 'hardcore rave music' (the 'Green Apple Weekend'). Something for everyone!

Hutchison Continues to Take Over the World...

Keeping Hutchison Telecom out of the news seems impossible. In fact, as readers based in the north-west of England can testify, Rabbits are breeding fast – if not furiously. This is good news for GPT Mobile Communications, who provide the hardware for Hutchison's Rabbit Telepoint system. GPT, which is the 60/40% joint venture between GEC plc and Siemens AG, has orders for 12,000 CT-2 base stations and 30,000 handsets. But let us not confuse Rabbit Telepoint with the original, which flopped somewhat spectacularly, despite the hype: "The 4-player industry could not deliver what it promised, and the system did not operate to a firm standard", according to GPT's chairman Richard Reynolds. "The big difference is that the Rabbit service provides a handset that subscribers can use at home, in the street and at work."

Meanwhile, Mori and the Henley Centre for Forecasting have been conducting some research on behalf of Hutchison Telecom. The findings suggest that as much as 20% of the UK population could be using a mobile phone by the end of the decade. But there are hurdles for the British cellular phone industry to overcome before the British consumer is entirely easy with mobile phones, the main one being the 'obnoxious (would-be?) yuppy' image.

Morse Test Changes

The Radiocommunications Agency is proposing a new format to the 12 words- per-minute Amateur Radio Morse Test. The new test will require the candidate to receive a minimum of 120 letters and 7 figures in the form of a typical exchange between radio amateurs. In the sending test, the candidate will have to send, by hand on a standard Morse key, a message of not less than 75 letters and 5 figures, also in the form of a typical exchange. Full details Tel: (071) 215 2217

Sync Chip Cleans Clock Phase

The AVASEM 9170 is a clock generator that creates an output clock synchronised to a continuous input clock. The CMOS phase lock technology will be a useful tool for regenerating clocks in high-speed computer systems where timing skew is critical. Through the use of two select pins, multiples or divisions of the input clock can be generated with zero delay.

Output frequencies can be created up to 100MHz with a maximum error of 1·0ns. The phase-lock feedback is user-selectable, making it possible, with an additional 74HC244 octal buffer, to synchronise up to eight sources.

Glasgow 1993

Forget Barcelona, Atlanta or Seoul, the next generation of world-class competitors – robots – are warming up now with only one athletics goal in mind – Glasgow 1993.

The race commenced long ago in laboratories, workshops, classrooms, engineering plants, factories and university research institutes from San Francisco and Singapore, to Moscow and Manchester. Discussing the interest shown so far, Dr Peter Mowforth, director of Glasgow's Turing Institute said: "Without even an official announcement about the event, word has got out and for the past two years enquiries have been pouring in from literally all over the world. The excitement in both the academic and commercial worlds is incredible."

The International Robot Games has been launched thanks to the tremendous success of a pilot event in Glasgow two years ago. Dr Mowforth and his colleagues were then overwhelmed with the entries, which ranged from high tech robots built in Russia, South America and Japan, to homespun creations from primary schools in Scotland, and garden shed inventors in Mexico and India.

As far as possible technologically, the games will strive to emulate the human Olympics with almost identical events, rules, judging, national anthems, medals – and even an official torch to burn throughout the event. There are even rumours that a robotic Pavarotti will sing the opening anthem! When pushed for details of drug testing arrangements, Dr Mowforth and his colleagues declined to comment.

Xmas Comes Early at BT

Every Sunday during November and December, BT's directly-dialled calls to and from anywhere in the UK will be charged at the local cheap rate. Michael Hepher, BT's Group Managing Director, explains: "No matter where you call to in the UK – even if it's from Land's End to John O'Groats – it will only cost the price of a cheap rate local call. That's equivalent to 84 pence for an hour's chat."

A ten minute long band 'A' call (up to 56·4km, or approximately 35 miles) on a Sunday would normally cost 40p, while a band 'B' call (over 56·4km) would cost 79p. A similar length call over a 'B1' low-cost route would be 60p. All these calls will cost only 15p during the period of the "Sunday Special" offer – Sunday, November 1 to Sunday, December 27.

The "Sunday Special" offer applies to all calls except those made from payphones, made with a Chargecard, made to or from a mobile phone, made to premium rate services, or made via the operator. Customers using ISDN lines are also excluded. In case you wondered, calls from the UK mainland to Northern Ireland are included, but not those to the Republic of Ireland; however, calls from Northern Ireland to the Republic and the UK mainland are.

For operational reasons known only to BT, national peak rate (Monday to Friday, 9am to 1pm) will be charged at standard rate during November and December for some 3·8 million customers on certain old-style analogue exchanges. From BT's point of view, it may be "tough luck Mercury", but it could also be tough on Oftel. Has BT, under pressure from the regulatory quango to separate its local and long distance call accounts, stumbled on a winning formula? If BT were unable to repeat their "Happy Hours" gesture, unwelcome wrath from telephone subscribers would fall on Oftel.

Speedy Modem Standard Delayed Further

A new modem standard, 'V.Fast', which will enable improved data transmission speeds, is being held back by the International Telegraph & Telephone Consultative Committee (CCITT). The new standard is set to reform modem technology, providing a cheaper and fast way of sending data over existing telephone lines. Having spent three years developing the 'V.Fast' standard, the CCITT claim it will be September 1993 before the new technology is ratified.

Proponents of 'V.Fast' technology are annoyed that the certification process is taking so long. Several companies unable to wait for the completion of the approval process have already launched non-standard look-a-like products with the promise of software upgrades to meet the standard eventually certified by the CCITT.

Women in Industry

As part of an ongoing effort to encourage women into industry, over three hundred female 'A' level students took part in this year's Engineering Training Authority (EnTra) Insight Scheme.

Insight is a week-long residential course for sixth-form female students studying mathematics and physics, giving them an opportunity to learn first-hand about a career as a professional engineer. It aims to increase the number of girls entering the industry by encouraging their interest in university engineering degree courses.

The emphasis of the courses is practical throughout. Working together on a number of challenging projects, the students designed, built and tested a whole array of mechanical, electrical and electronic systems. These included buggies to travel along straight lines, structures to span set distances, a distress signal tower and a machine for dispensing sweets.

Guidance and group supervision came from professional female engineers, able to act as role-models and share past experiences with their younger counterparts. A day spent in industry, shadowing a graduate engineer together with talks from professional engineers, encouraged the female students to examine different branches of engineering and routes open to them.

Through Insight, EnTra has already succeeded in introducing engineering to thousands of high-calibre young women who would not have previously considered it as a career. Of the 5000 students who have participated in the courses since they were initiated, 40% have chosen to study engineering, half of whom had not originally intended to study it as a degree subject.

PICTURE CAPTION CHALLENGE

This month, it's Mercury's turn to come under the microscope. Again no prize, but what is going on?

- ★ Dutch Cable TV comes ashore.
- ★ Mercury discover a random BT cable network.
- ★ Mercury hauls in the QE2.
- ★ Engineers installing an LBN (Local Beach Network).

Not quite. The 'Beach Master' prepares for the pulling ashore of the Mercury Comms telecoms cable that will link the UK mainland with Northern Ireland. In case you're wondering, the fibre-optic cable will carry the equivalent of 46,000 simultaneous telephone calls.

Events Listings

To January 1993. The IRN-BRU Pop Video Exhibition. MOMI, South Bank, London. Tel: (071) 815 1339.

10 to 12 November. Image Processing '92. NEC Birmingham. Tel: (081) 742 2828.

19 to 22 November. Christmas Computer Shopper Show '92. Olympia, London. Tel: (081) 742 2828.

5 December. All-Formats Computer Fair. Birmingham Motorcycle Museum. Tel: (0608) 662212.

7 to 8 December. HDTV and Future Television. Cumberland Hotel, London. Tel: (071) 931 9985.

8 to 10 February '93. Microtech '93. Heathrow. Tel: (0344) 301491.

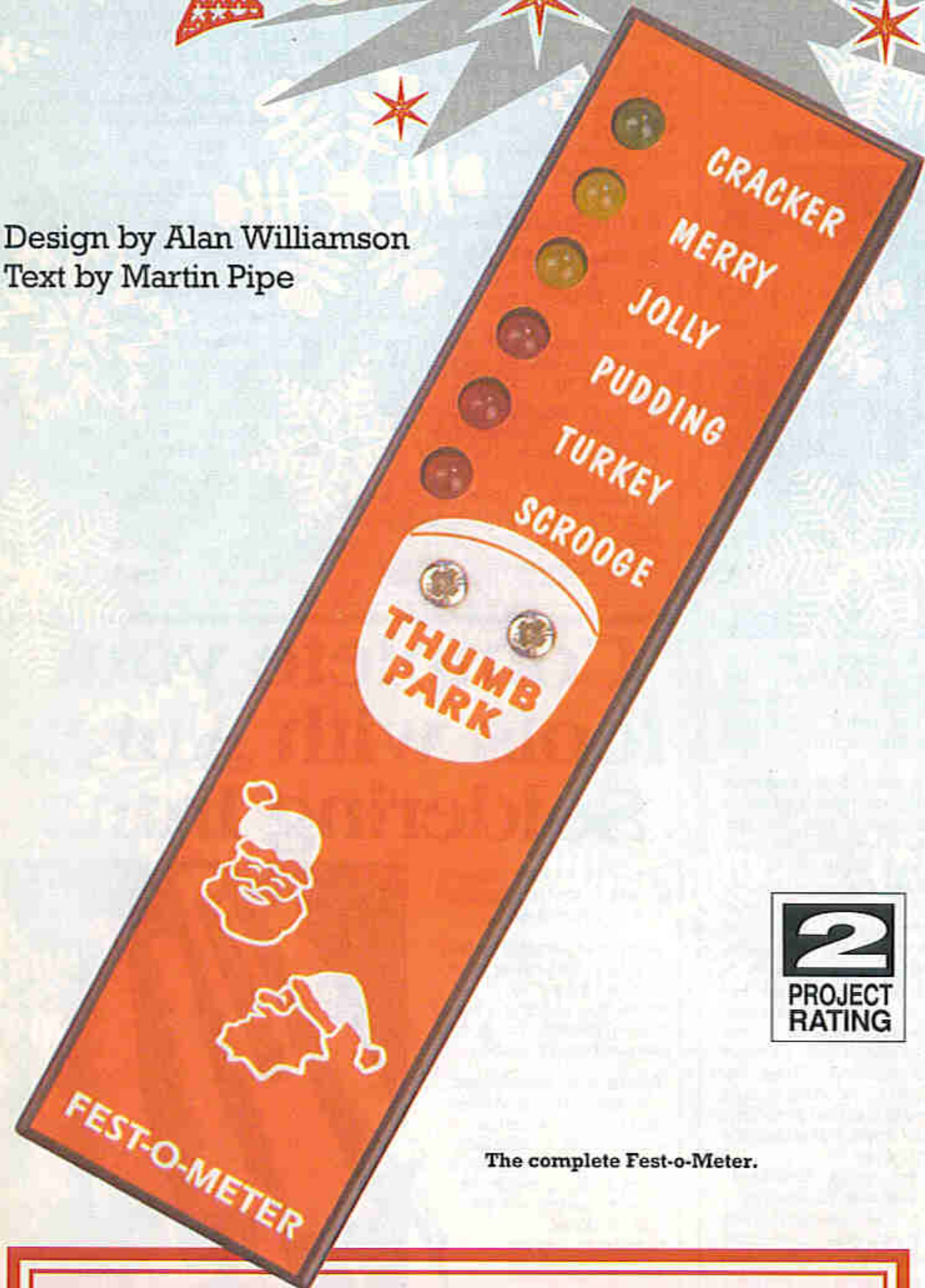
23 to 25 March. NEPCON. NEC Birmingham. Tel: (081) 948 9800. Don't forget to visit the Maplin Professional Supplies Stand!

24-31 March. CEBIT. Hanover. Tel: (081) 688 9541.

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

Fest-o-Meter

Design by Alan Williamson
Text by Martin Pipe



The complete Fest-o-Meter.

2 PROJECT RATING

- * FUN FOR ALL THE FAMILY
- * IDEAL BEGINNER'S PROJECT
- * LOW COST
- * CAN BE USED AS A SIMPLE 'LIE DETECTOR'

Ho! ho! ho! It's that time of year again, when 'Electronics' offers you another of its acclaimed (!) novelty projects – an ideal stocking filler! We have decided to christen this year's piece of electronic fun the 'Fest-o-Meter'. Instead of merrily twinkling away of its own accord like last year's Christmas Tree project, the Fest-o-Meter requires YOUR efforts to get any results! Like the Christmas Tree project, however, the Fest-o-Meter is a simple project and should pose no constructional problems even to the absolute beginner. Hours of fun can be had by family and friends trying to get all 6 of the LEDs to light by holding a finger over the unit's two contacts – the Fest-o-Meter depends on moisture in the skin to act as a high-value resistor and complete a circuit. If you are successful, you will be rewarded with a Christmas tune.

The younger members of the family will be amused watching Granny trying to get the last LED to illuminate, something that children will be able to do with much more ease. This is because their skin contains more moisture and therefore has a lower resistivity. Licking your fingers is cheating; if you are caught, you won't get any pudding!

This little project could be used beyond Christmas! It could, for example, function as a simple form of 'Lie Detector', as some of these employ the same principle. When telling lies people are supposed to sweat more, according to psychologists. These increased levels of moisture noticeably alter the resistivity of the skin – to such an extent that the Fest-o-Meter can detect it. Of course, any results gained using this method should be taken with a pinch of salt; after all, some people sweat a lot naturally, while others are just 'good liars'! But at the end of the day, it's all GOOD CLEAN FUN (apart from the sweat, that is – Ed.)!

Circuit Description

The circuit of the Fest-o-Meter, reproduced in Figure 1, is really very simple. The skin resistance of your fingers, combined with R1 to R6 and RV1, constitute a

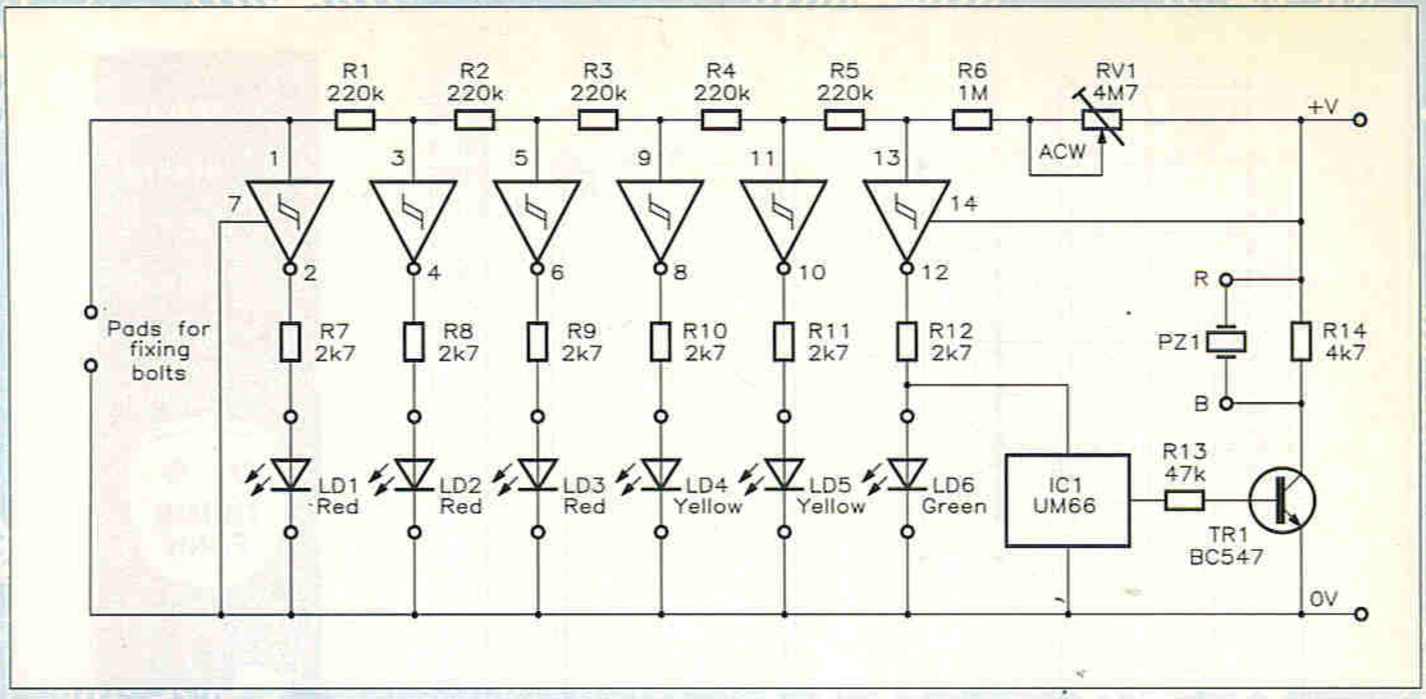


Figure 1. Circuit diagram of the Fest-o-Meter.

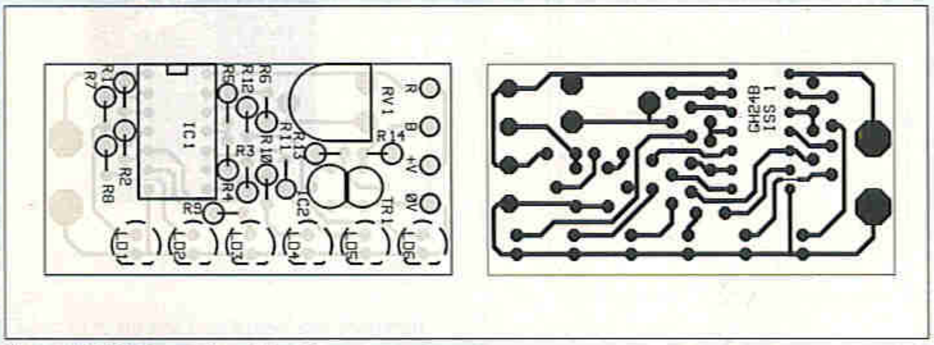


Figure 2. PCB legend and track.

potential divider which is connected to the inputs of IC1 (six Schmitt inverters in the same package, known as a 'hex inverter'). Each output of IC1 is connected to a low current LED via a series resistor. The inverters used are specifically Schmitt types, since they have a much better defined switching action – below a certain threshold the LED remains unlit; above it, the LED is switched on.

The input of each gate is at the supply potential when the contacts for your finger are open-circuit (literally 'untouched'!). When your finger is placed over the contacts (which are M2·5 bolts), the potential at the inputs of the hex inverter will become lower. When the potential at the input of each inverter drops below 40% of

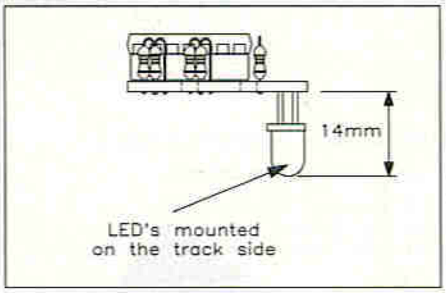


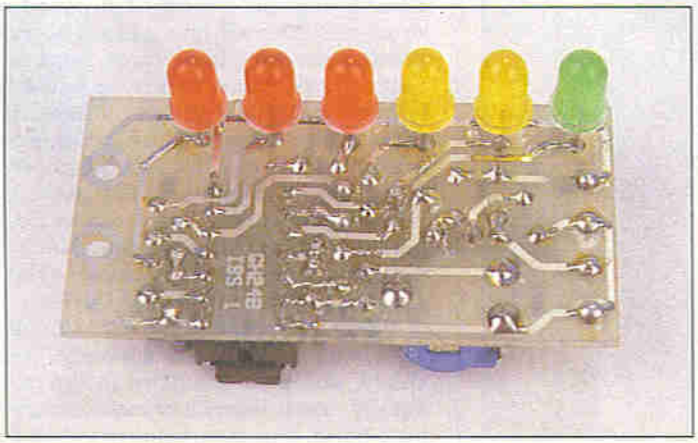
Figure 3. Fitting the LEDs to the track side of the PCB.

the supply voltage, the LED of each inverter will illuminate. The inverter at the top of the potential divider chain has a UM66 melody generator (IC2) in parallel with the LED. When this LED illuminates, the melody generator will then be powered up and a medley of Christmas tunes will be heard from the piezo transducer, PZ1. TR1 is used as a 'class D' (switching) amplifier to drive PZ1.

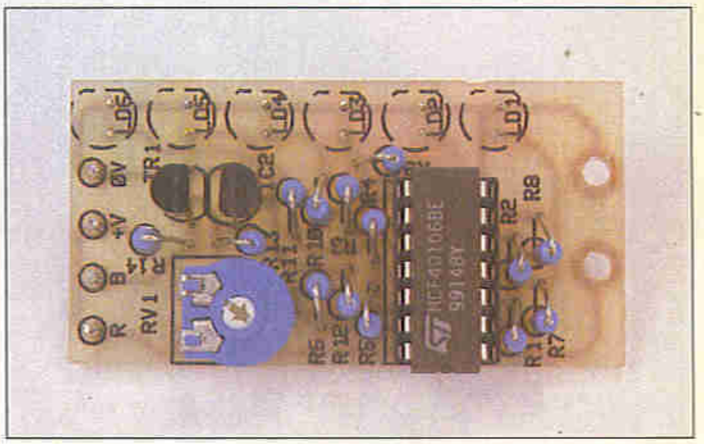
Construction

If you are new to electronic kit building, then please refer to the Constructors' Guide for sound practical advice on electronic kit building, soldering and the like. The leaflet is supplied with the kit and although intended for the novice, it offers information that is perfectly valid for the more experienced constructor. Due to its simplicity, however, the Fest-o-Meter is by no means a difficult project to assemble. The PCB legend and track layout are shown in Figure 2.

Begin by fitting all the resistors vertically, followed by the preset resistor RV1 and then the PCB pins which are inserted from the track side. Next, take note of the orientation notch on the PCB legend and install the IC socket accordingly, followed by IC1 – also aligning with the notch in the same position. Sort out TR1 from IC2 (they have the same physical appearance) and carefully fit into the appropriate positions. The LEDs are installed from the TRACK side of the PCB so that the distance



The assembled PCB – track side.



The assembled PCB – component side.

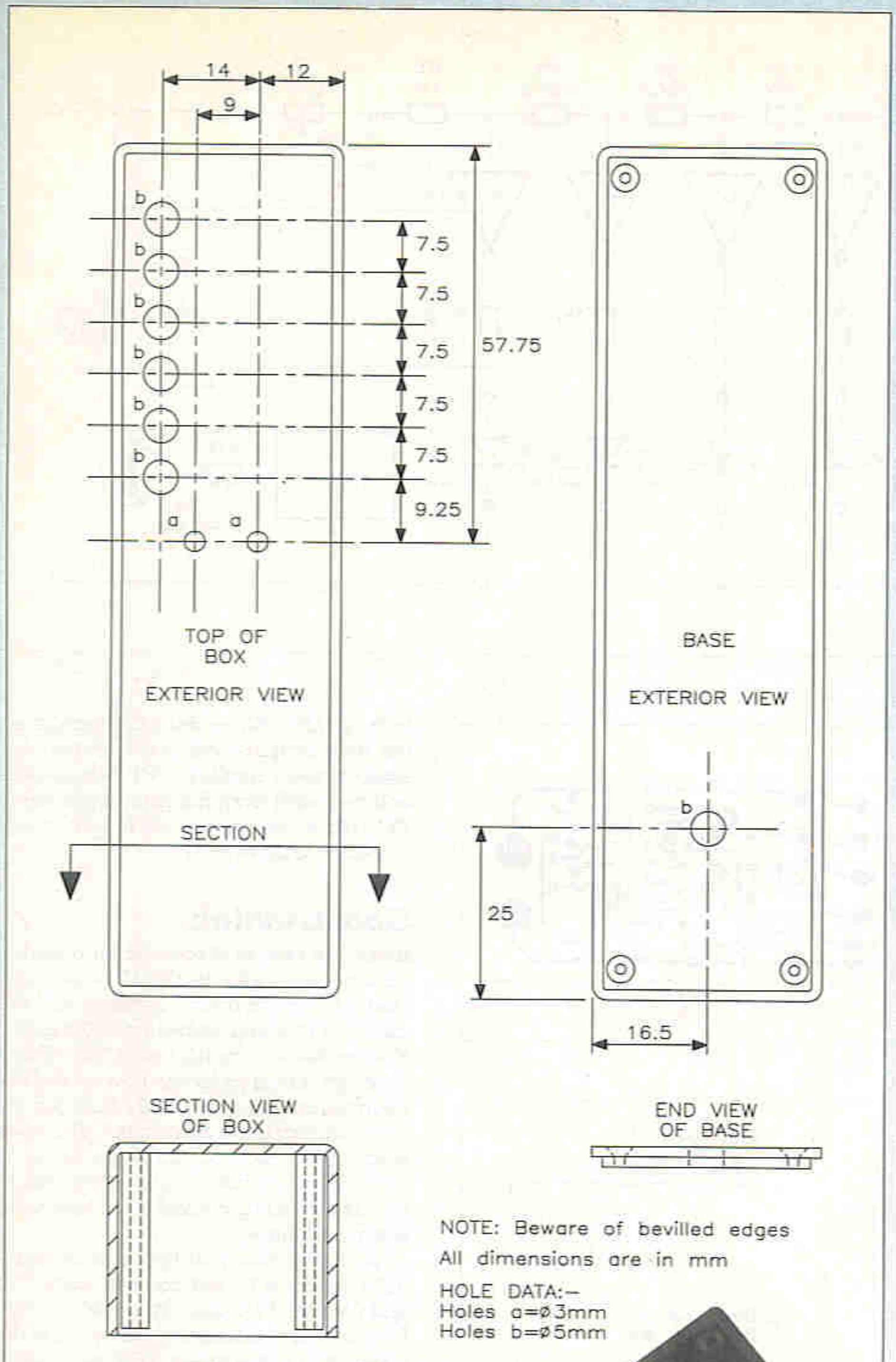


Figure 4. Box drilling details.

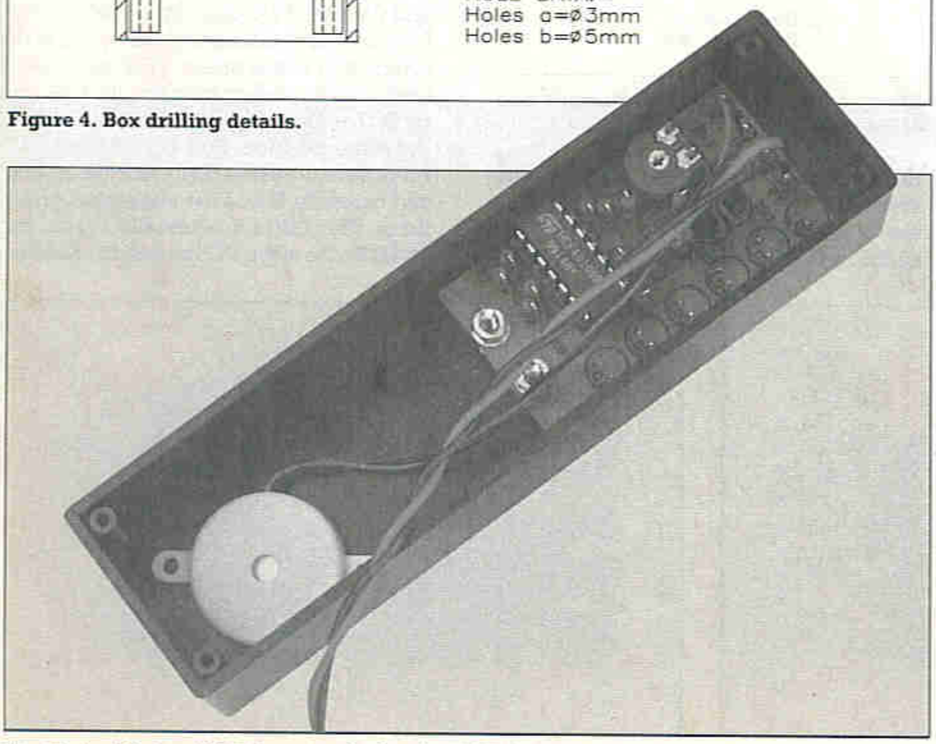

The Fest-o-Meter with lid removed, showing PCB in place.

Figure 5. Front panel label.

between the board and the tip of each LED is 14mm, as shown in Figure 3. When fitting the LEDs, solder only one lead initially so that it is easier to re-adjust to the correct height. If re-adjustment is necessary, reflow (melt) the solder joint, reposition and allow the solder to cool again. When all the LEDs are at the correct height and are in a straight line, the other lead of the LED can then be soldered. Once both leads have been soldered in place, resolder the initial LED connections to avoid any dry joints that may have been caused when re-positioning the devices. After you have finished assembling the PCB, please check your work for solder whiskers, dry joints, misplaced components and the like.

Box Drilling

Before marking out the holes, place something hard and flat along the side of the box, for example a piece of ply-wood 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 (such as a compass) to make indentations at the marked positions. This will prevent the drill from slipping. At this stage, be warned. Inaccurately-placed holes can lend a somewhat sloppy appearance to the project – would you want your kids to wake up to that on Christmas Day?

When you are satisfied that all holes have been marked out to the best of your ability, drill them as shown in Figure 4. Initially, use a 1mm bit to make accurate pilot holes. The pilot holes can then be followed by a 3mm drill for the screw

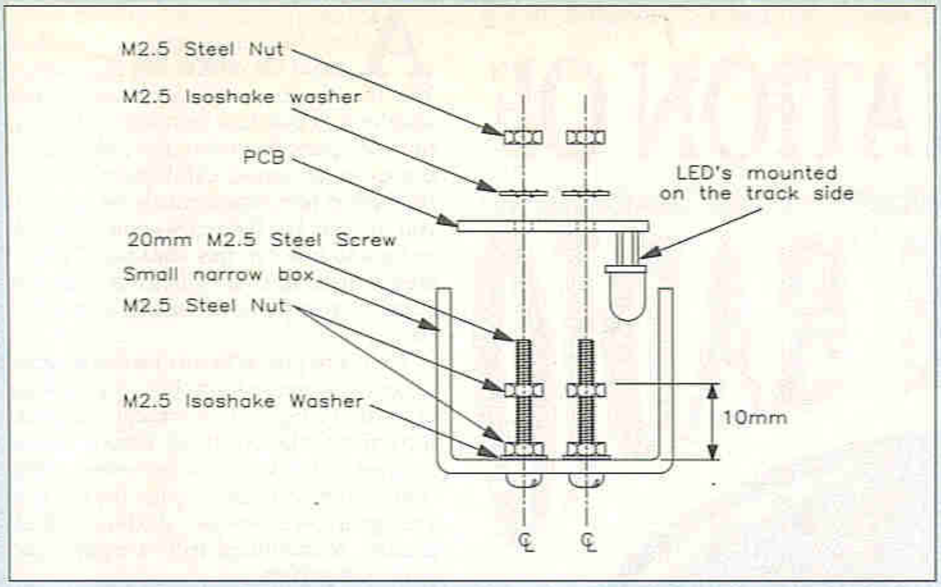


Figure 6. Accommodating the Fest-o-Meter PCB in its box.

holes, and a 5mm drill for the LED holes. Don't forget to drill the 3mm hole in the box base, so that the piezo sounder can be heard!

As soon as drilling has been completed, the self-adhesive label (reproduced in Figure 5) can be stuck onto the box. It is very sticky, and consequently difficult to reposition without removing and tearing – be sure to get it right first time! Once in place, use a sharp knife (be careful!) to cut out the LED and screw holes in the front panel.

The next stage is to assemble the PCB into the box using the M2·5 screws, nuts and shakeproof washers, as shown in Figure 6. These will form the contacts across which the skin resistance will be measured. The battery clip and piezo sounder wires can now be soldered to the appropriate PCB pins.

All that is left to do now is to attach a PP3 battery. Line up the clip with the battery correctly before carefully 'snapping' it into place – because merely touching it with reversed polarity may cause damage to the semiconductors. Adjust RV1 to its mid-way position; if you are able to get the last LED to illuminate easily, adjust RV1 clockwise (or anti-clockwise if you find it difficult) until you are just able to get the LED to turn on. Cut the supplied self-adhesive pad in two and stick it onto the piezo sounder – either side of its sound hole, and not over it! The piezo sounder can now be stuck over the corresponding hole in the base lid. After screwing the lid to the box body, your Fest-o-Meter is ready for use – or gift-wrapping!

Merry Christmas!

FEST-O-METER PARTS LIST

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

R1 to R5	220k	5	(M220K)
R6	1M	1	(M1M)
R7 to R12	2k7	6	(M2K7)
R13	47k	1	(M47K)
R14	4k7	1	(M4K7)
RV1	4M7 Horizontal Enclosed Preset	1	(UH11M)

SEMICONDUCTORS

IC1	40106BE	1	(QW64U)
IC2	UM66 Type 1	1	(UJ40T)
TR1	BC547	1	(QQ14Q)
LD1 to 3	LED Red 5mm 2mA	3	(UK48C)
LD4,5	LED Yellow 5mm 2mA	2	(UK50E)
LD6	LED Green 5mm 2mA	1	(UK49D)

MISCELLANEOUS

PZ1	Low Profile Sounder	1	(KU57M)
	Quickstick Pads	1 Strip	(HB22Y)
	PP3 Clip	1	(HF28F)
	Small Narrow Box	1	(FT31J)
	Steel Bolt M2·5 x 20mm	1 Pkt	(JY32K)
	Steel Nut M2·5	1 Pkt	(JD62S)
	Isoshake Washer M2·5	1 Pkt	(BF45Y)
	DIL Socket 14-pin	1	(BL18U)
	PCB	1	(GH24B)
	Pin 2145	1 Pkt	(FL24B)
	Front Panel Label	1	(KP58N)
	Instruction Leaflet	1	(XU02C)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

	Zinc Chloride HD PP3	1	(FK62S)

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 LT18U (Fest-o-Meter) Price £6.95.
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 1993 Maplin Catalogue.
Fest-o-Meter PCB Order As GH24B Price £1.86.
Fest-o-Meter Label Order As KP58N Price 80p.

THE FASCINATION OF VINTAGE RADIO

Part One
What's it All About?

by Geoff Arnold

In these days when it is possible to buy an integrated circuit to do almost any task you like to think of, it might seem strange that the radio equipment and techniques of years gone by should attract so much interest. There are many thousands of people, in the United Kingdom and right across the world, who search out and lovingly restore radio, TV, sound, recording and telegraph equipment, and telephones that may date anywhere from the turn of the century to a decade or so ago.

As with any hobby there are those who limit their involvement to reading about the objects that they desire. This may be for a variety of reasons, but usually it is due to a shortage of money, time or space. For them, the collecting of books, magazines, catalogues, service sheets and technical manuals becomes an end in itself. For the active equipment collector and restorer, this 'data bank' of reference material is an adjunct as vital as a stock of components, valves and other parts.

Do not be put off by an idea that in order to get anywhere in the hobby, you must go in for it in a big way. A vintage radio collection may be anything from a single receiver or book, to a house where every spare room and corner, plus the loft and perhaps a row of wooden sheds in the back garden, is crammed full of equipment, parts and papers.

Old or Young

It has to be admitted that many fans of vintage radio – myself included – might be classified as 'vintage' themselves, although I hasten to add that in the radio context the term is not limited to a specific period in the way that it is for cars! For these older devotees, the attraction stems from having used the equipment at home, at work, or in the Services – or simply from having seen it advertised or displayed in a shop window. There are three or four radios from the post-war years that I then thought exceedingly smart and desirable, and longed to own. If I see one now at a vintage swapmeet the yearning returns, although I have since learned from repairmen of the time that, in some of those sets, the elegant exterior concealed an unreliable nest of trouble.

For younger collectors, the interest in vintage radio was perhaps sparked off by recollections of a cherished set, in an aged relative's home, or by listening to tales of wartime exploits from their fathers or grandfathers. For others, who may be professionally involved in the application of 'cutting-edge' electronics technology on a day-to-day basis, it seems to provide relief from an environment in which most of the design decisions have already been made by the technologists of the integrated circuit fabrication houses. In our high-technology world, the desire to become involved in a hobby where we can get our hands on the 'nitty-gritty', be it gardening, D-I-Y or whatever, is innate in many of us.

Learning About Vintage Radio

Having decided that there is something rather fascinating about old-fashioned technology and equipment, how do you go about learning more? You may already know someone who has been bitten by the bug, in which case you are in a good position. Indeed, you may already have found that, once prompted to begin talking about vintage radio, the dyed-in-the-wool enthusiast takes some stopping!

A number of museums around the UK, especially those dealing with industrial, scientific, military or domestic themes, have sections devoted to radio and other communications systems, although often they

The Gecophone Model 2001 2-valve set of 1922, sitting atop its matching 2-valve LF amplifier. The instrument-like styling of the black ebonite control panel is obvious, but when the hinged doors are closed, the set resembles a 'smoker's cabinet', and therefore became known by that name.

are fairly small in scope. If you don't know of any in your area, a browse through the listings in a copy of "Museums and Galleries in Great Britain and Ireland" at your local reference library will be helpful.

Museums devoted entirely to radio and line communications topics, and general museums where they occupy a large part, are growing in number at the present time, due to an increasing realisation that valuable historical material and records will otherwise be lost to posterity. Almost every one of these museums is based on what were originally private collections of one or more individuals, although many have expanded considerably since those early beginnings.

Some of the museums are open all year round, for example the Science Museum in London, and the Royal Signals Museum at Blandford, Dorset. Others are open only from around Easter through to September or October each year, and are closed throughout the winter months. In this category are the Amberley Chalk Pits Museum, Amberley, West Sussex, the twin Wireless Museums at Arreton Manor and Puckpool Park on the Isle of Wight, and the Scottish Museum of Communications at Bo'ness, West Lothian.

As for the collections that are still in private hands, there are literally hundreds in the UK alone – some of them as large as anything on display in a museum. The costs and complications involved make it impossible to put them on permanent display, but quite a few of these collections are open to viewing by interested members of the public either on special occasions or by appointment. Perhaps the largest and best known of these is the Vintage Wireless Museum at West Dulwich, London, which can be viewed on application to the Curator, Gerald Wells, on 081-670 3667.

BTH Crystal Wireless Receiver Type C Form A of 1923 with twin crystal detectors. The basic set was variometer-tuned over the medium waveband, but a long-wave coil was available as an option.

Selections of exhibits from some of the other collections are put on show from time to time at communications exhibitions, vintage fairs and amateur radio rallies. Notable among these is the Journeaux Historic Wireless Collection, run by Bill Journeaux of Poole in Dorset, who is often to be found at events in southern England showing examples from his vast collection of pre-World War II radio sets and 405-line TV receivers.

Clubs and Societies

One way of becoming really involved in any hobby activity is to join a club or society. In the vintage radio and TV fields, some of these organisations devote most or all of their subscription income to publishing an informative newsletter; others exist purely to promote regular meetings of their members. The British Vintage Wireless Society produces a very interesting and attractive quarterly bulletin (planned to increase in frequency) as well as organising swapmeets for its members in Harpenden and occasionally elsewhere. Details of BVWS membership can be obtained from Dave Adams, the Society's Information Officer, at 69 Silver Lane, West Wickham, Kent BR4 0RX. The Vintage Radio Circle organises regular swapmeets at a venue near Swindon for its members, but does not produce a club journal. Membership details are available from M. Williams, 28 Barton Lane, Cirencester, Gloucestershire GL7 2EB.

On the military communications side, the amateur radio societies of the Royal Navy, Royal Signals and Royal Air Force give, from time to time, coverage to vintage services equipment in their magazines. Anyone with a past connection with the services is welcomed into membership, which could be well worth considering. The RNARS also embraces ex-merchant service personnel.

Some brands of radio equipment attract such a loyal following among owners that User Groups have been set up to exchange information and to put members in touch with each other. The Eddystone User Group, catering for owners of this well-known series of receivers, is a case in point. Further details are available from W. E. Moore, Moore Cottage, 112 Edgeside Lane, Waterfoot, Rossendale, Lancashire BB4 9TR. Another group, for owners of Collins equipment, has unfortunately closed recently due to falling support, and you will now have to go to the United States, home of Collins, for a newly-launched magazine devoted to the marque. Incidentally, vintage radio is indeed a very popular hobby in the USA, with societies and other organisations producing general coverage newsletters as well as specialised titles on such topics as communications receivers and valve circuitry, the latter termed 'hollow-state' to distinguish it from solid-state.

You should remember that all of these organisations are run on non-profitmaking lines, and your enquiries will be better received if accompanied by a stamped, self-addressed envelope for the reply.

Magazines

The dividing line between society newsletters or journals and magazines in this field is somewhat blurred, for there are several such publications on particular topics produced for circulation to subscribers who might just as easily have been organised as a club or user group.

The vintage television publication "405-Alive" is an example. Although it might be assumed from its title that its coverage is limited to the now extinct British 405-line system, it extends back to Baird and the French 819-line system, and even to early 625-line equipment. It deals with both transmitting and receiving equipment – in addition to cameras, programmes, test-

The JAY-GEE 'crystal-or-valve' set of 1924.

cards and personalities. Further details from Andrew Emmerson, 71 Falcutt Way, Northampton NN2 8PH.

Devotees of Morse Code communication and history, and collectors of vintage keys and other telegraph equipment, are catered for by a quarterly magazine mysteriously entitled "Morsum Magnificat". Although Morse Code is increasingly being phased out in professional communication systems, it is still very much alive in amateur radio circles, and MM combines the historical side with news of current events. Further details from 9 Wetherby Close, Broadstone, Dorset BH18 8JB.

Collectors of domestic radio receivers are catered for by a long-established publication entitled "The Radiophile", produced by Chas Miller at 'Larkhill', Newport Road, Woodseaves, Staffs. ST20 0NP. It combines detailed articles on fault-finding and restoration techniques with occasional items of off-beat humour.

On a broader front, embracing the whole range of domestic radio and TV, broadcasting, recording, amateur radio, military, aeronautical and maritime communications, is the bi-monthly magazine "Radio Bygones". It covers the equipment, the technology and the personalities behind the developments which we now tend to take for granted, with news of happenings in the vintage radio field and a full-colour photo-feature in every issue. Further details from 9 Wetherby Close, Broadstone, Dorset BH18 8JB.

This list of societies and magazines is by no means exhaustive. There are others in the UK which cater for specialist interests, and many more in mainland Europe, the USA, Australia and New Zealand – most of which receive mentions from time to time in the publications listed here.

Books Old and New

As already mentioned, collecting old books about vintage radio can be a hobby in itself, and that aspect will be dealt with in depth later in this series. However, researching and writing books on vintage radio topics continues to occupy authors and enthusiasts, and these 'modern' books provide a useful introduction to various aspects of vintage radio, as well as a basis of a personal reference library.

Many of the books in this category from UK authors are unfortunately out of print at the present time, and even those in print are likely to be difficult to find outside the lists of the specialist suppliers. Titles you should be able to locate fairly easily include the recently-published "Radio Art" by Robert Hawes. This looks at the evolution in domestic receiver design from the point of view of the cabinet rather than the more usual analysis of the circuit technology, and includes over 250 magnificent colour photographs. Others are "The Setmakers" by Keith Geddes and Gordon Bussey, a fascinating book which chronicles the history of the radio and TV receiver manufacturing industry in Britain from its earliest days, and "2MT – the Birth of British Broadcasting" by Tim Wander.

Of the traditional technology-based titles, you should still be able to find the "Practical Handbook of Valve Radio Repair" by Chas. E. Miller, an invaluable guide to the techniques of fault-finding, repair and restoration.

Two out-of-print books worth searching for in second-hand bookshops and markets are "Radio! Radio!" and "The Cat's Whisker", both written by Jonathan Hill and full of historical information, pictures and descriptions of domestic radio sets. A new, revised edition of "Radio! Radio!" is planned to appear some time during 1993. In similar vein are "Early Wireless" by Anthony Constable, and "Vintage Crystal Sets" by Gordon Bussey.

A considerable number of books on vintage radio and telegraphy have been published in recent years in Europe, the United States and Australia. Should your interests extend to sets originating in those countries, a look at the book-lists of the Vintage Wireless Company Limited, Tudor House, Cossham Street, Mangotsfield, Bristol BS17 3EN could prove rewarding.

Another company, Chevet Book Supplies of 157 Dickson Road, Blackpool FY1 2EU is a good source of second-hand books on radio and electronics, and also of 'warehouse clearance' lines of more recent books on those topics.

Before leaving the subject of books, there is one area – valves – where recourse to earlier publications is essential. If you are to understand the operation of valved receivers, or do any work on them, it is vital that you understand at least the basics of valve characteristics and biasing. If your technical education has been confined to the solid-state world, the fact that virtually all valves require reverse bias applied to the control grid at all times, if they are not to be destroyed, can come as something of a surprise. A study of one of the elementary text-books from the days of valves is the best way of filling such a gap in your knowledge.

Starting a Collection

Most collections start fairly haphazardly with just one piece of equipment, or perhaps a book which catches your imagination. A second item is added, then another, and usually a theme will quickly establish itself. As the number of variants on the original item grows, they have a habit of leading in different directions, starting new themes, and before long you will have to decide how much space, time and money you are prepared to devote to your collection.

As soon as you have more than a couple of items, it is a good idea to start a log in a small notebook, recording where and when you acquired each item, how much you paid for it and what repair or restoration work you do on it. It is also worth noting where in your personal reference library you can find related technical details, a circuit diagram and information such as the date of manufacture.

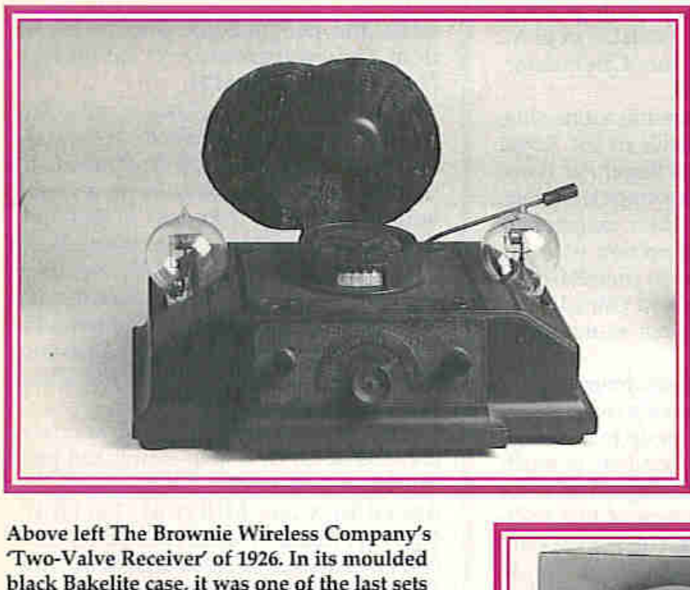
People don't just collect complete sets, of course. For example there are large collections of loudspeakers, from the days before the loudspeaker was incorporated into the cabinet with the rest of the set. There are even larger collections of valves, from the tiny types used in hearing aids up to the giants, measuring eighteen inches in height or more, which form part of huge broadcasting transmitters.

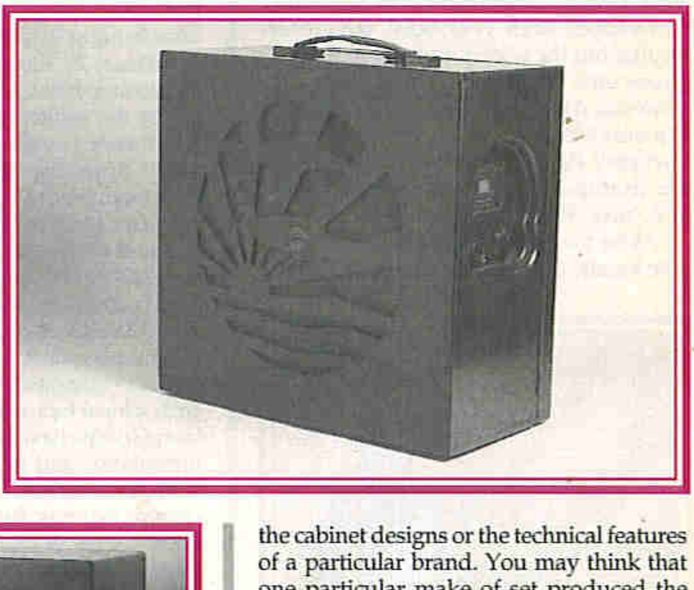
Choosing a Theme

The theme that you choose is of course entirely up to you and, to some extent, to chance! Here though are a few suggestions, not in any particular order, of the different types of themes that might be adopted, to help you organise your thoughts.

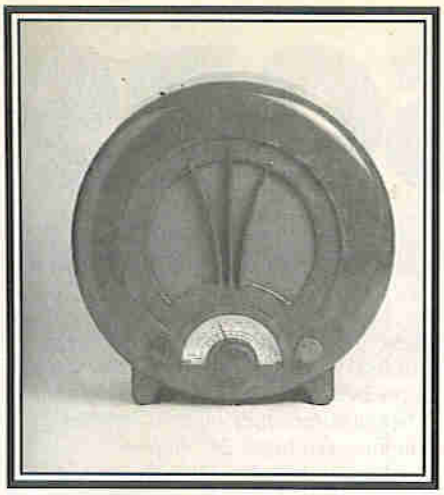
Collecting by manufacturer is perhaps one of the most obvious. You may admire the cabinet designs or the technical features of a particular brand. You may think that one particular make of set produced the best sound quality, or the best 'station-getting' performance. Perhaps you had a relative who used to work for a radio manufacturer. There are many reasons.

Sets from a particular age or era may take your fancy. Back in the first days of domestic radio production – in the 1920s and early 30s – there were many, many different manufacturers. A collection based on sets made during a period of just two or three years could give enormous variety.





Above left The Brownie Wireless Company's 'Two-Valve Receiver' of 1926. In its moulded black Bakelite case, it was one of the last sets to have externally-mounted valves.
Above right: One of the earliest Pye sets with the famous 'rising sun' loudspeaker grille, the Model 25C was a 5-valve battery set covering medium and long wavebands, released in 1929.
Right: Reputed to be the first mains-powered receiver to include the loudspeaker within its cabinet, the 'H-I' was made in around 1926–27 for operation from 200V DC by the Swedish Aga Company, now more famous for its solid-fuel stoves!



This later variation on the 'round Ekco' theme, the AD75, was a 3-valve, long and medium wave AC/DC mains set, first launched in 1940 and re-released in 1946, when it became the last of the genre.

The snag, of course, is that not so many sets of that era remain. A variation on the age or era theme sometimes adopted is to collect a few representative designs from each era. The era chosen does not have to be particularly old. For example, if such things take your fancy, a collection of early transistor sets is fairly easy to put together at present, with jumble sales and car boot sales providing a happy hunting ground. Once you get started, you never know where it will lead you.

Collecting equipment produced for a particular application or use is yet another option. This brings in all the military, marine, aircraft and other professional sets. It is well to remember, though, that much of such equipment is large and heavy; the phrase 'built like a battleship' is often appropriate! You need pretty substantial shelves or benches to store and display sets which can weigh upwards of half a hundredweight. If you have a background in the armed services, or the merchant navy, you have a ready-made theme with some background knowledge to go with it.

My final theme type is collecting by style, meaning sets in plastic, metal, fabric-covered, polished wooden cabinets or whatever appeals to you. These theme types are not exclusive, and you can combine them to widen the scope of your theme, or specialise and narrow it down.

Finding Collectibles

Where you will find items for your collection obviously depends on what you choose to collect. Second-hand shops, jumble and car-boot sales are good for things from the 1960s onwards, and you may with good fortune occasionally find something a little earlier.

The amount of pre-war equipment available on the general market is far less, much of it being already in collectors' hands. Still, you never know your luck. If that era is the one for you, it will really pay to join one of the societies so that you can go along to their swapmeets.

Although a limited amount of military communications equipment changes hands at these radio swapmeets, you may have more luck at one of the military vehicle rallies, as these often have sections devoted to wireless. Unfortunately, they have a reputation for being rather expensive. The surplus and second-hand radio dealers who advertise regularly in the amateur radio press are a good source of military and other professional equipment, as are small advertisements in magazines. Such traders are often encountered at amateur radio rallies; these give you a chance to examine the equipment thoroughly before buying it.

Domestic Radio

Crystal sets, being the very earliest domestic radios, have a certain fascination. Like the earliest valve sets, they are very collectible. Many of the early manufacturers had a background in scientific instrument making, and this fact is evident from the appearance of their radio sets. Presumably having the materials, fittings and skills in instrument making, they saw little reason to produce radio receivers which were any different.

Early crystal set designs were divided between those built onto base-boards or otherwise having their works permanently open to view, and those built into boxes with lids. Obviously, the need to have ready access to the cat's whisker adjustment on the crystal meant that a completely closed cabinet was impractical. The earliest domestic valve sets, on the other hand, were mostly of open construction, with the valves sitting in holders mounted on the top panel. Designers of military sets of the era had recognised that a more rugged and protected design was needed for their products, and the fact that sets for the home market were so different must presumably be put down to production costs.

By the middle of the 1920s, most new domestic receivers had their valves enclosed within the cabinets, and by 1927 sets were looking less like scientific instruments and more like pieces of furniture, with some stylistic thought put into the design of cabinets and loudspeaker grilles. The famous Pye 'sunrise' loudspeaker fret design first appeared in that year.

During the 1930s, domestic receivers came mostly in veneered wooden cabinets, although the plastics of the day were used for their control knobs, and for some cabinet fittings such as tuning dial surrounds and pieces of decorative trim. A number of manufacturers, notably Southend-based E. K. Cole who made sets under the Ekco trade-mark, were producing complete cabinets moulded from Bakelite. The first of the so-called 'round Ekcos', the Model AD65, appeared in 1934. The round Ekcos have become a cult item in recent years, highly sought after by people wishing to include them in the furnishings of a 1930s-style room. As a result, such sets in good condition now change hands at astronomical prices. A peep at the couple of pages devoted to radio sets in the annual "Miller's Collectibles" price guide will give an idea of current values, but take a deep breath before you look!

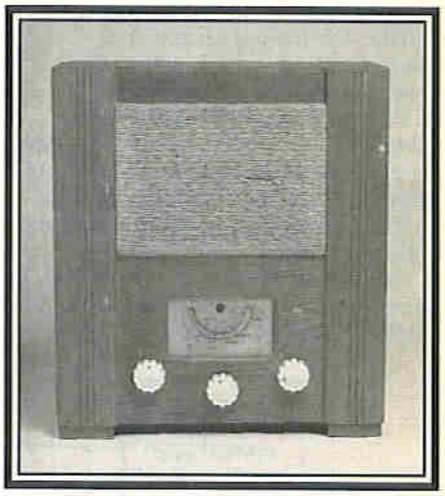
Between 1940 and 1945, the manufacture of domestic radio receivers in the UK was naturally severely limited, confined almost entirely to the production of a standard 'Wartime Civilian Receiver' design. This was produced by no fewer than 44 different manufacturers and came in a 3-valve plus rectifier mains-powered version, as well as a 4-valve battery-powered version. These receivers were housed in very 'Utility-looking' varnished or oiled wooden cabinets. Most covered the medium wave band only, but later production included a long-wave band.

Civilian Receivers are still being unearthed from lofts and garden sheds, and provide a reasonably-priced introduction for newcomers to vintage radio wishing to get their hands dirty (literally) on a restoration job.

Domestic TV

To anyone having thoughts of finding an original Baird 30-line Televisor for their collection, the best advice is to forget it! There are very few still in existence, even in museums. Should you feel inclined towards the 405-line era which followed, then you have considerable scope, for despite many having been consigned to the council tip, there are lots still around. Here again, there are one or two models which have become 'yuppie favourites' in recent years, notably the Bush TV22 with its 9in. screen and plastic cabinet.

Although vintage radio receivers will go on receiving radio programmes, albeit not for the most part the same stations or programmes that they used to receive, the situation for vintage TV sets is different. The last of the 405-line Band I and Band III TV transmitters has now long since closed down, and if a collector is to have his vintage TV as a working exhibit, he requires some other source of programme material. Luckily, a number of enterprising enthusiasts have acquired copies of several TV programmes from the 405-line days, which are now preserved on videotape. With the aid of a suitable videotape player and a VHF modulator capable of handling sound and vision to the old System-A standard, you can enjoy a real breath of nostalgia!



This 1944 AC mains Wartime Civilian Receiver is hardly in showroom condition. The wooden cabinet is 'tatty', the loudspeaker fabric is torn, the tuning dial is corroded and the control knobs are not original. Despite this, all of its parts (apart from the fibreboard back cover) are present. Typical of a set requiring fairly simple restoration, this would be an ideal project for a newcomer to the hobby.

The magazine 405-Alive has already been mentioned as a source of information, materials and contacts with other vintage TV enthusiasts. One particular aspect of TV

Continued on page 29

COPROCESSORS

by Frank Booty

Some time ago, a major US magazine wondered whether the Intel 286 chip was dead. The conclusion was no, it wasn't. Comparisons were made of the 80286's CPU performance to that of the 80386 and its 16-bit relative, the 386SX. It was found that the 286 chip would still meet the needs of most business users for a good while. But there was one exception.

This was the Intel 287 floating point coprocessor, which is a comparatively slow speed chip. Coprocessors are used to speed up some maths operations. Adding a maths coprocessor is recommended for those applications with mathematical operations involving very large numbers, floating point numbers, complex calculations and graphics. Examples include spreadsheets, business graphics and computer aided design (CAD).

The fastest version available can only 'run' at 12·5MHz – it's the Intel 80287-XL – while the 387 coprocessor, which works only with the 386 processor, runs at speeds up to 33MHz. The obvious conclusion is that, for maths intensive applications that use a coprocessor, the 386 is a better deal than the 286. But this situation has changed.

Companies such as Integrated Information Technology (IIT), Weitek, Advanced Micro Devices (AMD), Cyrix and Harris started to sell chips that were direct replacements for Intel's 287 and 387 (not to mention what may be likely to happen in the 487 camp).

The IIT chip plugged directly into the 287's socket and was designed to work with exactly the same software. IIT also planned to match its pricing to that of the Intel chip. The chip is a clone (virtually) of the Intel 287, but with three exceptions:

Firstly, the IIT version runs at speeds up to 20MHz – as fast as the 387SX-20 – thus removing any speed advantage the 386/387 combo has at these speeds.

Secondly, the IIT chip runs all 287 software, but also has the special matrix instructions, which speed certain kinds of maths operations including 3-D graphics. However, these instructions are not much use unless software developers design their programs to make use of this chip's capabilities.

Thirdly, even at the same clock speed, the IIT chip actually performs floating point maths 'two to three times as fast' as the Intel 287. So, if there was an Intel 287 in a computer, it could be removed and an IIT 287 plugged into the same socket, giving improved performance immediately. Independent benchmarks show improvements of 60% in speed by replacing the Intel chip with IIT's version.

According to IIT, it took a complete redesign of the coprocessor to enable the chip to run so fast. Instead of trying to reverse engineer Intel's chip, IIT says it took Intel's specifications and designed the new chip from the ground up. Consequently, the IIT chip has a much larger percentage of its surface area devoted to actually performing floating point maths, and four times as many registers as the Intel chip.

The engineers who co-founded IIT also used to work for Weitek, who has verified that the IIT chip does not infringe any of its patents. Further, the company did not believe they would get a legal challenge from Intel – Intel of course is at liberty to cut prices at will.

Not unsurprisingly other companies came out with faster 287 chips to complement their 286 CPUs. But it was IIT who set the ball rolling and made it possible for users to upgrade current computers simply by changing one chip.

With the faster numeric coprocessing chip, low cost 286 based systems, with slightly longer lifetimes than had hitherto been expected, became a reality. Subsequently low cost 386s have been appearing and 386 oriented software has been gaining ground. But those familiar AT clones are hard to beat in terms of price/performance.

Of course, just to muddy the waters somewhat, there come the inevitable court cases. There were two in particular, involving Cyrix and AMD. Intel asked a federal judge in Texas to prevent Cyrix Corporation selling its speedy maths computer chips because they used some of Intel's patented technology. Intel asked US District Judge Paul Brown to halt production of Cyrix maths coprocessors until the legal battle was resolved.

Attorneys for both sides presented the judge with giant diagrams and used boxes, cards and even a Ferris wheel-like contraption to explain what goes on inside the tiny chips. Intel's attorney, Paul Janicke, contended there was direct literal infringement in the coprocessor.

After listening to the arguments, many of which were presented in a closed court because of their proprietary nature, Judge Brown indicated he would rule later. The patent infringement matter is one of several in a complex legal case between the two companies.

"A temporary injunction would force Cyrix Corporation to stop shipping products", said the company's chairman and co-founder, Jerry Rogers. In two years, the company had taken more than 10% of the $300 million a year maths coprocessor market on which Intel once had a virtual monopoly.

In his argument before Judge Brown, Janicke said Cyrix used a combination of patented elements that gave Intel's maths chip an edge. These include the way in which it stores numeric information, decides when and how to round a calculation, and when and how to signal the computer and its user that the equation has been rounded, and, therefore, is less precise.

In the closed court, Cyrix attorneys countered that their chips do not use the patented technology. "Of the more than 340,000 transistors in the maths chip, Cyrix would have to change about a dozen or two to avoid violating the patent", said Intel's general counsel Tom Dunlap.

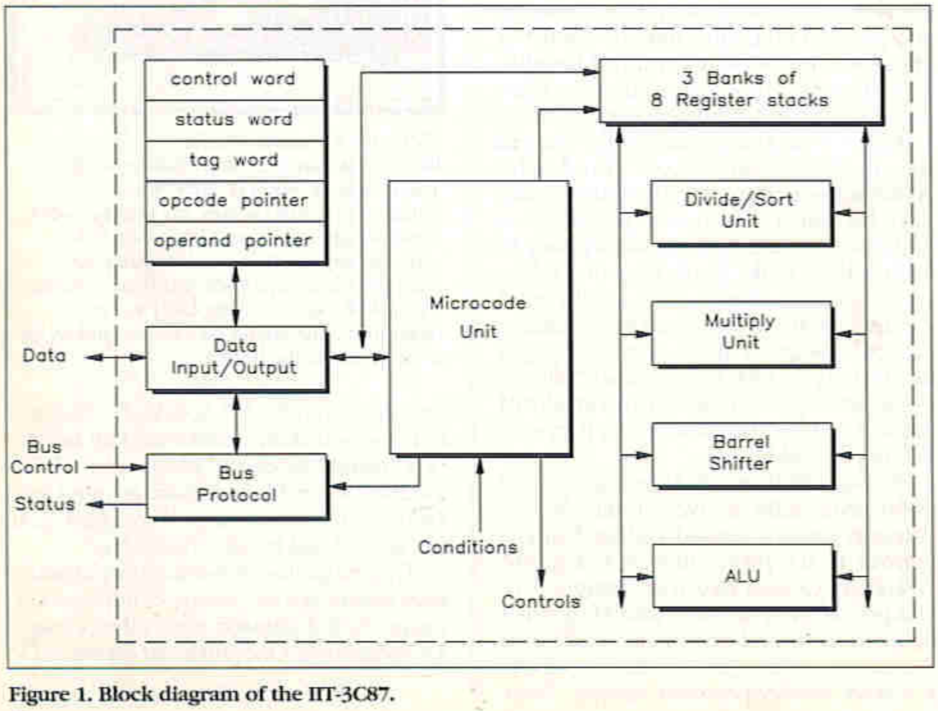


Figure 1. Block diagram of the IIT-3C87.

Data Formats	Range	Precision	Most Significant Byte … HIGHEST ADDRESSED BYTE (7 0 7 0 7 0 7 0 7 0 7 0 7 0 7 0 7 0 7 0)
Word Integer	10^4	16Bits	[15 … 0] Two's Complement
Short Integer	10^9	32Bits	[31 … 0] Two's Complement
Long Integer	10^{19}	64Bits	[79 … 0] Two's Complement
Packed BCD	10^{18}	18Digits	S, X (79 72), Magnitude d_{17}, d_{16}, d_{15}, d_{14}, d_{13}, d_{12}, d_{11}, d_{10}, d_9, d_8, d_7, d_6, d_5, d_4, d_3, d_2, d_1, d_0 (… 0)
Short Real	$10^{\pm 38}$	24Bits	S (31), Biased Exponent (23), Significand (… 0), 1▲; Two's Complement
Long Real	$10^{\pm 308}$	53Bits	S (63), Biased Exponent (52), Significand (… 0), 1▲; Two's Complement
Temporary Real	$10^{\pm 4932}$	64Bits	S (79), Biased Exponent (64), 1 (63▲), Significand (… 0)

Figure 2. Different methods of holding numerical data.

Meanwhile, AMD defeated a legal effort by Intel aimed at disrupting shipments of AMD's 80C287 maths coprocessor chip. US District Court Judge William Ingram ruled (in August, 1990) that Intel failed to satisfy the burden of proof required to prevent others from using the '87 product numbering system' to designate maths coprocessor devices.

"The product designation number was the principal issue of concern to AMD in the hearing on Intel's request for a preliminary injunction", said Thomas Armstrong, vice-president and general counsel. "All of the other concerns raised by Intel were essentially irrelevant because, in an effort to expedite the case, we had previously agreed to virtually everything subject to the court hearing's order."

"We are deeply gratified that Judge Ingram's ruling will allow free market forces to determine the success or failure of this product", Armstrong continued. "AMD never claimed to be an authorised source for Intel's maths coprocessor. Indeed even before the hearing on the preliminary injunction, we had neither agreed to nor had we already put in place each of the actions included in Judge Ingram's order. As a result, the ruling will have no impact whatsoever on AMD's ability or plans to ship the product."

"The genuine question at issue is whether AMD has the right to copy and distribute Intel's microcode under a cross-license agreement between the two companies. We believe we clearly have that right, and we are prepared to do everything possible to expedite a court decision on that question."

The situation is still the same today. The court hearing had followed the announcement by AMD of CMOS versions of the industry standard 80287. The AMD 80C287 allowed 80286 based computers to perform mathematical calculations up to 10 times faster when using applications such as Lotus 1-2-3, Excel, dBASE IV, Paradox and AutoCAD.

A Look at Some of the Products

INTEGRATED INFORMATION TECHNOLOGY (IIT)

The IIT-3C87 80-bit numeric coprocessor is a high performance chip that is both pin and software compatible with the Intel 80387, yet operates up to 50% faster in the same socket and at the same clock rates. Moreover the CMOS implementation requires 25% less power than the 80387. There are a total of 32 registers, in three banks of eight, available to the user. It's upwardly software compatible with the 8087 and 80287, and implements ANSI/IEEE standard for binary floating point arithmetic. It handles full range transcendental operations for sine, cosine, tangent, arctangent and logarithm. It runs all 80387 software and is available in 16, 20, 25 and 33MHz speed grades.

The IIT-3C87 includes embedded microcode capable of performing 4 x 4 matrix multiply transformations that speed up 3D graphics modelling by three times. Internally, it represents all numbers in extended precision 'real' format (that is, real numbers with fractions as opposed to integers etc.). All other formats are converted to extended precision real format when they are accessed from memory. When operands are stored back into memory, a reversal type conversion of this process is performed.

The chip supports seven data types. The least significant digits of the operands are stored in memory with the least significant bit in the lowest memory address. To achieve the highest system performance, operands should start at a double word boundary (physical memory address divisible by four), otherwise additional memory cycles will be required to access the whole operand.

The IIT-3C87 recognises 80-bit denormalised numbers as zeros. Therefore, unlike Intel coprocessors, the IIT unit *does not* raise the denormalised exception flag. This feature is provided so that the chip is recognised as being in the system so that software can take advantage of the exclusive 4 x 4 matrix instructions available with the IIT–3C87.

The chip's register set may be used by applications programmers in addition to the registers in the CPU. The IIT–3C87 provides 32 internal 80-bit registers, which are organised as four banks of eight registers each. Register banks 0, 1 and 2 are user accessible. Register bank 0 corresponds to the eight stack registers used in software written for the Intel-80387.

Applications programs written for the Intel 80387 use the first bank of eight 80-bit registers. The programmer is also provided with an additional 24 80-bit registers arranged as three banks of eight that are not found on the Intel chip. These extra banks may be used for 4 x 4 matrix operations. The first bank of registers can be used as eight individual registers that are explicitly addressed, or as an eight register stack where operations are usually performed on the first item on the stack (top of stack).

The top of stack is identified by the TOP field of the status word. When floating point data is pushed onto the top of stack, TOP is decremented by one and the data is loaded into the newly identified register. When data is popped from the stack, the value identified by TOP is stored and TOP is incremented. The IIT–3C87 stack is built downwards toward lower addressed registers. This is in keeping with the general convention for microprocessor stacks. The data registers are addressed by instructions either implicitly or explicitly. The instructions that operate on the top of stack register are implicitly addressed by TOP. Instructions that explicitly address a register do so relative to the register address defined by TOP.

The IIT–2C87 is a high performance numeric processor extension that is both pin-out and software compatible with the 80287, and is also a low power CMOS device capable of operating at clock rates up to 20MHz. It performs most of its functions in far fewer clock cycles than is required by the 80287. When combined with the faster clock frequency (the IIT–2C87 can operate on the same clock as the 80286), the floating point processor achieves performance at least two times faster than the 80287. When used with an 80286 processor, the computing system conforms to the IEEE floating point standard. The IIT–2C87 is packaged in a 40-pin ceramic package.

The IIT–2C87 includes a built-in instruction to calculate a 4 x 4 matrix transformation, which results in the capability to perform matrix transformations six to eight times faster than the 80287.

Weitek

The WTL 4167 floating point coprocessor is a high performance single chip floating point coprocessor for Intel's 80486 32-bit microprocessor. It delivers two to three times the system performance of the 80486's on-chip maths coprocessor. The interface signals between the 4167 and the 80486 are provided by a 142-pin socket.

The 4167 is upwardly object-code compatible with the 1167 coprocessor daughterboard and the 3167 coprocessor chip. All of the applications ported to the 3167 will run without modification on the 4167. FORTRAN, C and Pascal compilers fully support the 4167, allowing new applications to be easily recompiled to take advantage of the Weitek coprocessor.

Several key suppliers are involved in providing complete end user solutions that support the 4167. Manufacturers developing systems based on the Intel 80486 must design the 142-pin 4167 coprocessor socket into their motherboards. They will offer a coprocessor detection mechanism by modifying their ROM BIOS.

Systems software developers, including operating system, DOS extender and Extended Memory Manager developers, need to enable the addressing of the Weitek coprocessor and, in the case of multitasking environments, they also have to handle coprocessor context switching.

Compiler manufacturers support coprocessor presence detection, initialisation, exception handling and code generation. Applications vendors recompile their applications to take advantage of the Weitek coprocessor. Addressing, initialisation, presence detection, exception handling, context switching and coprocessor emulation for the 4167 are the same as they are for the 3167. Therefore, the 4167 works in all of the operating system environments that support the 3167.

The Weitek Abacus 3167 is a high performance single chip floating point coprocessor for Intel's 80386 32-bit microprocessor. It delivers two to three times the performance of Intel's 32-bit 80387 numeric coprocessor. The interface signals between the Abacus 3167 and the 80386 are provided by a 121-pin socket called the extended maths coprocessor (EMC) socket, which is a superset of the 80387 socket. The EMC socket allows either the Abacus 3167 or the 80387 to be installed in the system.

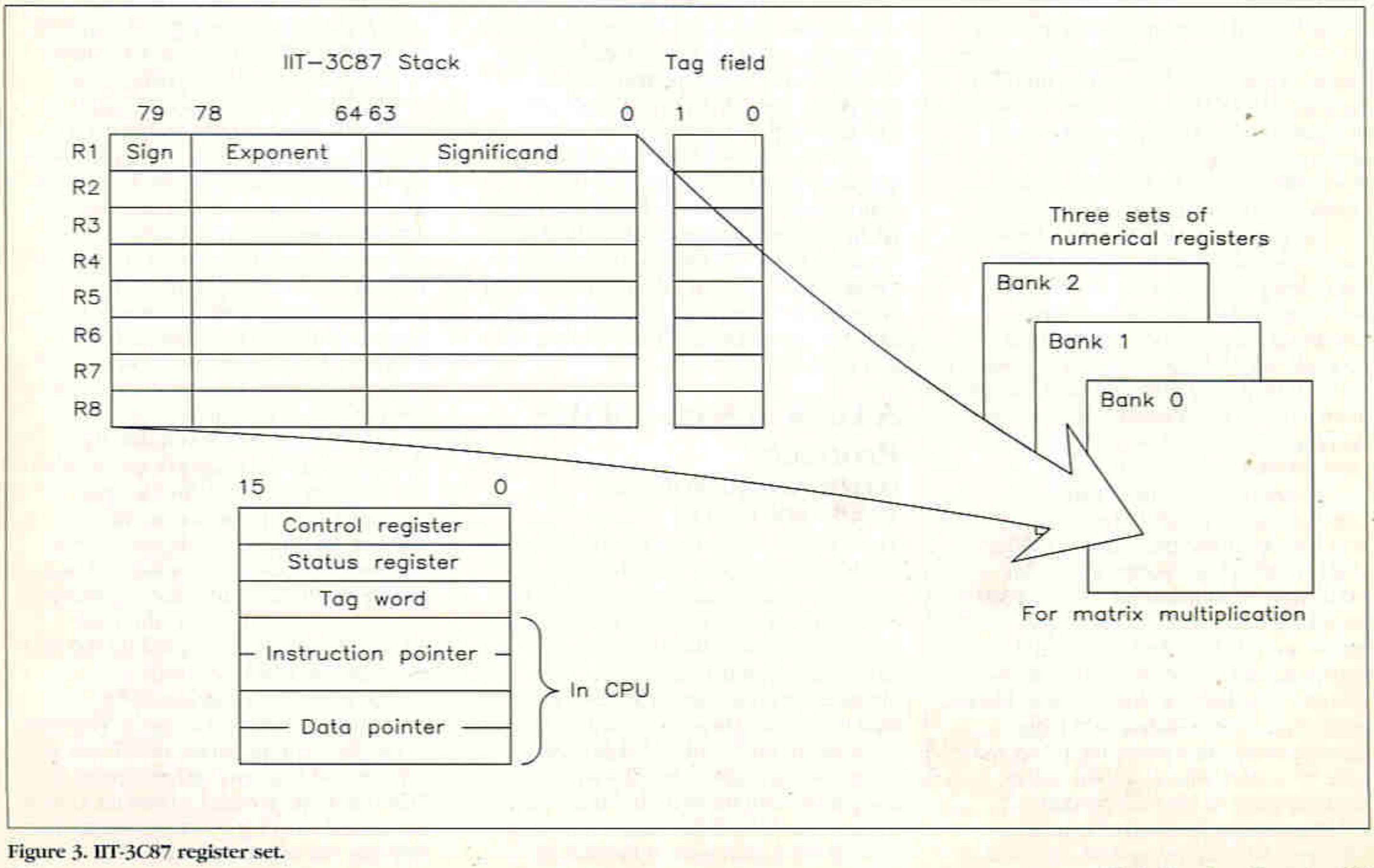


Figure 3. IIT-3C87 register set.

Both coprocessors can be used at the same time if the system board contains both an EMC socket and an 80387 socket or if an EMC daughterboard (containing a separate 80387 socket) is used. The Abacus 3167 is pin for pin compatible with the WTL 1167 floating point coprocessor daughterboard. C, FORTRAN and Pascal compilers fully support the Abacus 3167, allowing programs to be written in high level languages. The Abacus 3167 is upwardly code compatible with the WTL 1167 coprocessor daughterboard. Also, all code written for the Abacus 3167 coprocessor (for 80386 based PCs) will run on the Abacus 4167 (for 80486 based PCs).

The high level language compilers which support the chip run under UNIX, MS-DOS protected mode and Virtual 86 mode. The Abacus 3167 conforms to the IEEE standard format for floating point arithmetic in both single and double precision (ANSI/IEEE Standard 754–1985).

The Abacus 3167 coprocessor is a memory mapped peripheral. From the system designer's standpoint, integrating the Abacus 3167 into the system is as simple as adding memory at an upper address. To the 80386 and its application software, the Abacus 3167 appears to be a segment of memory. Instructions are executed by performing memory moves to and from the coprocessor.

As a low power CMOS device, the 3167 dissipates 2·0W max. at 25MHz.
It is offered in speed grades of 20, 25 and 33MHz.

Intel

The 487 SX Maths Coprocessor is the end user, floating point upgrade for 486 SX microprocessor based systems. It is the first Intel product designed to fill the performance upgrade socket of 486 SX based systems. The 487 SX is 100% binary compatible with the 486 DX microprocessor and upward binary compatible from the 387 DX coprocessor. Over 2,100 commercially available software packages have been designed for increased performance with the 487 SX and other Intel coprocessors. The 487 SX delivers 4·5 32-bit double precision Whetstones and a 5·0 SPEC floating point rating performance at 20MHz, delivering up to 70% higher performance than a 33MHz 387 DX maths coprocessor.

Highlights of the chip include the ability to directly extend the 486 SX CPU instruction set to include trigonometric, logarithmic, exponential and arithmetic instructions for all data types. It conforms with the ANSI/IEEE standard 754–1985 for binary floating point arithmetic, and is designed to function as *both* the CPU and coprocessor to obtain maximum floating point performance. It also possesses built-in exception handling. There is also a complete 32-bit architecture, high speed CMOS IV technology, 20MHz frequency and 169 lead pin grid array package.

The 487 SX is an extension to the 486 SX microprocessor and is designed to fulfil the end user requirement for maths upgrade capabilities for desktop systems. By separating the maths coprocessor function from the 486 SX microprocessor, a new low price point 486 CPU based system can be produced. End users can opt for adding maths coprocessor capabilities either at the time of system purchase or after the system is installed. A maths upgrade path for more than 30% of system purchasers who are expecting to need floating point capabilities is thus satisfied. The desktop 486 SX CPU based system is converted into a platform suitable for applications such as financial modelling and spreadsheets, and business or engineering graphics.

All this only goes to show how sophisticated these 'on-the-side' coprocessor ICs actually are, and need to be to satisfy today's and tommorrow's computing needs, especially in view of the increasing 'normal' use of graphics at the user interface.

Availability

A range of Cyrix, Intel, Weitek coprocessors are available from Maplin.

Manufacture	Generic Type	Speed	Order Code
Cyrix	287XLT	20MHz	CR07H
Cyrix	387SX	25MHz	CR08J
Cyrix	387DX	33MHz	CR09K
Cyrix	387DX+	40MHz	CR10L
Intel	487SX	25MHz	ZG26D
Weitek	487DX	33MHz	ZG27E
Weitek	487DX+	50MHz	ZG28F

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JAYBEAM LR1/2M 2m Colinear and Jaybeam 6Y/2M/12Y/70CM 2m & 70cm combined Yagi, £30 each. Tel: Roy, (0702) 525050.

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SILVER REED COLOUR PEN GRAPH EB50, mains adaptor, parallel interface to CP compatible, operating manual etc. In good condition. £8 o.n.o. Tel: (0392) 75896 (Exeter).

BBC-B COMPUTER, 12in. Amber monitor, 40/80 track disk drive, joystick, small plotter/printer, software, games, Exmon, DFS, Basic ROMS, books etc. All for £120 o.n.o. Tel: Steve, (0243) 379263 (Portsmouth area).

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WANTED

THE BOOK 'Soul of CP/M' by Waite and Larfore will purchase plus p.&p. Tel: T. Page, (0522) 522317 (Lincoln).

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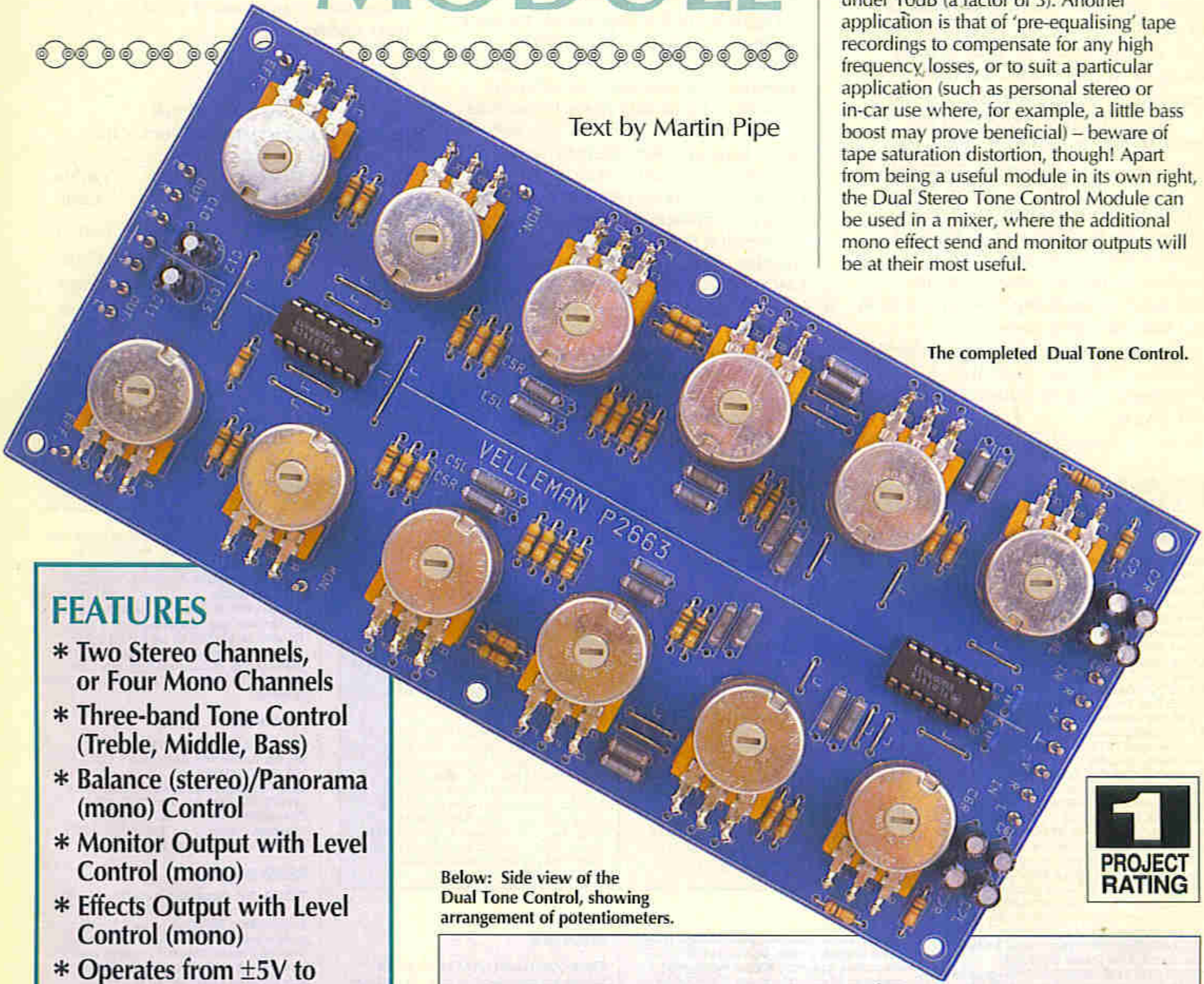
MODULAR MIXING SYSTEM PART TWO

DUAL STEREO TONE CONTROL MODULE

Text by Martin Pipe

This unit can be used to provide tonal adjustment over two stereo (four mono) channels, although it should be noted that the tone controls of each stereo channel are 'ganged' i.e. *independent* adjustment of all four channels is impossible – unless you replace each dual potentiometer with two single ones! Please note, however, that if a stereo channel is to be used as two mono channels, cross-talk may be noticeable; modifications to overcome this will be given later. The three tone controls have turnover frequencies of 50Hz, 1kHz and 15kHz – which equate to the bass, middle and treble ranges respectively. As a result, it may be used as a comprehensive tone control for power amplifiers and disco systems. In addition to its main function, the unit provides a voltage gain of just under 10dB (a factor of 3). Another application is that of 'pre-equalising' tape recordings to compensate for any high frequency losses, or to suit a particular application (such as personal stereo or in-car use where, for example, a little bass boost may prove beneficial) – beware of tape saturation distortion, though! Apart from being a useful module in its own right, the Dual Stereo Tone Control Module can be used in a mixer, where the additional mono effect send and monitor outputs will be at their most useful.



The completed Dual Tone Control.

1 PROJECT RATING

FEATURES

* Two Stereo Channels, or Four Mono Channels
* Three-band Tone Control (Treble, Middle, Bass)
* Balance (stereo)/Panorama (mono) Control
* Monitor Output with Level Control (mono)
* Effects Output with Level Control (mono)
* Operates from ±5V to ±15V DC Supply

APPLICATIONS

* Tone Control for Amplifiers
* Pre-Record Equalisation for Tape Machines
* Suitable for use in Modular Mixing System

Below: Side view of the Dual Tone Control, showing arrangement of potentiometers.

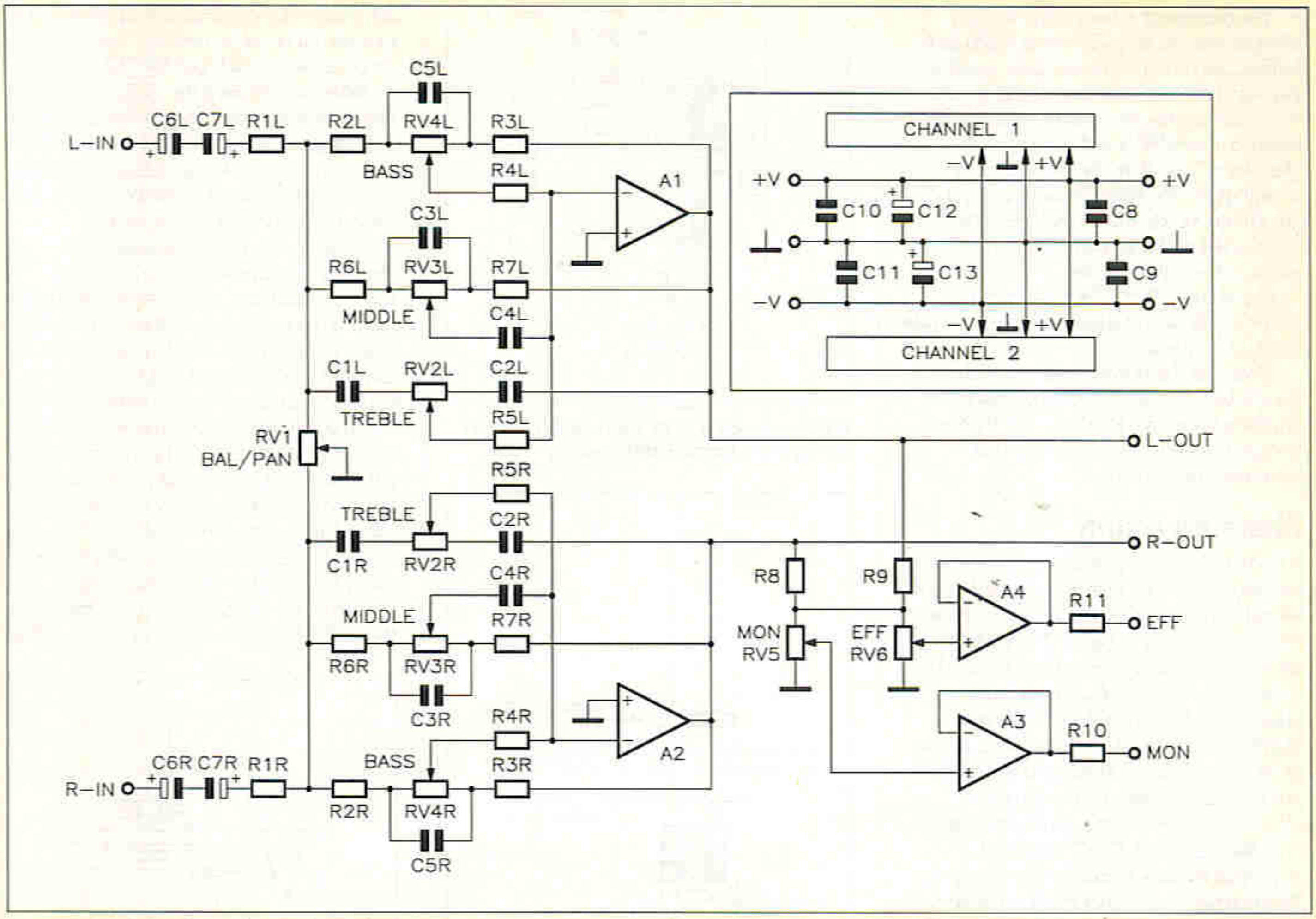


Figure 1. Circuit diagram of the Dual Stereo Tone Control. Note that this project consists of two identical circuits on the same PCB.

Circuit Description

Note that the module has two of the circuits shown in Figure 1, as there are *two* stereo channels.

The input signals are AC-coupled by means of C6 and C7. These 22µF capacitors in series (11µF effectively) enable safe coupling to take place – whether there is a DC offset on the input or not. R1L/R and RV1 act as a potential divider; a greater or lesser part of the left and right signal is grounded depending on the position of the control – the result is effectively a 'balance' control. In addition, R1L/R set the input impedance while RV1 has an effect on the gain of each stage.

Based on Baxandall equalisation networks, the tone controls of each channel are in the feedback path of a op-amp gain stage. The three tone controls are based around A1 (left channel) and A2 (right channel); each has a set of components that will determine the op-amp's gain at that particular frequency – note that the three are wired in parallel. These components are: R2, R3, R4, RV4, C5 (bass); R6, R7, RV3, C3, C4 (midrange); and R5, RV2, C1, C2 (treble). Because the tone controls are in the feedback loop, each will exhibit a 'shelving' characteristic – once the frequency has passed the control cut/boost level, the amplitude will level off. Generally, though, the gain of the circuit is around 10dB when the controls are set to their 'flat' i.e. central positions.

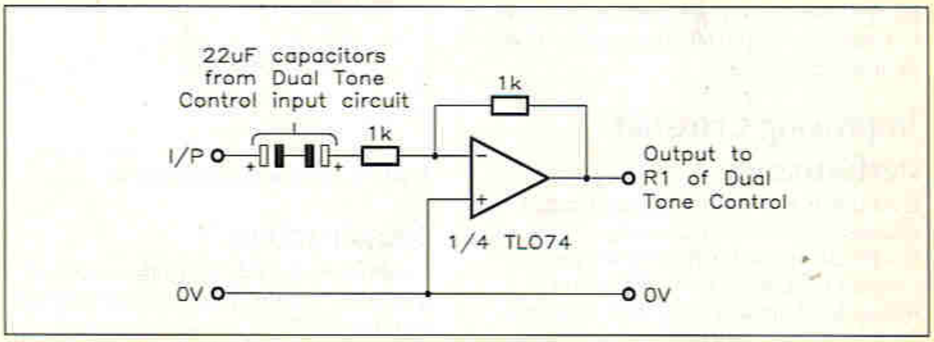


Figure 2. Inverting buffer circuit diagram.

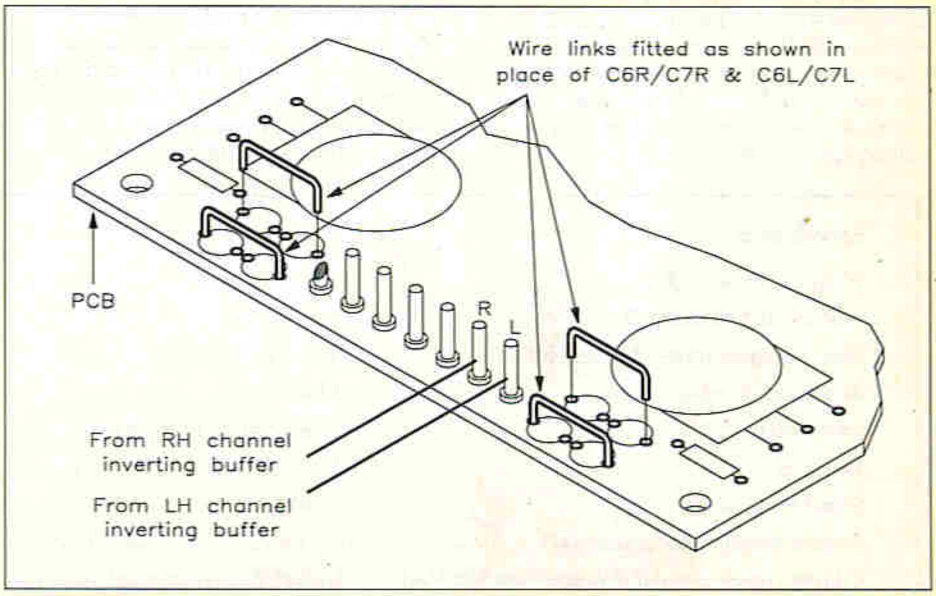


Figure 3. Modifying Dual Stereo Tone Control PCB to accommodate the inverting buffer.

The outputs of A3 (monitor) and A4 (effects), two op-amps wired as unity-gain buffers, are mono. In these cases – and in any situation where the main outputs are summed together in a mono system – the balance control RV1 will act as a 'panorama' pot, with the degree of left or right presence being influenced by the adjustment of R1. R8 and R9 are used to mix the left and right channels, while RV5 and 6 act as input dividers.

Capacitors C9 to C13 decouple the circuit's split power supply rails over a wide range of frequencies.

Note that the power supply, which should be a DC regulated type, can be anything from ±5V to ±15V. The higher voltage is recommended for the best headroom performance.

Phase Inversion

It is important to note that the signal provided by the unit itself is inverted. If you intend to use this module in its own right, the circuit shown in Figure 2 (a straight-forward unity-gain inverter) can be used to correct the phase, if you feel that it is important. This simple inverting buffer circuit can use the same power rails as the Dual Stereo Tone Control, and so should not pose any problems. The circuit is effectively inserted between electrolytic coupling capactors C6/C7 (L/R) and R1(L/R) in the input circuit – see Figure 3. This diagram shows that these capacitors are replaced by links – note that they will be used in the inverting buffer. Bearing in mind the two stereo channel pairs, a quad low-noise op-amp (TL074) would be ideal for this application.

Improving Crosstalk Performance

If the unit is to provide four independent channels with tone adjustment, modifications can be made to improve the crosstalk performance – in other words, reduce breakthrough from other channels. Such breakthrough is far more noticeable when the channels are completely un-related! The main change involves replacing RV1 (4k7 linear) with two 2k2 resistors, fitted as shown in Figure 4. If the mono effect send and monitoring facilities are not required, R8 and R9 (and the other relevant components, if required) can be left off for even better results.

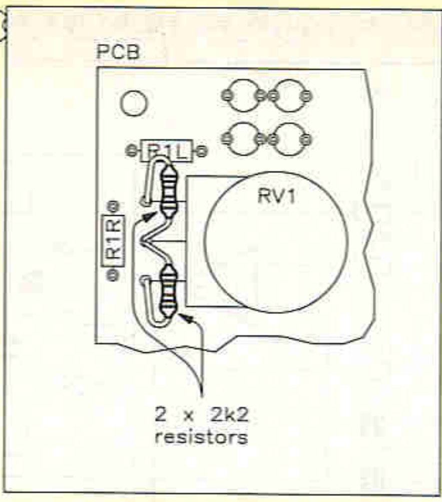


Figure 4. Replacing RV1 with two 2k2 resistors for improved crosstalk performance.

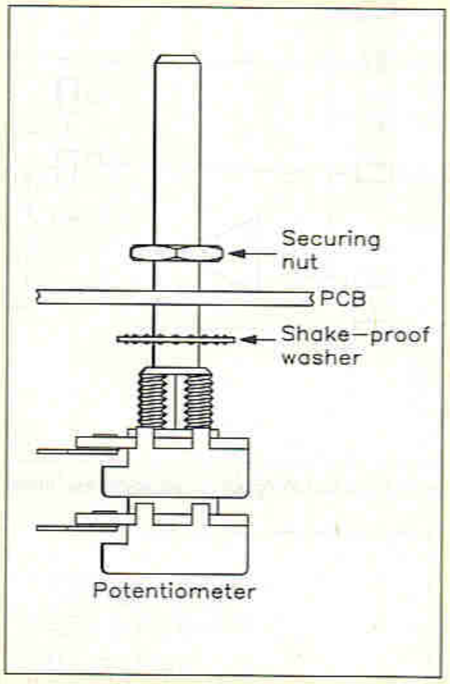


Figure 5. Fitting the potentiometers.

Construction

Construction is fairly straightforward, and full details are given in the leaflet supplied with the kit. If you are new to project building, refer to the Constructors' Guide (order separately as XH79L) for helpful practical advice on how to solder, component identification and the like. From its component side at least, the PCB appears to be symmetrical down the centre due to the fact that two identical circuits are present. This fact could be used to its best advantage during construction; be warned, though – it is not a complete 'mirror image' (in particular, watch out for C12 and C13)!

When assembling the PCB, it is best to leave the potentiometers till last as some of the components are located between them – and once the potentiometers are in place, access to these areas to the board is limited. Otherwise, construction is mostly straightforward. Be sure to insert the electrolytic capacitors the correct way round; in addition, note that their leads will need pre-forming before they can fit neatly to the board prior to soldering. Do not forget to omit C6 and C7 (L/R) – eight capacitors in all – if the inverting buffer is to be used, replacing the capacitors with links; refer again to Figure 3. The orientation of IC1 and IC2 is also critical; note that these two components are fitted in IC sockets. The sockets, rather than the ICs themselves, should be soldered in place – the ICs should be inserted just before testing.

Each control potentiometer is fitted from the COMPONENT side of the PCB, and a shakeproof washer is fitted over the control shaft before inserting into the PCB as shown in Figure 5. Before tightening its securing nut, each potentiometer should be aligned so that its pins line up with the corresponding legend on the PCB; the supplied lengths of tinned copper wire are used for the interconnections as shown in Figure 6. These lengths of wire (or alternatively the component lead off-cuts) are also used for the wire links on the board. There are 17 links in total (21 if the inverting buffer is used).

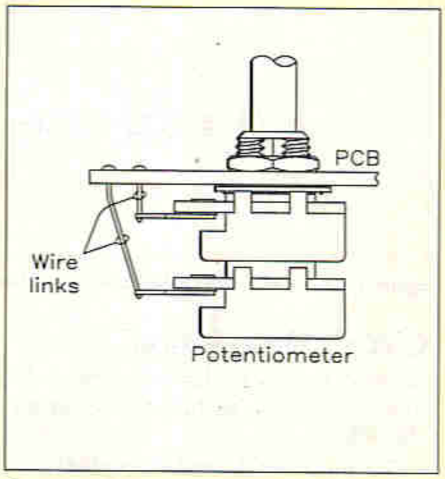


Figure 6. Connecting the potentiometers.

When fitting the PCB pins, note that they are also fitted from the component side. After completion assembly, it is prudent to check your work – finding any incorrectly-placed components could save considerable time and expense later on. Other gremlins to watch out for include solder bridges/whiskers and poor joints. Finally, clean the solder side of the PCB with a suitable solvent to remove any corrosive fluxes that may compromise the module's long-term reliability.

The inverting buffer, if used, can be made up on a small piece of stripboard – the eight 22µF electrolytic capacitors left over will now be required!

Specification.

Number of channels:	2 stereo (4 in all)
Number of tone controls:	3 per channel
Tone control turnover frequencies:	50Hz, 1kHz, 15kHz
Boost and cut range:	±12dB
Mono outputs:	Effects Send and Monitor
Distortion:	0·02% (max)
Signal-to-noise ratio:	>92dB
Current consumption (quiescent):	10·5mA (±5V); 13·7mA (±15V)
Current consumption (full output into 10k load):	11mA (±5V); 16·7mA (±15V)

Testing and Installation

The best form of testing is to use the Dual Stereo Tone Control in its intended application. Ensure that the power supply can provide the required current. The module should be installed away from any strong mains fields (power transformers and the like), and should be installed in a screened case. If the completed board is to form part of a modular mixing system, it should be built into a screened case anyway.

Screened cable (such as XR15R) should be used for all audio connections, to reduce the possibility of hum pickup.

Supply voltage (±)	Maximum Input Levels (Vrms)	
	Tone controls set flat	Tone controls set at max.
5·0V	3·3V	0·7V
9·0V	6·7V	1·6V
12·0V	10·0V	2·3V
15·0V	12·0V	3·2V

Table 1. Maximum input levels.

To avoid distortion the input level should not exceed a certain level, which is determined by the supply voltage – see Table 1.

Finally, Figure 7 shows the physical layout of the controls (and connections), so that you can ergonomically design your Dual Tone Control into proposed or existing equipment.

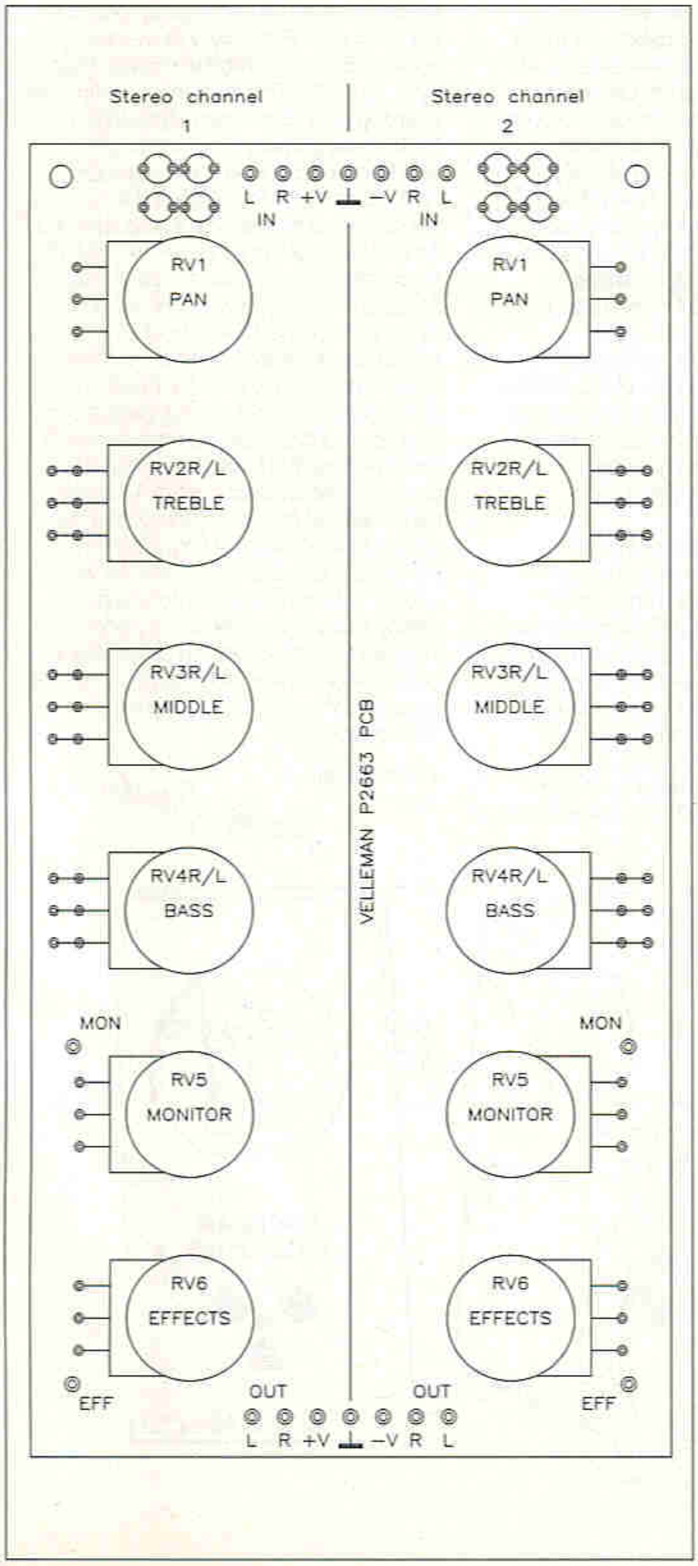
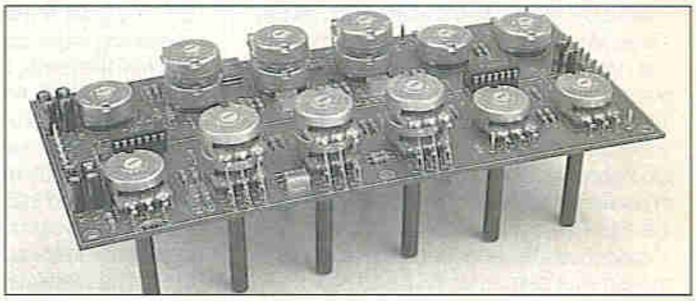


Figure 7. Layout of controls and connections.



PARTS LIST

Components marked with a ⋆ are duplicated for the second stereo channel.

RESISTORS: All 0·25W Carbon Film (Unless Specified)		
R1(L/R) ⋆	1K	4
R2 to R5 (L/R) ⋆	47k	16
R6(L/R), R7(L/R) ⋆	15k	8
R8 to R11 ⋆	10k	8
RV1 ⋆	4k7 Linear Potentiometer	2
RV2,3,4 (L/R) ⋆	470k Linear Ganged Potentiometer	6
RV5,6 ⋆	47k Logarithmic Potentiometer	4
CAPACITORS		
C1 to C3 (L/R) ⋆	1nF Polyester Layer	12
C4(L/R) ⋆	4n7 Polyester Layer	4
C5(L/R) ⋆	10nF Polyester Layer	4
C6, C7 (L/R) ⋆	22µF 25V Radial Electrolytic	8
C8 to C11	100nF Ceramic	4
C12, C13	10µF 50V Radial Electrolytic	2
SEMICONDUCTORS		
IC1, IC2	TL074 Quad Op-Amp	2
MISCELLANEOUS		
	14-Pin DIL Sockets	2
	PCB Pins	18
	PCB	1
	Instruction Booklet	1
	Tinned Copper Wire	1 length

OPTIONAL (Not in Kit)			
	Constructors' Guide	1	XH79L
	Screened Cable	As Req.	XR15R
	TL074C Quad Low-noise Op-Amp	1	RA69A
	1k 0·6W Metal Film Resistor	8	M1K
	Stripboard 1039	1	JP46A

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 in kit form only.

Order As VE32K (Dual Stereo Tone Control) Price £39.95.

Please Note: Some items, which are specific to this project (e.g., PCB), are not available separately.

Stray Signals

by Point Contact

In the post-war euphoria it was announced, as Britain and other countries embarked upon ambitious nuclear power programmes, that this new form of power would usher in "an age of plenty and prosperity for all". In practice it hasn't quite worked out like that! Even leaving aside outright disasters such as Chernobyl and near-disasters such as the Three Mile Island incident, nuclear power has not come up to expectations. Nuclear plants have turned out to have a much shorter life than predicted – often not even covering their construction costs!

On February 26th 1992, the consortium of power utilities that own the 32-year old Yankee Rowe nuclear power plant in Massachusetts announced that it would remain shut permanently. It had been closed down five months earlier for safety checks, but it turned out that the cost of proving that the installation was safe, to continue in service, would be so astronomical as to be uneconomical, thus dashing industry hopes that nuclear power plants could be safely proved to have a 60-year operating life. Only three days later LILCO (the Long Island Lighting Co.) signed over, for the princely sum of one dollar, its $5·5 billion Shoreham nuclear power plant to the Long Island Power Authority, who will dismantle it – following a 25-year battle as to whether the plant should be allowed to operate. With the demise of the UK's SGHWR (steam generating heavy water reactor) programme following the decommissioning of the Winfrith plant, nuclear power seems to be in disarray world-wide – even in France where EDF produces the bulk of the country's power from nuclear installations, there are rumblings of disquiet.

Turning from heavy-current to light-current topics, you will remember PC recounting how he has transferred his allegiance (and his telephone line) from BT to NYNEX – a change from copper wires to fibre-optic cable! I see that NYNEX is proposing to build a billion-dollar cable link, called FLAG, from the UK to Japan. It will link up with the ends of existing trans-oceanic cables and thus encircle the earth; hence the name FLAG (Fibre-optic Link Around the Globe).

PC first came across the use of fibre-optic cable as a communications medium during the 1970s when it had already been designed into parts of the military's Ptarmigan system. In an on-going (yet apparently little-noticed) revolution since then, it has replaced copper cables in many applications. In BT's international network, as a matter of fact, it has replaced satellites as the mainstay, the latter now carrying only 25% of the traffic, just as previously satellites had displaced repeatered trans-oceanic multi-channel cables with their frequency-division multiplex signal structure of groups, supergroups and mastergroups/hypergroups. Whereas such copper cables carried at best a few thousand lines each, each fibre-optic cable (operating at 2·4GBits/second) will have a capacity approaching *half a million* telephone calls! The growth in demand for international traffic capacity, especially that generated by wide-band data and video services, is such that two new transatlantic cables, planned by BT for completion in 1992/1993, are already fully accounted for. BT is therefore already proposing two more such cables, to be in service around 1995.

If you cast your mind back to the last *Stray Signals*, you will remember the spectacular misunderstanding of the computerised direct-debit. Well, another (slightly more embarrassing) misunderstanding occurred to Mrs. PC the other day. Recently, PC wanted to consult "Simplified Modern Filter Design", by P. R. Geffe. This extremely useful book was originally published in the United States, and subsequently in the UK by Iliffe Books Ltd., but is now long out of print. At one time PC had his own copy, but someone borrowed it a long time ago. As she was going into W———, Mrs. PC kindly offered to enquire for it at the library. At the entrance, she waited while a man came out – he had a little trouble trying to pull the door towards him before realising that it opened outwards. He made a jocular remark about always getting into trouble, and then realised from her blank look that Mrs. PC hadn't recognised him. (It was the heart attack victim whom she had helped at the swimming-pool a few weeks earlier - see last Stray Signals.) He apologised, explaining who he was, adding "Of course, you're not used to seeing me with clothes on". A perfectly innocent remark under the circumstances, but one wonders what lurid conclusions a nosey neighbour overhearing it might have drawn!

Yours sincerely,

Point Contact

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

Dear Editor

Developing the Development System

Dear Sir,
The introduction of the Z80 CPU PCB has filled a gap in the market for the 'experimenter'. I have in use two such boards; one is used as the development system for the other that acts as an overall 'House Manager'.
As the PCB has buffered bus lines and an edge connector, its potential use could be improved if the PCB layout were altered such that a more logical use were made of the buffer ICs.
In order to use the module as part of a close-coupled system, in which either system can access the other's RAM or I/O ports, the data/address bus must be able to go into a high impedance state. The PCB, as currently designed, does not allow this state.
A further increase in usability can be obtained with the inclusion of a 'scratch area' for user logic by the provision of a matrix of through-plated holes. I have achieved a similar effect by 'Ararlditing' a strip of copper-clad board in the area between the edge connector and IC10.
One use for this space is an LED driver whose input is wired to 'halted'. This is a useful facility to have on a development system – some way of knowing when it has stopped! Perhaps Maplin could market a small PCB as described, complete with a self-stick backing?
To change the subject, please, please alter the Cashtel on-line ordering system so that pre-typed text files may be transmitted when placing an order. The question and answer system in use does nothing to keep phone bills down, and makes it difficult to automate the ordering procedure.
T. Trueblood, Liverpool.

Thank you for your suggestions. It's nice to see plenty of use being made of our Z80 CPU cards. However, and not just because yours is the only query so far as regards grabbing control of the memory away from the CPU, it would be extremely expensive to modify the board as you suggest, unless it were really necessary. For example, a component change – and therefore possibly a redesigned PCB – may be required because an item was no longer manufactured (and the Z80 board has appeared in one 'Second Time Around' already)! This also applies to any extra modification board. However, your suggestions are very good and perfectly valid; perhaps you may like to publish them as a 'Circuit Maker' item?
As regards Cashtel, it would be a bit awkward transmitting an automated order only to find that the system is trying to select an item which is out of stock or doesn't even exist (misspelt order code). This would bypass the facility provided by Cashtel, to see whether items are available and your typing is correct. Automated methods require careful setting up, so the question and answer method is the best compromise; it follows the manner in which our own mainframe terminals operate, and it seems to have worked perfectly alright for years. Sorry!

A Word of Warning

Dear Sir,
Congratulations on yet another quality catalogue – every issue seems to improve! However, may I make one observation about the publication, and also a comment or two about the 'Electronics' magazine.
Firstly, what appears to be a rather dangerous printing error on page 483 in the circuit diagram for the Ni-Cd charger. The mains transformer appears to have both secondary windings shorted out which, if the unit is assembled, would at best cause any fuses to blow, and at worst overheat the transformer causing it to burn out and possibly damage other items in the vicinity. I would suggest that the correct circuit should have both 0V ends of each secondary connected to the lower point of the rectifier and both 20V ends connected to the upper point of the rectifier.
Secondly, the 'Electronics' magazine. There appears to have become a tendency for you to include full constructional details of Velleman Kits, treating them in the same way as one of your own projects. Whilst these are without doubt very good kits, I feel that the space could be better used to publish constructional details of projects which are not available in 'kit form only'. Perhaps if you wish to publish details of Velleman kits as at present you could label them 'Kit Reviews' or similar, as you used to.
I appreciate there may be several customers who have totally the opposite opinion, but I think it would improve your already excellent magazine if the above point were included. Also, how about an index every 10 or so issues – it can sometimes take me ages to find a particular article!
D. A. Oram, West Yorkshire.

Thanks for your observations on that erroneous circuit diagram – yes, it is quite nasty, isn't it! The member of the Drawing Office responsible has been sent to bed early after a bread and water supper! But seriously, if any other readers spot errors in the magazine or catalogue, please do write in and tell us – that way, corrections can be published and hassle saved for many people. Your comments on the Velleman kits are perfectly valid, but hopefully we will start to publish more non-Velleman projects soon; some of these may be non-Maplin kit projects – similar to those published by other electronics magazines, but to the same high standards that you have come to expect from 'Electronics'. Velleman kits have proliferated in recent editions of 'Electronics' primarily for two reasons. Firstly, we believe that many of them are of great interest to our readers. In addition, the Maplin design team normally responsible for most of the kits have been very busy lately with various other projects – many of which you will find out about in future issues!
The subject of an annual index is one that comes up time and time again. The problem is that of time – or the lack of it. Nevertheless, the number of requests (nay, pleas!) for such an index have been increasing of late, and so we are seriously considering the matter.

S·T·A·R L·E·T·T·E·R

This issue, R. Kirkwood from Nottingham, receives the Star Letter Award of a £5 Maplin Gift Token for his interesting observations.

Early Bird

Dear Sir,
Being a long-standing subscriber to the magazine, it would appear that you receive far too many complimentary letters, so here are a couple of gripes!
1) Please get a grip of your cover/publication dates!
My October 1992 issue arrived on 24th August, and was not an early exception. I can cope with magazines appearing up to one month before their cover date, but *two months ahead* is a little over the top!
In 1991, my Christmas issue arrived during the last week of October – long before I'd given the slightest thought to Christmas shopping. Towards the end of November, I was being wished a "happy new year" with the January 1992 issue (I still hadn't started Christmas shopping!), and, with the arrival of Christmas 1991 I had done my shopping but was also in possession of your February 1992 issue and, by now, somewhat confused!
Please, for the sake of my sanity, either change your cover dates (give us 13 months in 1993?) or delay your publication dates by two or three weeks – otherwise there seems little point in putting the month on the cover!
2) DECORATIVE FISH CARVING (a new book in the Catalogue) – frankly, I'm astounded that you are prepared to encourage such an obviously dubious pastime – don't the decorative fish object? Thank you for allowing me to bring some much-needed objectivity to your letters page. Apart from that, I suppose you're not doing too bad really! (Oops – nearly another compliment there!)

If you had bought your copy of 'Electronics' at a newsstand, it would have been one month (slightly less, in fact!) ahead of its cover date. For example, the official 'on sale' date of this issue (December) is November 6th; as you have noticed, it is now the trend for magazines to be published a month in advance. Normally, the fact that the subscribers receive their copies of 'Electronics' before anybody else is seen as one of the benefits of being a subscriber! The subscription magazines are mailed out directly by the company that prints them; newsagents have their copies sent to them via a distributor which takes time. This period is allowed for in the (seemingly early) publication date. Most subscribers are pleased that they get their magazines early, but those who don't should simply hide the magazine for a week or so once it has dropped through the letterbox!
It's nice to know that a 'long-standing subscriber', who has probably received many copies of 'Electronics', can only find the cover date to gripe about – that's a kind of compliment in itself! As to the Decorative Fish Carving issue (a catalogue rather than a magazine gripe), we have contacted the publishers of the book who assure us that it is a little known fact that many fish thoroughly enjoy decorative carving, and cannot understand why anybody should be so concerned about what they get up to in their own pond!

Handy Hints

Dear Sirs,
I detail 3 tips which you might like to consider for inclusion in your 'Circuit Maker' section of the Maplin Magazine.
1. When stripping the insulation from multistrand cables, first cut the cable to about 1in. longer than required. Then only half-strip the excess insulation which can then be easily spun between finger and thumb to twist the conductors to prevent them from splaying. When they are cut to the required length, the excess conductors are not scattered, causing potential short circuits to nearby equipment into which they may fall, but are held together by the excess insulation.
2. Do not discard the excess lengths of large cable ties but cut, drill and use them to replace the broken or stripped-thread fibre cord grips used in older types of 13A mains plugs.
3. Most scientific calculators give priority to reciprocals over subtraction. This can be used to advantage to calculate the value of parallel resistor (Rp) needed to reduce a selected resistor (Rs) to a required close tolerance value (RCT) with only 7 moves.
D. A. Castleton, Ipswich.

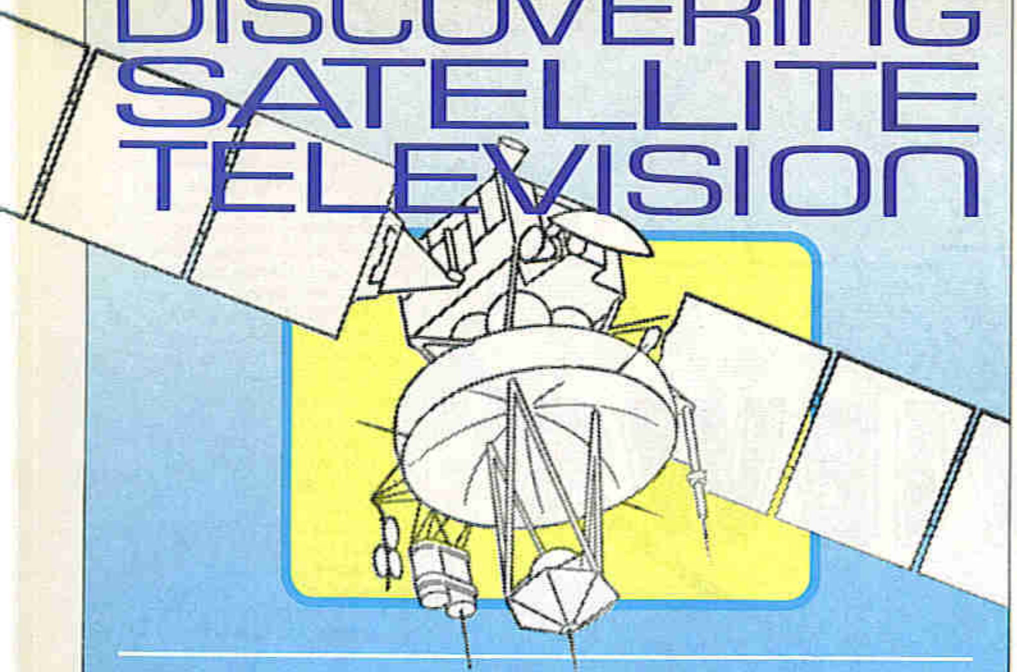
Thanks for the tips!

Problems in Reverse

Dear Sir,
In the News Report of Electronics No.58, you included a report on 'British Solution to RSI'. I noticed that the picture has been flipped horizontally and was wondering how this could have happened. Elsewhere in the magazine in the 'Projecting Ahead' article it is stated that:
"Artwork (photographs and diagrams) are 'scanned' into the computer with a digitiser".
If this is the case, how could the photograph possibly be reversed!
One other baffling point; why is there a picture of a 3·5in. disk on the front cover when there are no articles about disks in the magazine?
S. Adams, Rickmansworth.

Whoops – you noticed! The photograph appears to be flipped horizontally; this is because it was submitted as a transparency and put into the scanner the wrong way. Had it been a print, however, it would have been impossible not to notice anything amiss under similar circumstances!
A lot of our cover images are supplied by photograph libraries, and the cover of Magazine 58 was no exception! Bearing in mind the content of the magazine (10A PSU, Z80 Development System, etc.), the one chosen seemed best to capture the (busy technical) mood! For this reason, the artist presumably decided to include the line drawing of the disc. Quite fetching anyway, we're sure you'll agree!

DISCOVERING SATELLITE TELEVISION



Part Two
Signals from the Clarke Belt

by Chris Yates and Martin Pipe

In the fifty-odd years since Arthur C. Clarke first suggested using artificial satellites as orbiting transmission platforms and the BBC broadcasted pictures from Alexandra Palace in London, there has been an explosion in the choice of viewing available across the continent. Whilst a large portion of that has been terrestrial based, recent technological advances have put satellite television reception within easy reach of the average man in the street, shrinking the continent and offering an insight into lifestyles (and indeed programming standards) that can be very different from our own.

The race to provide Europe with a satellite television service was sparked off by the WARC 77 agreement which specified the frequencies to be used for direct-to-home broadcasting, but imposed various constraints (such as the granting of permission from national governments). Each country was allocated an orbital 'slot' for its DBS satellite, so that mutual interference problems could be eliminated. However, the WARC 77 allocations were drawn up with a range of frequencies (11·95 to 12·5GHz) specifically intended for DBS (Direct Broadcast Satellite) use, and did not cover any other frequencies – including the telecommunications bands on either side of the DBS frequencies. This legislative 'loop-hole' led to the television transponders of many telecommunications satellites using frequencies just outside the DBS band – for example, those of the French-operated Telecom birds and the two Astra television satellites. The latter are operated by Société Européennes des Satellites, a Luxembourg public company with a share capital of around 120 million ECUs.

Astra – the Technology

Co-located at 19·2° East, Astra 1A and 1B serve a wide European area. Astra 1A, based around a GE Astro Electronics 4000 spacecraft, was launched on December 11th, 1988 and heralded a 'new era in television entertainment'. Each of the 16 main transponders on Astra 1A has a power of 45W and a 26MHz bandwidth. There are also six back-up transponders which could be used if one of the main ones failed. Each transponder is 'steerable'; in other words, the beam can be centred over a given area for optimum reception. Astra 1B, launched on March 2nd 1991, is based on a GE Astro Electronics 5000 platform. The main difference between 1B and its sister craft is the transponder output power – it has been increased to 60W. One would assume that this would provide improved reception quality, but – a matter of considerable controversy – the TWTAs (travelling wave tube amplifiers) on some of the satellite's transponders are apparently working at less than optimal efficiency. As a result, and even with the 16 best transponders in use, Astra 1B did not appear to perform as well as the original craft. Be that as it may, SES now claim that all problems have been resolved...Controversy aside the two Astra birds are still the most powerful European non-(official) DBS satellites. 29 of the combined pool of 32 transponders are currently leased by 22 broadcasters radiating programmes in 7 different European languages and 2 transmission formats. The number of available channels available from Astra is set to increase to 48 in 1993, if the prospective launch of 1C goes ahead. In 1994, Astra 1D could be launched, although the transponders of this satellite are likely to act as replacements and back-ups for the existing three.

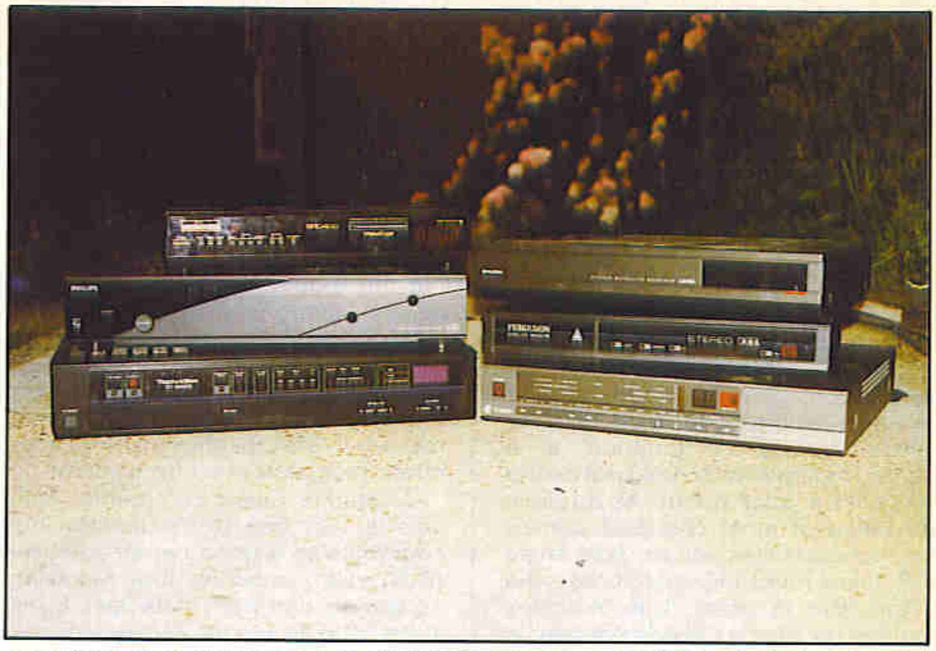
The vast majority of Astra's programme providers utilise the common or garden PAL format, which was originally developed by German company Telefunken in the mid-Sixties. Here, the low-bandwidth colour ('chrominance') information is quadrature amplitude-modulated on a 4·43MHz subcarrier which occupies a tiny part of the spectrum carrying the high-bandwidth brightness ('luminance') information. Other methods used to convey colour information are the original American NTSC and the French SECAM systems – these are similar in concept (though not theory!) to PAL. These subcarrier-based systems were introduced in the early days of terrestrial colour TV to retain compatibility with the more common black-and-white sets of the day; the PAL subcarrier frequency of 4·43 MHz being chosen to minimise visible luminance (brightness) 'dot' interference (with the US NTSC system, it is 3·58MHz, but this difference is due to their different line and field frequencies). The sound information is supplied on one or more audio subcarriers (refer to Part 1 of this series). Whilst PAL serves its purpose admirably well, picture quality is prone to distortion – the 'check shirt' syndrome. This is due to interaction between the 4·43MHz chrominance and the fine-detail luminance components around that frequency (such as those of a televised check shirt or jacket!). In addition, the resolution of the PAL system is apparently limited to around 120,000 pixels, although this obviously depends on the transmission medium and the quality of the display being used.

In an effort to overcome those drawbacks, some broadcasters have opted for the new MAC (Multiplexed Analogue Components) formats in which compressed chrominance, luminance and sound information are transmitted separately by Time Division Multiplexing. Such a system is not subject to the constraints imposed by downwards-compatibility with existing systems; it is therefore ideal for use with satellite broadcasting, where the wide bandwidths (typically 8·5MHz) required are easily available. As the three components are transmitted sequentially as 'packets', rather than at the same time, there is less interaction between them. The net result is a brighter and sharper picture; the effects of cross-talk are eliminated and resolution is increased to around 180,000 pixels. The problem centres around the higher cost to the consumer, hence only a small handful of Astra clients have so far opted to go down the MAC road – with a little financial incentive from the EC, who would like everyone to use the D2-MAC/Eurocrypt system. At the time of writing, the only Astra-borne channels using the D2-MAC/Eurocrypt system are Filmnet (refer to past *News Reports*) and the Scandinavian TV3/TV1000 networks. A full discussion of colour broadcasting systems would alone justify a fully-blown article in *Electronics* – as indeed it has. Readers wishing to find out more about this fascinating subject are referred to J. A. Rowan's recent 'Video Processing Systems' series – in particular Part Two, which can be found in Issue 53.

PAL or MAC, Astra's medium to high power footprint can be easily received (theoretically at least), on a dish antenna as small as 60cm, throughout Western Europe and the Iberian Peninsula. This is the prime reason why it is so popular with both viewers and broadcasters alike – and explains how SES can charge premium rates for the rental of transponders aboard its two 'hot birds'. At the time of writing, the Astra story is being continuously broadcasted on the Astra 'Info Channel' located at 11·656GHz (Channel 30), with English, French and German soundtracks. If you have access to an Astra system, it makes very interesting watching (at least for the first time, but be warned – the programme will continue to be transmitted until such time as Astra can find a broadcaster to rent the transponder!)

Astra is the only truly pan-European satellite operation, and has gained such a following that SES claim penetration into around 34 million homes across the continent – and that number continues to rise steadily. Almost 9 million of these receive the signals via their own domestic dish installation. In the UK, Amstrad was responsible for virtually single-handedly launching the domestic satellite equipment market in the United Kingdom, with their no-frills 'get-you-going' SRX100/200 systems featuring 60 or 80cm dishes, with 1·8dB noise figure LNBs, aligned to the Astra satellite and feeding a set-top receiver. Whilst many of these systems are still giving sterling performances nearly four years later, there is now a wider choice of equipment and manufacturers. Even Amstrad have upgraded in the shape of the SRD400/500 PAL-only and SRD600 PAL/D2-MAC receivers, which have on-board 'Videocrypt' decoders – vital to watch encrypted movies and the like. The SRD600 is a truly pan-European satellite receiver; as well as a Videocrypt decoder, it features a Eurocrypt card reader for encrypted D2-MAC transmissions. In addition to these receivers, Amstrad also markets TVs and VCRs with in-built satellite tuners.

Amstrad equipment is aimed specifically at the mass market but then so is Astra's programming, a fact reflected in the almost constant diet of soaps, game shows, sport and movies that seem to be the mainstay of many of the broadcasters. That said, there is *quality* programming, but you have to dig deep and search for it. For example, on German channel 3SAT you will find excellent jazz and wonderful opera. The acclaimed Cable News Network (CNN) and Sky News should not be missed, with around-the-clock coverage of major events often well in advance of the terrestrial broadcasters. Let us hope that the recent arrival of CNN does not give Sky (sorry, BSkyB) an excuse to close down its excellent (but loss-making) Sky News service – in the



A selection of satellite receivers. Top to bottom, left: Amstrad SRD400 – the first receiver to integrate a Videocrypt decoder; Philips STU-902 BSB receiver – an eventual collectors item; Technisat ST-6000S multi-satellite receiver with 99 channel/30 satellite memory, on-screen graphics and stereo sound.
Top to bottom, right: Salora 5902, a highly-regarded 48-channel stereo receiver intended for use with Astra but capable of much more; Ferguson SRA1-S (manufactured, in fact, by Pace) stereo Astra receiver with only 32 channels; Multipoint M1700, an early (circa 1985) 24-channel receiver dating back to the days when you needed a dish of at least 1·5m diameter to receive anything at all.

Popular to contrary belief, there's *far* more to satellite TV than just BSkyB!

opinion of many, it really is the only unscrambled Sky channel worth watching! However, Astra is not the be-all and end-all of satellite television in Europe, but is the tip of a constantly expanding iceberg which doesn't cost an arm and a leg to tap into, provided that you know what you are doing.

Eye to the Sky

The transponders of many non-DBS satellites (such as Intelsat V1 F4) tend to be of lower power than Astra. In addition, their coverage may be directed over a wide area (wide or 'global' beam), or 'targeted' at a certain region (which need not be the UK) with a 'spot' beam. As a result, reception of most channels carried by such satellites will be poor even with a low-noise high-gain LNB – if a 60cm dish is used. This indicates that the receiver's FM demodulator is struggling to discriminate between the weak signal and noise. Although experimentation is encouraged (refer to the 'Cable News Network' article in issue 50 of *Electronics*), a bigger dish will be required to bring the picture quality up to long-term tolerable level! Such a dish (at least 80cm in the south of Britain, or 1m in the north) would improve matters considerably, particularly in the British microwave-attenuating climate! However, under new restrictions imposed by the Department of the Environment, dishes are restricted in size to 60cm, or 80cm in more northerly areas. If you want bigger dishes (no matter how well hidden!), you legally need to waste money and time obtaining planning permission, a long-winded and bureaucratic process that should be reserved only for the erection of buildings and service roads, etc. Apart from dealing with officious and inflexible local planning departments, you will also need to convince your neighbours! One could argue that a satellite dish visible from the front of the house is an eyesore (and it is, but so are the fronts of many modern buildings!), but the regulation legally applies to dishes hidden in a back garden as well. Once again, the Powers that Be have shown their ignorance in technical matters; there are circumstances when dishes of the specified diameter are insufficient for adequate reception even from Astra!

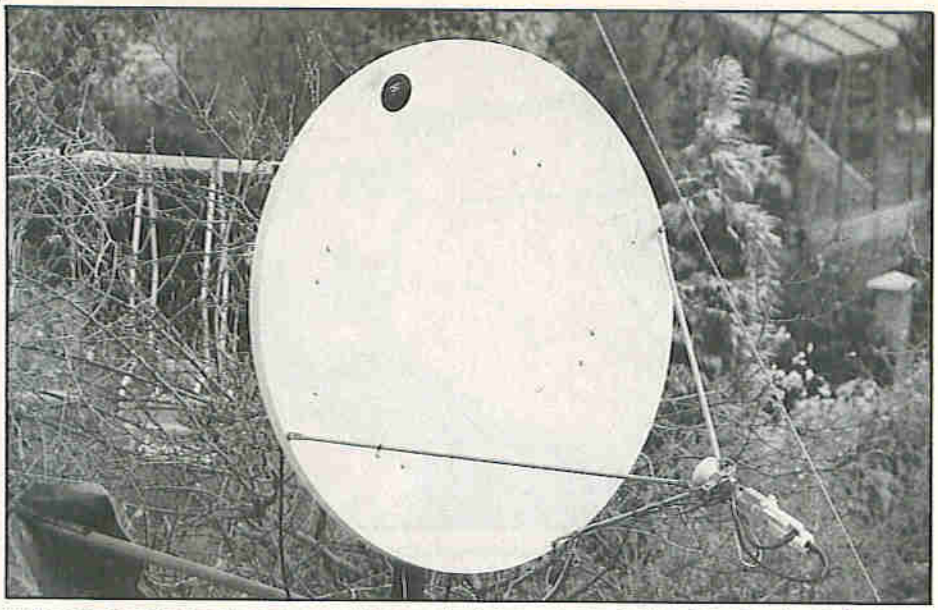
Despite these comments, dish size is only one of the factors that contribute to a good carrier-to-noise (C/N) ratio, ensuring that receiving equipment can work at its best. Even if the dish is optimally aligned, the noise figure and gain of the LNB are important. If the LNB produces a lot of noise, this may well 'swamp out' the weaker signals, causing problems with demodulation later on. The final conversion gain of the LNB is equally important (many satellite dealers are seemingly ignorant of this, wishing to express the noise figure only). A high gain (of, say, 55 to 60dB) will compensate for the losses incurred in quite a long cable run, and will ensure that the indoor receiver has a good, strong signal to work from. An in-line amp, installed at the LNB side of the feeder could be used – but these introduce noise into the system themselves.

Another factor is the threshold level of the FM demodulator. This is defined as being the point where the C/N ratio of the signal applied to the demodulator's input starts to become non-linear in relation to the signal-to-noise ratio of the output. The practical upshot of this? At C/N values close to threshold, annoying impulse noise – visible as comet-tailed black and white streaks, popularly known as 'sparklies' – intrudes onto the picture. Low thresholds (generally, the lower the better) are obtainable by techniques such as 'threshold extension', but many manufacturers are fond of quoting figures as low as 6dB; such 'spec-manship' is rather academic. At a C/N ratio of less than around 7·5dB, the picture is virtually unwatchable!

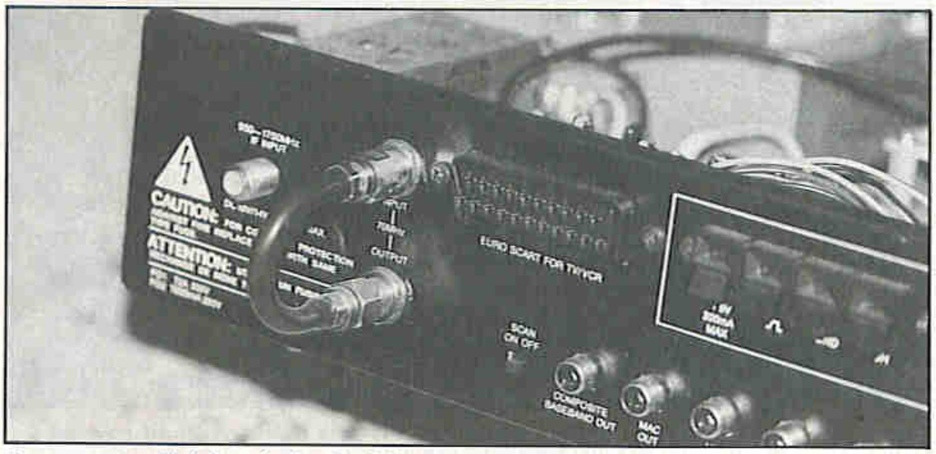
The point being made here is that, even with a dish of the correct diameter, these other considerations need to be made before good reception can be ensured. As mentioned, a 60cm dish will be insufficient for even Astra if the system is lacking in these other areas. Along with the above factors, and the transponder power/coverage, there are many other elements, such as signal attenuation in wet weather, the set-up of the polarising device (if used) and feed, and any obstructions between the satellite and the receiving dish. The most important factors are considered in a calculation known as the 'link budget'. This has been designed to determine the optimum receiving system configuration, in a specific area, for a particular channel or satellite. Each significant gain and (potential) loss along the chain, from transmitter to receiver, plays a part in the calculation – which is unfortunately beyond the scope of this article. Several books covering this subject are, however, available from Maplin. These include the 'Newnes Guide to Satellite TV' by D. J. Stephenson (order as WT06G), and 'The Satellite Book' by John Breeds (order as WT46A). The link budget, involving a certain amount of mathematics, lends itself to computerisation – and PC programs, such as Swift Publication's excellent 'Satmaster', are available to do the job with mimimum fuss.

Even when used with the highest quality microwave components and receiver available, a 60cm dish could never be used to satisfactorily recover most of the other satellites that carry interesting television channels on their transponders. Nevertheless, it is possible to receive the Eutelsat II F1 bird at 13 degrees east, in addition to Astra, with the addition of a mounting bracket known as a 'Little Extra' and an extra LNB. These items can be attached to a standard 60cm dish, giving dual-satellite operation without the need to motorise, at a cost of well under

An 80cm dish is the minimum size required for passable multi-satellite reception in the south of England. 80cm Astra dishes, required in nothern Britain, are often available from satellite dealers instead of the more common 60cm dishes. Athough these may provide a starting point, they tend to have simple azimuth-elevation (Az-El) mounts which will require motorisation on both axes for reliable results. However, please note that a 1m dish (at least) will be required in more northerly regions.



In the south of England, many satellites can be intercepted reliably with a modern 1·2m installation – truly a 'window on the world'! The photo shows a normal FSS band LNB, together with one modified to cover DBS and Telecom, coupled to a wideband feed and polariser via an OMT (orthomode transducer). The result? Complete coverage of the broadcast Ku-band.



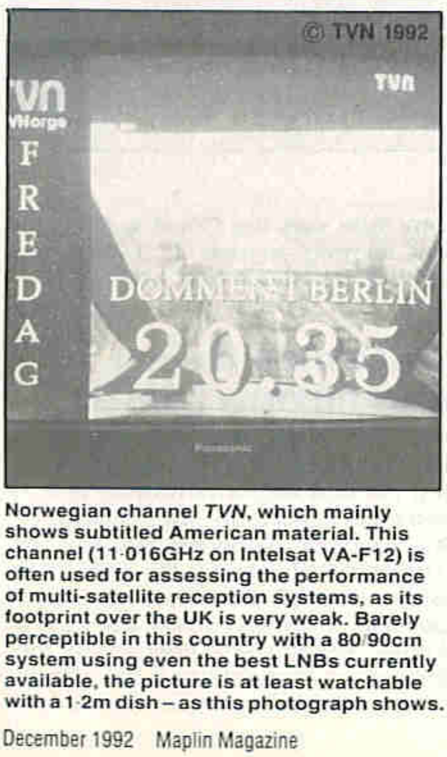
If you use a small dish, reducing the IF bandwidth may help to make the weaker signals watchable. Pictured is a 70MHz loop – now a fading sight from (even the best of) modern multi-satellite receivers – which enables filter networks to be attached.

£100. However, as already mentioned, the quality would by no means be perfect, and would be likely to deteriorate rapidly in wet conditions. Such an arrangement would, nonetheless, enable you to enjoy programmes from the modestly-named Super Channel, the adult channel After 12 (scrambled), and American propaganda (sorry, 'information') from Worldnet in addition to the daily outpourings from Astra. 11 F1 also offers television programming from Europe and the Middle East, as well some superb radio – including the BBC World Service, Deutsche Welle 2, VOA and Concert Radio.

If you are making do with a basic satellite television rig to intercept birds other than Astra, you may encounter distorted or non-existent sound. This is because some Astra receivers do not allow continuous tuning of the sound subcarrier (older Amstrad receivers, for example, offer only fixed combinations of the 7·02, 7·20, 7·38 and 7·56MHz narrowband subcarriers – and not the 6·6MHz wideband subcarrier widely used by non-Astra satellite broadcasters). Take heart, though – there are several inexpensive upgrades available to rectify the problem.

Best of the Rest

Whilst a 'Little Extra' and a second LNB present a cheap alternative to motorising, it is no substitute to a system that can track a dish (of at least 90cm diameter) across the sky from east horizon to west horizon (and, thankfully, vice versa!), pulling in the growing number of satellites beaming into Europe. At last count fifteen such birds were offering in excess of a hundred channels



Norwegian channel *TVN*, which mainly shows subtitled American material. This channel (11·016GHz on Intelsat VA-F12) is often used for assessing the performance of multi-satellite reception systems, as its footprint over the UK is very weak. Barely perceptible in this country with a 80/90cm system using even the best LNBs currently available, the picture is at least watchable with a 1·2m dish – as this photograph shows.

Satellite	Location	No. of Full-time channels	Frequency
Intelsat VB F15	60° E	6	10·95 to 11·70GHz
DFS1 Kopernikus	23·5° E	5	10·95 to 12·75GHz
		5	12·50 to 12·75GHz
Eutelsat I F5	21·5° E	1	10·95 to 11·70GHz
Astra 1A/1B	19·2° E	29	10·95 to 11·70GHz
Eutelsat II F3	16° E	4	10·95 to 12·75GHz
Eutelsat II F1	13° E	14	10·95 to 12·75GHz
Eutelsat II F2	10° E	10	10·95 to 11·70GHz
Eutelsat I F4	7° E	4	10·95 to 12·75GHz
Tele X	5° E	3	10·95 to 12·75GHz
Intelsat VA F12	1° W	7	10·95 to 12·75GHz
Telecom 1c	5° W	7	12·50 to 12·75GHz
Telecom 1a	8° W	2	12·50 to 12·75GHz
Olympus 1a	18·8° W	2	11·70 to 12·50GHz
TDF 1A	19° W	4	10·95 to 12·75GHz
TV Sat 2	19·2° W	4	10·95 to 12·75GHz
Intelsat V1 F4	27·5° W	9	10·95 to 12·75GHz
Marcopolo 1	31° W	5 (Due to close)	11·70 to 12·50GHz
PAS 1	45° W	1	10·95 to 11·70GHz

Table 1. European Television Satellites

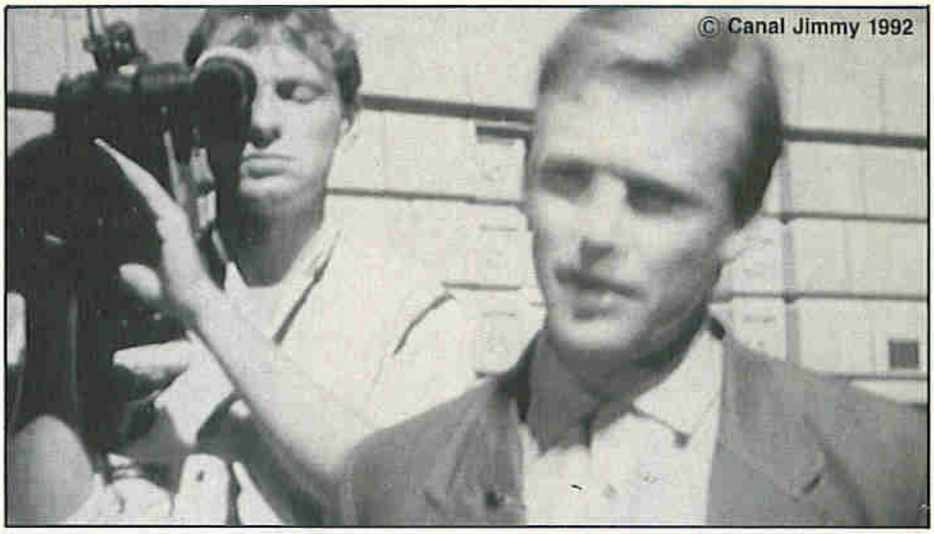
Note: This list details the main satellites feeding into Europe. Occasionally used birds and 'C' Band transponders have been omitted.

(see Table 1), although some – particularly those originating in Germany – duplicate channels already being shown on Astra.

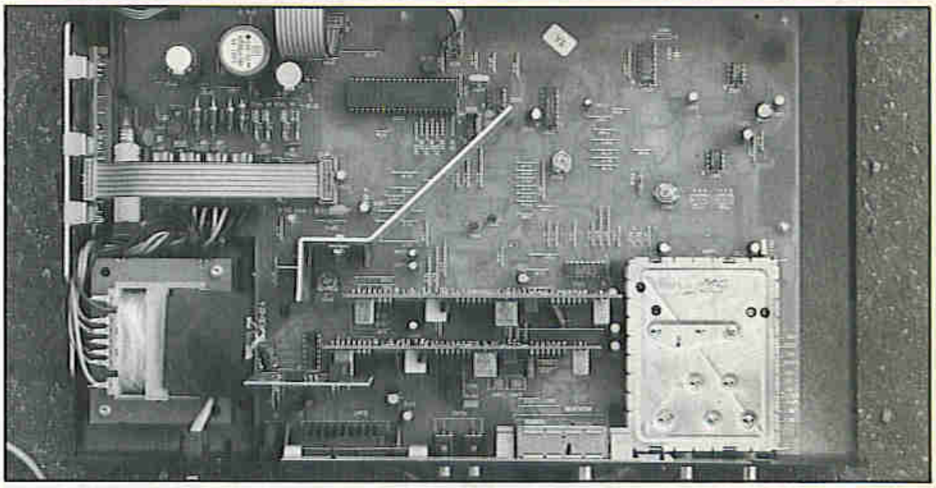
Away from 19·2 East, transmissions in English are thin on the ground. One of the exceptions is Intelsat V1 F4 at 27·5 West, where one can tune into CNN direct from the States, marvellous documentaries on the Discovery channel, classic films from Bravo (for which you, ahem, need a decoder), and news feeds originating from Brightstar and the like. There is also superb live coverage of proceedings from Westminster by the Parliamentary Channel (operated by, you've guessed it, United Artists Communications!). Elsewhere it is very much a case of 'yer pays yer money and takes yer choice' – in this case, a choice of French, German, Spanish and Italian programming interspersed with Norwegian, Danish, Swedish, Arabic, Japanese and even Serbo Croatian! The latter, RTB, gave a fascinating insight into the human effects of the civil war in Yugoslavia. RTB can (still?) be found on the virtually-forgotten Eutelsat I F4 satellite.

Worth looking in on are the French stations operating from Telecom 1C at 5 West. However, they are broadcast in the SECAM format which will reveal a mere black-and-white picture on PAL-only television sets. A Secam to PAL transcoder will be needed to view them in glorious colour. Of particular note is Canal Jimmy, a 'nostalgia channel'. Many American and British programmes from the '60s and '70s are shown here – some dubbed, but some with sub-titles. In particular, the classic *Monty Python's Flying Circus* is shown, with French sub-titles, on Tuesday evenings. Repeated on Sunday evenings, this alone is enough to justify the price of a satellite system and transcoder!

Satellites broadcasting in MAC are still few and far between. Apart from the occasional HD-MAC test on Eutelsat II F3, the only real source of D2-MAC transmissions for those with the required equipment is the DBS cluster at 19°W. Here, three satellites co-exist quite peacefully; the German TV Sat 2 (which shows four of the channels that you can see on Astra, but with improved picture and sound quality), the French TDF-1A (which shows four channels including arts channel La Sept and fantastic pop music station MCM (Euromusique). The other main MAC contender is parked at 31°W. This sad old (?) bird is none other than Marcopolo, which brought us the short-lived joys of the late and lamented BSB – pioneer of the IBA (remember them?) developed D-MAC system, which arguably brought us the best picture/sound quality yet seen on a domestic TV set. All but the worthwhile parts of the BSB service were absorbed into the 'new' BSkyB following the 1990 takeover (*whoops!* merger) – and BSkyB inherited the old broadcaster's 5-transponder satellite. However, it is legally due to relinquish control of this bird at the end of the year, when (hopefully) somebody else can make use of it. Until then, all of BSkyB's channels – except the 'Comedy' Channel – can be found on Marcopolo – with some of the technical quality that disgruntled BSB viewers had come to expect. There are rumours that the second BSB satellite (Marcopolo 2) had been placed in orbit with the existing bird – why then was the Comedy Channel not allowed to use it? I think we should have been told why!



Oddly-named French 'oldies but goodies' channel *Canal Jimmy*, which shares a Telecom 1C transponder with educational broadcaster *Canal J. Canal Jimmy* shows classic 60s and 70s series from the UK, US and even France. However, although a 65cm dish will give sufficient gain in the South-East of England for sparkly-free reception, a low-noise Telecom LNB and multi-standard TV/SECAM-to-PAL transcoder will be required.



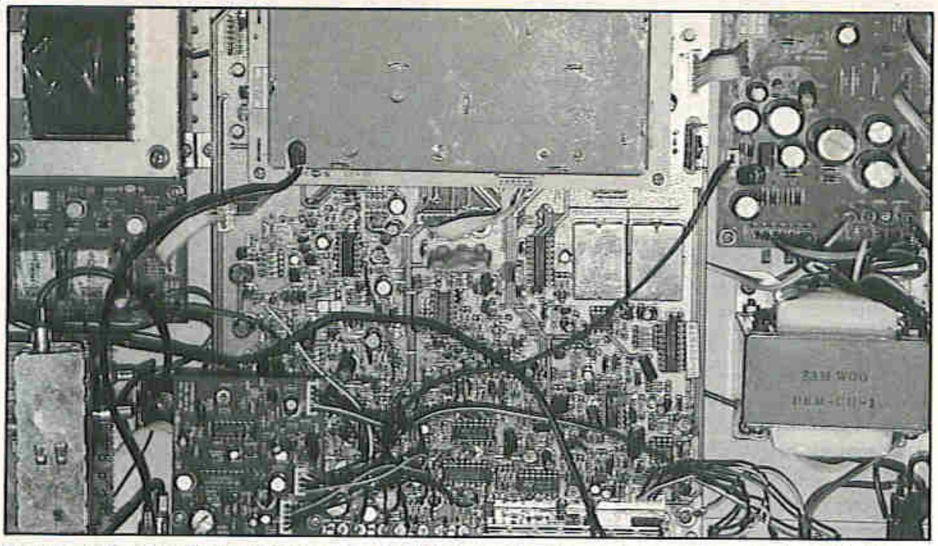
Salora 5902 receiver. The two sound tuning/demodulator sub-PCBs are shown mounted vertically next to the screened tuner/baseband demodulator module. Between these and the mains power transformer can be seen a small PCB which drives a magnetic polariser. The 40-pin ITT microcontroller can clearly be seen towards the top of the photograph.

User	SNG Number	Downlinks
BBC	UKI 1, 16, 17, 20, 21, 23, 25	FSS Band (10·95 to 11·70GHz)
ITN	UKI 7, 11, 31	FSS Band
Sky News	UKI 34	FSS Band

Table 2. SNG Registration

Satellite News Gathering (SNG)

It is fair to say that satellites have revolutionised news gathering, offering the chance for newswatchers to witness history in the making – as superbly demonstrated by Ted Turner's CNN during the Gulf War. Such coverage would not have been possible just a few years ago, and if further proof were needed of the immediacy that satellites can offer, it came with the hostage releases late



Technisat ST-6000S. Despite its apparent complexity, this unit has design features that are common to all satellite receivers. The large screened box visible towards the top of the photograph is the demodulator unit. The IF stages (there are two in this unit as it has a 70MHz loop) are the screened boxes that can be seen towards the bottom left. Under the demodulator is the control section, unusually based around an 8085 8-bit microprocessor running operating software stored in a 32K x 8 EPROM. The sub-PCB that can be seen next to the IF stages contains audio and video switching/buffering circuitry for the receivers SCART socket, and a magnetic polariser interface. The densely-populated main PCB, a double-sided type, contains control and stereo audio/video processing circuitry, including an on-screen graphics generator. The PSU boards and transformers for the receiver and actuator are located at the far right and far left respectively.

last year. This time it was an ITN satellite news gathering unit that uplinked picture material for all UK broadcasters via the Viseurope transponder (Telecom band) on Eutelsat 11 F1 at 13° East, allowing step-by-step coverage of the hostages' journey into freedom. The BBC, ITN and BSkyB operate their own SNG units, the material from which is usually downlinked in the FSS band (10·95 to 11·7GHz). A list of their registration numbers is given in Table 2. In addition, British Telecom and several specialists provide SNG units on a lease basis as and when they are needed.

Once Seen...Never Forgotten!

Where a steerable dish system comes into its own is in its ability to intercept transmissions carried via the many birds used solely to provide these news feeds and outside broadcast links. In addition to these are the NTSC and PAL Brightstar feeds on Intelsat V1 F4, the 12GHz Visnews feeds on Eutelsat II F1, and the Ku-band transponder on board the Russian Gorizont 15 satellite, parked at 14 West. The latter often carries transmissions destined for Western news broadcasts. Visnews is a regular user of this bird with daily feeds from their Moscow Bureau, but it is not unknown to see links to the BBC Television Centre and ITN in London.

Also worth monitoring is PanAmSat PAS 1 at 45° West; unfortunately, in the UK it appears quite close to the horizon, and many people may not be able to get a direct line-of sight with the bird. A pity, because PAS 1 is often the source of United States to European news feeds and is likely to buzz with activity in the lead up to the Presidential elections, which could see a Democrat take-over of the Republican-held White House. Despite its proximity to the horizon, British Rail apparently use one of the transponders aboard this satellite for relaying reports and messages to its stations – the commuters amongst you will no doubt have seen the 90cm dishes sprouting up at your local BR port of call, and the television monitors in the waiting rooms. Sports freaks are not left out in the cold with such events as live horse racing downlinked by SIS from Intelsat V F2 at 21·5° West, which is sometimes in the clear but more often than not encrypted and in the B-MAC format. If searching out the illusive is your main interest, then a fully steerable system with the best LNB and set-top receiver you can afford cannot be more highly recommended. It is the only way to achieve results comparable with those chronicled in many of the specialist publications.

In the next part we will discuss the various encryption methods including Videocrypt and Eurocrypt – two of the most widely used and supposedly uncrackable systems.

Vintage Radio continued from page 11.
nostalgia, the collection of information and examples of old captions and test-cards, is covered by another magazine entitled TV Graphics Review. Further details are available from HS Publications, 7 Epping Close, Derby DE3 4HR.

Radio and TV Novelties

Since the very beginnings of radio production, manufacturers have been making various novelties and curiosities. Some of these were actual receivers, loudspeakers, etc., in an unusual format, intended for sale to the public. Others were advertising and promotional material designed for use by retailers in decorating their shop displays, or as give-aways to the general public.

Among the earliest novelty receivers was a 1923 crystal set built in the form of a plywood cut-out figure of Felix the Cat, who was a popular animated cartoon character of the time. Another was a 1924 crystal set housed in a china 'Uncle Tom' figure. In 1927, several novelty loudspeakers were produced, made of china or papier mâché in the form of parrots, or oriental personages. More recently, there have been receivers in various strange guises such as a small beer-barrel, a hamburger, a drinks dispenser, a bottle, a figure in a spaceship and even a set built into a pair of sunglasses!

The 'Uncle Tom' Grafton china crystal set. The top hat carries the coil, with a slider at the back for tuning. The crystal is in the form of a diamond shirt-stud, with the cat's whisker protruding from the bow tie. This novelty set, produced in 1924, stands almost 9 inches high.

Whereas the loudspeaker and controls on a radio can be concealed or disguised in all sorts of ways, the scope for novelty TV receivers is limited by the need to have the screen visible. Accordingly, a collection of novelty TV sets would have to be based on unusual ideas for shape and decoration.

Prominent in the types of advertising and promotional material which may form the basis of a collection are posters, display cards, advertisements and catalogues. As well as being interesting in itself, such material can also give much useful information about the development and evolution of the various manufacturers' product lines.

The second part of this series will look at amateur and professional radio equipment, telegraphy collectibles, audio and recording.

CIRCUIT MAKER

Circuit Maker is a forum for readers' circuits, ideas and tips. The circuits and information presented here must be considered as a basis for your own experimentation, no warranty is given for suitability in particular applications, reliability or circuit operation. Maplin cannot support, in any way, the information presented here. However, where possible, we will endeavour to check that information presented, is correct and that circuits will function as stated. If you would like your ideas to be considered for inclusion in Circuit Maker, please mark your submission 'Circuit Maker' and send it to: The Editor, 'Electronics – The Maplin Magazine', P.O. Box 3, Rayleigh, Essex, SS6 8LR.

Dual Wire Transmission System

by Simon Ford

This dual wire transmission system allows information, about eight switch positions, to be 'sent' down two wires. The circuit has a wide range of possible uses e.g., on a large model railway layout. On such layouts, there are many wires connecting the point motors, lights etc., to the main control panel. With this system, two wires from the transmitter can run along the length of the layout, branching off to receivers at suitable places, which then on-pass the control signals to the relevant point motor etc. Robotics is another suitable application where too many wires may restrict movement.

Circuit Description

The circuit is based around two ICs, the M145026 (transmitter) and the M155027 (receiver). The transmitter circuit consists of four ICs. A 4020 binary counter IC and an oscillator, based around a NE555 IC, are used to gate a 74LS251 multiplexer IC which encodes each switch input, in turn, into a four bit binary code. The first bit tells the receiver if the switch is on or off, and the last three bits identify the switch. This binary encoded signal is then passed to the transmitter IC. The oscillator circuit is also used to provide the transmission clock pulses.

The receiver circuit uses only three ICs, a 74LS259 8-bit addressable latch, a 2803A buffer and the main receiver IC, which is used to convert the incoming data back into binary form. The latch converts the binary information back into the corresponding eight switch positions. A feed from the receiver's 'Valid Data' pin is connected to the latch IC so that any corrupt data will be ignored. The latch outputs are fed to the buffer IC which is able to drive relays or solenoids directly.

PARTS LIST

RESISTORS: All 0.6W 1% Metal Film		
120Ω	1	(M120)
6k8Ω	1	(M6K8)
10k	10	(M10K)
22k	1	(M22K)
100k	1	(M100K)
CAPACITORS		
1n5F	1	(WX58N)
10nF	4	(RA44X)
100nF	1	(RA49D)
SEMICONDUCTORS		
NE555	1	(QH66W)
4020BE	1	(QX11M)
M145026	1	(UJ49D)
M145027	1	(UJ50E)
74LS251	1	(YF92A)
74LS259	1	(YF97F)
ULN2803A	1	(QY79L)
BC182L	1	(QB55K)
LED (5mm Green)	1	(WL28F)

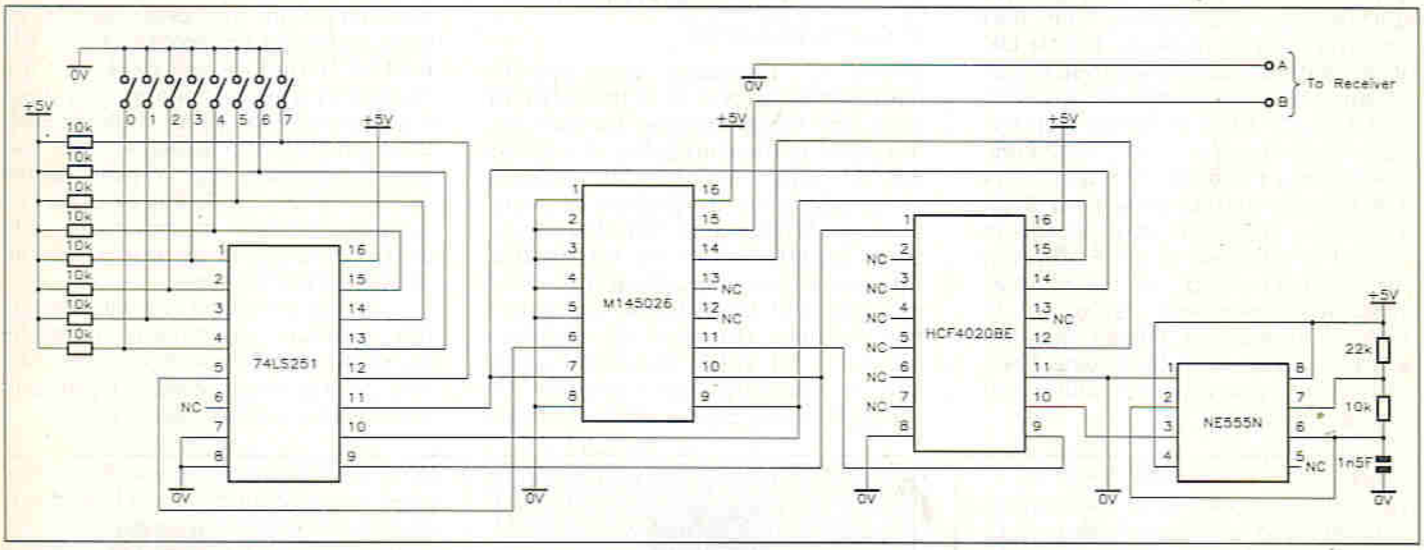


Figure 1. The transmitter/encoder.

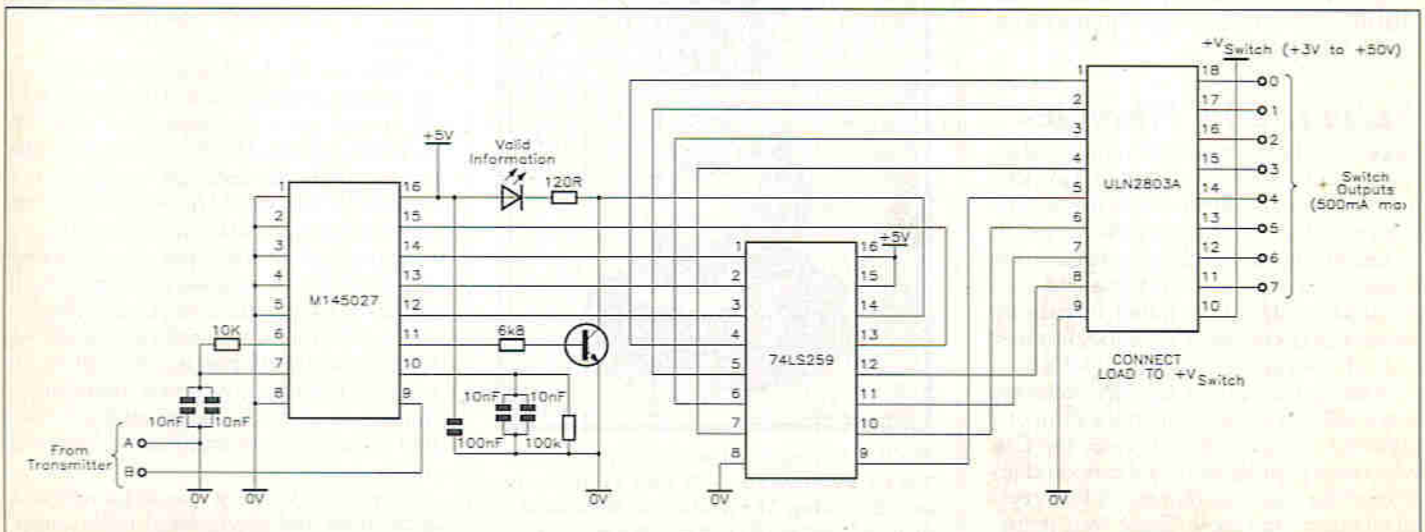


Figure 2. The receiver/decoder.

FAST FORWARD TO THE FUTURE

by Alan Simpson and Martin Pipe

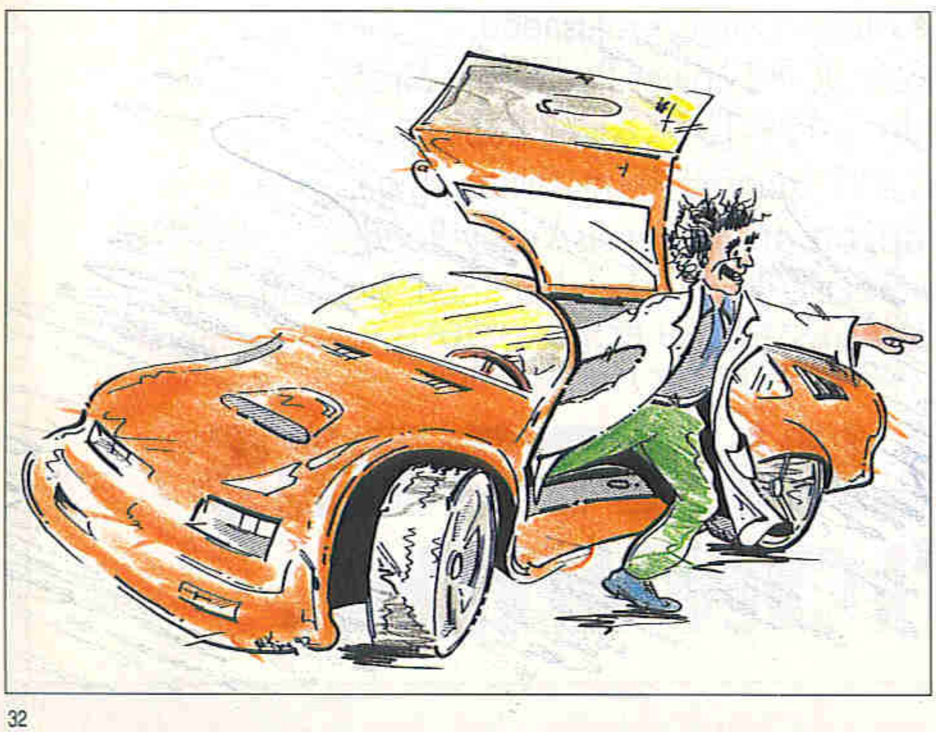
The year 2000 is closer than you think (actually 7 years – Ed.). In the interests of helping you to prepare for – or survive – the event, 'Electronics – The Maplin Magazine' has been interfacing with the future, via a recycled ZX81, and has managed to retrieve an annual review for that year. So it's 'ready steady go' for a courageous leap forward in time!

2000 – A Look Back

In terms of technological development, this year has had a lot going for it! The world of electronics has been rapidly changing as 'Electronics' readers will have noticed. The global edition of the magazine now comes to you on your home electronic text processing unit in full high-resolution colour. Referring to a previous issue now takes only a couple of key strokes or, for those readers with the latest gear, a brief spoken word command. For those of us who still have stocks of paper – ah, yes, that rare commodity – selected pages of 'Electronics' can be colour laser-printed for reference.

With BT's monopoly on telecomms networks at last being broken, it is quicker (and cheaper!) to fax a ten-page report at the Group 7 rate than it is to stick on a second class £9·90 stamp. Postmen, having been consigned to the dole-queues of history, can now be found only in the BC (Before Computers) history books.

As predicted a long time ago, the trend of bigger memories in smaller packages is still being followed, to quite astonishing proportions. Megabytes and gigabytes have long since been replaced by terabytes and petabytes, but this year's wonder must surely be the credit-card sized 'Interworld' memory module for the CC-I (Credit Card-Interactive) system; its modest size belies the hyper-encyclopaedic store of text, full motion video and CD-quality sound contained within.



Read My MIPS

Earlier this year, Intel engineers proudly announced that the physical dimensions of the CPU and support circuitry of a '686 128-bit PC have been reduced to those of a matchbox. This exciting development paves the way for hand-held computer systems vastly superior to the notebook PCs of the '90s - perhaps the 'Hitch-hiker's Guide to the Galaxy', made famous by Douglas Adams in the last millenium, may become reality – particularly if Interworld-style memory modules are used. But the distinct disadvantage of such small computers will be obvious – they will be easily misplaced, just like pocket-phones, multi-function remote control units and personal DCC players.

Bearing in mind this pre-occupation with miniaturisation (which has been with us almost as long as electronics itself), it is probably just as well that the development of voice-recognition systems has advanced so much in the past year. After all, can you imagine operating a QWERTY keyboard the size of a cigarette packet? We have progressed far on the path to ergonomic success since the days when TV/VCR (remember them?) manufacturers would cram 50 or 60 keys in a 15cm x 6cm area, and expect a ham-fisted individual to be able to operate it!

Down to Earth

Even the field of home entertainment has progressed in leaps and bounds in the last 10 years or so. 90% of homes now have a DTH (direct-to-home) satellite receiving dish or a broadband ISDN-IV cable connection. As a result we have SHD-

MAC television pictures in 50% of homes, cast onto white wall-mounted screens by colour LCD projection systems. It's just a shame that the broadcasters in question put out the same Australian PAL and American NTSC-transcoded rubbish that was floating around in the ether at the same time as the Eurocrats started forcing them to change over to MAC.

Apart from high definition television, ISDN-IV has opened up a world of communications to those tapped into it – teleshopping, telecommuting, networked multi-user virtual reality games and electronic mail are just a few of the facilities that this excellent system is providing. No wonder that the ISDN-IV network is currently growing at a rate of 15% per annum!

The year 2000 also saw the implementation of John Major's long-awaited Computer User's Charter – yes, despite the whingeing, a sixth consecutive Conservative Government was returned to power! This piece of legislation will impose financial sanctions on suppliers – both hardware and software – who do not produce the goods on time. Important requirements are that all new systems must be as staightforward to use as possible, and that all instruction manuals are written in standard English. The prayers of computer users the world over, who have been campaigning desperately for decades, have at last been answered!

On the lighter side of things, a complaint was received by the Telecomms Niggle Board (TNB) that only 99·9% of public phone boxes were working at Kings Cross Railway station. BT's chairman immediately visited the site and apologised to all concerned and offered to resign. The individual who complained took his place on the BT board and was given a free telephone card. However, passengers who complained that the plethora of public phones on the station concourse blocked the entrance to the trains, were ignored.

The government also came under pressure from various 'save our teachers' pressure groups. Thanks to Virtual Reality techniques, individual computer generated images have taken over from real-life teachers who are now facing mass redundancy. As a knock-on effect, the plans of many university graduates, who feel that 'when all else fails, teaching will do', are now in jeopardy!

In accordance with new laws passed at the UN, virtual reality will ensure that only simulated wars are fought – much to the distress of greedy arms dealers, who up until the new legislation had delighted in making money out of death. Ex-employees of the arms industries will, however, delight in another of the positive advantages of VR – you can now holiday in the Virgin Islands without having to pack a suitcase – just the companion of your dreams in digital form, whether Samantha Fox (Who's she? – Ed.) or Michael Douglas. However, the Mary Whitehouse Heritage Trust drew a line at new VR chat-up channels which encourage interactive contact.

Of course, the 2001 Maplin Catalogue will incorporate many new sections including Satellite, Cellular Communications, Virtual Reality and Magnification (to help you find any missing equipment!).

Meanwhile, here's hoping your own high tech dreams all come true!

Christmas Quiz

In accordance with the 'season of goodwill', this year's Christmas Quiz is designed not to be too taxing. The prize is also generous; the senders of the first five correct entries picked out of Santa's sack can choose any book from this month's Top 20.

1. *Who had the most popular Christmas record?*
   a) Ted Heath
   b) Bing Crosby
   c) Andrew Lloyd Webber

2. *What is the colour of Rudolph's nose?*
   a) Puce
   b) Red
   c) Tangerine

3. *What is the traditional custom on Boxing Day?*
   a) The Royal Albert Hall stages a fighting contest
   b) Seasonal gifts are handed out to the servants
   c) Surprise Christmas presents are opened

4. *What traditional TV programme can you count on?*
   a) A vintage episode of Coronation Street
   b) A James Bond Movie
   c) A six part rerun of Dr Who

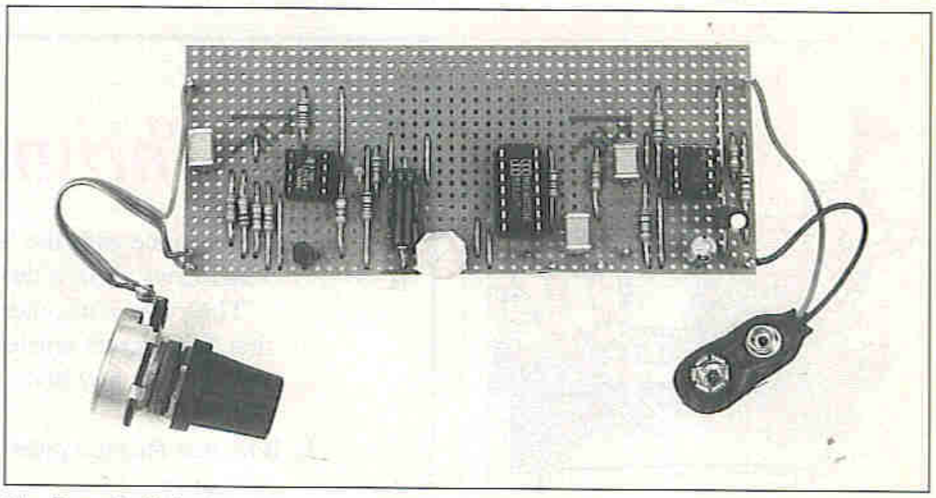
Bob's MINI-CIRCUITS

Tremolo Unit

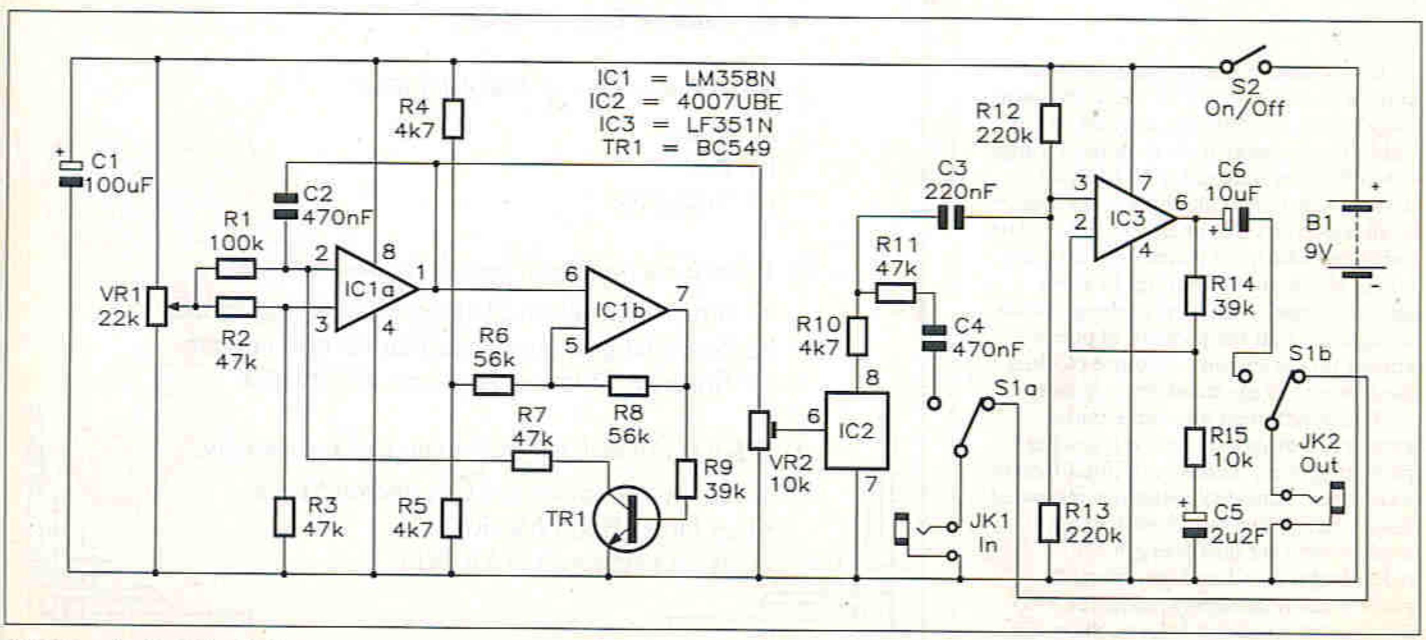
The tremolo is one of the oldest and most simple of electronic music effects. The effect is produced by varying the amplitude of the processed signal at a low frequency (usually around 1Hz to 2Hz). It can be generated manually using a swell pedal by operating the pedal at the appropriate rate, but an automatically generated effect is far more convenient in use. This circuit provides a conventional tremolo effect at a rate which is variable from under 1Hz to around 10Hz. It is easily modified to provide a more dynamic effect, this is described later.

It is important that the low frequency modulation oscillator provides an appropriate waveform, which means one that provides smooth variations in volume. This basically means either a sine-wave or a triangular-wave modulation signal, and in this case it is a triangular waveform that is used. This is simply because a triangular waveform is easier to generate than a reasonably pure sinewave type. The modulation signal is provided by IC1 which is used in a modified version of the standard squarewave/triangular waveform generator. It is actually a form of voltage controlled oscillator (VCO), having the control voltage provided by VR1. The latter therefore acts as the modulation rate control.

The amplitude modulation is added to the input signal via a simple VCA based on IC2. This is a CMOS inverter and a complementary pair of MOSFET transistors, but in this case only one N-channel MOSFET transistor of this device is actually used. Thus connections are only made to three pins of IC2, and the other eleven are just ignored. The transistors in the CMOS integrated circuit are enhancement mode devices, which means that they are normally switched off and are biased into conduction by a forward bias voltage.



The Tremolo Unit.

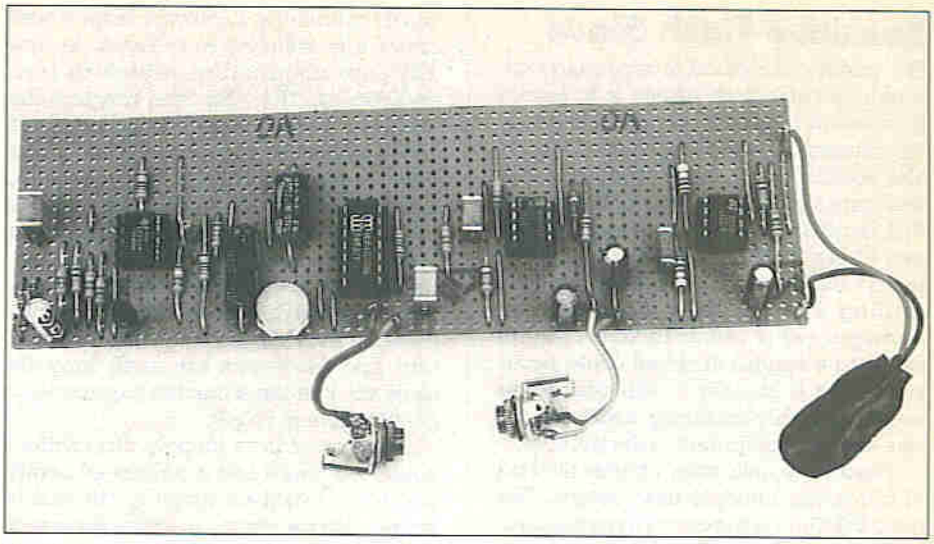


The Tremolo Unit circuit diagram.

IC2 operates as a voltage controlled resistor which forms an attenuator in conjunction with R10 and R11. R10 limits the maximum attenuation to about 20dB, which gives what most people consider to be the best tremolo effect. The output of the LFO is connected to the input of IC2 by way of VR2. The latter is needed to attenuate the otherwise excessive output level from IC1. It is adjusted to give a reasonably smooth and symmetrical modulation characteristic, and this is just a matter of using trial and error to arrive at what is subjectively judged to be the best effect.

IC3 is an output buffer stage, which also provides a small amount of voltage gain to compensate for the general losses through the VCA. S1 provides in/out switching, and it simply bypasses the unit altogether when the effect is switched out. The current consumption of the circuit is only about 3·5mA from the 9V PP3 battery.

Construction of the unit should not be difficult, but bear in mind that the 4007UBE used for IC2 is a CMOS device, and that it consequently requires the standard anti-static handling precautions to be observed. This device must be the unbuffered type having a 'UBE' suffix (which is the only type sold by Maplin). Ideally a unit of this type should be housed in a diecast aluminium box. A box of this type is very tough and provides excellent screening properties. A folded aluminium box will suffice, and is much cheaper. S1 should be a heavy-duty push-button switch mounted on the top panel of the case so that it can be operated by foot. Most switches of this type are of the successive operation variety (i.e. operating the switch once switches out the effect, a second operation switches the effect back in again, a third operation switches it out once more, and so on).



The Dynamic Tremolo Unit.

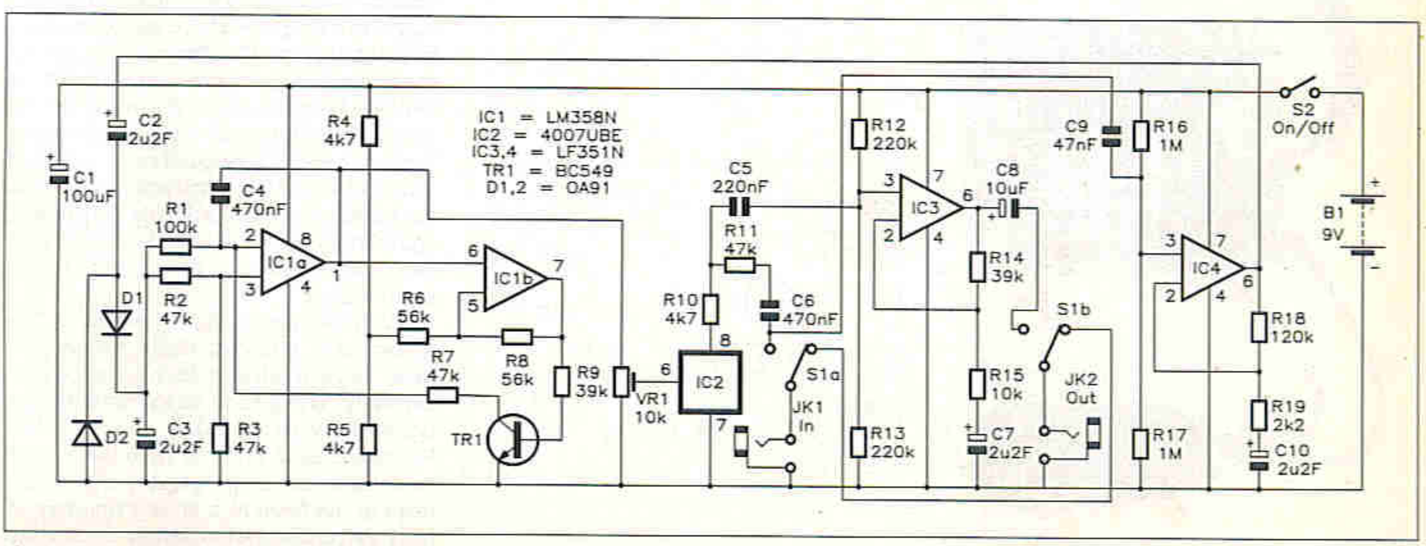
Dynamic Tremolo Unit

A conventional tremolo unit has already been described; this type of tremolo effect is still used a fair amount, but is considered rather 'tame' by many. It is certainly a much more simple effect than flanging, phasing, etc. A more interesting tremolo effect can be obtained by varying the tremolo rate in some way. Manual variations can actually be achieved quite easily using an ordinary tremolo unit with the modulation rate potentiometer controlled via a pedal mechanism. Automatic variations can be provided by a very low frequency modulation oscillator or, as in this case, linking the tremolo rate to the envelope of the input signal. The higher the input level, the faster the tremolo rate. When used with a guitar this gives a high initial rate, but the rate steadily decreases as each note from the guitar decays. As with practically any effect which is linked to the dynamic level of the signal, this gives an interesting and quite 'natural' effect.

It is not very difficult to add dynamic rate control to the tremolo circuit, due to the use of a voltage controlled oscillator (VCO) to provide the amplitude modulation signal. Instead of providing the control voltage from a potentiometer it merely has to be generated by a simple envelope follower circuit. Basically, this just means using a simple rectifier and smoothing circuit to convert the input signal to a corresponding DC voltage. This circuit is based on D1 and D2. Germanium diodes are used in the rectifier circuit as they have a lower forward voltage drop than silicon diodes. This gives more accurate tracking at low signal levels. The attack time of this circuit is very short, and although the decay time is much longer, it is still short enough to give accurate tracking on practically any input signal.

Quite a large voltage swing is needed in order to take the VCO over a reasonably wide frequency range. As a result of this the output level from most guitars is too low to drive the rectifier and smoothing circuit at an adequate level. IC4 is therefore used ahead of the rectifier circuit to provide buffering and a boost signal level. The specified value for R18 is suitable for low output guitar pick-ups, but for operation with high output pick-ups R18 will need to be much lower in value (around 10k). With very low output pick-ups a higher value might be beneficial (about 220k). The current consumption of this circuit is about 4·5mA, a 9V PP3 battery is therefore adequate as the power source.

When constructing the unit bear in mind that the 4007UBE used for IC2 is a CMOS device which consequently requires the standard anti-static handling precautions to be observed. Also remember that D1 and D2 are germanium diodes which are vulnerable to heat damage. Extra care should therefore be taken when soldering these components into circuit.



The Dynamic Tremolo Unit circuit diagram.

Sensitive Flash Slave

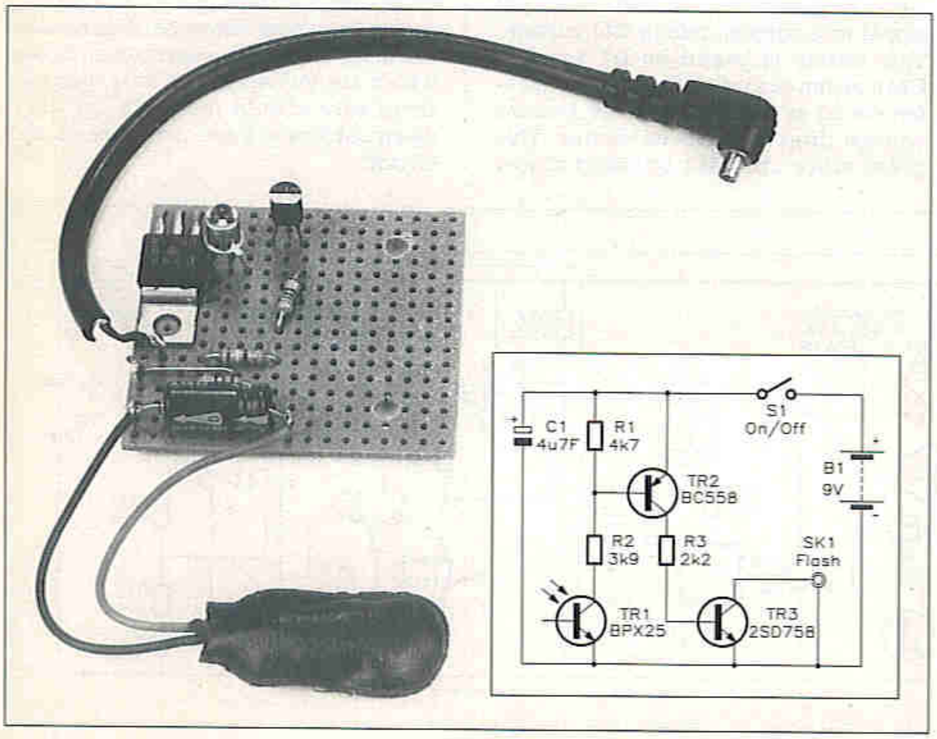
The traditional method of triggering multiple electronic flash setups is to have a lead which connects the flash socket of the camera to a multi-way flash adaptor. The sockets of the latter connect to the flashguns, usually via extension leads so that the flashguns can be mounted well away from the camera. This gives good results, but inevitably means having leads trailing all over the place. Such an arrangement is rather inconvenient in use, and a serious accident could occur because it is so easy to trip over loose leads, probably smashing some expensive camera equipment in the process.

Flash slave units offer a better method of triggering multiple flash setups. The main flash unit is triggered from the camera's flash socket or 'hot-shoe' in the normal way. The secondary flashguns are triggered via separate flash slave units which respond to the pulses of light from the main flashgun. This avoids the need for any long leads, reducing the risk of accidents and making it easier to make changes to the positions of the flashguns. Many modern cameras lack a flash socket, and a flash slave then represents a very convenient method of using multiple flash, since it avoids the need for a 'hot-shoe' adaptor. An on-camera or built-in flashgun can be used to trigger the secondary guns by way of flash slave units.

This flash slave trigger unit is very simple but still achieves a high level of sensitivity. The photo-sensor needs to be a fairly rapid type for this application. A photo-transistor (TR1) has been chosen as this offers better sensitivity than a photo-diode, but it is fast enough for the present application. In total darkness TR1 has the very low level of leakage associated with normal silicon transistors. The leakage level becomes much greater when it is subjected to light, and it can become more than a milliamp under bright conditions. A leakage level of well under one milliamp is sufficient to bias TR2 into conduction, which in turn switches on TR3. TR3 then triggers the flashgun. This is a high voltage transistor which will work properly with old flashguns having high voltage trigger circuits, and modern types having low voltage triggering. Note that the flashgun must be connected to TR3 with the correct polarity (i.e. the negative flash lead to earth, and the positive lead to TR3's collector). Power is provided by a small 9V PP3 battery, and this has an extremely long life since the unit has a current consumption of only around 100μA.

Construction is largely straightforward, but there are a couple of points which are worth mentioning. The first is simply that the circuit diagram is correct in showing no connection to the base of photo-transistor TR1 - this is not an error. The second point is that the miniature coaxial connectors normally used on electronic flash units are not standard 'off the shelf' components, and are difficult to obtain. It might be possible to obtain a suitable socket from a specialist photographic supplier, but probably the easiest option is to buy a short flash extension lead. The socket plus about 100 millimetres of lead can be cut from this, and wired up to the circuit board. The convention seems to be to have a black lead carrying the negative signal, and a white lead carrying the positive one. However, it is probably advisable to check the polarity of the signal using a multimeter.

Usually a unit of this type will be used indoors. The walls, ceiling, etc., then provide reflections from the main gun which make the aim of the slave units largely unimportant. Simply aiming them up at the ceiling seems to guarantee perfect triggering regardless of where the primary flashgun is aimed. When used out-of-doors there may well be little reflected light to assist triggering, and the slaves will then have to be aimed at the main flashgun with reasonable accuracy. Avoid aiming the slave units at the sun or any sources of fairly bright light. This could saturate TR1 and prevent the unit from operating properly.



The Sensitive Flash Slave. Inset: The Circuit diagram.

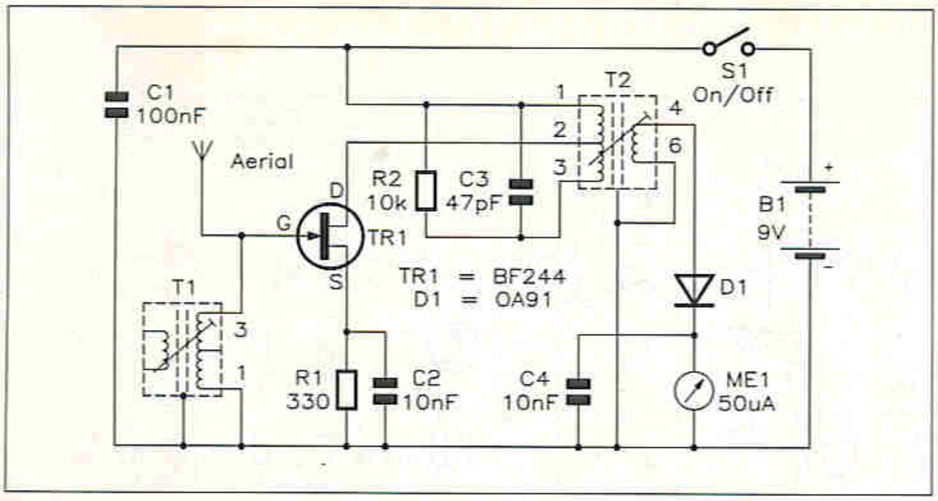
Radio Control Field Strength Meter

A field strength meter is useful when testing and setting up radio control equipment. The basic function of a field strength meter is to indicate the strength of the signal radiated by the transmitter. With most units of this type, including the present design, the meter scale is in arbitrary units. The meter is used to provide relative readings so that you can see if an adjustment, change to the aerial, etc. has improved or reduced the performance of the transmitter. When things go wrong it is useful to have a field strength meter so that you can determine whether or not the transmitter is actually radiating a signal.

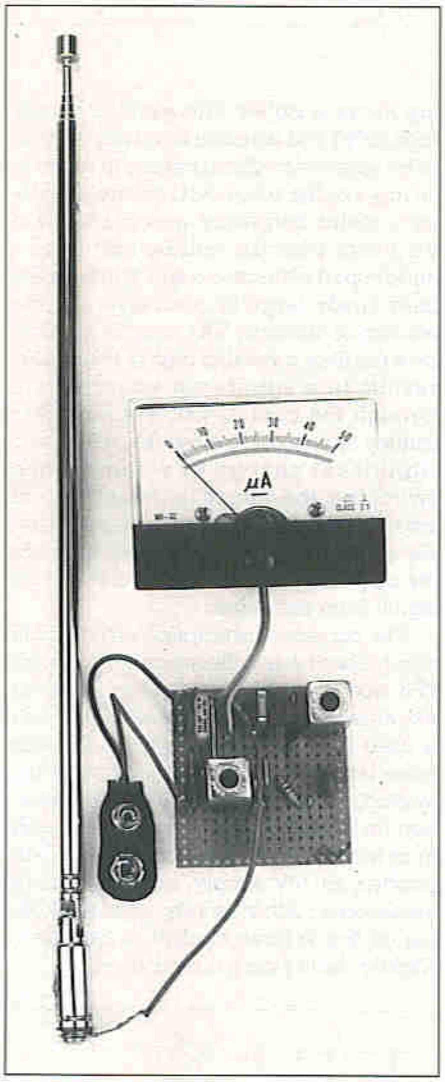
The circuit is very simple indeed, and it consists basically of an rf amplifier feeding into a rectifier and smoothing circuit. The rf amplifier has JFET transistor TR1 operating in the standard common source mode. The main winding of T1 plus the input capacitance of TR1 (about 50pF) act as the input tuned circuit. There is a small winding on T1 which can be used as an aerial coupling winding, but in this case it is better to couple the aerial direct to the tuned circuit. This is due to the fact that the aerial is a short and inefficient telescopic type. This will give very poor results if it is fed into a low impedance coupling winding. A much better signal transfer is obtained if the aerial is coupled direct into the high impedance tuned circuit. The aerial is too short for this method of connection to cause any serious problems with loading of the tuned circuit.

The primary winding of T2 acts as the drain load for TR1, and this tuned winding adds to the selectivity of the unit. However, with only two tuned circuits operating at quite a high frequency the circuit still has quite a wide bandwidth. If the unit is tuned to the middle of the radio control band it will respond quite well to any of the radio control channels. The secondary winding of T2 couples the output signal to a simple rectifier and smoothing circuit based on D1. This directly drives the meter, and as the output signal is likely to be quite weak, the meter should be a sensitive (50μA) type. Inexpensive 'tuning' meters having full scale values of around 200 to 250μA will actually work in the circuit, but will obviously give correspondingly lower sensitivities. The current consumption of the circuit is only around 2mA.

With any circuit that operates at frequencies of around 27MHz the component layout needs to be designed carefully. Try to have all the connections carried by reasonably short tracks. Feedback from pin 3 of T2 to pin 3 of T1 can cause instability, which will manifest itself in the form of a strong reading on ME1 regardless of whether or not the transmitter is switched on. R2 is used to



The Radio Control Field Strength Meter circuit diagram.



The Radio Control Field Strength Meter.

'damp' the second tuned circuit so that the layout is not excessively critical. If necessary the circuit can be damped more heavily by making R2 lower in value. With a layout that has a low level of stray feedback it might be beneficial to make R2 higher in value, or even to remove it altogether. D1 is a germanium diode, and as such it is very vulnerable to heat damage. Take due care when soldering it into circuit.

The cores of T1 and T2 must be peaked for maximum sensitivity on one of the middle radio control channels. With the unit close to a transmitter operating on one of these channels there will probably be a small deflection of ME1's pointer. If not, adjust the core of T2 until a deflection is obtained. It is then just a matter of adjusting the cores of T1 and T2 for maximum deflection of the meter. If ME1 is driven beyond full scale, move the unit further away from the transmitter so as to bring the reading back in-range. When using the unit with one of the more powerful radio control transmitters it might sometimes be helpful to reduce its sensitivity. This can most easily be achieved by retracting the aerial a little.

Modulated Syndrum

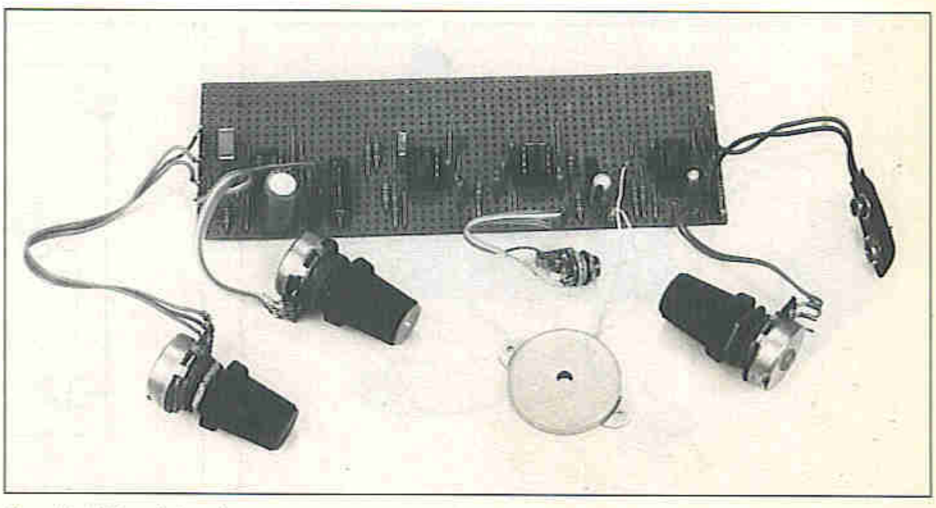
The original 'Syntom' and two companion syndrum projects were published by Maplin some ten years ago now. These have proved to be some of Maplin's most popular projects, which is not really surprising when you consider their low cost and the wide range of sounds they can generate. These projects produce various fixed or swept pitch sounds, such as disco-drum, wave, and gong sounds. Although they are very versatile, there are some types of sound which they cannot produce. In particular, the pitch of sounds can only be at a fixed frequency, or swept in sympathy with the envelope of the output signal. There is no provision for modulated sounds generated with the aid of a low frequency oscillator (LFO).

This syndrum circuit is loosely based on the original 'Syntom' circuit, but instead of having the voltage controlled oscillator (VCO) controlled from the envelope generator circuit, it is fed from the triangular output of an LFO. This permits a useful range of 'warbling' sounds to be produced. Like the original design the unit is touch sensitive and it is activated by tapping the case.

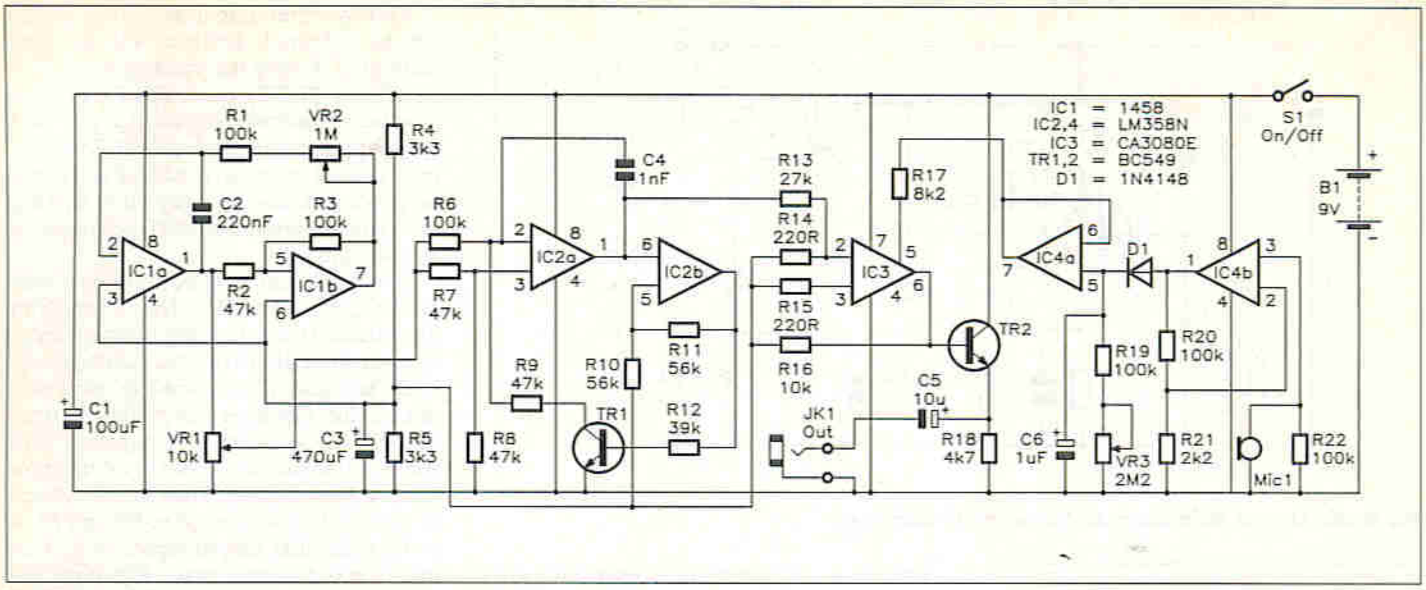
The basic tone is generated by a simple VCO based on IC2. This is similar to the standard triangular/squarewave oscillator configuration, with IC2a acting as the integrator and IC2b operating as the trigger circuit. However, an additional transistor (TR1) is used, and together with some extra resistors at the input this provides voltage control. The control voltage is applied to the junction of R6 and R7. It is the triangular output signal from IC2a that is used in this case, although the squarewave signal from IC2b could be used if preferred. The lower harmonic content of the triangular signal gives better sounds for most purposes.

A standard triangular/squarewave oscillator based on IC1 produces the low frequency modulation signal. IC1a acts as the integrator while IC1b operates as the trigger circuit. The triangular output signal from IC1a gives a good modulation characteristic. Again, the squarewave output could be used if preferred, but it would simply switch the VCO between two pitches, whereas the triangular signal provides a better, swept, effect. VR1 enables the output voltage range to be varied. When VR1 is well backed-off the VCO operates at low frequencies with a modest amount of modulation. Advancing VR1 gives a generally higher pitched output together with a greater modulation depth. VR2 enables the modulation frequency to be varied from under 1Hz to around 10Hz.

IC3 and TR2 act as the voltage controlled attenuator (VCA), and these are used in a conventional transconductance amplifier configuration. The CA3080E used for IC3 has no built-in output buffer stage, making it necessary to include TR2 as an emitter follower output stage. The control signal for the VCA is produced by first using IC4b to amplify and half wave rectify the output from MIC1 (which is actually a piezo electric sounder). A



The Modulated Syndrum.



The Modulated Syndrum circuit diagram.

smoothing circuit then produces a proportional DC signal from the output of IC4b. VR3 controls the decay time of this signal, which can be anything from a few hundred milliseconds to around five seconds. IC4a simply acts as a buffer stage between the smoothing circuit and the control input of the VCA.

The current consumption of the circuit is about 7mA, and a PP3 size battery is therefore adequate as the power source. I used a cased ceramic resonator for MIC1, but any resonator fixed on the inside of the case should work properly. With some resonators, the circuit might be oversensitive, but this can be corrected by making R21 higher in value. The output from the unit is approximately 5V Pk-to-Pk, which should be sufficient to drive any mixer, power amplifier, etc.

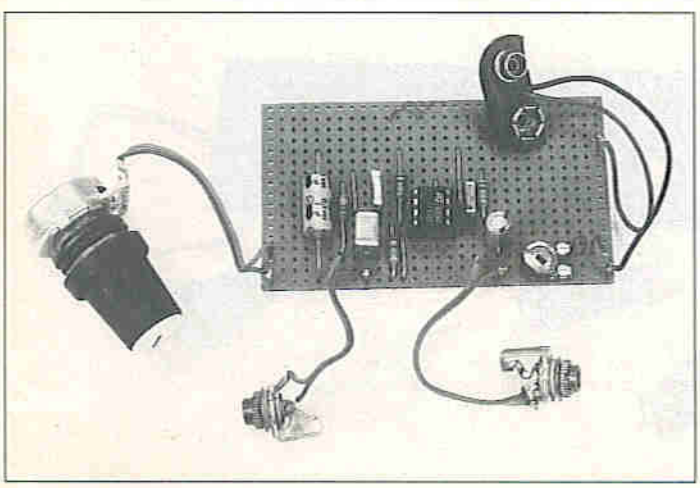
Wah-Wah Effects Unit

A wah-wah effects unit (or waa-waa if you prefer) is a simple form of filter effect. It is produced using a bandpass filter which is swept up and down the audio range giving a sort of nasal 'wah-wah' sound. Traditionally a wah-wah unit is controlled via a pedal which permits manual control of the filter's centre frequency. With units that are designed for home construction an alternative method of control is often used. This means having some form of automatic filter control, such as sweeping its centre frequency via an envelope follower or a low frequency oscillator. These methods do not necessarily give better results, and are probably inferior to having manual control by a talented player. However, they do avoid having to build the pedal mechanism, which is an awkward aspect of construction unless you are very good at the mechanical side of project construction.

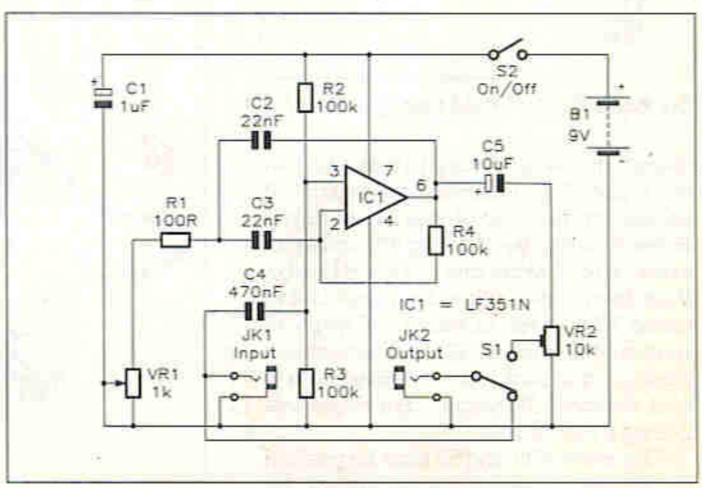
This wah-wah circuit is for a traditional pedal-type effects unit, which means that it is very simple from the electronic point of view. It is more difficult as far as the mechanical aspects of construction are concerned. Fortunately Maplin can supply an extremely well made and very robust foot-pedal unit. The unit as supplied is fitted with a 100k potentiometer and a screened cable fitted with a jack plug; these should be removed. A 1k linear potentiometer should be fitted in place of the original one. Conveniently, there are two holes in each side of the pedal; these can be used to fit the ¼in. jack sockets.

The circuit is very straightforward, and the filter is based on a well known configuration. In fact this filter is usually encountered in its inverting form, but for the present application the non-inverting mode is better. This permits a fairly high (50k) and constant input impedance to be achieved without having to resort to an input buffer stage. VR1 controls the filter's centre frequency, and permits it to be swept over the middle and upper-middle part of the audio spectrum. R4 has been made large in comparison to the resistance through VR1 and R4 so as to give the filter a suitably high Q value. This results in a significant voltage gain through the circuit. VR2 is adjusted to reduce the output level so that there is no significant change in volume when switching the effect in or out. In/out switching is provided by S1, and this simply switches the output socket between the output signal from VR2 and the direct signal from the guitar.

The current consumption of the circuit is only about one milliamp or so, and each PP3 size battery will therefore have an extremely long operating life. If the unit is used with high output guitar pick-ups there is a risk of the unit becoming overloaded, which will result in strong distortion on signal peaks. Powering the unit from two PP3 batteries wired in series will provide an 18V supply, and much more 'headroom'. Alternatively, simply backing off the volume control of the guitar slightly should cure the problem.



The Wah-Wah Effects Unit.



The Wah-Wah Effects Unit circuit diagram.

TREMOLO UNIT PARTS LIST

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

R1	100k	1	(M100K)
R2,3,7,11	47k	4	(M47K)
R4,5,10	4k7	3	(M4K7)
R6,8	56k	2	(M56K)
R9,14	39k	2	(M39K)
R12,13	220k	2	(M220K)
R15	10k	1	(M10K)
VR1	22k Linear Potentiometer	1	(FW03D)
VR2	10k Min. Horizontal Preset	1	(UH03D)
CAPACITORS			
C1	100µF 10V Axial Electrolytic	1	(FB48C)
C2,4	470nF Polyester Layer	2	(WW49D)
C3	220nF Polyester Layer	1	(WW45Y)
C5	2µ2F 100V PC Electrolytic	1	(FF02C)
C6	10µF 50V PC Electrolytic	1	(FF04E)
SEMICONDUCTORS			
IC1	LM358N	1	(UJ34M)
IC2	4007UBE	1	(QX04E)
IC3	LF351N	1	(WQ30H)
TR1	BC549	1	(QQ15R)
MISCELLANEOUS			
S1	DPDT HD Push-Button	1	(FH93B)
S2	SPST Ultra-Min Toggle Switch	1	(FH97F)
JK1,2	¼in. Mono Jack Socket	2	(HF90X)
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)
	8-pin DIL Socket	2	(BL17T)
	14-pin DIL IC Socket	1	(BL18U)

DYNAMIC TREMOLO UNIT PARTS LIST

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

R1	100k	1	(M100K)
R2,3,7,11	47k	4	(M47K)
R4,5,10	4k7	3	(M4K7)
R6,8	5k6	2	(M56K)
R9,14	39k	2	(M39K)
R12,13	220k	2	(M220K)
R15	10k	1	(M10K)
R16,17	1M	2	(M1M)
R18	120k	1	(M120K)
R19	2k2	1	(M2K2)
VR1	10k Min Horizontal Preset	1	(UH03D)
CAPACITORS			
C1	100µF 10V Axial Electrolytic	1	(FB48C)
C2,3,7,10	2µ2 100V PC Electrolytic	4	(FF02C)
C4,6	470nF Polyester Layer	2	(WW49D)
C5	220nF Polyester Layer	1	(WW45Y)
C8	10µF 50V PC Electrolytic	1	(FF04E)
C9	47nF PolyesterLayer	1	(WW37S)
SEMICONDUCTORS			
IC1	LM358N	1	(UJ34M)
IC2	4007UBE	1	(QX04E)
IC3,4	LF351N	2	(WQ30H)
TR1	BC549	1	(QQ15R)
D1,2	OA91	2	(QH72P)
MISCELLANEOUS			
S1	DPDT HD Push-button	1	(FH93B)
S2	SPST Ultra-Min Toggle Switch	1	(FH97F)
JK1,2	¼in. Mono Jack Socket	2	(HF90X)
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)
	8-pin DIL Socket	3	(BL17T)
	14-pin DIL Socket	1	(BL18U)

SENSITIVE FLASH SLAVE PARTS LIST

RESISTORS: All 1% 0·6W Metal Film

R1	4k7	1	(M4K7)
R2	3k9	1	(M3K9)
R3	2k2	1	(M2K2)
CAPACITOR			
C1	4µ7F 100V Axial Electrolytic	1	(FB18U)
SEMICONDUCTORS			
TR1	BPX25	1	(QF30H)
TR2	BC558	1	(QQ17T)
TR3	2SD758	1	(UF77J)
MISCELLANEOUS			
S1	SPST Ultra-Min Toggle Switch	1	(FH97F)
SK1	Min Coaxial Socket	1	see text
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)

RC FIELD STRENGTH METER PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	330Ω	1	(M330R)
R2	10k	1	(M10K)
CAPACITORS			
C1	100nF Ceramic	1	(YR75S)
C2,4	10nF Polyester Layer	2	(WW29G)
C3	47pF Polystyrene	1	(BX26D)
SEMICONDUCTORS			
TR1	BF244A	1	(QF16S)
D1	OA91	1	(QH72P)
MISCELLANEOUS			
T1,2	Toko KANK3335R	2	(FDO4E)
S1	SPST Ultra-Min Toggle Switch	1	(FH97F)
ME1	50µA 2in. Panel Meter	1	(FM98G)
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)
	Telescopic Aerial	1	(YT20W)

SYNDRUM PARTS LIST

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

R1,3,6,19,20	100k	5	(M100K)
R2,7,8,9	47k	4	(M47K)
R4,5	3k3	2	(M3K3)
R10,11	56k	2	(M56K)
R12	39k	1	(M39K)
R13	27k	1	(M27K)
R14,15	220Ω	2	(M220R)
R16	10k	1	(M10K)
R17	8k2	1	(M8K2)
R18	4k7	1	(M4K7)
R21	1k	1	(M1K)
VR1	10k Linear Potentiometer	1	(FW02C)
VR2	1M Linear Potentiometer	1	(FW08J)
VR3	2M2 Linear Potentiometer	1	(FW09K)
CAPACITORS			
C1	100µF 10V Axial Electrolytic	1	(FB48C)
C2	220nF Polyester Layer	1	(WW45Y)
C3	470µF 16V PC Electrolytic	1	(FF15R)
C4	1nF Polyester Layer	1	(WW22Y)
C5	10µF 50V PC Electrolytic	1	(FF04E)
C6	1µF 100V PC Electrolytic	1	(FF01B)
SEMICONDUCTORS			
IC1	1458C	1	(QH46A)
IC2,4	LM358N	2	(UJ34M)
IC3	CA3080E	1	(YH58N)
TR1,2	BC549	1	(QQ15R)
D1	1N4148	1	(QL80B)
MISCELLANEOUS			
MIC1	Miniature Piezo Sounder	1	(FM59P)
S1	SPST Ultra-Min Toggle Switch	1	(FH97F)
JK1	¼in. Mono Jack Socket	1	(HF90X)
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)
	8-pin DIL Socket	4	(BL17T)

WAH-WAH UNIT PARTS LIST

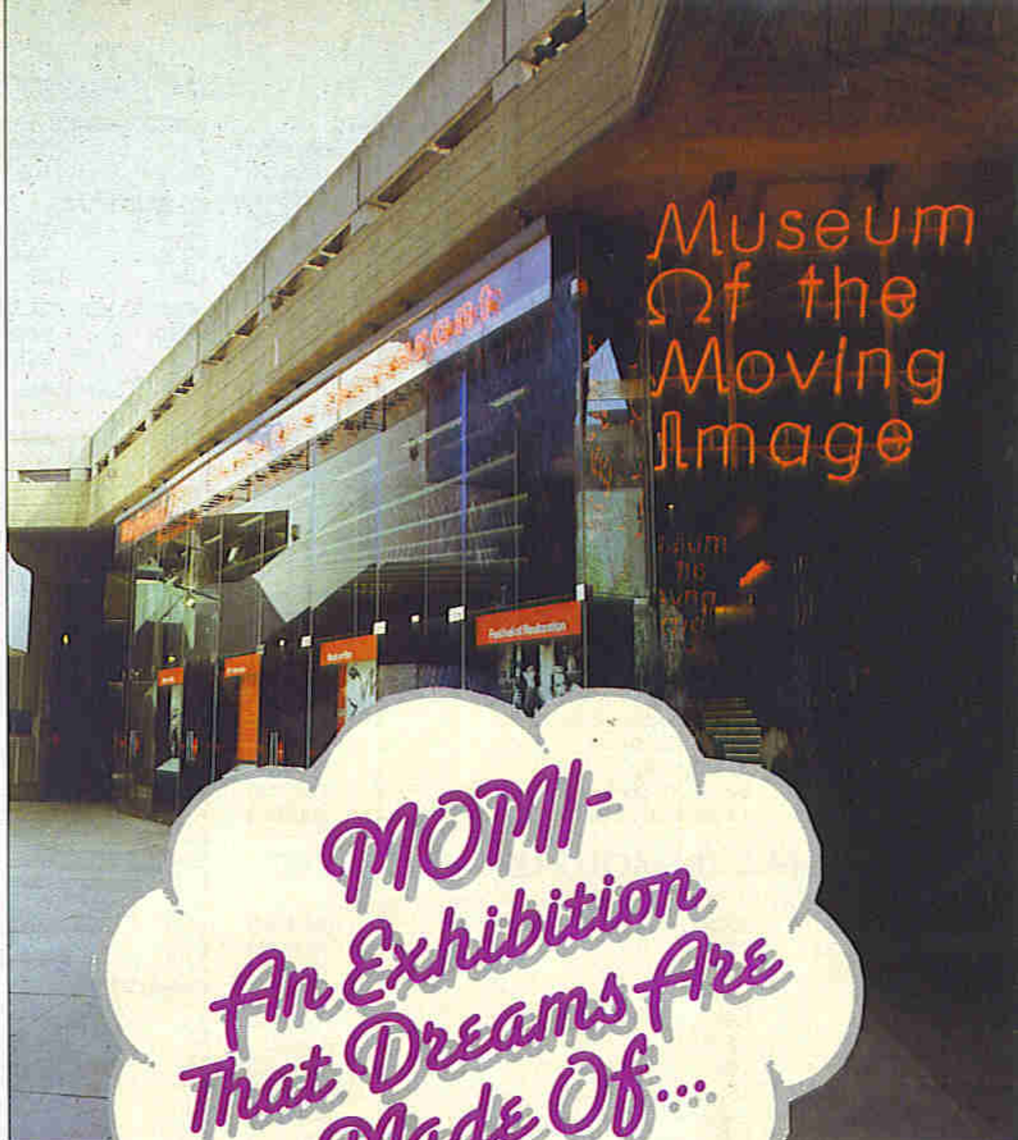
RESISTORS: All 0·6W 1% Metal Film (Unless specified)

R1	100Ω	1	(M100R)
R2,3,4	100k	3	(M100K)
VR1	1k Linear Potentiometer	1	(FW00A)
VR2	10k Min Horizontal Preset	1	(UH03D)
CAPACITORS			
C1	1µF 100V Axial Electrolytic	1	(FB12N)
C2,3	22nF Polyester Layer	2	(WW33L)
C4	470nF Polyester Layer	1	(WW49D)
C5	10µF 50V PC Electrolytic	1	(FF04E)
SEMICONDUCTOR			
IC1	LF351N	1	(WQ30H)
MISCELLANEOUS			
S1	SPST HD Push-button	1	(FH92A)
S2	SPST Ultra-Min Toggle Switch	1	(FH97F)
SK1,2	¼in. Mono Jack Socket	2	(HF90X)
B1	9V PP3 Battery	1	(FK58N)
	Battery Clip	1	(HF28F)
	8-pin DIL IC Socket	1	(BL17T)
	Pedal Mechanism	1	(XY28F)

The Maplin 'Get-You-Working' Service is not available for these circuits.

MOMI- An Exhibition That Dreams Are Made Of...

by Alan Simpson



Enter the Dreamworld

Since opening in 1988, some two million visitors have visited the Museum of the Moving Image (MOMI) to pay homage, or to explore the magical worlds of cinema and television. The award-winning MOMI is not only the most exciting cinema and TV museum in the world, but one of the most entertaining and educational exhibitions that you could choose to visit.

Anyone who has had a dreamy affair with a celluloid celebrity will find their dreams coming alive at MOMI. One MOMI claim to fame is the showing of over 1000 films and TV extracts continuously; whilst you are there you can catch clips from "ET", "Blue Angel", "Pretty Woman", "Lassie", or any number of Charlie Chaplin classics.

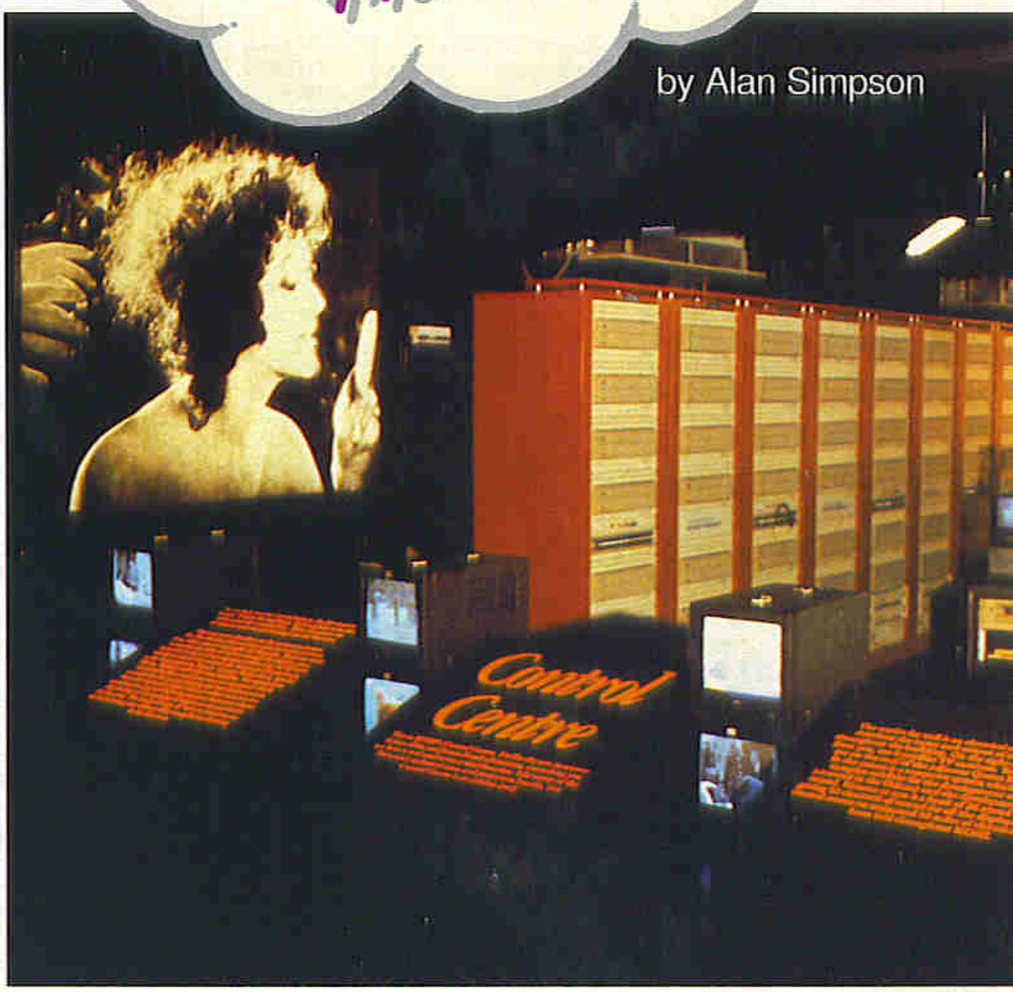
And that's not all. You can fly like Superman, read the news, be interviewed by Barry Norman, make your own cartoon, or even audition for Hollywood during your MOMI visit. For those who like pushing buttons, the Museum will be a joy. But it's not all play; MOMI's main role is to educate. There are many fascinating displays detailing the chronological development of the moving picture – from early experiments at the end of the last century, to television and the powerful influence that it exercises on our everyday lives.

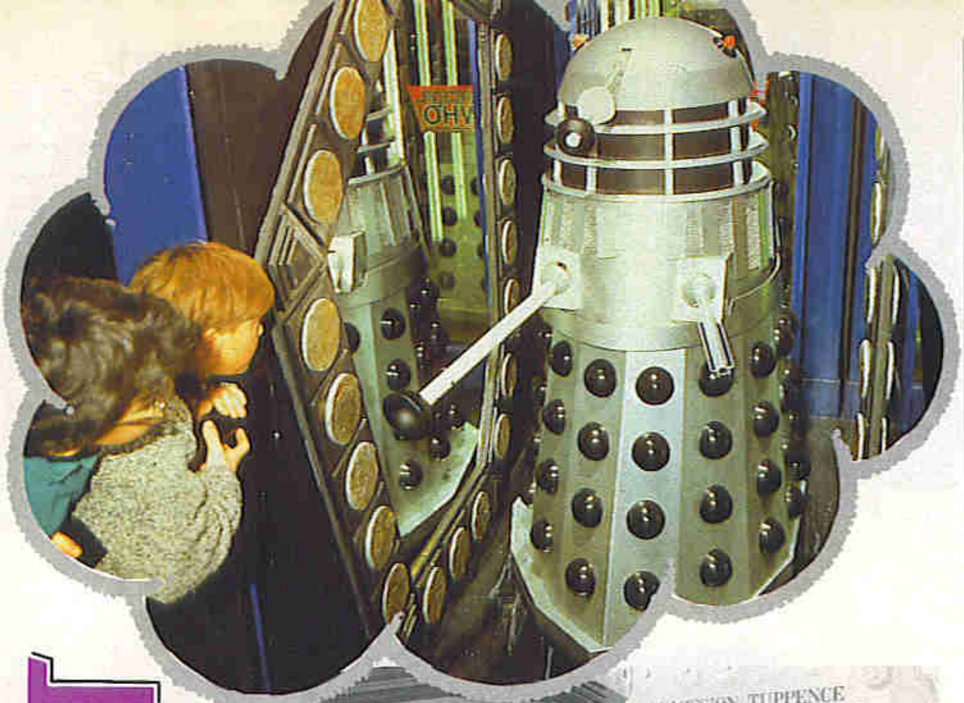
MOMI statistics flow nearly as fast as bullets fly in the average Western; there are over 50 different permanent exhibition areas, over 3,000 square metres of space, 6 actor-guides in attendance at any one time, 72 LaserVision videodisc players enabling images to be shown continuously throughout the exhibits, over 1,000 video sequences shown continuously (each under computer control allowing controlled selection in only one or two seconds), and compilation films in 20 areas. Talking about compilation films, the incredible 'Precious Images', an Oscar-winning 'short' that presents 500 film extracts in six minutes, is definitely in the 'not to be missed' category. If that clip ever gets put on sale, it would go straight in at 'number one' on the video sales list, and stay there until further notice.

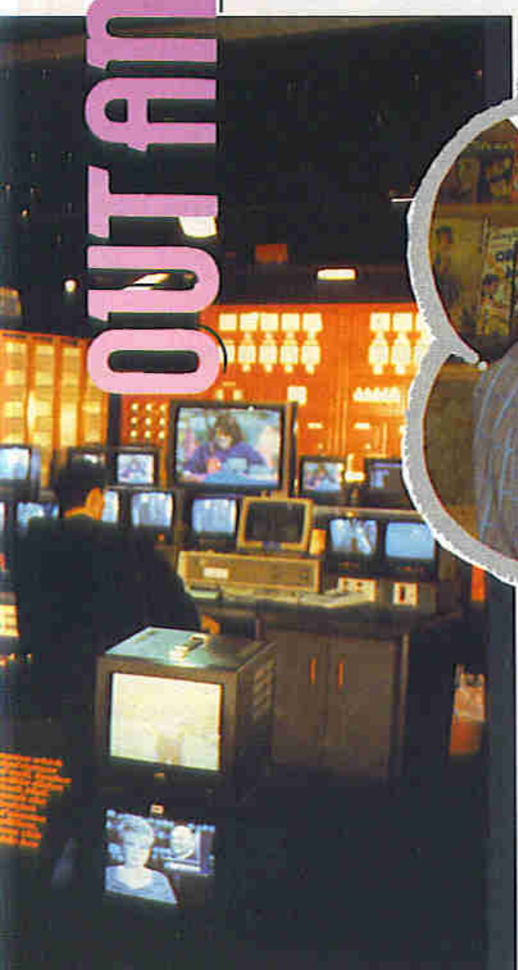
Behind the Screens

At MOMI, film is used whenever the art of cinema is under consideration. Video, however, is used for all television-originated images, where a film is shown for content rather than reproduction quality, or for small-screen exhibits. For the continuous display of film, special endless-loop film handlers are used.

MOMI is part of the British Film Institute and is the sister organisation of the National Film Theatre, sharing the site on London's South Bank. Margaret Thatcher, then Prime Minister, would have been pleased to know that it was built without government subsidy (What's one of those? – Ed.) at a cost of £12 million. The Museum has certainly justified this level of expenditure, having notched up an impressive array of awards, including the British Authority 'Come to Britain' Trophy, the English Tourist Board 'Development Award for a Visitor Attraction', and the







Above: The Western set at MOMI. Ever fancied stepping into the cowboy boots of John Wayne, Audy Murphy or Randolph Scott?
Top: Face to sink-plunger with Doctor Who's worst enemy.
Above centre: In the first decade of the 20th century, increasingly luxurious cinemas were being built to accommodate ever-growing audiences. Tribute to these is paid in MOMI's 'Electric Cinema'.
Left: MOMI's Control Room, an exhibit itself.

Times' 'Museums Year Award'. Now MOMI itself is issuing some awards; in association with Channel 4, it is inviting young animators to submit a proposal for an animated film of 3 to 6 minutes duration, comprising an outline storyboard and drawings. The four winners will each win a MOMI scholarship of £2,400, a budget of up to £1,250 towards animation materials, and the possibility of being commissioned by the TV channel for full production funding.

The history of the cinema, of course, predates MOMI by many generations. Perhaps the peak of movie theatre attendance was back in the pre-TV era of 1946 when there was an astonishing 1,635,000,000 admissions in the UK alone. Then, each film-goer paid a now equally astonishing sum of one shilling with the top price (back seat stalls) at just 3 shillings and sixpence. Just try getting into any of today's movie theatres for the equivalent of 5 pence; although this frugal sum would have bought a lot more then than it does now! In the West End you are unlikely to get much change out of £10 (elsewhere a fiver) – hardly the stuff of which cinema revivals are made! Perhaps film distributors feel that they can make more money out of video and pay-TV!

Shimmy with Marilyn

Opened in 1988 by HRH the Prince of Wales, MOMI was conceived some seven years previously. Over 200 experts from all areas of the film and TV industries have contributed to the success of the Museum. In addition to its permanent exhibits, MOMI hosts three to four changing exhibitions annually (themes range from Magic Lanterns to the Muppets) and it continues to develop, with regular new acquisitions, such as a towering 'stand-in' model of Frankenstein's Monster from the classic 1935 production of 'The Bride of Frankenstein', Marilyn Monroe's shimmy dress from the film 'Some Like it Hot', and Charlie Chaplin's hat and cane. Other new acquisitions include a large selection of cameras on loan from the Samuelson Collection,

Taking Mummy to MOMI

At MOMI, there are exhibits that will appeal to all members of the family at major 'experiences' (a PR buzzword coined by today's financially-motivated museums) include being screened 'soaring over London' by a method of video colour separation overlay ('chromakeying'), reading the news by autocue and being interviewed by Barry Norman, the BBC's outspoken film critic. Here, thanks to a complex control system, you can watch a rerun of your 'on-air' news and interview attempts. One presentation that will please Mummy is a rather quaint display of renovated TV sets showing programmes of the appropriate vintage. There is also a nine-monitor videowall presenting the history of TV commercials, the soundtrack being heard through a personal handset.

K9, a Dalek, and the Giant Robot walk through the doors of the Tardis, straight from MOMI's recent 'Doctor Who' event. Nearby video monitors show compilations from this cult TV sci-fi series.

The driving force behind MOMI's design is technical manager Charles Beddow, who has been awarded an MBE for his efforts in promoting excellence in moving image projection. Charles, who doubles as technical manager of the National Film Theatre, is a self-confessed movie enthusiast. He is also the founding member of the Projected Picture Trust, a charity whose aim is to preserve valuable cinema equipment.

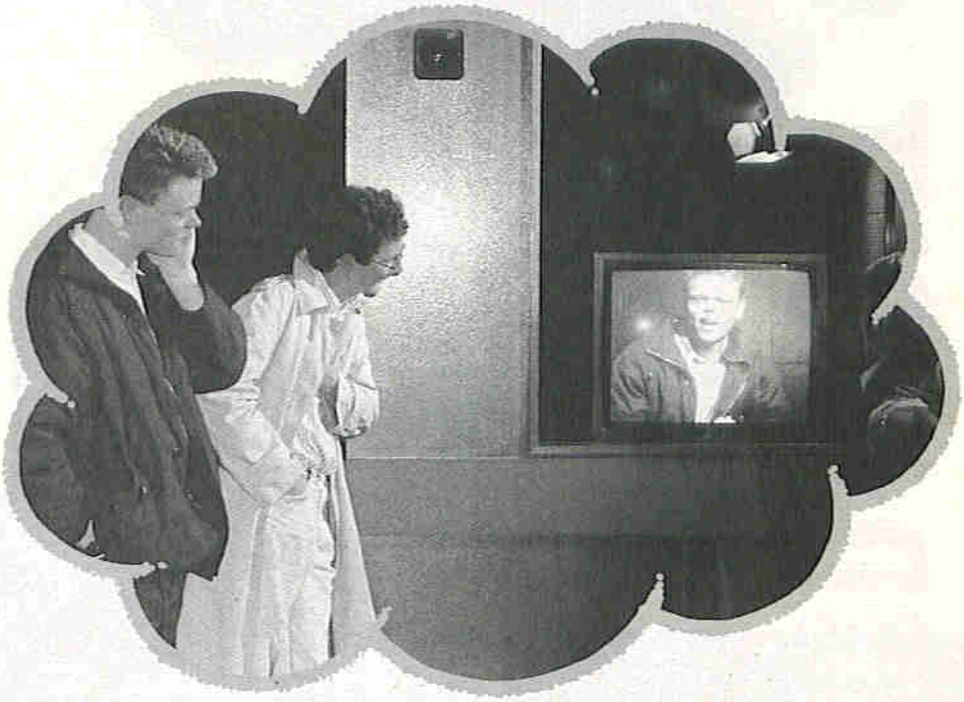
Charles was also responsible for the design of the British Pavilion at Japan's Expo '85. For continuous audio-visual presentation, the LaserVision system was chosen. As he confirms, videodisc offers superior sound and picture quality over videotape, needs less maintenance and, most importantly, needs no rewind interval. Ironically, LaserVision was marketed in the early Eighties as a domestic system by Philips but, despite its technical superiority over all other home video products of the time, it was a commercial 'flop' in Europe. This was, no doubt, due to the fact that it was a 'play only' medium. In professional circles, however, it has been far more successful – as its use by MOMI will testify. To keep costs down, every disc player (there are 70 in total) is normally shared by several exhibits; depending on their length, several programmes may fit onto one of the double-sided 12in. discs, each of which can hold up to 72 minutes of high-quality video and stereo sound.

Although the Museum was conceived and created by Leslie Hardcastle and David Francis, it was Charles who had the responsibility for converting the then 48 car parking spaces under Waterloo Bridge, into MOMI. Many problems had to be overcome before the Museum was completed. For example, the MOMI ceiling is in fact the underneath of the bridge, which contracts by about 100mm during the winter months, and expands again as it gets warmer. As a result, none of the museum exhibits must be allowed to touch the ceiling. Designing and implementing high technology calls for significant funding. "In line with most museums", says Charles, "MOMI is competing hard for customers in these less than buoyant times, but thanks to its range of innovative attractions, the Museum is doing remarkably well."

The main deck of MOMI, explains Charles, is a false floor. Despite the local authority's (rather expensive) decision to designate the museum as a cinema, which meant that all cabling had to be enclosed in metal trunking, and that firebreaks had to be installed at regular positions, the team managed to lay the services pipework and 50 miles of cable in good time. Apart from power, these cables include video/audio signal lines and optical fibre data links for the computers.

The overall aim, says Charles, is to get audience participation. For this reason, most exhibit demonstrations do not last beyond six minutes – enough time for the visitors to understand what is going on without creating a 'bottleneck'. Equipment, meanwhile (particularly telephone handsets), has to be robust to withstand being continually handled by a million or more visitors a year. Not all the equipment survived the initial pressures, and had to be replaced or redesigned.

As can be expected from MOMI, there is no shortage of (operational) projectors. "We can show anything from 8mm to 70mm, and also 3D to video," says Charles.



Top: This screen, guarded by *Star Wars* Stormtroopers, is based on a film set from H.G. Wells – *Things to Come*.
Above: Reading the news from an Autocue is just one of MOMI's 'interactive' exhibits.

Lights, Sound, Camera, Action...

MOMI also provides the opportunity to audition for a movie role. Budding actors and technicians are invited to 'play act' a typical Western brawl – your intrepid 'Out and About' reporter was assigned the role of sound effects man, which entailed the banging of a toolbox lid to simulate the sound of shooting. He is still awaiting his call to Hollywood! (don't give up your day job! – Ed.).

Most evenings, there are special 'Master Class' screenings in the MOMI Cinema. Typical are lectures about adding live music to silent performances, costumes for film, modern TV and film puppetry, and features on a diverse range of subjects ranging from children's TV to the sixties Hippy cult. There is also a flourishing MOMI education programme, with a series of one-day events, workshops and seminars for children, adults and teachers. The programme embraces such areas as home video, as well as the standard topics of English, history, art, geography, design and technology. Also on the MOMI curriculum is maths – in the form of animation, 2D/3D shapes, bar charts and graphs. Special teaching packs and material are available.

In keeping with its proclaimed objectives, most of the permanent exhibition areas in the Museum make use of some form of moving image. Behind much of the electronics is the specialist lighting, sound and image company Electrosonic. The company was responsible for developing and installing the equipment, a combination of standard video equipment together with specially designed sub-systems. Although where possible MOMI uses 35mm film, all of the small moving images are displayed on video screens; in addition, many exhibits utilise slide projection techniques.

Where a large image (anything over 10 feet wide) is required, the cost of installing and running 35mm equipment in permanent locations is less than that of video. An added bonus is the fact that film has a superior image quality to that offered by present-day video.

All the LaserVision players are controlled in groups of three by a controller unit. Depending on the exhibit, continuously repeated or randomly accessed programmes are shown. In all cases the controllers act as computer peripherals, receiving data from the central computer. An advantage of having a separate controller is that it is relatively easy to replace a faulty unit with a back-up.

Multimedia

The 'Sound in the Cinema' experience is driven by a video projector, but includes a host of historic exhibits relating to the development of cinema sound. These light up and run during the sequence. The video and main sound track, as well as the lighting sequences are driven by a rack-mounted PC, using a standard multimedia control program. To give an idea of the complexities involved, the Odeon foyer reconstruction requires the combined resources of 4 disc players, 4 monitors, one video tape machine, six slide projectors and a computer to run two different shows in succession. Electrosonic were also aware of the need for visitors to actually see the projecting equipment at work. In one case you can see two endless-loop platters working in a projection room.

In Control

Also on public show is the central control room, which requires a technician to be present the whole time the Museum is in operation. Thanks to a battery of monitors, the operator can maintain automatic control of the entire shooting match, monitoring security and fire requirements by means of a series of remote switching cameras. If necessary, a PA can relay a public announcement.

Visitors will be able to see a control room brimming over with 17 instrument racks, switching equipment, monitors and computers, not to mention the aforementioned 70 videodisc players. The room also houses the main power distribution and printers, which supply details of the state of the museum and the number of visitors present.

It is from this room that the temperature is controlled throughout the Museum. The system is programmed to optimise the usage of heat in the building; if 1000 visitors are present, then the heating (no longer required due to all that body heat) will be shut down. Apart from being an efficient and sensible management of energy, visitors feel more comfortable - cinemas take note! It is interesting to note that organisations like MOMI, who are not associated in any way with 'green marketing', are the ones actually doing something to minimise wastage of resources! In a similar way, the Museum's audio system monitors the ambient sound level, allowing it to be matched to the number of (noisy) visitors present.

Pop Goes the Video

At the time of writing, one of the special exhibitions at MOMI is the IRN-BRU Pop Video Exhibition. As the name suggests, a huge selection of music films and videos is on offer, allowing the visitors to determine for themselves whether the pop video is simply a modern phenomenon of the 'three-minute-culture' generation eagerly exploited by the record industry, or a legitimate contemporary art form in its own right. The exhibition captures the whole history of music on film from the first film 'talkie', when Al Jolson sang to an excited cinema audience in 'The Jazz Singer' back in 1927, through to Queen's Bohemian Rhapsody (quoted by many as the most influential pop video ever), and MTV's eye-catching 24-hour methods of music presentation. You too can join Elvis in a cell (Jailhouse Rock) and see the ethereal film-work with which the Beatles chose to promote 'Strawberry Fields Forever'. The exhibition is scheduled to run to January 1993, so you may have to hurry! To deal with the anticipated demand, the Museum has installed a new DEC-based reservation system which allows visitors to book – not only on specific dates, but at specific times. At the close of its season at MOMI, the Pop Video exhibition will be going on tour.

Fatal Attraction

So, if you can't get no satisfaction from your TV set or local cinema, or you need to make some close encounters of the film kind, you should lose little time desperately seeking out MOMI.

MOMI is open every day (except 24th to 26th December) from 10am to 6pm. Allow at least two hours for your visit! Ticket prices are £5.50 (adults), £4 (children and concessions), and £4.70 (students). In addition, there is a family ticket (costing £16) which admits 2 adults and up to 4 children. For details contact MOMI, South Bank Centre, Waterloo, London, SE1 8XT, or listen to its 24-hour recorded information telephone hotline on 071-401 2636. Budding animators should contact Nick Golding on 071-815 1376.

'Electronics – The Maplin Magazine' is providing some positive encouragement. MOMI have kindly provided us with six family tickets, normally worth £16 each. To win one, all you have to do is answer four simple questions. All entries will, as always, be put into the Editor's (somewhat threadbare) festive hat, and will be drawn on 31st December 1992 (that's if I survive the left-over turkey sandwiches! – Ed.). We also have copies of the glossy MOMI souvenir brochure for three runners-up.

Multiple entries will be disqualified from the draw – only one entry per household, please. Post your entry (answers, name, address and daytime telephone number) to: 'MOMI Contest'. The Editor, 'Electronics – The Maplin Magazine', P.O. Box 3, Rayleigh, Essex, SS6 8LR.

1. Is Hollywood a suburb of:
   a) San Francisco?
   b) San Diego?
   c) Los Angeles?
2. Spot the world's most famous film dog.
   a) Lassie.
   b) ET.
   c) K9.
3. Spot the odd one out.
   a) Goldfinger.
   b) Sound of Music.
   c) Octopussy.
4. What does the film code PG stand for?
   a) Sponsored by a well-known tea supplier.
   b) Paying Guest.
   c) Parental Guidance.

WAVEFORM GENERATOR CIRCUITS

Part 4 by Ray Marston

Ray Marston takes an in-depth look at pulse generator circuits in the fourth part of this 'Circuits' series.

Last month Part 3 looked at a selection of practical square-wave generator designs. This part concentrates on practical pulse-generators; these are circuits that produce a single or 'one-shot' rectangular output waveform cycle when triggered by a suitable input signal. Such generators may take several basic forms, and can be designed around a variety of semiconductor devices.

Pulse Generator Basics

Circuit designers often have to devise means of generating pulse waveforms. If the need is to simply generate a pulse of non-critical width on the arrival of the leading or trailing edge of an input square-wave, a circuit element known as a 'half-monostable' or edge-detector may be used, as shown in Figure 1. Alternatively, if the need is to generate a pulse of some specific width on the arrival of a suitable trigger signal, a standard monostable or 'one-shot' multivibrator circuit may be used.

In the standard monostable circuit, the arrival of the trigger signal initiates an internal timing cycle which causes the monostable output to change state at the start of the timing cycle, but to revert back to its original state on completion of the cycle, as shown in Figure 2.

Note that once a timing cycle has been initiated the standard monostable circuit is immune to the effects of subsequent trigger signals until its timing period ends naturally.

This type of circuit can sometimes be modified by adding a RESET control terminal, as shown in Figure 3, to enable the output pulse to be terminated or aborted at any time via a suitable command signal.

A third type of monostable circuit is the 'retriggerable' monostable. Here, the trigger signal actually resets the monostable and then, after a very brief delay, initiates a new pulse-generating timing cycle, as shown in Figure 4, so that each new trigger signal initiates a new timing cycle, even if the trigger signal arrives in the midst of an existing cycle.

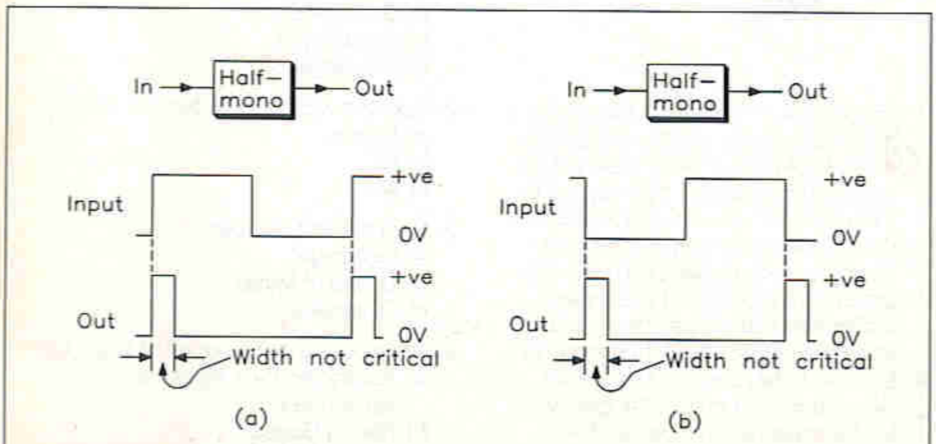


Figure 1. A 'half-monostable' circuit may be used to detect (a) the leading or (b) the trailing edge of an input waveform.

Thus, the circuit designer may use a half-monostable, a standard monostable, a resettable monostable, or a retriggerable monostable to generate pulses, the 'type' decision depending on the specific circuit design requirements.

The pulse generator may be designed around a variety of types of semiconductor device, or may be designed around a dedicated pulse generator IC; the choice is usually dictated by considerations of economics and convenience, rather than by the actual design requirements.

'Half-Monostable' Pulse Generator Circuits

The simplest of all pulse generators is the 'half-monostable' type. One of the most popular applications of this is as an 'edge detector', which generates a simple output pulse on the arrival of the leading or the trailing edge of a rectangular input waveform; the precise width of the output pulse is usually non-critical.

The basic method of making an edge-detector is to feed the rectangular input waveform to a short-time-constant C–R differentiation network, to produce a positive output spike on the arrival of each leading edge and a negative one on each trailing edge, and to then eliminate the unwanted waveform spike with a discriminator diode. The remaining sawtooth-shaped spike is then converted into a clean pulse shape by feeding it through a Schmitt trigger circuit.

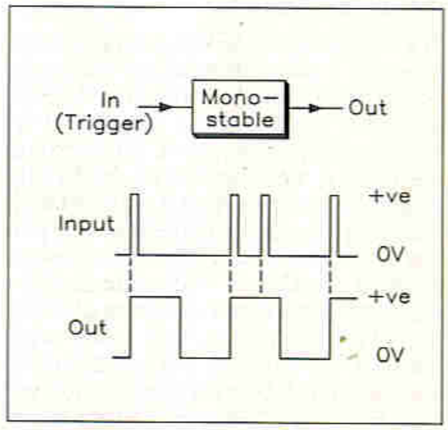


Figure 2. A standard monostable generates an accurate output pulse on the arrival of a suitable trigger signal.

The simplest way of making a practical edge-detector is to use a CMOS Schmitt trigger IC, since these incorporate built-in protection diodes on all input terminals, and these can be used to perform the discriminator diode action described above. Figures 6 to 8 show a selection of edge-detector designs based on CMOS Schmitt stages. Note that each gate of the popular 4093B quad 2-input NAND Schmitt IC can be used as a normal Schmitt inverter by wiring one input terminal to the positive supply rail and using the other terminal as the input point, as shown in Figure 5, which also shows how a non-inverting Schmitt can be made by wiring two inverting Schmitts in series.

Figure 6a shows a practical leading-edge detector circuit. Here, the Schmitt's input is tied to ground via R, and C–R have a time-constant that is short relative

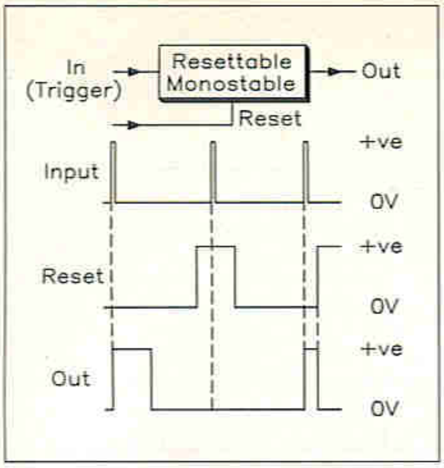


Figure 3. The output pulse of a resettable monostable can be aborted by a suitable reset pulse.

to the period of the input waveform. The leading edge of the input signal is thus converted into the 'spike' waveform shown, and this spike is then converted into a good clean pulse waveform via the Schmitt. The circuit generates a positive-going output pulse with a period (P) of roughly 0·7CR.

Figure 6b shows how to make a trailing edge detecting half-monostable. In this case the CMOS Schmitt input is tied to the positive supply rail via R, and C–R again has a short time constant. The circuit also generates a positive-going pulse with a period of roughly 0·7CR.

Circuit Variants

Two useful variants of the edge-detecting half-monostable circuit are the 'noiseless' push-button switch of Figure 7 which eliminates the adverse effects of switch contact bounce and noise, and the power-on reset-pulse generator circuit of Figure 8, which generates a reset pulse when power is first applied to the circuit.

In Figure 7, the Schmitt's input is grounded via R1 and R2, so the circuit's output is normally low. When push-button switch PB1 is closed, C1 charges rapidly to the full positive supply value, driving the Schmitt output high, but when PB1 is released again C1 discharges relatively slowly via R1, and the Schmitt output does not return low until roughly 20ms later. The circuit thus ignores the transient switching effects of PB1 noise and contact bounce, etc., and generates a clean output pulse of roughly 20ms longer than the mean duration of the PB1 closure.

The Figure 8 'power-on reset-pulse generator' circuit produces a 700ms pulse (suitable for resetting external circuitry, etc.) when power is first applied. When power is initially connected C1 is fully discharged, so the Schmitt input is pulled low and its output is switched high, C1 then charges via R1 until, after about 700ms, the C1 voltage rises to such a level that the Schmitt output switches low completing the switch-on output pulse.

4001B/4011B CMOS Monostable Circuits

The cheapest and easiest way of making a standard monostable is to use a CMOS 4001B quad 2-input NOR gate or a 4011B quad 2-input NAND gate IC one of the configurations shown in Figures 9 or 10. Note, however, that the output pulse widths of these circuits are subject to fairly large variations between individual ICs and with variations in supply rail voltage, and these circuits are thus not suitable for use in high-precision applications.

Figures 9 and 10 show alternative versions of the standard monostable circuit, each using only two of the four available gates in the specified CMOS package. In these circuits the output pulse duration is set by the C1–R1 values, and approximates of 0·7 x C1 x R1. Thus, when R1 has a value of 1M5 the pulse period is roughly one second per µF of C1 value. In practice, C1 can have any value from about 100pF to a few thousand µF, and R1 can vary from 4k7 to 10M.

Note in these circuits that the input trigger pulse or signal can be direct coupled and its duration has little effect on the length of the generated output pulse. The NOR version of the circuit (Figure 9) has a normally-low output and is triggered by the edge of a positive-going input signal, and the NAND version (Figure 10) has a normally-high output and is triggered by the edge of a negative-going input signal.

Also note that the pulse signal appearing at 'A' has a period equal to that of either the output pulse or the trigger pulse, whichever is the greater of the two. This feature is of value when making pulse-length comparators and over-speed alarms, etc.

The operating principle of these monostable circuits is fairly simple. Look first at the case of the Figure 9 circuit, in which IC1a is wired as a NOR gate and IC1b is wired as an inverter. When this circuit is in the quiescent state the trigger input terminal is held low by R2, and the output of IC1b is also low. Thus, both

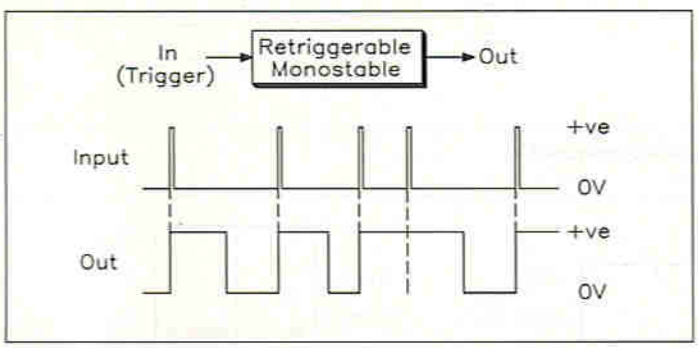


Figure 4. A retriggerable monostable starts a new timing cycle on the arrival of each new trigger signal.

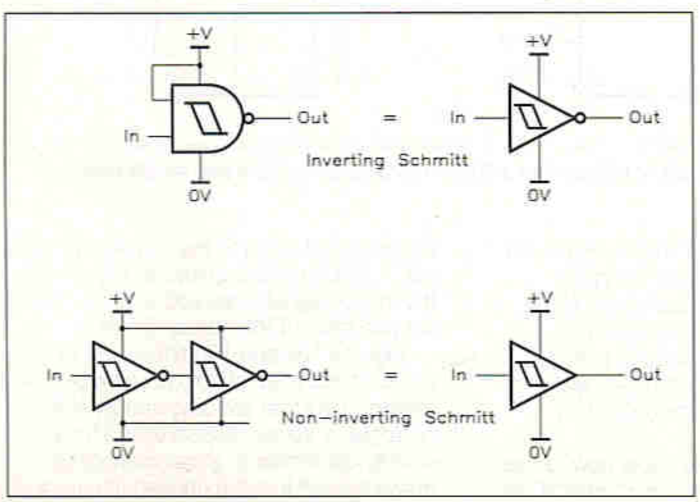


Figure 5. Ways of using a 4093B CMOS 2-input NAND gate to make an inverting or non-inverting Schmitt trigger stage.

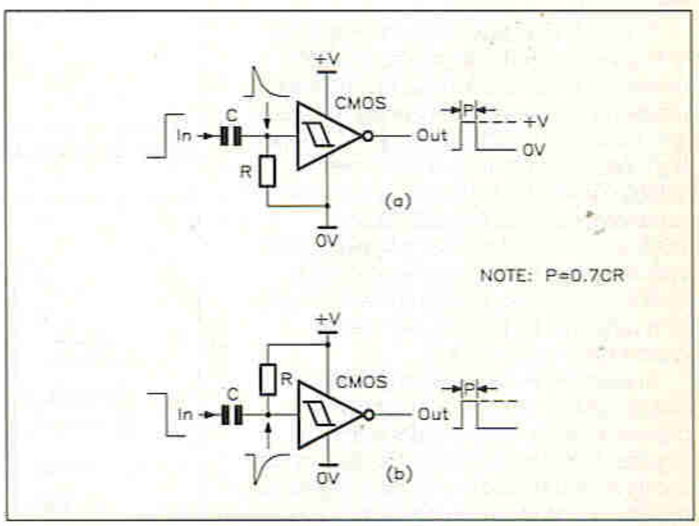


Figure 6. CMOS leading-edge (a) or trailing-edge (b) detector circuits.

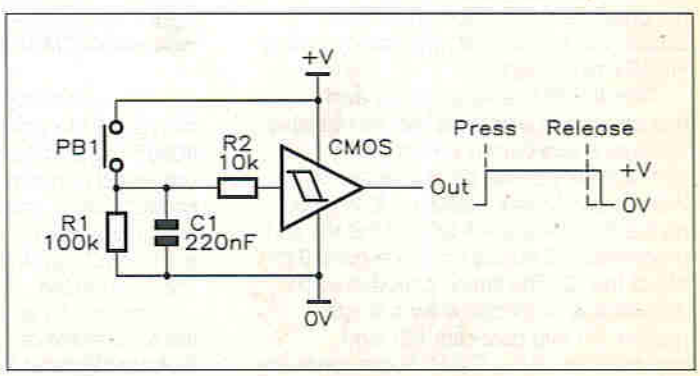


Figure 7. CMOS 'noiseless' push-button switch.

inputs of IC1a are low, so IC1a output is forced high and C1 is discharged.

When a positive trigger signal is applied it forces the output of IC1a low and (since C1 is discharged at this moment) pulls IC1b input low and thus drives IC1b output high; IC1b output is coupled back to the IC1a input, however, and thus forces IC1a output to remain low irrespective of the prevailing state of the trigger signal. As soon as IC1a output switches low, C1 starts to charge up via R1 and, after a delay determined by the C1–R1 values, the C1 voltage rises to such a level that the output of IC1b starts to swing low, terminating the output pulse. If the trigger signal is still high at this moment, the pulse ends non-regeneratively, but if the trigger signal is low (absent) at this moment it ends regeneratively.

The Figure 10 circuit operates in a similar way, except that IC1a is wired as a NAND gate, with its trigger input terminal tied to the positive supply rail via R2, and the R1 timing resistor is taken to ground.

4047B/4098B CMOS Monostables

A number of dedicated CMOS and TTL monostable pulse generator ICs are available; the best known of the CMOS devices are the 4047B monostable/astable IC, and the 4098B dual monostable (a greatly improved version of the 4528B). These ICs have rather poor pulse-width accuracy and stability, but are quite versatile and can be triggered by either the positive or the negative edge of an input signal, and can be used in either the standard or the retriggerable mode. Figure 11 shows the outlines and pin notations of the two ICs.

The 4047B actually houses an astable and a frequency-divider stage, plus logic networks. When used in the monostable mode the trigger signal starts the astable and resets the counter, driving its Q output high. After a number C–R controlled astable cycles the counter flips over and simultaneously kills the astable and switches the Q output low, completing the operating sequence. Consequently, the C–R timing components produce relatively long output pulse periods, this period approximating 2·5 x C x R.

In practice, R can have any value from 10k to 10M. C must be a non-polarised capacitor with a value greater than 1nF. Figures 12a and 12b show how to connect the IC as a standard monostable triggered by either positive (a) or negative (b) input edges, and Figure 12c shows how to connect the monostable in the retriggerable mode. Note that these circuits can be reset at any time by pulling RESET pin 9 high.

The 4098B is a fairly simple dual monostable, in which the two monostable sections share common supply connections but can otherwise be used independently. Monostable–1 is housed on the left side (pins 1 to 7) of the IC, and monostable–2 on the right side (pins 9 to 15) of the IC. The timing period of each monostable is controlled by a single resistor (R) and capacitor (C), and approximates 0·5 x C x R. R can have any value from 5k0 to 10M, and C can have

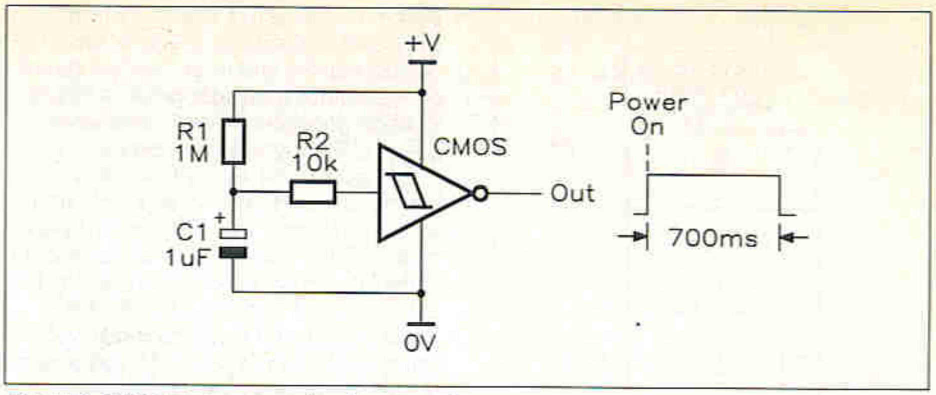


Figure 8. CMOS power-on reset-pulse generator.

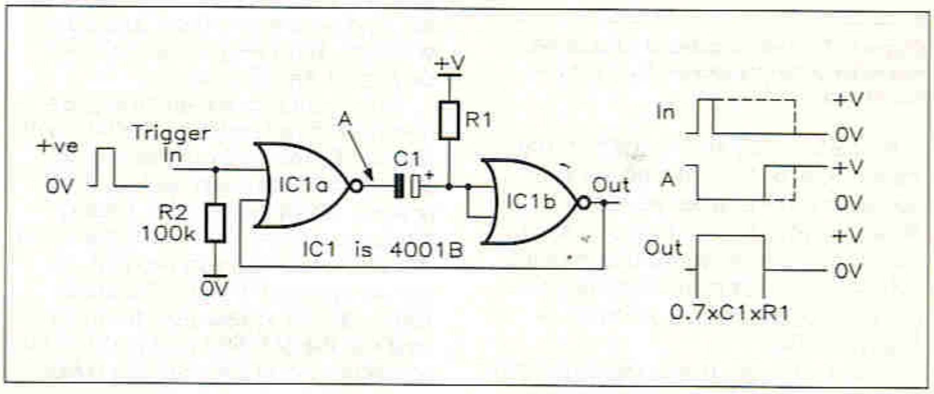


Figure 9. CMOS 2-gate NOR monostable.

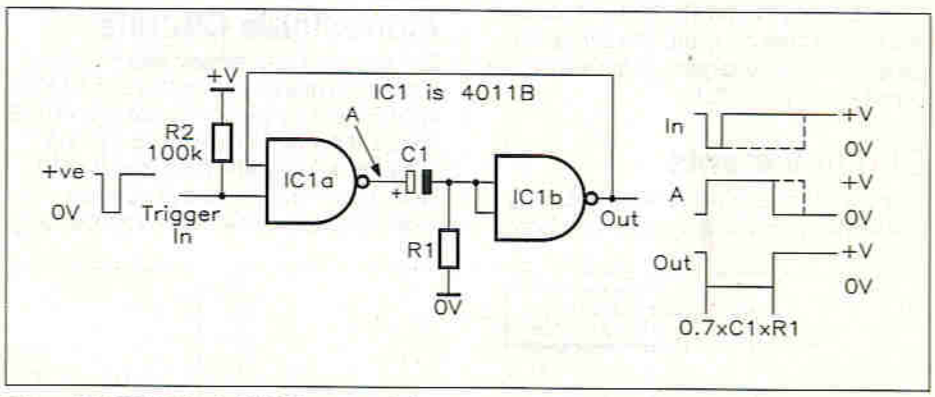


Figure 10. CMOS 2-gate NAND monostable.

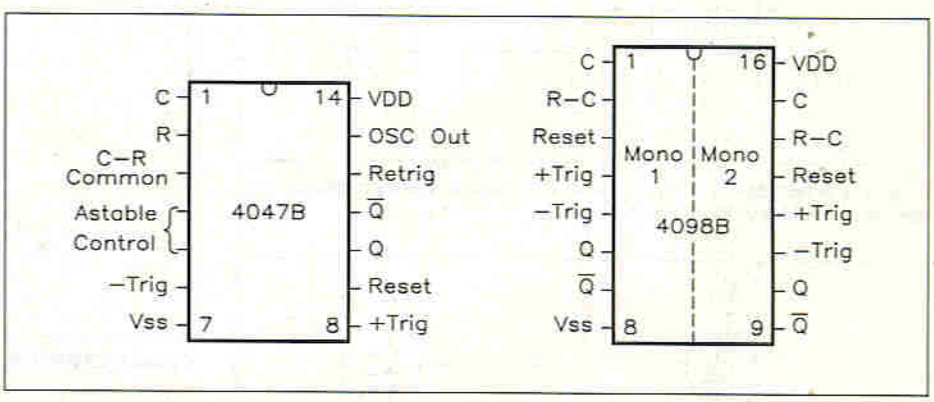


Figure 11. Outlines and pin notations of the 4047B monostable/astable and 4098B dual monostable CMOS ICs.

any value from 20pF to 100µF. Figure 13 shows a variety of ways of using the 4098B. Note in these diagrams that the bracketed numbers relate to the pin connections of monostable–2, and the plain numbers to monostable–1, and that the RESET terminal (pins 3 or 13) is shown disabled.

Figures 13a and 13b show how to use the IC to make retriggerable monostables that are triggered by positive or negative input edges respectively. In Figure 13a the trigger signal is fed to the '+ TRIG' pin and the '– TRIG' pin is tied low. In Figure 13b the trigger signal is applied to the '– TRIG' pin and the '+ TRIG' pin is tied high.

Figures 13c and 13d show how to use the IC to make standard (non-retriggerable) monostables that are triggered by positive or negative edges respectively. These circuits are similar to those mentioned above except that the unused trigger pin is coupled to either the Q or the not-Q output, so that the trigger pulses are blocked once a timing cycle has been initiated.

Finally, Figure 13e shows how the unused half of the IC must be connected when only a single monostable is wanted from the package. The '– TRIG' pin is tied low, and the '+ TRIG' and RESET pins are tied high.

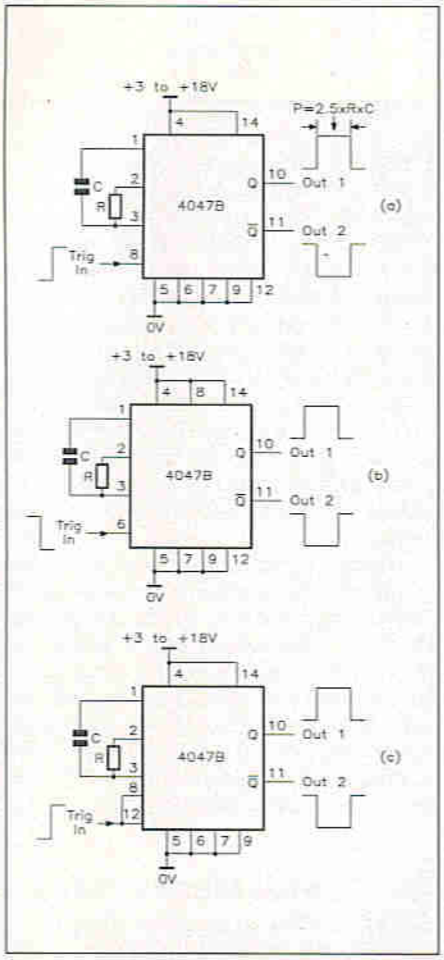


Figure 12. Various ways of using the 4047B as a monostable. (a) Positive-edge-triggered monostable. (b) Negative-edge-triggered monostable. (c) Retriggerable monostable, positive-edge triggered.

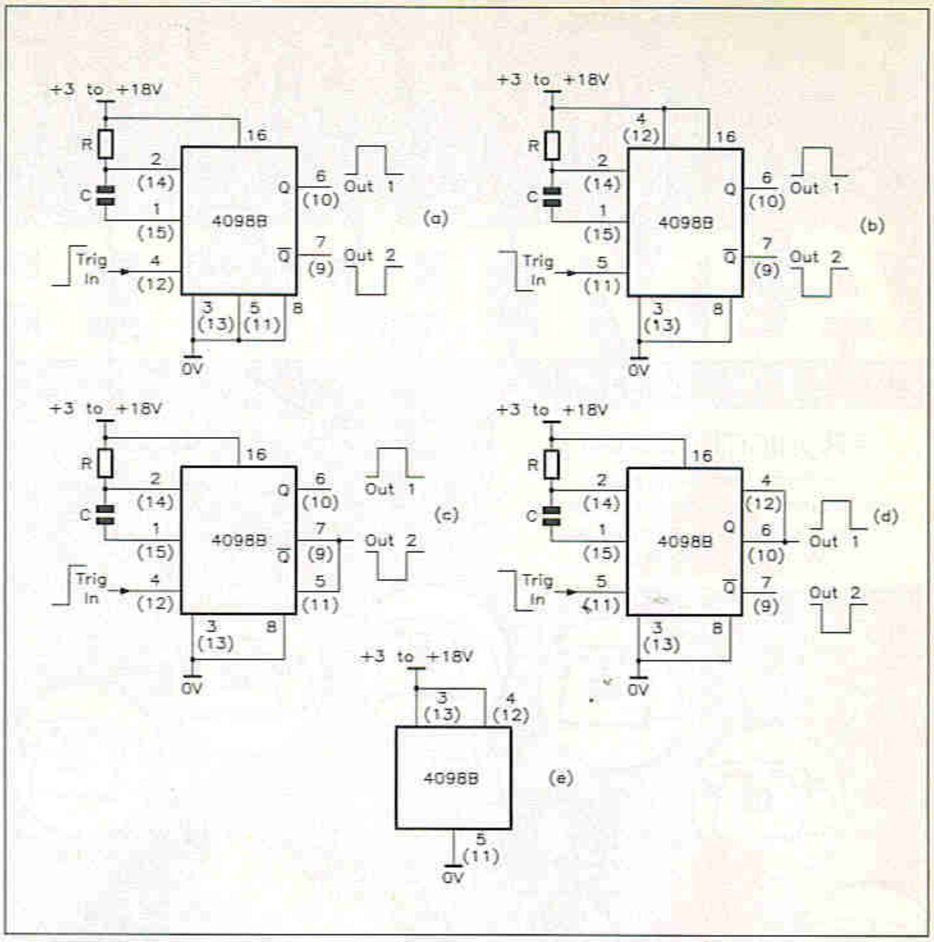


Figure 13. Various ways of using the 4098B monostable. (a) Positive-edge-triggering, retriggerable monostable. (b) Negative-edge-triggering, retriggerable monostable. (c) Positive-edge-triggering (non-retriggerable monostable). (d) Negative-edge-triggering (non-retriggerable monostable). (e) Connections for each unused section of the IC.

The 74121 TTL Monostable

The 74121 is a dedicated TTL monostable pulse generator IC that can usefully generate output pulse widths from a few tens of nanoseconds up to several hundred milliseconds. Figure 14 shows the outline, pin notations, and simplified internal circuit of the device, which can be triggered on either the leading or trailing edges of an input waveform, and has three alternative input trigger terminals.

The normal way to trigger this IC is to tie pins 3 (A1) and 4 (A2) low (at logic 0) and apply the trigger signal to its pin 5 'B' input terminal; Figure 15 shows the IC used in this way and connected as a simple 30ns pulse generator (using its built-in timing components), with the trigger signal applied to pin 5 via a transistor buffer stage. Pin 5 is connected to an internal Schmitt gate, which in this mode triggers the monostable on the leading edge of the input waveform; these inputs can have slow-rising edges.

An alternative to trigger the 74121 is to disconnect input B or tie it to logic 0, and apply the trigger signal (which must have sharp leading and trailing edges) to pins 3 (A1) and/or 4 (A2) of the IC. A1 and A2 are negative-edge triggered logic inputs, and trigger the monostable when the input switches low.

Dealing next with the IC's timing circuitry, note that the IC has three timing-component terminals. A low-value timing capacitor is built into the IC, and can be augmented by external capacitors wired between pins 10 and 11 (positive terminals of polarised capacitors should go to pin 11). The IC also houses a 2k0 resistor, which can be used as a timing component by wiring pin 9 to pin 14, either directly or via an external series resistor (maximum value 40k); alternatively, the internal resistor can be ignored and an external timing resistor (1k4 to 40k) can be wired between pins 11 and 14. Whichever

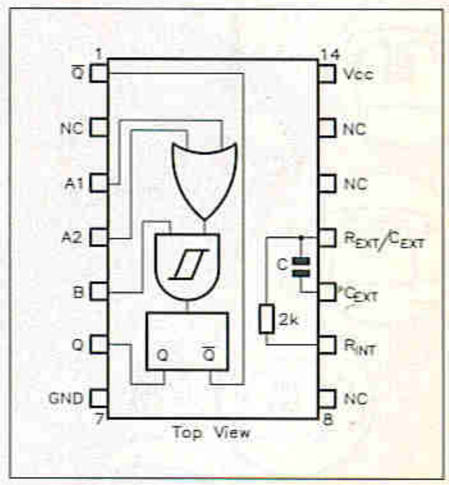


Figure 14. Outline, pin notations, and simplified internal circuit of the 74121 TTL monostable multivibrator IC.

Continued on page 62.

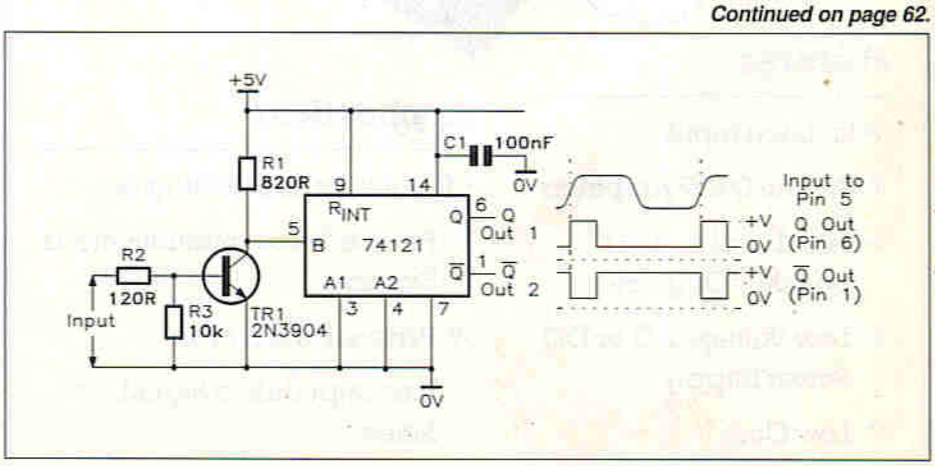
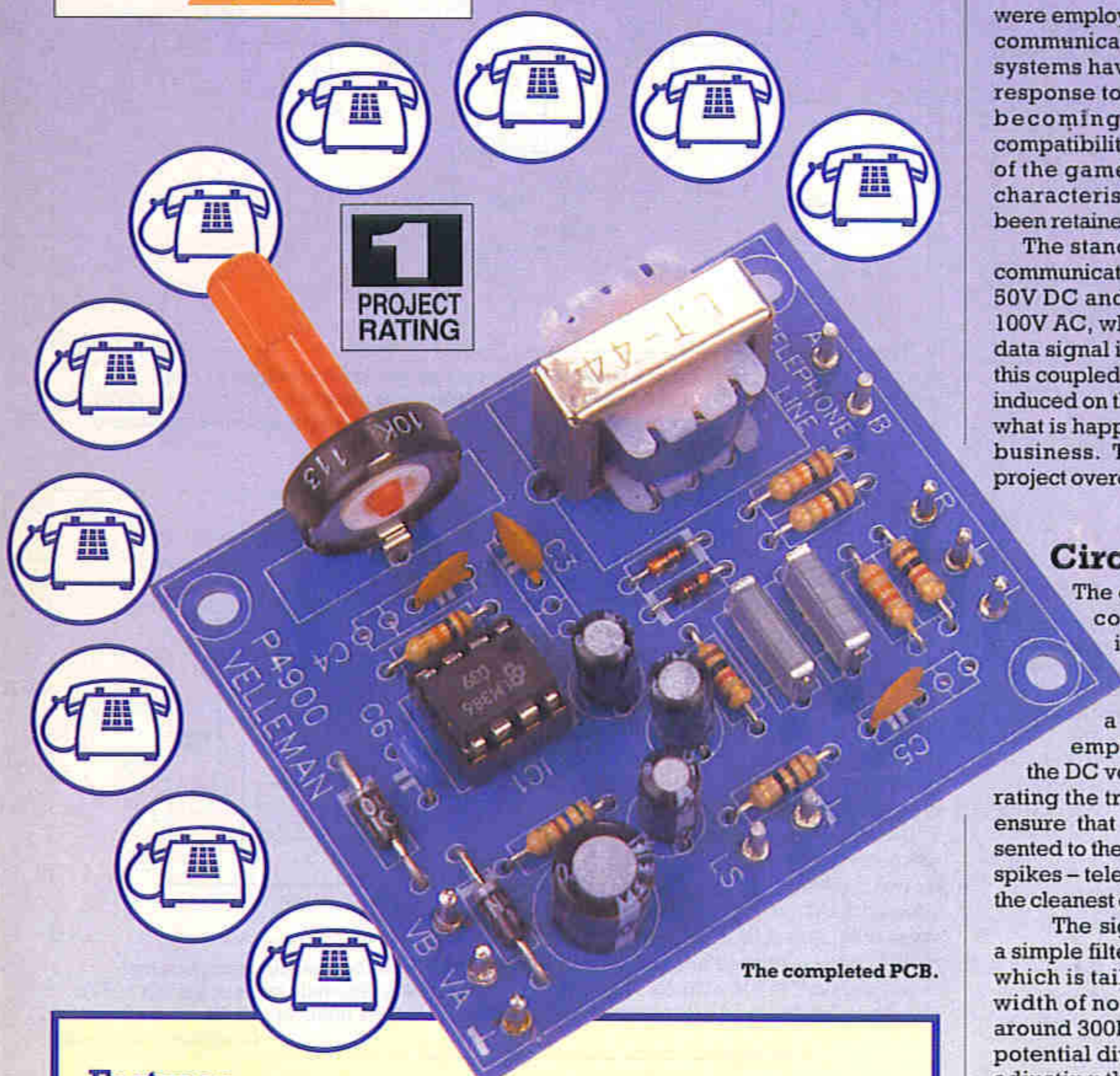


Figure 15. 30ns TTL pulse generator using 'B' input leading edge triggering.

TELECOMMUNICATIONS AMPLIFIER

PROHIBITED from direct or indirect connection to public telecommunication systems. Action may be taken against anyone so connecting this apparatus.

Text by Martin Pipe and Nigel Skeels



The completed PCB.

Telecommunications circuits are notoriously 'unfriendly', mainly due to the origins of such systems. When communications technology was in its infancy, comparatively crude electro-mechanical signalling methods were employed to achieve long distance communication. Over the years, these systems have continuously evolved in response to more modern technology becoming available. However, compatibility was, and still is, the name of the game, so many of the original characteristics have, to some extent, been retained.

The standing line voltage of a telecommunication system is in the order of 50V DC and the ring signal is around 100V AC, whereas the actual speech or data signal is quite low by comparison; this coupled with other noise and spikes induced on the line mean that monitoring what is happening 'on-line' is a difficult business. This simple but effective project overcomes these problems.

Circuit Description

The circuit diagram of the Telecommunications Amplifier is shown in Figure 1. Since complete isolation from the line is essential a transformer (T1) is employed. C1 and C2 prevent the DC voltage on the line from saturating the transformer core. R1 and R2 ensure that only minimal load is presented to the line. D1 and D2 'clip off' any spikes – telephone lines do not provide the cleanest of signals!

The signal is then passed through a simple filter network, the response of which is tailored to the limited bandwidth of normal telephony circuits – around 300Hz to 3kHz. RV1, wired as a potential divider, provides a means of adjusting the signal level to the amplifier stage.

Features

* Isolated Input
* Built-in 0·5W Amplifier
* Line Level and 8Ω Speaker Outputs
* Low Voltage AC or DC Power Supply
* Low Cost

Applications

Monitoring and Testing of:

* Private Telecommunications Systems
* Private Data Lines
* Low Impedance Signal Lines

Important note: Direct or indirect connection of this project to public telecommunications systems is prohibited by law. Action may be taken against anyone so connecting this project. However, this project does have many legitimate uses, including monitoring private telecommunications systems, data lines and other low impedance signal lines where an isolated connection is required.

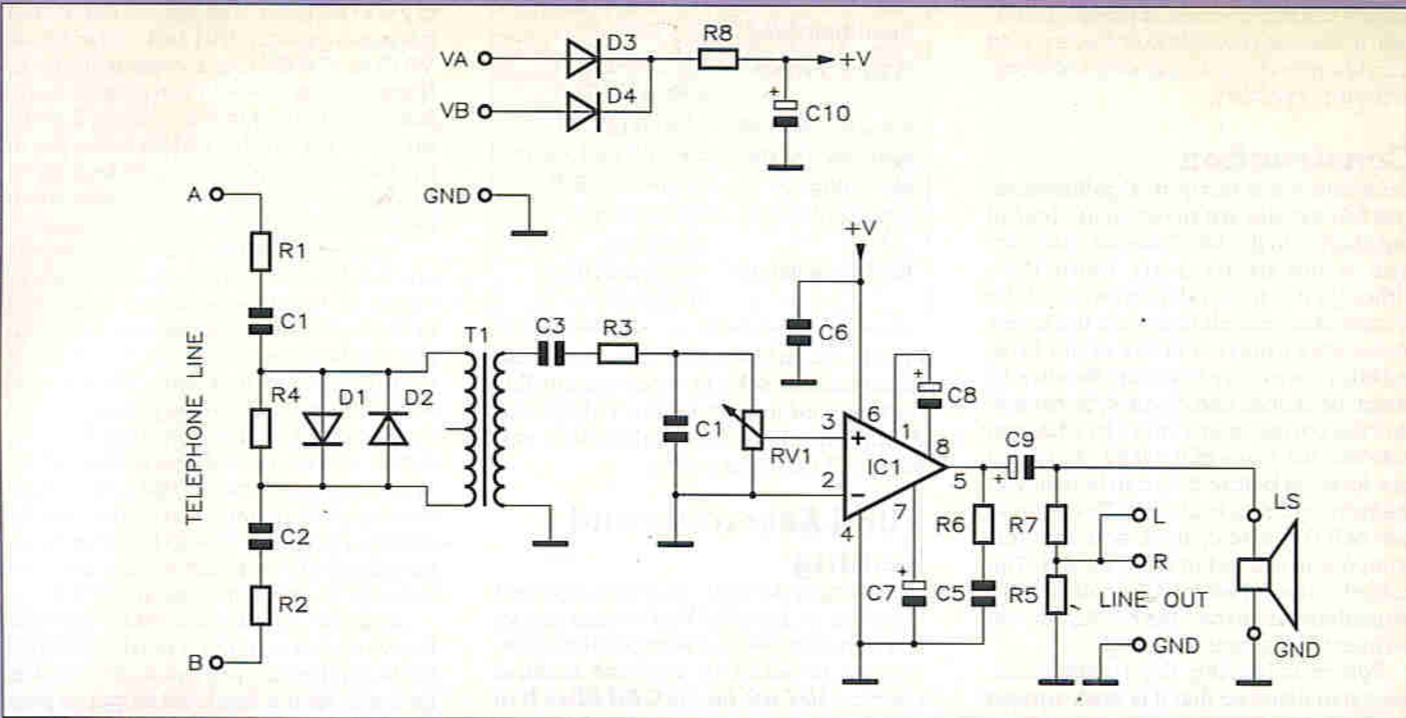


Figure 1. Circuit diagram.

The amplifier circuit is based around the ubiquitous LM386 amplifier IC, which is configured to provide 40dB of (a factor of 100). Power output is specified as 500mW into 8Ω, which is enough to drive a small loudspeaker; YW53H would be ideal. If desired, an additional amplifier can be connected to the line level (0·775V rms) output. This is derived from the amplifier output by means of R5 and R7, which constitute yet another potential divider. The line level output is also ideal for the connection of an external amplifier or test equipment.

A simple full-wave rectifier circuit is provided on board, so that the Telecommunications Amplifier can be powered directly from a 6-0-6V transformer, with a rating of at least 150mA (an ideal choice would be YN14Q). This circuit comprises the rectifier diodes D3 and D4, R8 and reservoir capacitor C10. R8 and C10 form a low-pass filter to attenuate hum and supply-borne noise. A DC

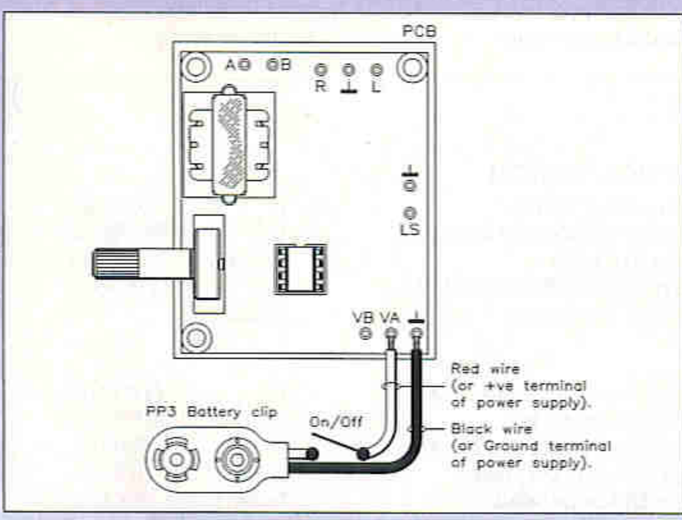


Figure 2. Connections to DC power source (9 to 15V), such as a PP3 battery.

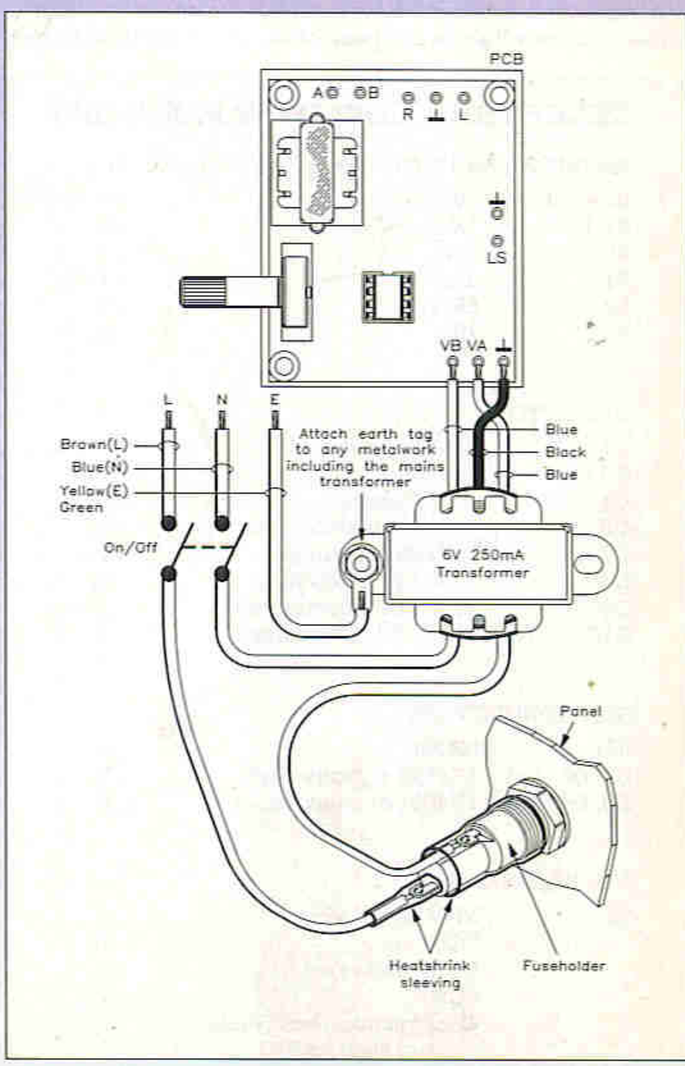


Figure 3. Connections to transformer.

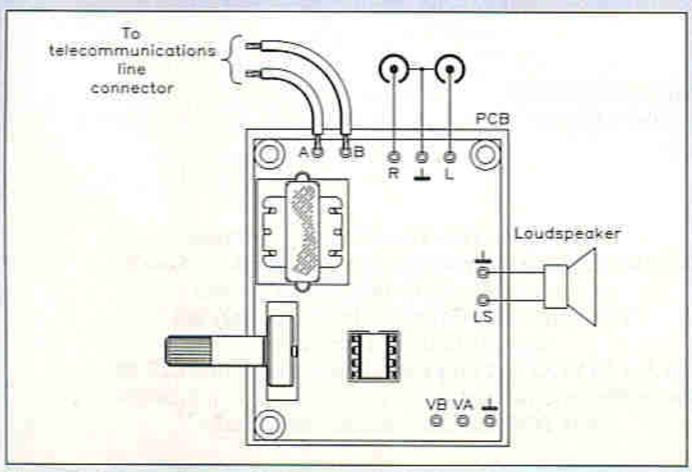


Figure 4. Connections to the input and output connections PCB.

supply can still be used to power the circuit, in this case the relevant diode would provide protection in the event of incorrect supply polarity.

Construction

Construction is fairly straightforward, and full details are given in the leaflet supplied with the kit. Order of construction is not particularly important, although it is generally better to fit the smaller components first since the larger items may obstruct areas of the PCB, making assembly trickier. Be sure to insert the diodes and electrolytic capacitors the correct way round; in addition, note that the leads of the latter will need pre-forming before they can fit neatly to the board prior to soldering. The orientation of IC1 is also critical; note that this component is fitted in an IC socket. The socket, rather than the IC itself, should be soldered in place – the IC chip should be inserted just before testing.

Before soldering the transformer, push it in place so that it is flush against the PCB. The mounting tags and pins should protrude through to the solder side; bend the mounting tags inwards and solder them to their large pads. After soldering in RV1, insert its control shaft and press home.

When fitting the PCB pins, note that they are fitted from the component side. After completing assembly, it is prudent to check your work – finding any incorrectly-placed components could save considerable time and expense later on. Other gremlins to watch out for include solder bridges/whiskers and poor joints.

Specifications

Supply Voltage:	7 to 9V AC or 9 to 15V DC
Supply Current:	150mA (peak)
Speaker Output:	500mW (8Ω load)
Line Output:	0dBm (0·775V)
Input Isolation:	Transformer Coupling
PCB Dimensions:	63(W) x 24(H) x 70(D)mm

Finally, clean the solder side of the PCB with a suitable solvent to remove any flux that may compromise the Telephone Amplifier's long-term reliability, and insert IC1 ready for testing.

Final Assembly and Testing

If powering the unit, via the suggested transformer, from 240V AC mains supply it is imperative that every possible precaution is taken to prevent electric shock. 240V AC mains CAN KILL! If in any doubt as to the correct way to proceed, seek advice from a suitably qualified engineer.

Since the voltage across the telecommunications line connected to the unit will exceed 50V (i.e. a hazardous voltage) and that the unit may also be mains powered, it is essential, for safety reasons, that a suitable enclosure is used to house the project – DO NOT use the plastic box that the kit was supplied in.

The supply for the Telecommunications Amplifier must be able to source at least 150mA (peak). If a DC power supply is to be used, it should be connected between ground (0V) and either VA or VB (9 to 15V DC), as shown in Figure 2. Note that the unit will run satisfactorily from a 9V battery (not included). If a battery is to be used, a switch (inserted in the positive supply line) must be used to prevent continuous current drain when the Telephone Amplifier is not in use.

The suggested 6V-0-6V transformer should be connected up as shown in Figure 3, its centre tap being connected to the unit's GND terminal and the winding 'ends' connected to VA and VB. A double-pole switch and a 100mA fuse should be included in the primary circuit – refer once more to Figure 3. Heat-shrink sleeving should be used to cover any exposed connections at mains potential. It is imperative that mains wiring is properly routed to prevent any possibility of live wiring coming into contact with the telecommunications line.

An 8 ohm speaker should be attached between the terminals marked LS and GND, if required provision should also be made for the line level output on pins L/R and GND, see Figure 4. The A and B terminals should be wired to a connector suitable for coupling the unit to the telecommunications line.

After the unit has been assembled, a signal generator or other suitable signal source should be connected to the unit to facilitate testing. With the unit powered-up and a test signal applied, advancing the level control should produce an output from the loudspeaker.

If not, switch off the Telecommunications Amplifier and check that you have assembled the kit properly.

TELEPHONE AMPLIFIER PARTS LIST

RESISTORS: All 5% Metal Film (Unless specified)

R1 to R3	10k	3
R4, R5	1k	2
R6	10Ω	1
R7	3k3	1
R8	560Ω	1
VR1	10k	1

CAPACITORS

C1, C2	22nF Polyester	2
C3 18nF	Ceramic	1
C4, C5	47nF Ceramic	2
C6	100nF Monolithic Ceramic	1
C7	1µF 50V Electrolytic	1
C8	47µF 16V Electrolytic	1
C9	100µF 16V Electrolytic	1
C10	470µF 16V Electrolytic	1

SEMICONDUCTORS

IC1	LM386	1
D1, D2	1N4148 or equivalent	2
D3, D4	1N4001 or equivalent	2

MISCELLANEOUS

T1	LT44 Transformer	1
	PCB Pins	10
	8-Pin DIL Socket	1
	PCB	1
	Construction/User Guide	1
	Control Shaft for RV1	1

OPTIONAL (Not in Kit)

Constructors' Guide	1	(XH79L)
Miniature 8Ω 500mW Speaker	1	(YW53H)
Screened Cable	As Req.	(XR15R)
Chassis-Mount Phono Socket	2	(YW06G)
Mounting Hardware	As Req.	
Box	1	
250m A 6-0-6V Transformer	1	(YN14Q)
DPST Mains Switch	1	(YR69A)
20mm Panel Mounting Fuseholder	1	(RX96E)
20mm 100m A A/S Fuse	1	(UJ92A)
3-core 3A Mains Lead	As Req.	(XR01B)
Strain-relief Grommet	1	
Heat-shrink Sleeving	As Req.	
Solder Tag	1	
or		
Alkaline PP3 Battery	1	(FK67X)
PP3 Battery Clip	1	(HF28F)
Switch	1	

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 in kit form only.
Order As VE26D (Telephone Amplifier) Price £11.95
Please Note: Some parts, which are specific to this project (e.g. PCB) are not available separately.

COMPUTERS CAN BE A RIGHT PAIN!

By Alan Simpson

What do jockeys, tennis players, journalists, ballerinas, supermarket check-out girls and VDU operators have in common? Answer: that modern-day electronic curse, 'Repetitive Strain Injury' (RSI). In fact, end-user computer keyboard operators are the modern day equivalent of the 19th century, factory-sweated labour gangs.

It was not that long ago when offices were regarded as being a 'safe working place' or 'a cushy job' compared to say working in a steel mill or coal mine. The white collar workers had it easy, with pen in hand, they queued at the vending machine for their afternoon cups of tea. But now the office worker has become the focus of the medical world, who are worried about such matters as radiation emission from VDU screens and sundry cables running along, round or under desks, and poorly designed office chairs.

Staring at a VDU screen all day, just three feet away or even closer, affects the eyesight focal length, making it difficult to adjust to long distances. Occupational injury from computer usage is growing alarmingly, with thousands of lost man hours every year being reported. No wonder that in some quarters RSI stands for 'Repetitive Strain Industry'. Actually a more medically accurate definition of RSI is 'tenosynivitis', or 'Repetitive Strain Syndrome', which equates to the Health and Safety Executive's definition of 'an upper limb soft tissue disorder'. However, in the United States the ailment is more commonly known as 'Carpal Tunnel Syndrome' or 'Video Display Terminal Syndrome'. But whatever the term used, it is nevertheless very distressing for the sufferers.

Computer Blues

As the Journalist Handbook makes clear, an occasional twinge of pain, a slight burning sensation in the wrists at the end of a busy day, are the often-ignored warning signs. Agonising shooting pains, even paralysis of hands and arms, is the price paid by keyboard users who ignore it, anesthetised by the need to earn good merit marks from their bosses. Most, however, live 24 hours-a-day with dull but unrelenting pain – not quite bad enough to stop work altogether, yet bad enough to inspire fear of the consequences of continuing work. Alright, so there are the handbook recommendations and a range of preventative medicines and therapies, but the only real cure is complete avoidance of the work practice that causes it – typing on a computer keyboard.

Of course total avoidance is easier said than done. It effectively means chucking in your job in most instances. So you put up with it, and research has shown that over 90% of VDU operators suffer some sort of health problem. If all quit their workstations, the business world as we know it would grind to a halt – including the production of your favourite publication, 'Electronics – The Maplin Magazine'. To quote one photo-typesetter "my optician says I should only look at a screen for six hours at the most with breaks every hour or so. But my boss wants me to do TEN hours of copy-typing a day. So what would you do?"

But the costs to both the individual and society at large is high. The Ergonomics Society claim that RSI and work-related upper limb disorders cost Britain millions of pounds each year, while the British Chiropractic Association estimate that back pains alone cost UK businesses £3·5 billion a year in lost production.

Computers Can Make You Sick

Funnily enough, computers have not always been a health risk. The earliest equipment was based on electromagnetic switches and thermionic valves. Later, transistors were used and the computer became a viable, usable proposition, but it was still enormous (filling half a floor of an office) and cost the earth, so everyone didn't have one on their desk like they do today. Even if they did, such computers communicated with their operators via punched cards and teletype machines; a typewriter style keyboard, but no CRT.

Modern apparatus based on microelectronics is so small and cheap that your average desk is bare without one. That means that everyone crouches over a QWERTY keyboard and squints at a CRT, since a VDU is no different to a TV with the same emissions. But you don't watch your TV from a distance of 24 inches, do you? (Just one of the things we were told not to do when we were children.) The cabling and high speed digital electronics can also be a prime source of radiated fields.

Without getting too medical, although a copy of the famous 'Blackies Medical Dictionary' or even a copy of 'Pears Cyclopaedia' might assist the medical cause, RSI can occur at any time. It may lapse and reappear, or even occur some time *after* the VDU activity. The severity of the symptoms range from occasional aches and pains to a well-defined disease or injury and reduced work capability. At its worst, states the Ergonomics Society, it can make it excruciatingly painful to turn on a tap or even to brush your teeth.

Work Related Upper Limb Disorders (WRULDs) affect the fingers, hands, wrists, forearms, shoulders and necks of all kinds of workers in a variety of occupations. But more specifically, RSI can cause numbness and severe pains in keyboard users' arms and hands. It can produce a cocktail of afflictions, including tendon swelling, tennis elbow, and the ominously titled 'Carpal Tunnel Syndrome'. Other areas affected, include irritation to the eyes or skin, and back-pains.

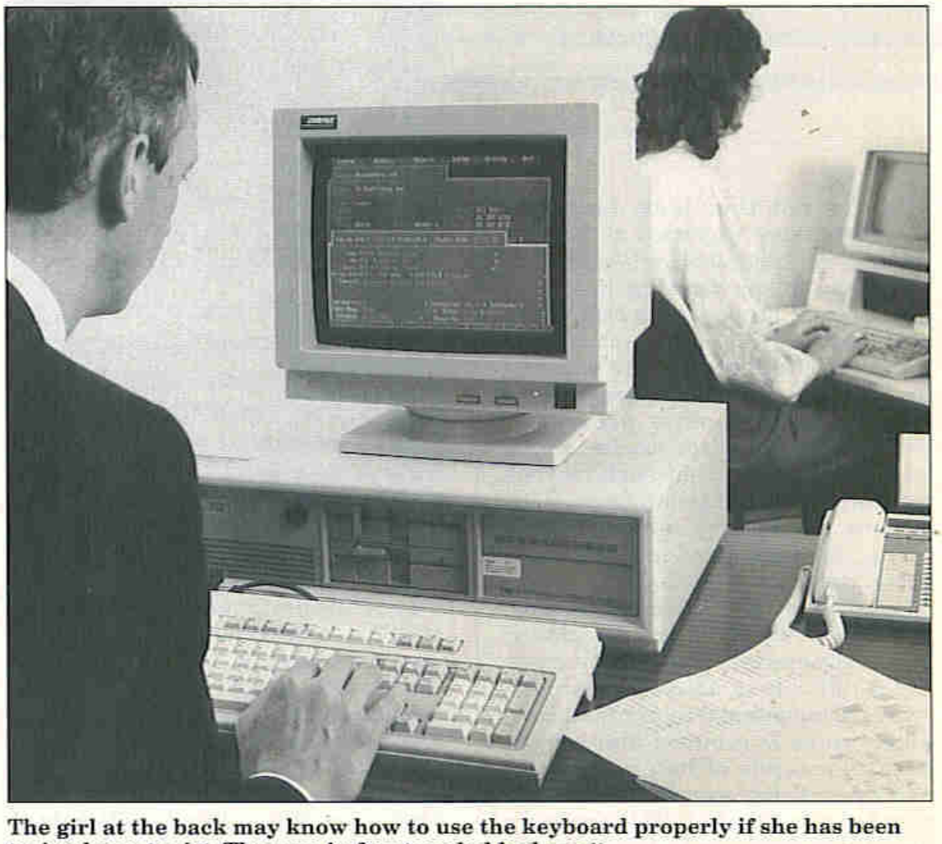
Musculoskeletal problems are widespread, and there is no doubt that you will know if you have got it. Symptoms include pain, swelling, tenderness, pins and needles, numbness, muscle weakness or spasm, loss of movement in joints, crackling sensations when tendons or swollen areas are pressed tightly, plus cyst-like swellings near tendons, tendon sheaths and joints. According to 'Repetition Strain Injuries – Hidden Harm' From Over-Use', a London Hazards Centre publication (telephone 071-837 5605), common RSI is a progressive, long-term condition which can be divided into three broad stages, though symptoms may arise in different orders.

1. Mild – pain, aching and tired wrists, arms, shoulders or neck during work, but improving overnight. This stage may last weeks or months, but is reversible.

2. Moderate – recurrent pain, aching or tiredness earlier in work hours and at night. This stage may last months.

3. Severe – pain, aches, fatigue and weakness even when resting completely. Sleep often disturbed; sufferer may be unable to do even light tasks

The typical crouch and squint posture of a computer operator.



The girl at the back may know how to use the keyboard properly if she has been trained as a typist. The man in front probably doesn't.

at home or work. This stage may last for months or years.

There is also a special warning that computer work is not healthy for people fitted with a pace-maker, or who may suffer from photosensitive epilepsy. Pregnant women using VDUs are also exposed to a greatly increased risk of miscarriage or birth abnormalities (and even men's fertility and virility are at risk). However, not all authorities are agreed on the risk to women. According to the US National Institute of Occupational Safety and Health, pregnant women who spend a large portion of their time in front of VDUs *do not* run a higher risk of miscarriage. But not all health activists are convinced, suggesting that the study did not properly address all the issues involved, including that of stress.

VDUs Can Damage Your Health

The villain of the peace is the terminal or computer keyboard. The standard typewriter keyboard is not ideally designed for either fast typing or comfort. The key layout is actually designed to slow you down, as this helps to prevent the jamming of the mechanical typewriter keys (and not to group letters that are most often used together into one area, which is a myth). Computer inputting staff are at greater risk, because not only are they in many cases not trained as typists, and therefore make do with a few, heavily used fingers, but they are often set a minimum target rate of 10,000 key depressions an hour. All factors which encourage RSI.

Posture, say the Osteopathic world, is the all-important element for keyboard users. Often the head is further forward than the rest of the body, creating constant tension which produces pain in the hand and wrists and sometimes eye strain and headaches. But when it comes to radiation health problems, there is less medical agreement. VDUs emit measurable quantities of radiation, and many earlier computer monitors exceeded the recommended safety level for X-Ray machines in general! Even now, there are still the lower frequency fields that come from the scanning coils around the CRT, which can have an effect on the human body. Certain screen filters that are supposed to reduce both VDU glare and the electromagnetic fields from monitors have received the thumbs-down from the US Food and Drug Administration, mainly on the grounds that they do not work, but also on the grounds that there was not sufficient money spent to conduct a meaningful series of tests.

Given the thumbs-up sign though by the National Radiological Protection Board are televisions, microwave cookers and computer screens in the course of a major survey into possible cancer risks. Experts examined links between cancer clusters in the population and radiation from electrical equipment, including mobile phones and short-wave radios. This finding will hopefully reassure the users of mobile phones who are worried about possible hidden hazards. These are said to be related to irradiation of a person's brain caused by the transmission of signals. Although the power of a hand-held mobile phone is relatively low – just 0·3 to 0·6W – the dose is exaggerated because the aerial is held close to the users skull. You have been warned!

However, mobile telephones do have one positive benefit. Singled out by the Chancellor as the 'scourge of modern society', they do in fact, says Cellnet, help reduce stress at work. A third of all those interviewed said that having a mobile phone effectively reduced their level of stress, by making it easier to keep in contact with their customers and helping them work more efficiently and perform more effectively. Perhaps they hadn't heard about irradiation.

A Better Place to Work

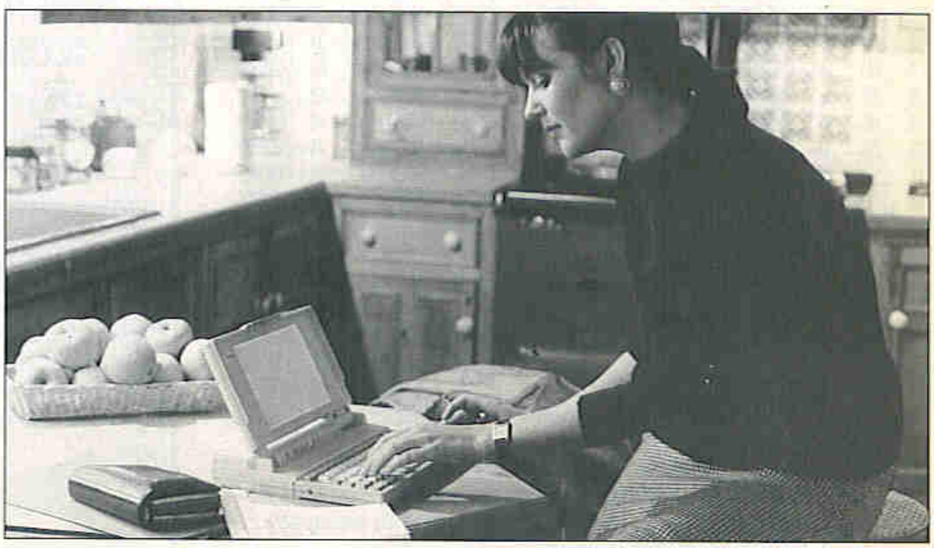
According to the industry expert Storm Larkins of The Hardware Environmental Protection Agency, health and fitness is greatly assisted by a well controlled workplace. Ambient room temperature in a computer area should be set at between 19 and 23 degrees celcius, with ongoing constraints on noise, air movement and humidity. Storm admits that no furniture can be totally ergonomically correct unless it combines functionality with varying adjustments. Chairs, he says, must be designed to suit both tall and short workers with, if necessary, foot stools being provided. Office furniture must pay regard to posture, providing strain and tension-free conditions for back muscles. User controls and frequently used tools of the trade should be within easy reach. After all, states Storm, you would not get into a strange car and drive off without first adjusting the seat and mirror! Also to be monitored is the ability to adjust lighting, to cut out possible glare and reflection on user screens.

Which raises another observation which is to do with the fluorescent strip lights most commonly found in offices. Because these flicker at 100Hz, powered as they are by the AC mains, this can augment the effect of the field frequency flicker of a monitor. Unconscious to the user, this apparently has an effect on the visual cortex of the brain, causing it to miss words on the screen which then have to be re-interpreted again to make sense, and this aggravates eyestrain. Ideally strip lights should incorporate their own HF drivers, operating the tube at a frequency greater than the monitor's line rate, say 40kHz. But they cost more, naturally.

Guidelines

BSI Guidelines include the need for the work-surface to support the keyboard at a 90 degree angle to seated users. The keyboard itself should be between zero and 25 degrees, while the display screen should be both flicker and jitter free. Also, says the BSI, colours used in the display should be kept to a minimum, with no bright colours against any dark backgrounds.

Steps to bring the UK into line with the proposed European Commission Directive on the use of VDUs within the office and work environment have been announced by the Health and Safety Commission. The main provisions of the proposed regulations – to be introduced by the 1st Jan 1993 – are that employers must assess their workstation population to identify possible risks to the health and safety of the users. They must then take steps to reduce any risks identified. Each worker must be entitled to periodic breaks, or a change of activity, to get him or her away from the screen for a bit, and users should have the right to have appropriate eye and eyesight tests on request.



Ergonomically, everything is wrong in this picture. However, being a laptop, the computer has a liquid crystal display rather than a CRT, so does not flicker or emit X-rays or electro-magnetic fields.

The Commission believe that the most widespread problems experienced by workers have been associated with prolonged display screen working, resulting in musculoskeletal disorders, visual fatigue and mental stress. A workstation, says the Commission, includes not only the desk, chair and computer, but also the software and immediate work environment. With an estimated 7 million individual workstations in the UK which come within the definition of the regulations, the Health and Safety inspectors are going to have a busy time!

The Dark Side of The Room

One perceptive VDU supplier has warned that, although many VDUs have radiation emission screening at the front, unpleasant rays can be emitted from its unshielded backside (if you'll excuse the expression). Another industry supplier comments that radiation levels can be reduced to low levels by winding the scanning coils in a 'saddle-saddle' configuration, instead of the more usual saddle-toroidal, or to incorporate some phase cancelling-mechanism. So far, only the environmentally aware Swedish industry have produced a 'green' VDU which reduces the electrostatic *and* electromagnetic fields generated, in response to government regulations. With ICL having taken over Nokia Data, perhaps the UK will soon enjoy 'green' VDU technology. Meanwhile, when it comes to screen flicker, Storm Larkins says that the CRT field rate should be as high as possible, certainly higher than the present common standard of 50 or 60Hz.

A Testing Time

In order to meet the EC limits for emission standards, all products will need to be tested in a certified open-area test site, or in a certified anechoic chamber with an equivalent performance to an open-area site. The testing of products will have to be carried out by an approved laboratory, using approved test gear.

One further word of warning however, after a hard session on your radiation emitting VDU, should you then be rushing off to a Mediterranean beach for a rest to soak up the sun's rays instead? But help is possibly at hand, the Bamboo Delight Company of Saratoga, California, is offering 'previously secret health techniques' to prevent and cure RSI. The cure, derived from Kung-Fu and Chi-Kung, is a series of exercises used extensively by Japanese workers. A $40 video tape reveals all!

Whether the UK VDU directive or the Bamboo Delight Company will come to the rescue of those suffering from RSI is not clear. But with the dedicated help of the medical world, and prods from the EC, office work looks like being made more comfortable and productive for all concerned. Providing businesses co-operate, and there may be a big problem there. One industrial relations commentator has cited the possibility that, since workers' unions have gone out of fashion so to speak (mainly reduced to shadows of their former selves by Maggie Thatcher's government), many new-technology terminal operators, PC users and programmers are not affiliated to any union. To cut a long story short, a possible scenario is one where 21st century keyboard operators will be as much slaves to their machines and at risk from them, as were the unfortunate souls of the industrial revolution. Interested only in productivity, employers will tend to 'switch off' and not want to know about any Health and Safety regulations, and doctors' waiting rooms will see an increase of RSI sufferers with nowhere else to turn except the dole. Mind you, they didn't even have that in the 18th and 19th centuries.

A free copy of the leaflet 'New Health and Safety at Work Regulations' with all the relevant data is available from Health and Safety Area offices, or by telephoning 0742-892345 or 071-221 0870.

MAPLIN'S TOP TWENTY KITS

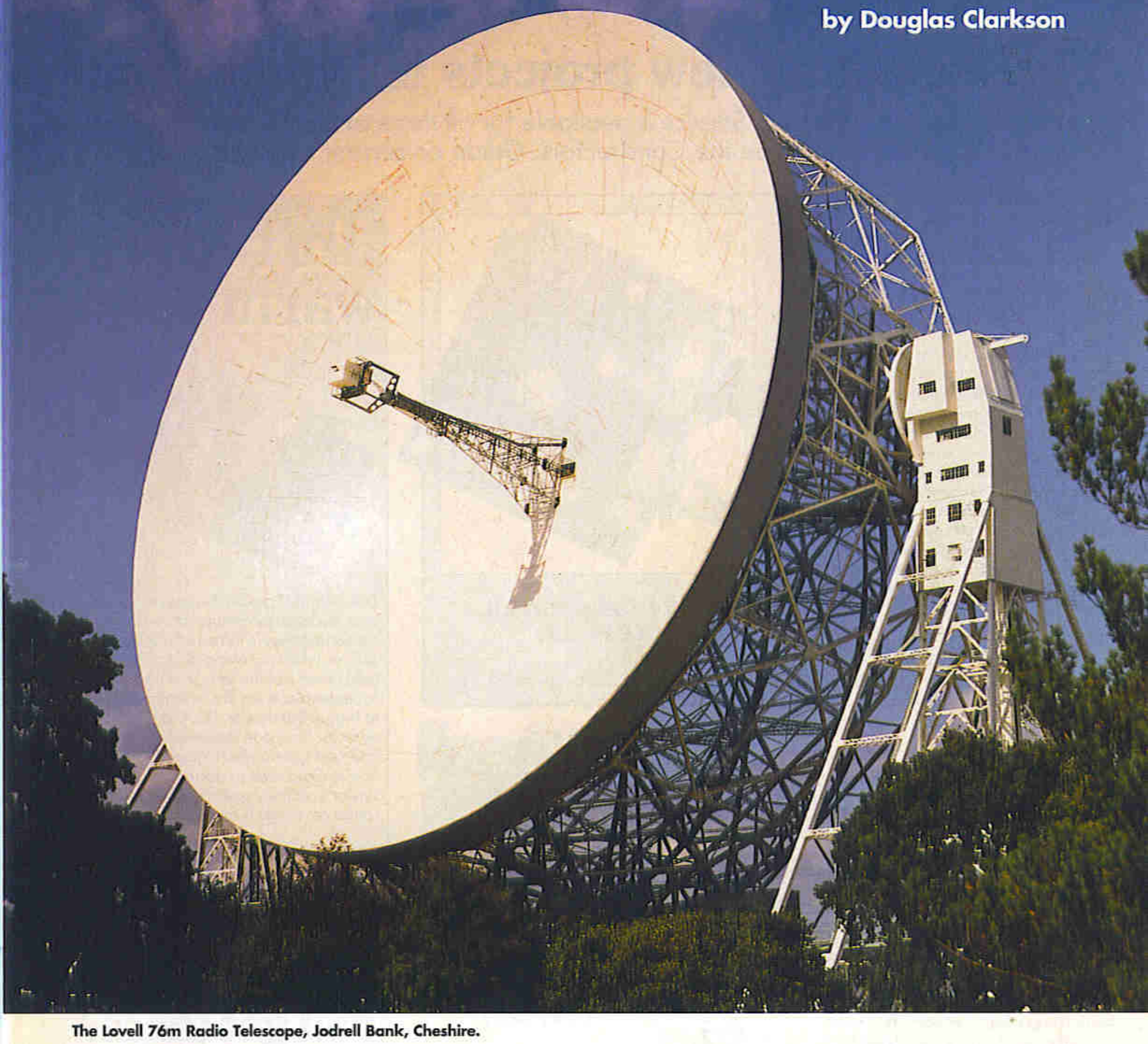
POSITION			DESCRIPTION OF KIT	ORDER AS	PRICE	DETAILS IN		
1.	(1)		MOSFET Amplifier	LP56L	£20.95	Magazine	41	(XA41U)
2.	(3)		L200 Data File	LP69A	£ 4.75	Magazine	46	(XA46A)
3.	(2)		TDA7052 Kit	LP16S	£ 4.95	Magazine	37	(XA37S)
4.	(6)		Live Wire Detector	LK63T	£ 4.75	Magazine	48	(XA48C)
5.	(10)		RS232/TTL Converter	LM75S	£10.75	Magazine	31	(XA31J)
6.	(7)		Car Battery Monitor	LK42V	£ 9.25	Magazine	37	(XA37S)
7.	(4)		1/300 Timer	LP30H	£ 4.95	Magazine	38	(XA38R)
8.	(5)		IBM Expansion Sys	LP12N	£21.95	Magazine	43	(XA43C)
9.	(8)		Vehicle Intruder Alarm	LP65V	£11.25	Magazine	46	(XA46A)
10.	(9)		Courtesy Light Extender	LP66W	£ 2.95	Magazine	44	(XA44X)
11.	(-)	NEW ENTRY	UA3730 Code Lock	LP92A	£11.45	Magazine	56	(XA56L)
12.	(11)		PWM Motor Driver	LK54J	£10.75	Best of Book	3	(XC03D)
13.	(16)		LM353 8W Amplifier	LW36P	£ 7.95	Catalogue	'93	(CA10L)
14.	(13)		MSM6322 Data File	LP58N	£12.95	Magazine	44	(XA44X)
15.	(-)	NEW ENTRY	Lights On Reminder	LP77J	£ 4.75	Magazine	50	(XA50E)
16.	(19)		Mini Metal Detector	LM35Q	£ 7.25	Magazine	48	(XA48C)
17.	(17)		Partylite	LW93B	£12.45	Catalogue	'93	(CA10L)
18.	(-)	NEW ENTRY	50W Power Amplifier	LW35Q	£19.95	Catalogue	'93	(CA10L)
19.	(14)		TDA2822 Stereo Amp	LP03D	£ 7.95	Magazine	34	(XA34M)
20.	(15)		LM386 Power Amplifier	LM76H	£ 4.60	Magazine	29	(XA29G)

Over 150 other kits also available. All kits supplied with instructions.

The descriptions are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate project book, magazine or catalogue mentioned in the list above.

An Introduction to RADIO ASTRONOMY

by Douglas Clarkson



The Lovell 76m Radio Telescope, Jodrell Bank, Cheshire.

In the Beginning

While mankind has, from his earliest days, been able to gaze skywards and observe the visual magnificence of the night sky, the ability to scan the skies for radio waves is a relatively recent development. In the 1930s Bell Telephone Laboratories at Holmdel, New Jersey, were developing a system for ship-to-shore radio communication at a frequency of 20MHz. It was necessary to determine what the likely nature of interference at this frequency would be.

In order to investigate this phenomenon, Karl Jansky built a rotating antenna some 30 metres wide and 4 metres high. While there was specific interference from both local and regional thunderstorms, a background 'hiss' could be detected from a fixed area in the sky.

During 1932, Jansky confirmed that the strongest signal appeared to come from the centre of the Milky Way – our 'home' galaxy. Although Jansky published his findings through the eminent mechanisms of Bell Labs, there was surprisingly little interest shown in his findings by the then proponents of astronomy.

It was left to a young radio engineer, Grote Reber, to build a receiver (at his own expense) 'in his own backyard'. This allowed him to plot a map of radio emissions in the plane of the Milky Way. Reber's findings, however, drew little attention from the scientific community, which was pre-occupied with World War II. During this period, however, developments in radar were bringing about rapid advancements in radio wave generation and detection.

During the war there was intense interest in developing counter-measures against enemy defensive radar. One method was that of 'Window', which involved the distribution of strips of metal foil from aircraft which resonated at the wavelength of the probing radar. While 'Window' was an excellent countermeasure against enemy radar, it was equally dangerous if it was used in the same way against the Allies. There was understandable panic when what appeared to be enemy 'Window' was detected on UK defensive radar systems. It fell to one J. S. Hey in 1942 to resolve this dilemma. It was quickly determined that the disruptive echoes were generated by heightened sunspot activity close to the centre of the solar disc.

After the war, Hey moved to the Royal Radar Establishment at Malvern in 1952, and built radio telescopes on the old airfield at Defford (see Figure 1). He was later to provide invaluable help to Sir Bernard Lovell when extending the network of ground-based telescopes outwards from Jodrell Bank.

As the frequency range of detectors was extended to around 10,000MHz, workers at Bell Labs were able to tune into the black-body radiation of the sun. In 1946 Hey, with co-workers Parsons and Phillips, probed the radio wave emissions of the Milky Way in greater detail than Reber had been able to undertake. An area of heightened activity was detected around the constellation of Cygnus. Known as Cygnus 'A', this phenomenon was later identified as the first 'radio galaxy'.

These early workers were observing through the radio 'window', which encompassed wavelengths ranging from 1cm to 30 metres. Normally, this band of frequencies is transparent to the earth's atmosphere. Observations at less then 3cm, however, are liable to significant absorption by moisture in the atmosphere.

Enter Radio Astronomy

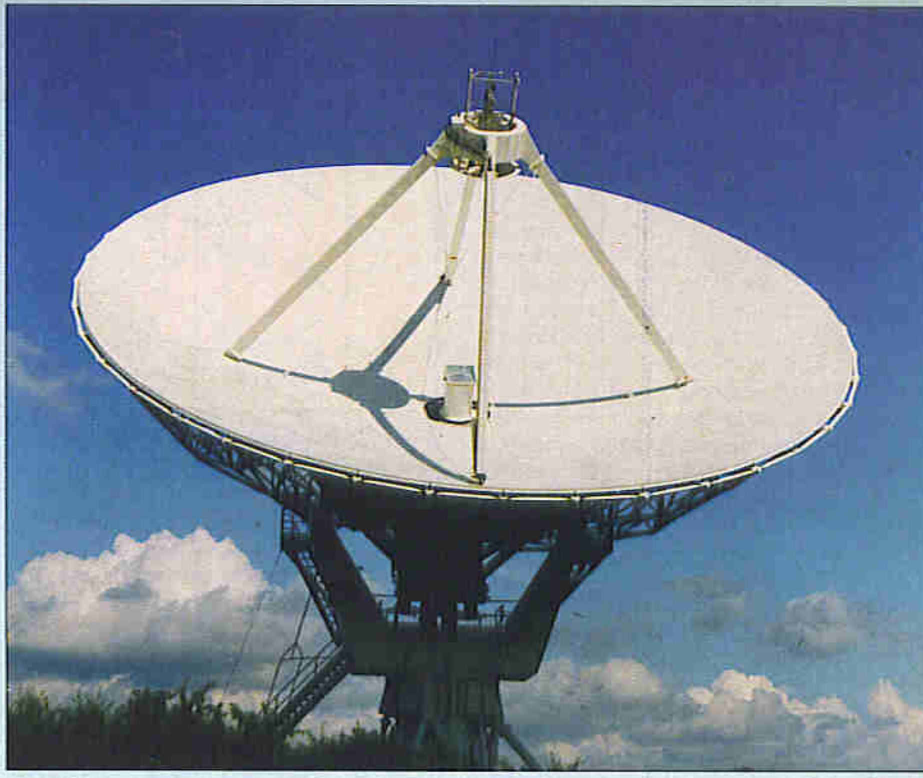
Eventually, those in the mainstream astronomy community began to take the emerging area of radio astronomy more seriously. In 1944 a Ph.D. student at the Leiden Observatory proposed that a frequency of $1{\cdot}42 \times 10^9$Hz would be produced by an energy transition within unionised Hydrogen atoms. This corresponded to a wavelength of 21cm. It was not until 1951, however, that Jan H. Oort, director of the observatory, was able to detect the 21cm line in the radio emissions of the Milky Way. This was the first of many 'radio spectrum' lines to be identified.

This discovery made possible the mapping of hydrogen gas distribution in the Milky Way. The stars in the Milky Way are, to a greater or lesser degree, enveloped in a cloud of interstellar dust which obscures and reddens starlight. It is estimated that the stars in the vicinity of the Sun of the Solar System are dimmed by a factor of 2 for light travelling a distance of 3000 light years. The 21cm wavelength, however, passes through the interstellar dust unaffected, allowing astronomers to probe sections of the galaxy which cannot be observed optically. By observing the Doppler shift of the radiation caused by relative motion between the Earth and the gas clouds, the velocity of Hydrogen gas within the Milky Way can also be probed. As expected, the velocity of the gas increases with distance from the nucleus of the Galaxy in a similar way to that of a spinning top. The same method can also be used in mapping the velocity of gas surrounding previous supernova phenomenon within, for example, the Crab Nebula.

Previously, absorption of optical spectra by the dust clouds had confirmed the presence of ions of sodium, potassium, calcium, titanium and Iron. In the region of the Sun, these dust clouds vary in size from a fraction of a light year to a maximum of 200 light years. The smaller dust clouds also tend to be the most dense.

Molecules contained within the dust clouds also give rise to radio emissions. Over 50 different molecules, including those of carbon monoxide and formaldehyde, have been detected providing a means of probing the extent of such clouds.

The ability to detect hydrogen gas using this technique allowed significant progress to be made in understanding the shapes of galaxies. Since optical information is often



The Tabley 25m Radio Telescope, Northwich, Cheshire.

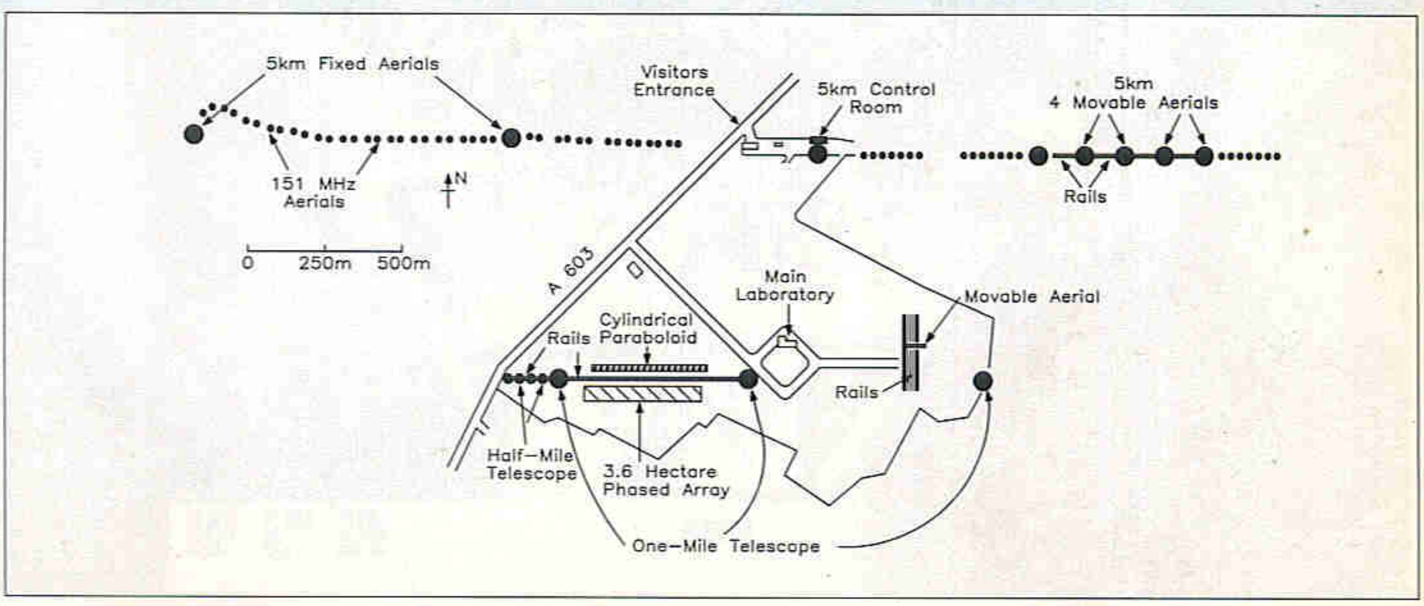


Figure 1. Layout of observing systems at the Mullard Radio Astronomy Observatory

obscured by dust clouds, astronomers were able to map out more fully the extents of galaxy structures in addition to estimating the degrees of relative motion within galaxies.

The Jodrell Bank Observatory

The history of Radio Astronomy, however, is strongly identified with the Cheshire-based Jodrell Bank observatory – the brainchild of Professor (later Sir) A. C. B. Lovell of Manchester University. His drive was indeed that of a spirit of discovery, which to him appeared to be absent in an age when earthbound optical telescopes were consolidating astronomical data rather than making radical new discoveries. Initial discussions about the engineering design of the great dish telescope began in September 1949 and after the raising of an initial level of funding, work began in 1953. The telescope was tested for the first time in February 1957, during a time of great public indifference. In addition, the newly-opened observatory was suffering from a poor level of funding – a problem which, unfortunately, is allowed to affect most modern-day scientific research. The general principle of operation of the detector is shown in Figure 2, where radio waves (effectively assumed parallel) are reflected to a receiver at a focus of the mirror surface.

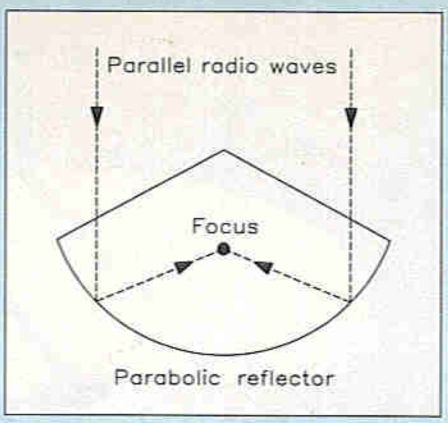


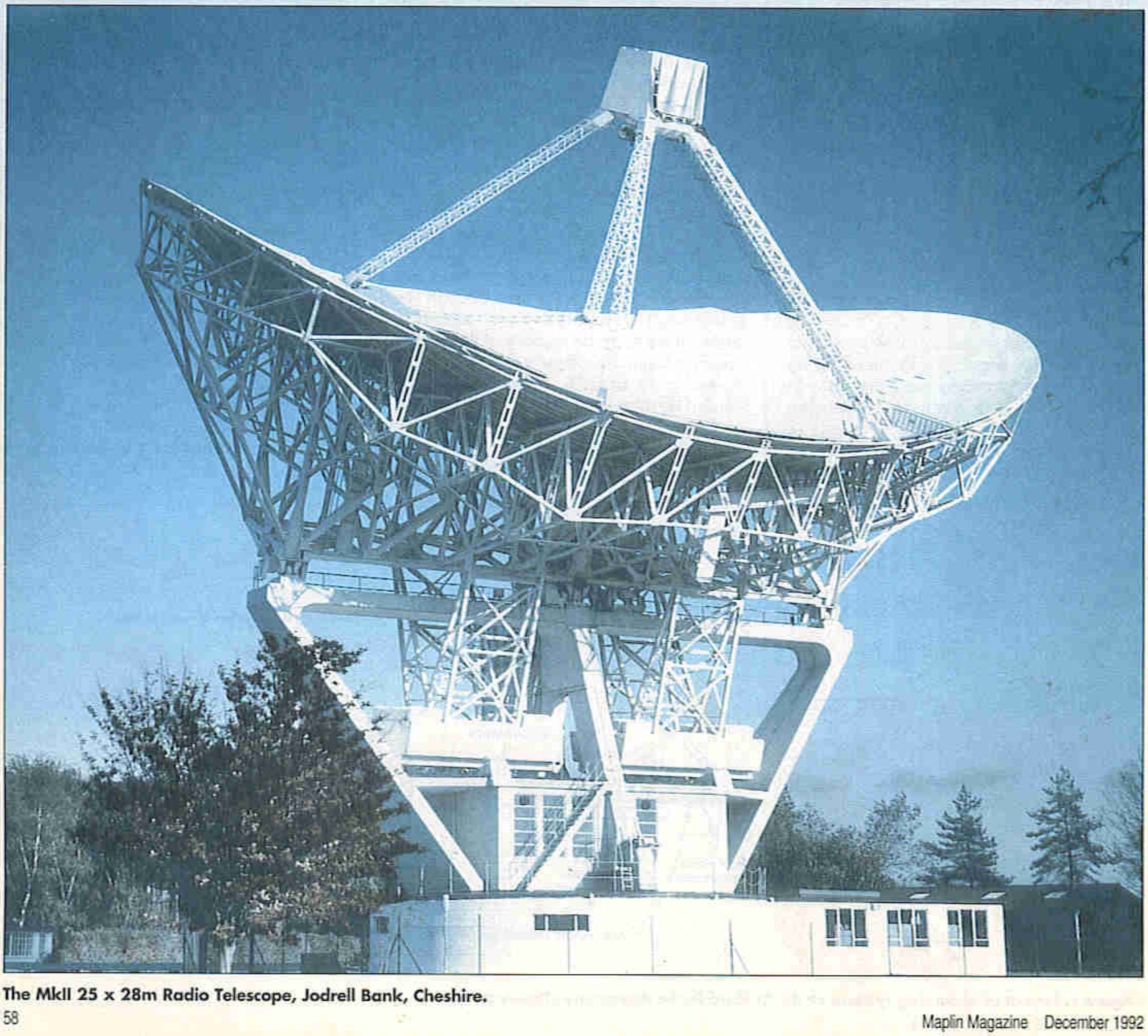
Figure 2. General principle of dish focusing radiation to focal position.

In those early days, there was little indication of the range of momentous discoveries that radio astronomy would usher in – discoveries that would change the fundamental views of the origin and evolution of the Cosmos.

The original Mark 1 system used a central antenna, onto which signals from the parabolic dish were focused. The telescope was in fact updated in 1971, to allow it to be positioned with greater accuracy – essential in circumstances where higher frequency sources are to be resolved. A new dish surface, with superior reflective properties, was added above the previous one to improve its efficiency. Improvements were also made to replace load-bearing structures of the positioning mechanism, as these had become worn through years of constant use.

But, back in 1957, these modifications were in the dim and distant future. The world was ushered into the space age on October 4th of that year, with the launch of Sputnik I. Harold Macmillan, then Prime Minister, was able to announce to the House of Commons that the 'great radio telescope' at Jodrell Bank had successfully tracked the satellite. Life from this point on became a little easier for all those involved in the project. However, the financial worries were only finally resolved in May of 1960 by Lord Nuffield, who settled the scheme's remaining deficit of £50,000. After this generous donation, everyone began to focus complete attention on using the equipment for scientific investigation.

Initially radio sources within the Milky Way were investigated. The remnants of the 1064 supernova, which now forms the Crab Nebula, were found to be particularly active. The Veil Nebula in Cygnus was another site of interest. The initial observations of radio astronomy, however, indicated radio energy from sources outside the Milky Way. The sheer energy of such 'radio galaxy' sources was then difficult to explain.



The MkII 25 x 28m Radio Telescope, Jodrell Bank, Cheshire.

Resolution of Radio Telescopes

The two key attributes of a radio telescope are its gain and its resolution. The power gain of a parabolic reflector is proportional to the square of the ratio of the diameter of the aperture divided by the wavelength being sensed. Thus the parabolic reflector has less gain at longer wavelengths (lower frequencies). At higher frequencies, any deviations of the reflecting surface from a true parabola (caused by fabrication errors, etc.) will introduce losses.

The resolution of radio telescopes is often compared with that of the human eye, which can be considered to resolve to a few minutes of arc. This is roughly equivalent to distinguishing an object, the size of a 10p piece, at a distance of 50 feet. The best resolution which can be attained with earth-based optical telescopes is about 0·5 seconds of arc; this corresponds to resolving the same 10p piece at a distance of 8 miles. It was expected that the Hubble space telescope would allow an improvement of a factor of 10 in the resolving ability of a system located in space (i.e. freedom from atmospheric aberrations).

The resolving power of the initial Mark I Jodrell Bank telescope, at a wavelength of one metre, was about one degree of arc – a factor of some 20 inferior to that of the unaided human eye. This factor can be improved where a shorter wavelength is used. While it is possible to increase the resolving power of such devices by increasing the diameter of the collecting dishes, it became impractical and highly uneconomic to do this. For example, if a radio dish telescope with resolution comparable to the best optical telescopes was required for 1 metre observations, it would have been some 3000 times the size of the initial 250 foot device!

It was this basic fact which led to the development of 'radio interferometers' at various locations around the world. In the UK, later developments at Jodrell Bank and Cambridge would lead primarily to the development of such interferometer systems.

By using lines of individual smaller telescopes, it became possible for the Jodrell Bank observatory complex to achieve a resolution of 0·025 seconds of arc – a factor of ten better than the best ground based optical telescopes.

This technique began to be used on an international basis in 1969, when telescopes in America were linked across a distance of 8035km to a radio observatory in the Crimea, achieving a resolution of 0·0004 seconds of arc.

Using the radio interferometry technique, highly detailed radio maps of areas of the sky could be produced. However, even these ultra-high levels of resolution have not managed to resolve the topology problem of the mysterious quasar.

The Fate of the Mark VA Telescope

Sir Bernard Lovell had, in the 60s, wished to build a 400 foot telescope at Rhos Glascoed in Wales. This would have been interfaced to the initial Jodrell Bank complex. This project finally fell through in 1974 due to lack of funding. On reflection, however, perhaps the lack of public awareness of such a proposal contributed to its demise. Figure 3 shows the planned design of the 'giant' Mark VA telescope.

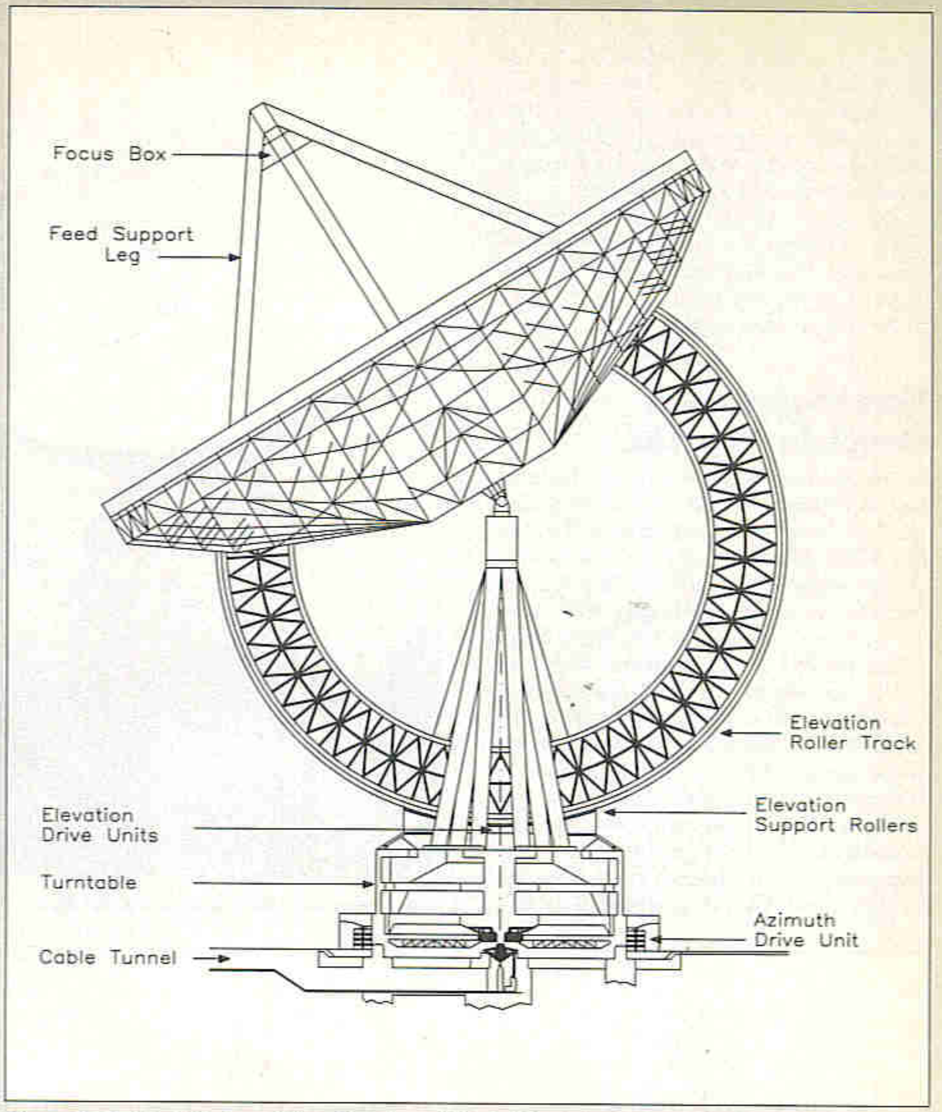


Figure 3. Original design of the abandoned Mark VA project.

Sir Bernard gives a detailed account of the rise and fall of the Mark VA radio telescope in his book 'The Jodrell Bank Telescopes'.

The MERLIN System

Figure 4 shows the distribution of the MERLIN (Multi-telescope Radio Linked Interferometer Network) telescopes, which are part of the Jodrell Bank observatory system. The system has grown from 4 stations to 6. This system was developed very much as a compromise answer to the absence of the large Mark VA dish telescope. The very high resolution obtainable using this network array has made possible the accurate mapping of large numbers of weak radio sources, even at longer wavelengths where resolution is correspondingly poorer.

Such maps are of considerable value in matching up areas of radio emission with their optical counterparts. For the present however, at least until the Space Telescope is fully operational, it is radio astronomy that can detect objects with higher resolving power. Significant developments have also been made in the processing of signals obtained from distant radio sources. It is possible, for example, to undertake a frequency analysis of a incoming band of signals several MHz wide, with a channel resolution of a few kHz. This makes possible rapid scanning for spectral absorption lines. In particular, use has been made of this technique for mapping out regions which contain OH (hydroxyl) radicals.

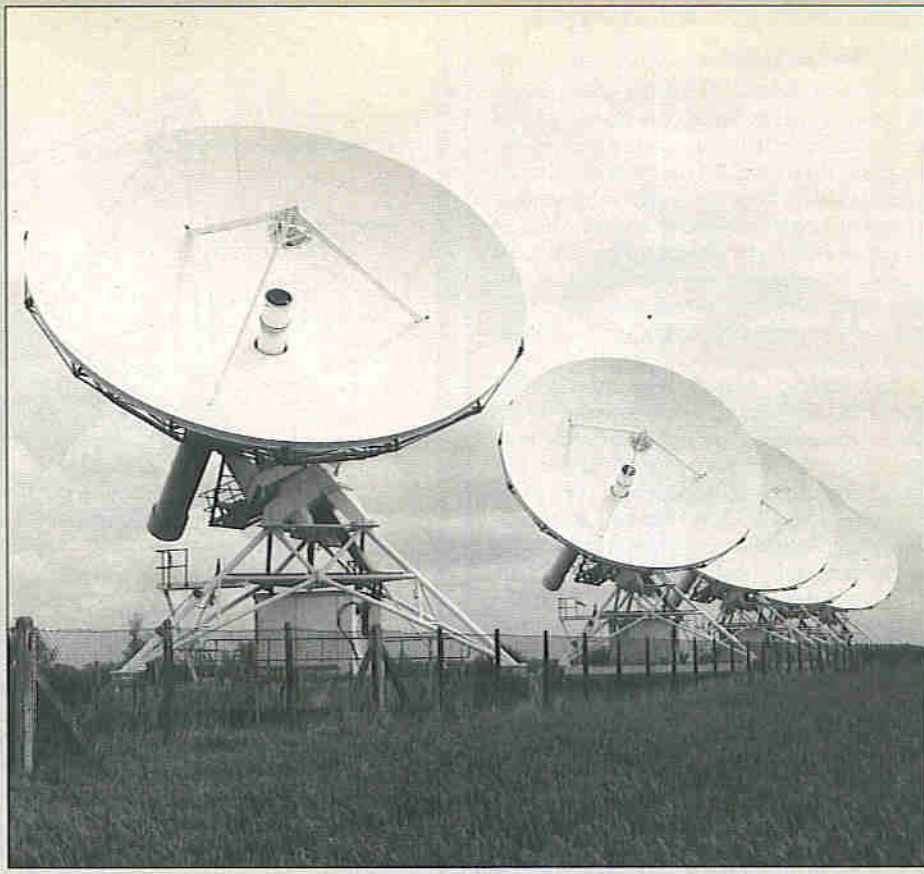
The View from Cambridge

Much of the development world-wide in high-resolution interferometer systems stemmed from the successes achieved by the systems at Cambridge under the direction of Professor (later Sir) Martin Ryle between 1946 and 1982. Figure 1 shows the layout of the various systems at the Mullard Radio Astronomy Observatory. The initial development was the so-called 'one mile telescope' implemented in 1965. The two end dishes were fixed approximately one mile apart, while the central one could be moved on a 760 metre railway track. This system was very clever – it used a natural phenomenon (the Earth's rotation) to compensate for the fact that only three dishes were used, presumably for economic reasons – British ingenuity wins again! As the earth rotated, the middle dish traced out the area in between the outer two, as if it belonged to a much larger array. Various traces of the mobile dish could be combined to build up a more detailed picture. This early system was expanded in 1972 to the Five Kilometre Telescope, which consisted of four movable and four fixed 13 metre dishes on a baseline of 4·6km. In this design, use was made of a disused railway. Science in the UK is trained to be thrifty!

The contribution to Radio Astronomy made by the Cambridge team was recognised by the awarding of the 1974 Nobel Prize for

Physics to Professor Ryle and Professor Hewish. The work at Cambridge has allowed detection of radio waves 11 billion years old. Significant development has been undertaken into refining image processing methods – the Maximum Entropy Method, in particular, is one extensively refined at Cambridge.

The photo right shows part of the Five Kilometre Telescope – also known as the 'Ryle Telescope'. The detecting powers of the telescope have recently been improved significantly using cooled amplifiers.



The 5 kilometre telescope at Cambridge.

Developments Outside the UK

As the field of Radio Astronomy became explored by more people, additional listening 'ears' on the radio universe came to the fore. The 1000 foot fixed dish in Puerto Rico charted additional areas of the Milky Way for the 21cm emissions of Hydrogen. A 64 metre dish was completed at Parkes, New South Wales in 1961. A 'cross detector' with arms 1·5km in length was completed near Canberra in 1964. An array telescope was completed at Dwingeloo in Holland, based on the success of the Cambridge systems. A 100 metre steerable dish observatory was built near Bonn, in western Germany, and commissioned in 1971. In the USA, a very large array system was built in New Mexico during the mid-70s. This consisted of 27 telescopes, each of 82 feet diameter, mounted on railway tracks in a 'Y' formation with arms of 21km.

Developments in radio astronomy began to take on an international nature when telescopes over a wide area were linked to each other. This allowed very long baseline interferometry (VLBI) experiments to be conducted – improving still further the resolution with which radio sources could be scanned.

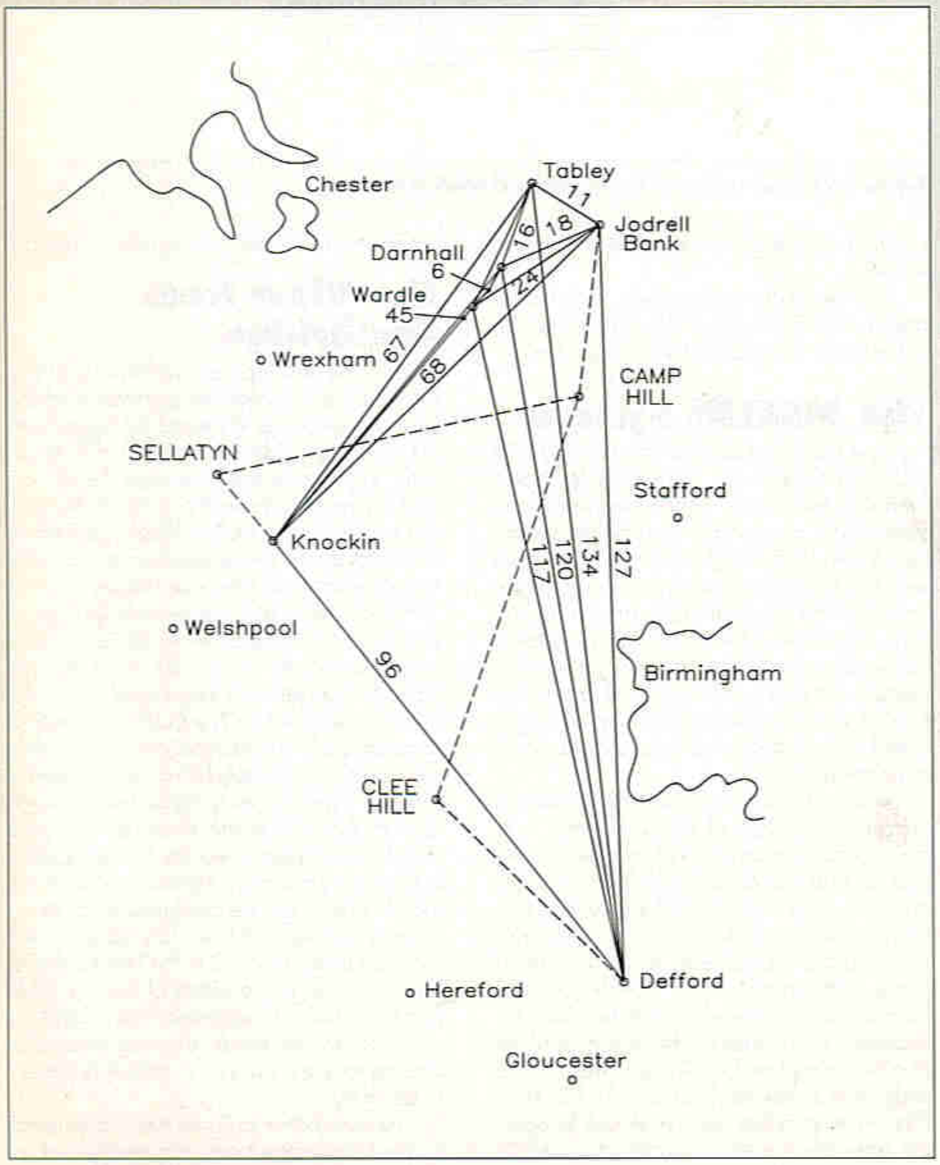


Figure 4. Diagram of the MERLIN system of linked telescopes.

The Puzzle of Quasars

As the understanding of radio emissions in the Milky Way and beyond was quietly progressing, the discovery of so-called 'quasars' in 1963 by Hazard and Schmidt stretched the imaginations of the scientific community to new limits which even today are not completely resolved. The term quasar is derived from 'quasi-stellar radio source'. Using the 'red shift' of spectral lines of hydrogen, the objects were related to the more remote galaxies. In optical appearance, they give the impression of a single star-like object. Observations of radio and X-ray emissions indicate that quasars are remarkably small – they have roughly the same size as our Solar System. If the observed objects are indeed at the estimated distances, then they are radiating energy in the order of 10^{12} (a million million) times that of our Sun. It is difficult to conceive of any process which could give rise to energy at this stupendous rate. When such objects were announced, the impression was given of very distant and immensely bright objects – a whole new class of phenomenon. A range of theories have been advanced to imply that the quasars are in fact significantly closer than estimated and that the red shift observed is due to other factors.

In the context of our Sun in the Solar

System, a quasar at a distance of 20 light years from the Sun would appear as bright, to us, as the Sun itself. This is approximately a million times the distance between the Earth and the Sun. There are apparently no quasars within the Milky Way.

There is still debate relating to the origin and mechanisms of quasars. The great problem is trying to believe that they are so far away; after all, such colossal energies are incomprehensible! A theory proving that they are much closer would remove their status as 'special objects'; one theory states that exceptionally strong gravitational field would cause the characteristic red shift noted with quasars – but with radiation from a much nearer source. Such gravitational fields could come from the controversial (i.e. yet to be *definitely* proved!) black holes – for the scientific community, 'swings and roundabouts' are encountered when trying to explain these complex spatial phenomena! Others argue that quasars could be also immensely powerful radiating sources caused by intense nuclear activity within large galactic structures (i.e. clusters of stars, or indeed large sections of yet-to-be identified galaxies) – which mask the detail of stars in the surrounding area. The Milky Way is considered to have a black hole at its centre. Perhaps Quasars are development phases of black holes that are subject to physical laws of which we have no present knowledge.

The Microwave Background

In the 'Big Bang' theory of the origin of the Universe, it is conjectured that an initial series of thermonuclear reactions took place in a primeval fireball. This process would also create a thermal radiation field in accordance with Planck's law of radiation. As the universe expanded, it would have cooled. Based on a theory developed by Tolman in 1934, its temperature would correspond to a temperature of about 5 degrees above absolute zero.

While scientific interest in the early 1960s was beginning to gather pace in this microwave background, communication scientists working on the Bell Labs' Telstar project became aware of excess radio noise which came from the sky in a completely isotropic fashion – i.e. it was evenly distributed throughout space. Papers published in 1965 confirmed that the background radiation noise temperature was 2·7 degrees above absolute zero.

This radiation is observed to be remarkably uniform – within one part in 10,000. The concept of the photons of this radiation converging on the earth from opposite directions presents something of a dilemma; the photons are entirely independent of each other, yet they have exactly the same radiation temperature. This suggests the general principle in Astronomy that 'things are the same in every direction'.

The COBE Revelations

On the 23rd of April 1992, preliminary findings of the NASA COsmic Background Explorer (COBE) satellite were announced – showing a variation, or 'lumpiness' in the microwave background noise. Orbiting 500 miles above the earth, the sensitive detection system was able to detect these noise temperature variations, which are in the minute order of 30 millionths of a degree. Scientists postulate that if the background radiation is 'lumpy' then areas of matter could also be 'lumpy', and from these galaxies could thus form; it is considered that this 'lumpiness' corresponds to 300,000 years after the Big Bang. Thus radio astronomy, using the leading edge of technology, has once again provided some tantalising evidence about the origin of the Universe.

Pulsars

It was to be at Cambridge that the next important phase of investigation in Radio Astronomy would take place. In 1967 Jocelyn Bell, then a research worker on the team, became aware of signals which were remarkably regular, having a period of some 1·3 seconds. Debate on the origin of such 'pulsar' signals did for a time entertain the theory that the signals were created by alien civilisations. It was later believed, however, that such radiation was caused by the rapid rotation of neutron stars with very powerful self-generating magnetic fields. Radio waves could only escape via the magnetic poles of the spinning star. In effect, the so-called pulsar was like a lighthouse, sending out a narrow beam of radio waves as it spun round. Radio observatories quickly confirmed the existence of other pulsars in the Milky Way and there was a race to discover the visible counterparts of radio pulsars. This was first undertaken with the Crab nebula pulsar in 1968, when a very faint object was observed to flash, at exactly the same rate as the radio pulsar. There was indication that supernova events such as the Crab nebula resulted in pulsar phenomenon. This was confirmed in the Gum Nebula where a pulsar with a very short period – 0·09 second – was identified as a remnant of a supernova explosion that occurred some 11,000 years ago.

While there is variation in the rotational periods and signal strengths of pulsars, they all share the fact that they are perceptibly slowing down – like spinning tops set spinning. One specific object is that of CP1919, which today has a period of some 1·3373 seconds. In 300 years time, this object will have a period of 1·3374 seconds. Presumably, the pulsars with the shortest periods are also the most youthful. Such radio sources can also exhibit variability in frequency, as if the neutron star itself is passing through some unstable phase.

The very nature of pulsars makes them relatively easy to detect, and it is estimated that there are in the region of 2 million in the Milky Way alone. It is difficult to believe that these were all created as a result of supernovae explosions. In addition, there must be a larger number of 'dead' pulsars in existence, since pulsars are in cosmic terms 'short lived'.

The sensitivity of detectors now enables researchers to detect pulsars in other galaxies. A pulsing source has, for example, been detected in the Large Magellan Cloud some 180,000 light years away. The nature of the signals detected can provide information about the nature of the material present in intergalactic space.

The photo below shows the brightest object in the radio sky – Cassiopeia – a remnant of a supernova explosion in our own galaxy, as seen on Earth about 300 years after its explosion. The picture was taken with the 5km telescope at a wavelength of 6cm. An expansion in the disturbed area of the supernova remnants – rich, perhaps, in Carbon atoms – has been observed over the past 20 years.

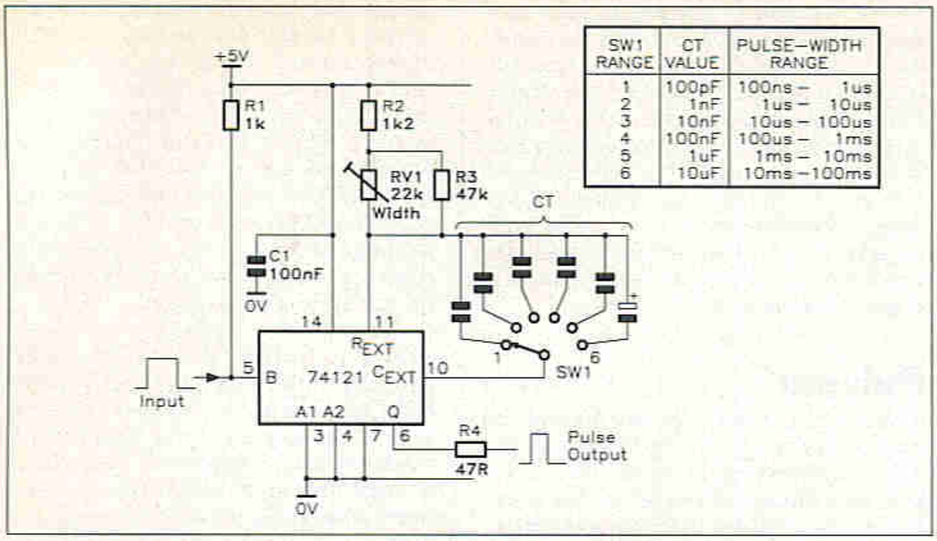
Galactic Radio Sources

Interest has quite naturally centred on explaining the workings of the immensely powerful radio sources in remote galaxies. It is clear

Continued on page 71.

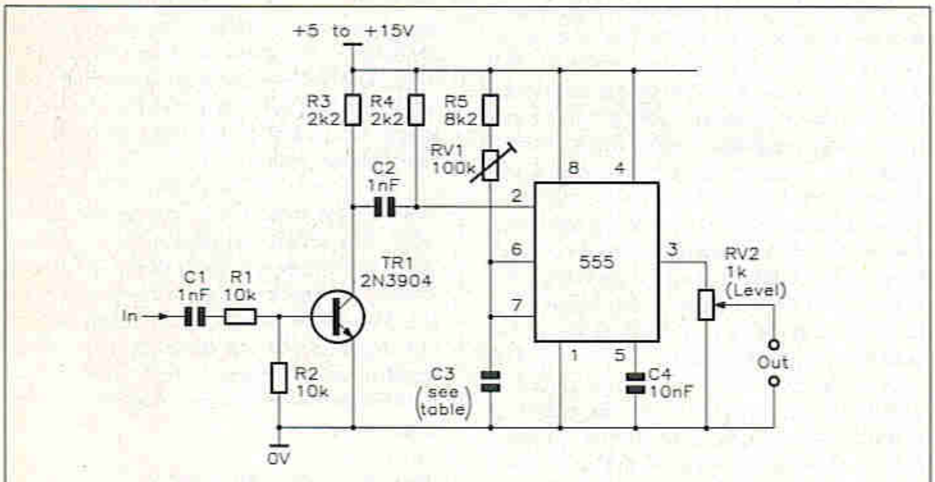
Radio image of Cassiopeia – a supernova remnant in the Milky Way.

Waveform Generator Circuits continued from page 47.



SW1 RANGE	CT VALUE	PULSE-WIDTH RANGE
1	100pF	100ns – 1us
2	1nF	1us – 10us
3	10nF	10us – 100us
4	100nF	100us – 1ms
5	1uF	1ms – 10ms
6	10uF	10ms – 100ms

Figure 16. High-performance add-on TTL pulse generator spans 100ns to 100ms.



C3 VALUE	PULSE WIDTH RANGE
10uF	90mS – 1.2sec
1uF	9mS – 120mS
100nF	900uS – 12mS
10nF	90uS – 1.2mS
1nF	9uS – 120uS

Figure 17. High-performance add-on TTL delayed pulse generator spans 100ns to 100ms.

connection is used, the output pulse width = 0·7 x RT x CT, where width is in milliseconds, RT is the total timing resistance in kilohms, and CT is the timing capacitance in µF. Note, incidentally, that the Figure 15 circuit uses the IC's internal timing components only.

Figure 16 shows how the basic Figure 15 circuit can be used as an add-on pulse generator that spans the range 100ns to 100ms in six decade ranges, using both internal and external timing resistors and decade-switched external capacitors.

Figure 17 shows how two of the above circuits can be coupled together to make an add-on wide-range delayed pulse generator, which does not generate its final output pulse until some pre-set time after the arrival of the initial trigger pulse. Note that this circuit gives both inverted and non-inverted outputs, which are each of fixed amplitude and are short-circuit protected via 47Ω series resistors. Its timing periods and CT values are identical to those listed in the table of Figure 16.

555-Based Pulse Generators

The 555 'timer' IC makes an excellent triggered pulse generator. It is triggered by signals fed to pin 2, and the output pulses are taken from pin 3. It has excellent pulse-width stability, and can be used to generate pulse periods from 5µs to hundreds of seconds. Its maximum useful pulse repetition frequency is about 100kHz.

Any trigger signal reaching pin 2 must be a carefully shaped negative-going pulse; its amplitude must switch from an OFF value above $^2/_3V_{CC}$ to an ON value below $^1/_3V_{CC}$ (triggering actually occurs as pin 2 drops through the $^1/_3V_{CC}$ value), and its width must be greater than 100ns but less than that of the desired output pulse, so that the trigger signal is removed by the time the monostable pulse ends.

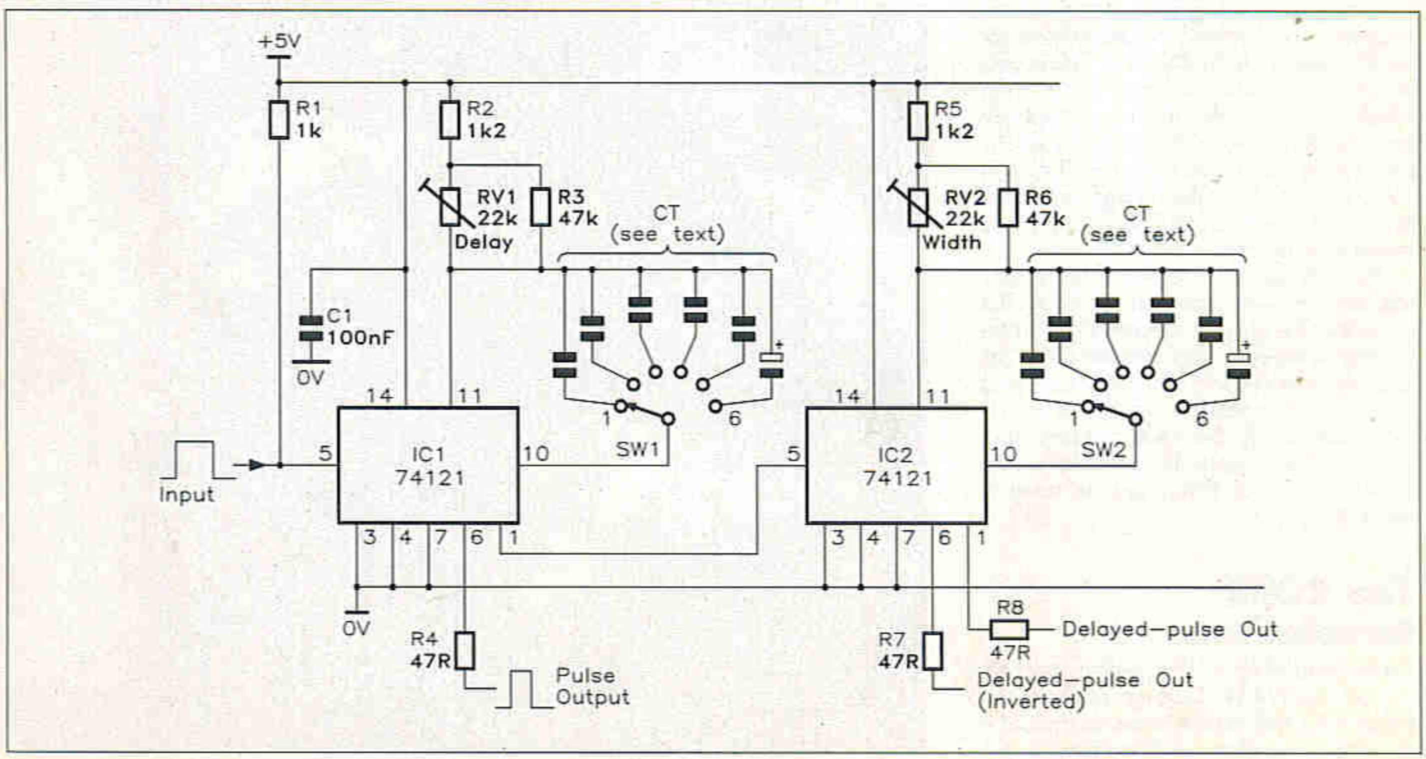


Figure 18. Simple add-on pulse generator is triggered by rectangular input signals.

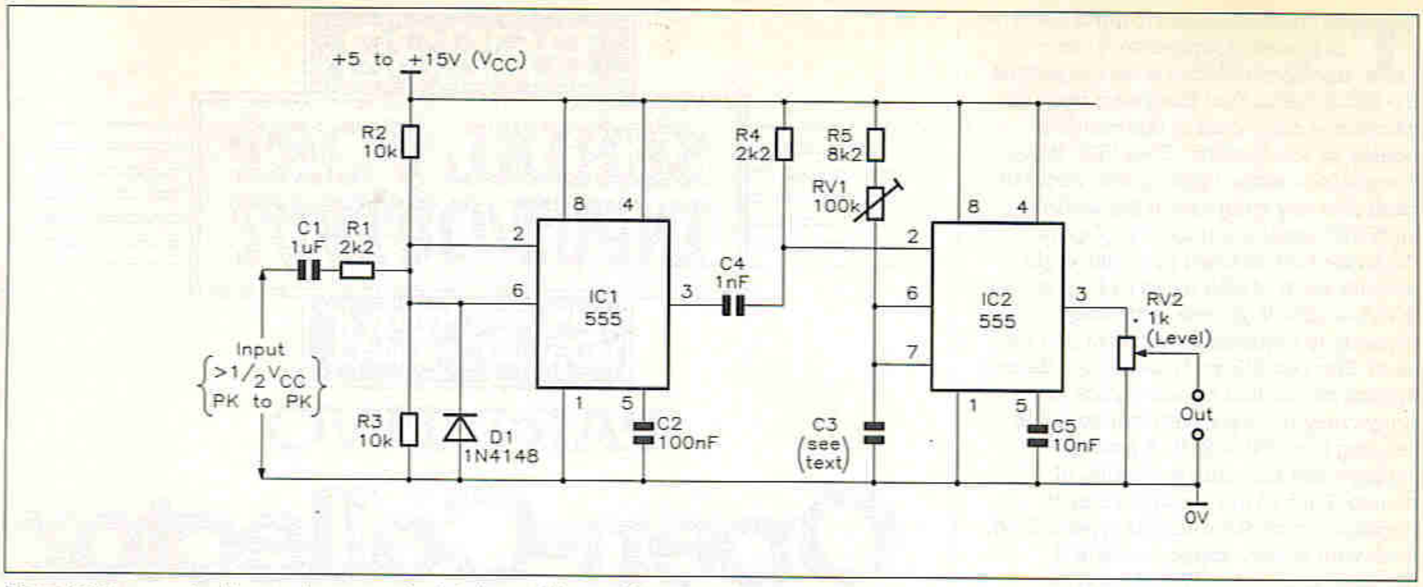


Figure 19. Improved add-on pulse generator is triggered by any input waveform.

One way of generating suitable 555 trigger signals is to first convert external input signals into good square waves that swing fully between the supply rail values, and to then couple these to pin 2 of the 555 via a short time-constant C–R differentiating network, which converts the leading or trailing edges into suitable trigger pulses. Figure 18 shows a circuit that uses this principle, but is meant for use with input signals that are already in square form.

Here, Q1 converts the input signal into one that switches fully between the supply rail values, and these are fed to pin 2 via the C2–R4 differentiating network. This circuit can be used as an add-on pulse generator in conjunction with an existing square-wave generator. Variable-amplitude output pulses are available via RV2, and their widths are variable over a decade range via RV1 and can be switched in decade ranges by using the C3 values shown in the table; the total pulse width range spans 9µs to 1·2 seconds. C4 decouples pin 5 and improves circuit stability.

Figure 19 shows how the above circuit can be modified so that it can be directly driven by any type of input, including a sine wave. Here, IC1 is wired as a Schmitt trigger and converts all input signals into a rectangular form that is used to drive the IC2 monostable in the same way as described above. This circuit can be used as an add-on pulse generator in conjunction with any free-running generator that gives Pk-to-Pk outputs greater than ½V_{CC}.

Finally, Figure 20 shows how three 555 ICs can be used to make an add-on delayed-pulse generator, in which IC1 is used as a Schmitt trigger, IC2 is a monostable that is used to control the pulse's delay width, and IC3 is used as the final pulse generator. The final output pulse appears some delayed time (set via IC2) after the application of the initial input trigger signal. Note that the C3 values of the Figure 19 and 20 circuits are identical to those listed in the table of Figure 18.

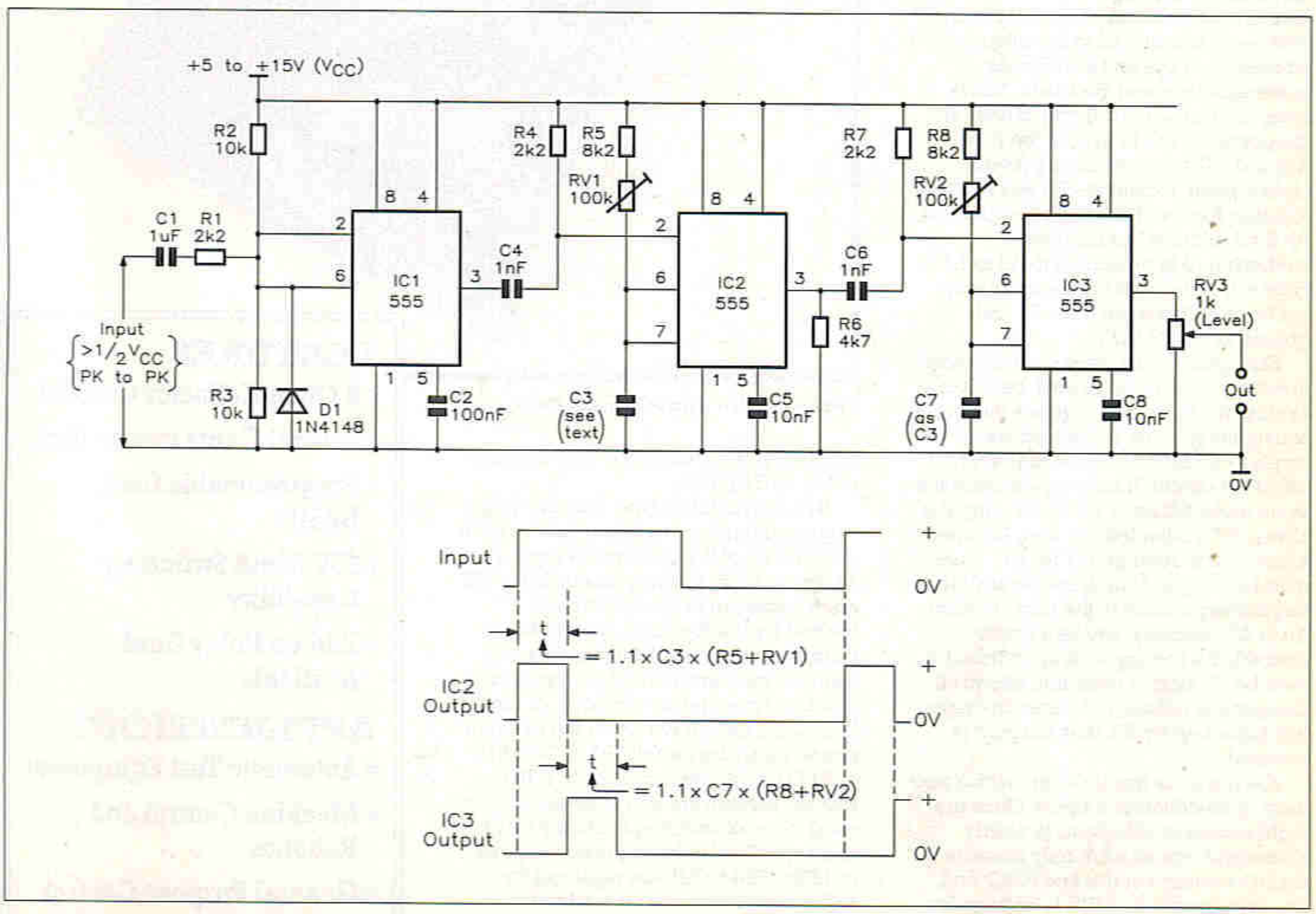


Figure 20. Add-on delayed-pulse generator is triggered by any input waveform.

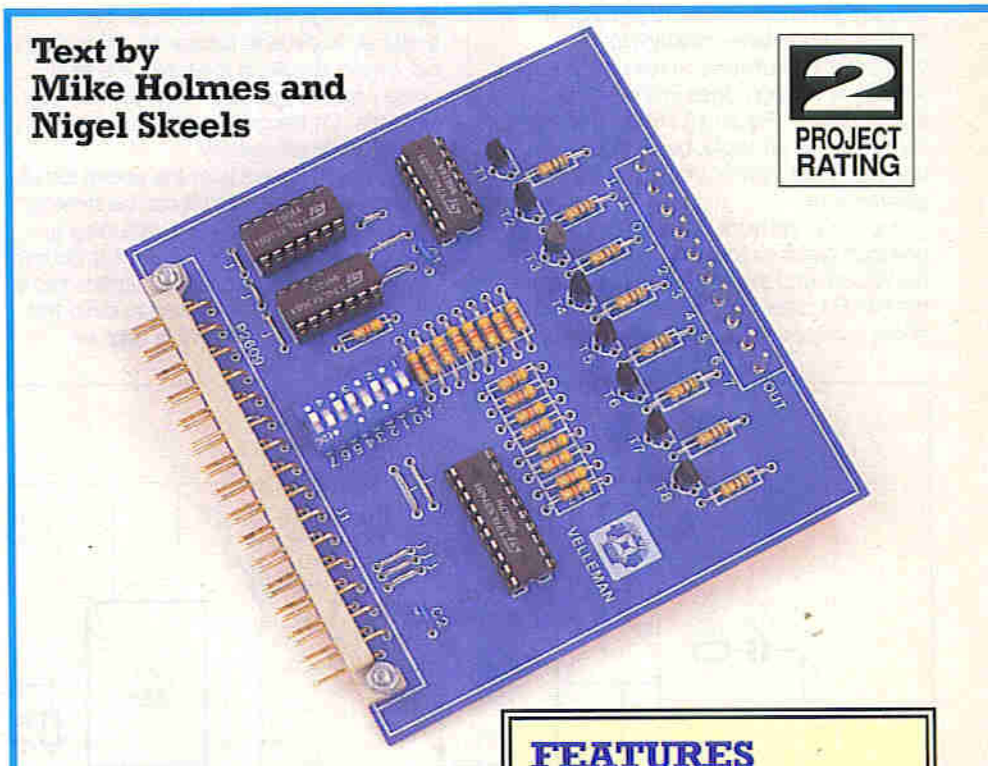
RS232 SERIAL PORT INPUT/OUTPUT SYSTEM

PART TWO

Open-Collector Output Card

Text by Mike Holmes and Nigel Skeels

2 PROJECT RATING



The assembled Open-Collector Card.

The Open-Collector Output Card is intended for use with the Intelligent Motherboard as part of the RS232 Serial Port Extension System, which was described in last month's edition of 'Electronics'. Together, these two projects alone open up the world of control to any computer equipped with an RS232 serial interface. The Open-Collector Output Card provides eight outputs, each of which can sink up to 50mA at 25V. If greater switching capacity is required then relays can be used. The flexibility of the open-collector system means that a wide choice of relays may be used, with coil voltages ranging from 6V to 24V. A suitable supply must be made available, of course. Each of the 8 outputs can, if required, control a different type of load, each with its own supply voltage if necessary; only the 0V rail need be common.

Circuit Description

As with any of the other plug-in cards for use with the extension system, a connection is made between the Open-Collector Card and the computer via the Intelligent Motherboard and Extension Card, which buffers the data signals, generates the necessary auxiliary signals and provides the power supply for the interface plug-in cards.

The circuit of the card, as shown in Figure 1, is essentially quite simple and mainly comprises an octal latch driving open-collector, transistor switched outputs. However, since several of these cards can be installed in the motherboard extension card at the same time, each is required to be uniquely addressed to prevent an address contention between the cards. This is achieved through the fitting of links at the positions 'A0' to 'A7' on the PCB. IC2 and IC3 between them provide eight 2-input, exclusive–OR gates, which together form an 8-bit logic comparator. An 8-bit address bus from the motherboard is presented to A0 to A7 in Figure 1, while wire links may or may not be fitted between R1 to R8 and ground at 'A0' to 'A7'.

Each gate has an open-collector non-inverting output, and in each case, the exclusive – OR action requires that the two inputs must be at different logic levels to achieve an active high (output off) at the output. If both inputs are at the same level, either '0' or '1', the output is always '0' (output low) or (on). Wherever a wire link is fitted at 'A0' to 'A7', there must be a logic '1' bit from the address bus corresponding to the same position, A0 to A7; similarly, where a link is omitted, the corresponding address bit must be '0'. Such a condition allows all the gates to release the common output line pulled up by R9, thus the card is selected.

IC4 provides two inverters which also have open-collector outputs. Once the eight exclusive–OR gates, properly addressed, are all off, it only remains for the I/O request control line IORQ and the write enable line WR to both go low to completely release the common output line, producing a positive going pulse at IC1 pin 11.

IC1 is an octal, D-type, positive edge triggered flip-flop, meaning that on each occurrence of the clock pulse input, pin 11, going high, the data bits on D0 to D7 are transferred to the outputs and latched by the flip-flops. D0 and D7 originate, of course, from the data bus from the motherboard. The outputs are non-inverting and so a logic '1' or (active high) data bit will switch on the relevant output transistor switch TR1 to TR8. R10 to R17 provide buffering for IC1. R18 to R25 are current limiting resistors and are used when connecting the Relay Card project (VF00A), driving opto-couplers or LEDs. R18 to R25 are replaced by links when driving other loads such as relays or filament lamps direct.

FEATURES

* 8 Open-Collector Outputs
* Several Cards can be Used
* Programmable from BASIC
* 25V 50mA Switching Capability
* Add-on Relay Card Available

APPLICATIONS

* Automatic Test Equipment
* Machine Control and Robotics
* General Purpose Control

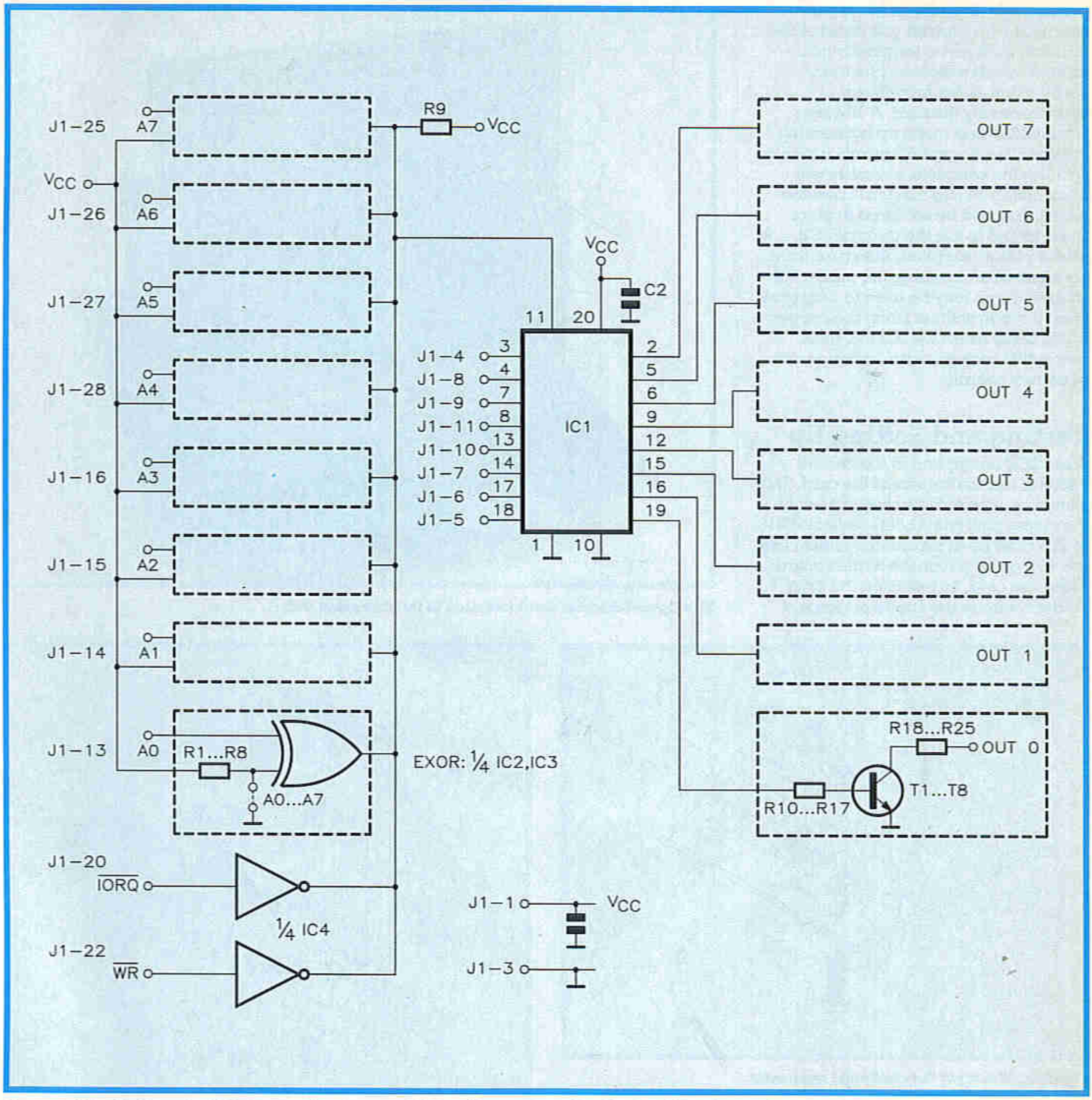


Figure 1. Circuit diagram of the open-collector card. Note only one example of each addressing and output stage are shown in detail.

Construction

Construction is quite straightforward and is dealt with in greater detail in the booklet supplied with the kit. However, the following notes are also beneficial.

As a recommended sequence of events, firstly fit the wire links between the PCB holes marked 'j'. After fitting these the card's address must be chosen; this is according to what other addresses you will be using for other cards, i.e., if this is the first card on the extension board then it can be given the address '1', which would be set by installing wire links at 'A0', 'A5', 'A6' and 'A7' (see Part 1 for a table showing the different addresses available including special addresses for the multiplexer and an external real time clock).

However, be warned that once the addressing links are fitted, the pattern may not be easily modified without risk of damage to the PCB. One recommendation therefore is that, if you want the facility of being able to alter the address settings at any time for greater flexibility and to better mix different plug-in cards, to be inserted at any position in the extension card, then you could use an octal SPST DIL switch (XX27E) at positions 'A0' to 'A7'. The hole spacing in this area is deliberately compatible with the standard DIL layout for this purpose. This will allow you to quickly and easily alter the card's address at any time.

Next fit the resistors, followed by the IC sockets, taking care to align the notch to the legend. If it is desired to drive loads directly instead of using the Relay Card project, R18 to R25 should be fitted with links instead of 560Ω resistors. Fit the transistors, matching their outline to the legend, then fit the capacitors C1 and C2. Although the ICs are not CMOS types and should not be at risk from static damage, do not insert them into their sockets yet until all other work has been completed.

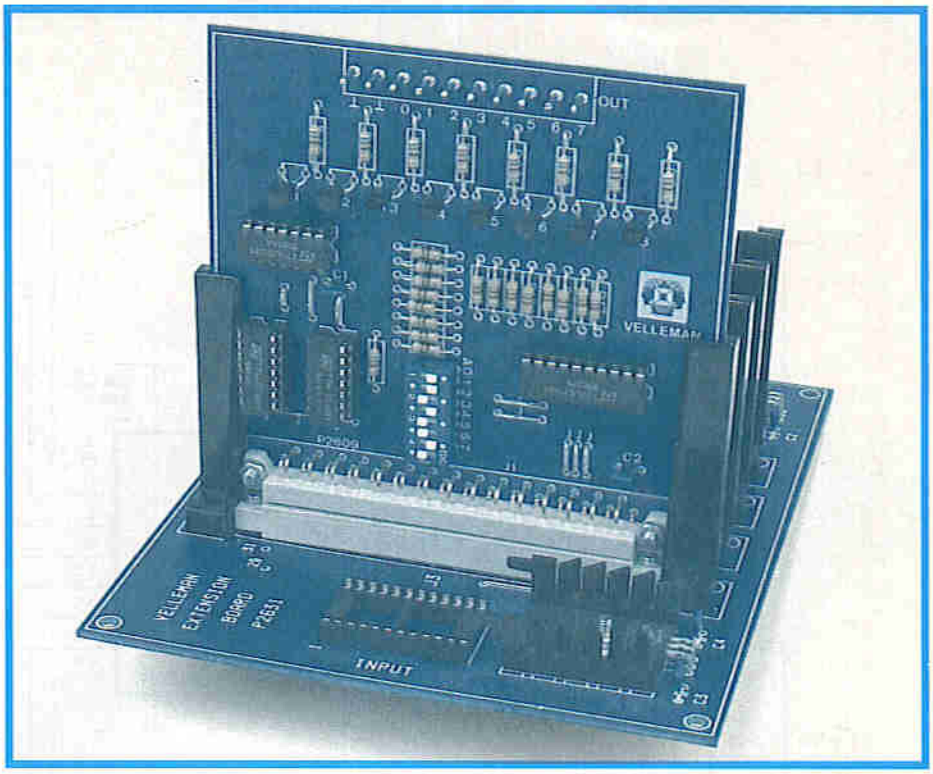
Fit the right-angled male PCB connector to the card by bolting in place using two M3 screws and nuts BEFORE soldering, as shown in Figure 2. Similarly fit the female connector to the motherboard, and solder. Then attach the upright PCB edge guides to the motherboard with the self-tapping screws as shown in Figure 3.

You can now either fit the PCB pins at

positions 'OUT' on the card, or as an alternative we suggest you could utilise a 10-way PCB screw terminal block instead, which will make changing connections easier for different applications for the card. A 10-way terminal block is made up by stacking together five 2-way PCB terminal blocks (JY92A); the complete assembly will immediately fit into the 'OUT' position on the card and be soldered in place. If you intend to use the original PCB solder pins as supplied, then care must be taken when inserting the pins, a hot soldering iron may be used to help push them through without lifting the copper track. Lastly insert the ICs into their respective sockets, again making sure of correct polarity.

Testing and Setting Up

A red LED is supplied in the kit with which to test the outputs of the card. This should be connected between each of the output pins (via a 560Ω resistor if R18 to R25 have been replaced by links) and the +9V outlet pin on the motherboard extension card, as indicated in Figure 4. Solder a wire to the anode or (longest



The Open-Collector Card installed in the Extension Unit.

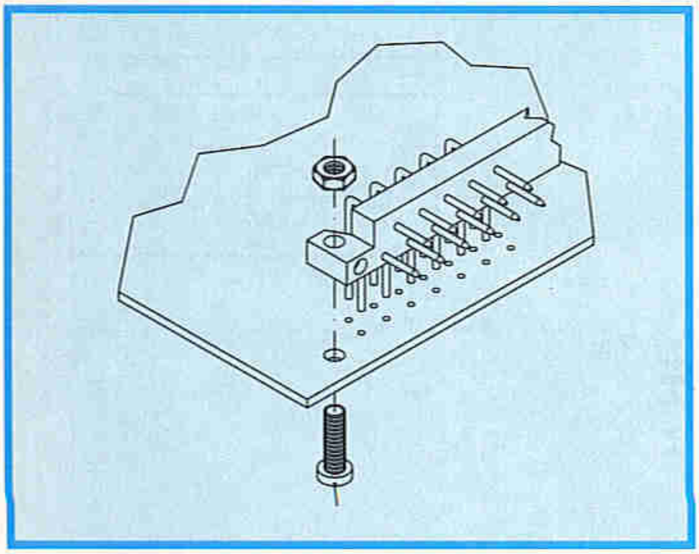


Figure 2. Mounting the card edge connector.

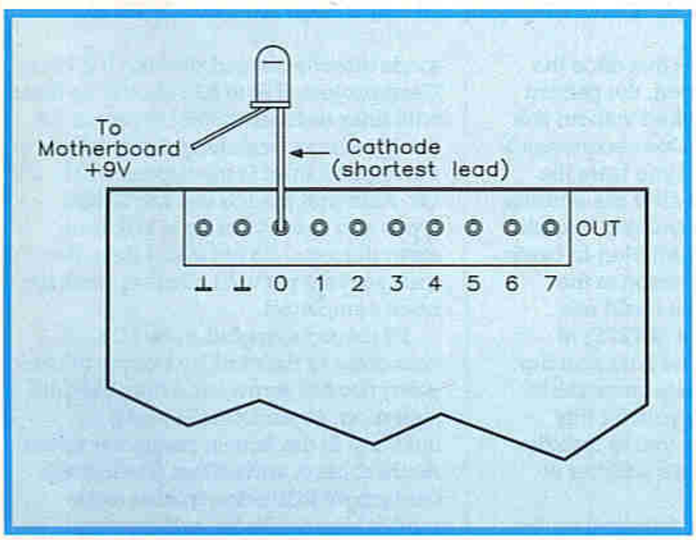


Figure 4. Using the supplied test LED to check the card's individual outputs.

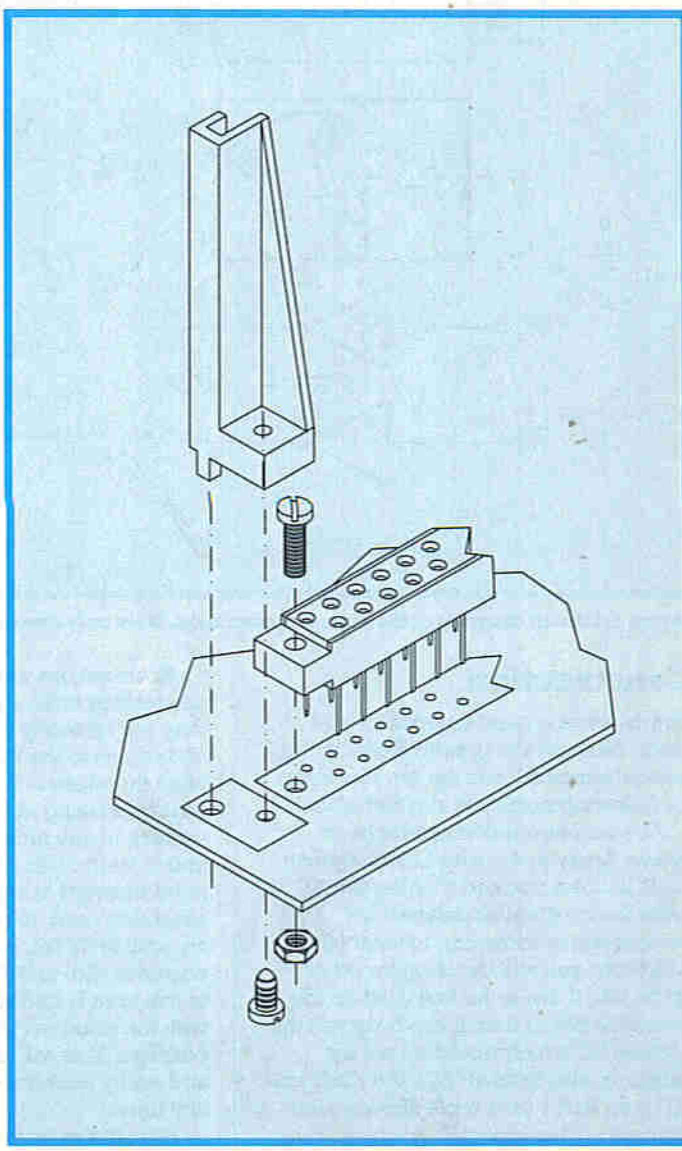


Figure 3. Mounting the motherboard PCB socket and card PCB guides.

lead) of the LED, and the other end to the +9V pin. After connecting, the outputs can be checked by setting all the outputs on, and touching each in turn with the cathode, or shortest lead, of the LED as though it were a test prod. This is done with the following motherboard commands (also see programmers guide):

```
EPEX
EPTX
EATX
EINT
OPDA 1 (Address of card) ,
       255 (All bits on)
```

Another Test Program

Begin by clearing the memory by typing 'CLRM' followed by 'YES' in reply to the prompt. Now that the memory is clear, the time and date can be set. After this is complete, you are ready to begin programming the memory.

Type the following: note that the line numbers are included here for convenience only and should not be entered into the program; also that the program has been written for a card with the address of '1'.

```
001 EATX XX XX XX
002 EINT XX XX XX
003 EPTX XX XX XX
004 EPTX XX XX XX
005 RDTD XX XX X0
006 OPDA 1 255 XX XX X0
007 OPDA 1 001 XX XX X1
008 OPDA 1 002 XX XX X2
009 OPDA 1 004 XX XX X3
010 OPDA 1 008 XX XX X4
011 OPDA 1 016 XX XX X5
012 OPDA 1 032 XX XX X6
013 OPDA 1 064 XX XX X7
014 OPDA 1 128 XX XX X8
015 OPDA 1 000 XX XX X9
```

This program will begin by enabling all of the automatic system functions. It will then print the time and switch all the outputs on, and then off, and continue to switch each output on, and then off until it gets to the last one where it will switch all the outputs off, and begin again to print the date and run through the rest of the program.

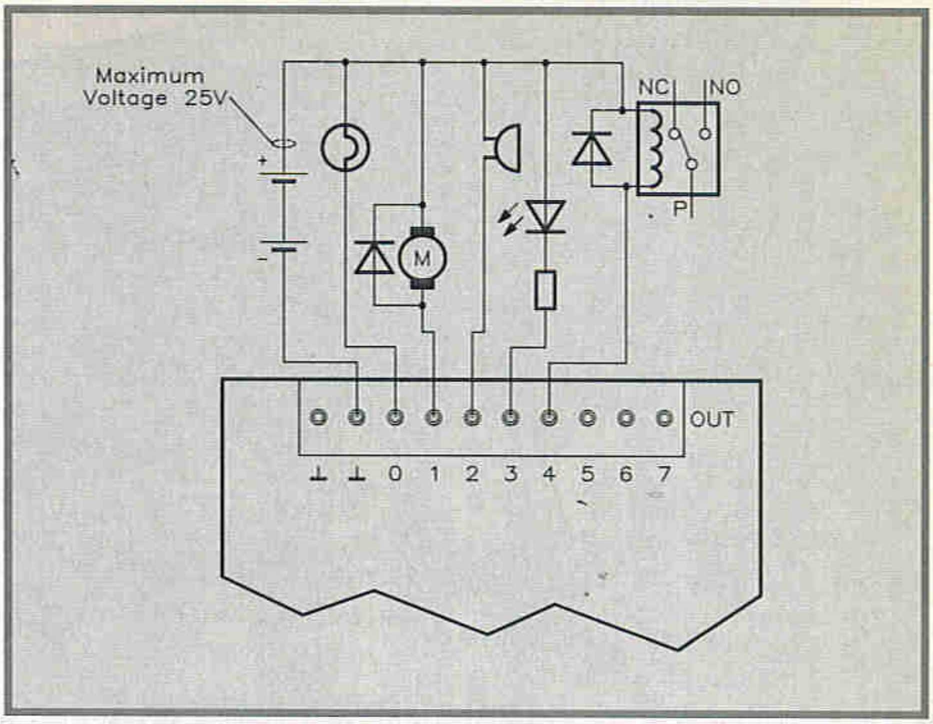


Figure 5. Examples of connecting various output devices.

The Open Collector Card in Use

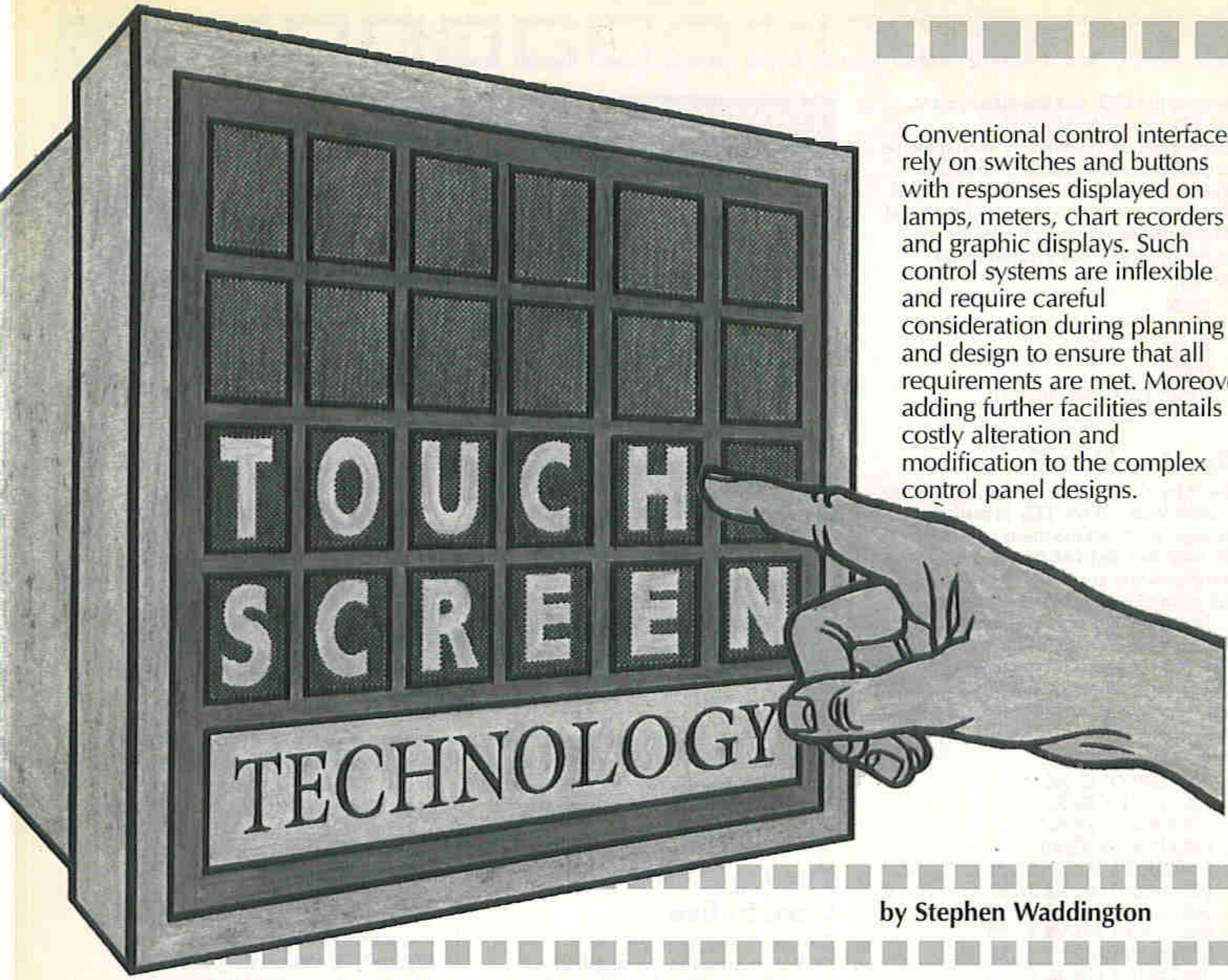
The card is plugged into the motherboard using the supplied connecting sockets. Each transistor on the card acts as a switch, so the output devices should be connected between a positive supply and whichever output pin is applicable. A range of different devices is illustrated in Figure 5. Note that the external supply's 0V should be connected to one of the 0V pins on the card; in Figure 5 this is illustrated with the battery. A variety of devices can be used, including lamps, LEDs, motors and relays. The card's maximum output capability is 25V at 50mA, and if greater voltages or currents are needed, then a relay card should be used instead (VF00A). If inductive loads are used, and these include motors and relays, then the device must be shunted by a diode in 'inverse parallel', as indicated in Figure 5. To reduce the possibility of electrical noise generated you could also include a 100nF capacitor across the inductive load, but the working voltage of the capacitor must be twice that of the total external supply. It is important to take into account the switch-on surge and stall current of loads; if the drive capability of the card is exceeded, the output transistors may be damaged.

OPEN COLLECTOR CARD PARTS LIST

RESISTORS: All 5% Metal Film			
R1-17	4k7	17	
R18-25	560Ω	8	
CAPACITORS			
C1,2	Monolithic 100nF	2	
SEMICONDUCTORS			
TR1-8	BC547 (BC237)	8	
IC1	74LS374	1	
IC2,3	74LS136	2	
IC4	74LS05	1	
MISCELLANEOUS			
	14-Pin DIL Socket	3	
	20-Pin DIL Socket	1	
	PCB Pins	10	
	31-Way PCB Plug	1	
	31-Way PCB Socket	1	
	PCB Guides	2	
	M3 x 4mm Screw	4	
	M3 Nut	4	
	Self-Tapping Screw	2	
	PCB	1	
	Instruction Booklet	1	
	Red Test LED	1	

OPTIONAL (Not in Kit)			
	2-Way PCB Terminal	5	(JY92A)
	SPST Octal DIL Switch	1	(XX27E)

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 in kit form only.
Order As VE92A (Open Collector Kit) Price £22.95
Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.



Conventional control interfaces rely on switches and buttons with responses displayed on lamps, meters, chart recorders and graphic displays. Such control systems are inflexible and require careful consideration during planning and design to ensure that all requirements are met. Moreover, adding further facilities entails costly alteration and modification to the complex control panel designs.

by Stephen Waddington

Touchscreen computer control has changed all this with its flexible technology. In such systems, a computer is used to interface between the desires of the user and the outside world. Gone are traditional switches, replaced by simplistic graphical pictures which the operator simply touches to issue commands. Elaborate software allows complex control sequences and patterns to be established which can then be checked, verified and implemented by the computer. The versatility of such systems is limited only by the quality and content of the software.

The Past

Touchscreen technology had a whimsical following during the mid-eighties. However, this was short-lived as Gail Noble, a spokesperson for Hewlett Packard, admits: "We used to sell a touchscreen several years ago, but a low market demand forced us to withdraw it." These old devices were unreliable and because of the low picture quality of Visual Display Units (VDUs), operators could only use them for a short period of time before headaches and eye strain set in.

But interest has now been revived. The computing fraternity – previously slow to acknowledge the scope of such an input peripheral – is realising the benefits of touchscreen systems. Improved displays and more reliable touchscreen systems provide a firm foundation for their launch into the realms of mainstream computer systems.

Touchscreens enable the user to interact on a one-to-one basis directly through the display. No keyboard or mouse usage is necessary, allowing the new user to concentrate solely on the task to be performed rather than the inputting itself. This simplicity means that users need not be familiar with individual computer systems, or even be computer literate at all.

The advances made in input, output and control now means that a computer is often employed as the central mechanism within a control system.

Touchscreens offer simplistic, dedicated operation, releasing the keyboard and other input peripherals, allowing the computer to be used in 'rougher' industrial environments where previously it was forbidden because of the adverse effects of dust, dirt and grease on a mouse or keyboard-based system.

Different Types

The textbook portrayal of a touchscreen is of a computer screen with transparent conductive pads fitted to its surface. In reality only one of the four main technologies available exists in this form, the resistive touchscreen, based upon a conductive overlay which is placed across the screen. Progressing up the ladder of complexity, there are infra-red systems that incorporate a series of infra-red beams which are projected across the surface of the screen with associated detectors responding to interruptions in the beam pattern. Even more involved are the systems based on capacitive contact with the human body, or surface acoustic waves which are transmitted across the screen.

Resistive

Resistive touchscreens can be manufactured using several methods; the most popular being those constructed from two layers of thin plastic, mounted on a transparent rigid support. A more slender version employs a glass substrate with a conductive laminate. In the principal form, two layers of polyester, coated on one side with a thin transparent conductive material such as indium tin oxide, are sandwiched together. The conductive layers are separated by tiny, transparent plastic beads in a defined array, the geometric arrangement of which can be altered to suit the screen actuation force required. The resulting flexible assembly is then mounted on either a rigid back panel of glass or polycarbonate. Glass provides greater rigidity and optical clarity.

Polycarbonate is often used in environments where glass is unacceptable.

Where optical clarity is essential, a reduced construction is employed. As described, a conductive layer is deposited directly onto a glass surface. Again the upper conductive layer is formed from polyester and plastic spacer beads are used to separate the two conducting surfaces. Essentially, the device is the same, although one layer of polyester has been removed, resulting in a slight improvement in light transmission through the touchscreen.

The resistive touchscreen can be operated in two modes, either as an analogue or matrix device. The analogue version allows superior resolution and is essential for graphical applications, whilst the matrix format provides a concise and accurate number of defined elements. The mode of operation is defined during manufacture, since it relates directly to the construction of the device.

In an analogue form, the two planes of conductive material are prepared with electrical connections, one with horizontally opposed bus bars, the other vertically as illustrated in Figure 1. Each plane is alternately driven with a constant DC voltage, whilst the other plane is used to detect the voltage drop at a given position. By this method the changing voltages correspond to the X and Y co-ordinate at any given point on the screen. By processing these signals through an Analogue to Digital converter in conjunction with a microprocessor the X and Y co-ordinates of a position on the screen can be ascertained.

A matrix-resistive touchscreen consists of an etched array, typically of rows and columns, although more complex patterns can be realised. When a position on the screen is selected a closed circuit is formed indicating which row and column has been actuated as illustrated in Figure 2. The touchscreen is interfaced to a host microprocessor by a simple decoding circuit, so providing the computer with details of the operators' requirements.

Ideally suited to industrial applications where there is no danger of damage from chemical corrosion, resistive touchscreens can be activated by almost any form of stimulus from a finger to a gloved hand. Unfortunately, the plastic versions of the device tend to lose resolution with time, since the conductive coatings gradually wear out. The cheapest of the four systems, however, they are easily moulded to fit the curvature of a monitor; additionally, the materials used in construction are relatively inexpensive.

Infra-Red

Infra-red systems were the first type of touchscreens to appear on the market. Now slightly refined, the technology rates alongside resistive systems in popularity and range of application. A series of infra-red beams generated by infra-red light emitting diodes around the edge of the screen, shine onto detectors at the opposite edge. A control circuit pulses the beams alternatively in the X and Y planes, creating a grid of light across the surface of the screen. The introduction of a finger or other stylus interrupts the beam pattern and detectors in the form of photo-transistors register the absence of light and report it to a host microprocessor. By processing signals from both the X and Y axis, the co-ordinates of a selected point can be established.

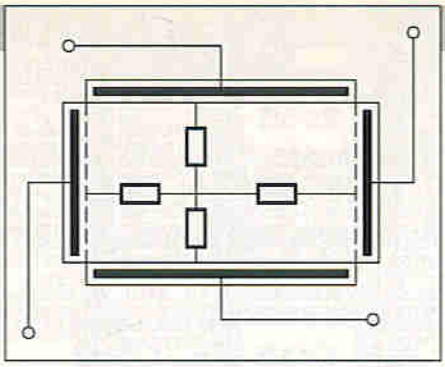


Figure 1. Analogue resistive touchscreen

A major disadvantage with infra-red technology, particularly in applications where the screen is used by inexperienced operators, is the problem of false touches. As the infra-red beams are suspended across the screen, a selection can be registered before contact with the screen is ever made. Parallax problems can be overcome by the use of a flat Liquid Crystal Display, or by confining the touch areas as close to the centre of the screen as possible on conventional display units. Unsuitable for use in hazardous environments as the detectors are affected by dirt and dust, infra-red systems do offer excellent image clarity since they do not rely on an overlay which often affects the colour and sharpness of an image.

Capacitive

Perhaps the most ingenious type of touch screen is the capacitive design. These devices use the operator's body capacitance to detect the position of touch. Comprising of a single layer substrate constructed upon a glass surface, the system employs electrodes around its periphery which are connected at the four corners to tuned oscillators within a control unit. When the screen is touched, the operator's body capacitance alters the frequency at which the tuned circuits oscillate. The controller monitors and measures the oscillations of each circuit in the X an Y direction and compares the values attained with standard measurements when no external influence prevails. From the resulting differential, the controller determines the point at which the screen has been touched.

Suited to a harsh environment, capacitive touchscreens are unaffected by dirt and moisture. They cannot be activated by gloves or other such objects, since the design relies on the capacitance of the operator's body.

Surface Acoustic Wave

At the cutting edge of technology are Surface Acoustic Wave (SAW) systems. These devices are based on the transmission of surface acoustic waves through a glass overlay from transducers to a series of receivers. The addition of a finger or external body to the surface of a SAW screen results in the absorption of

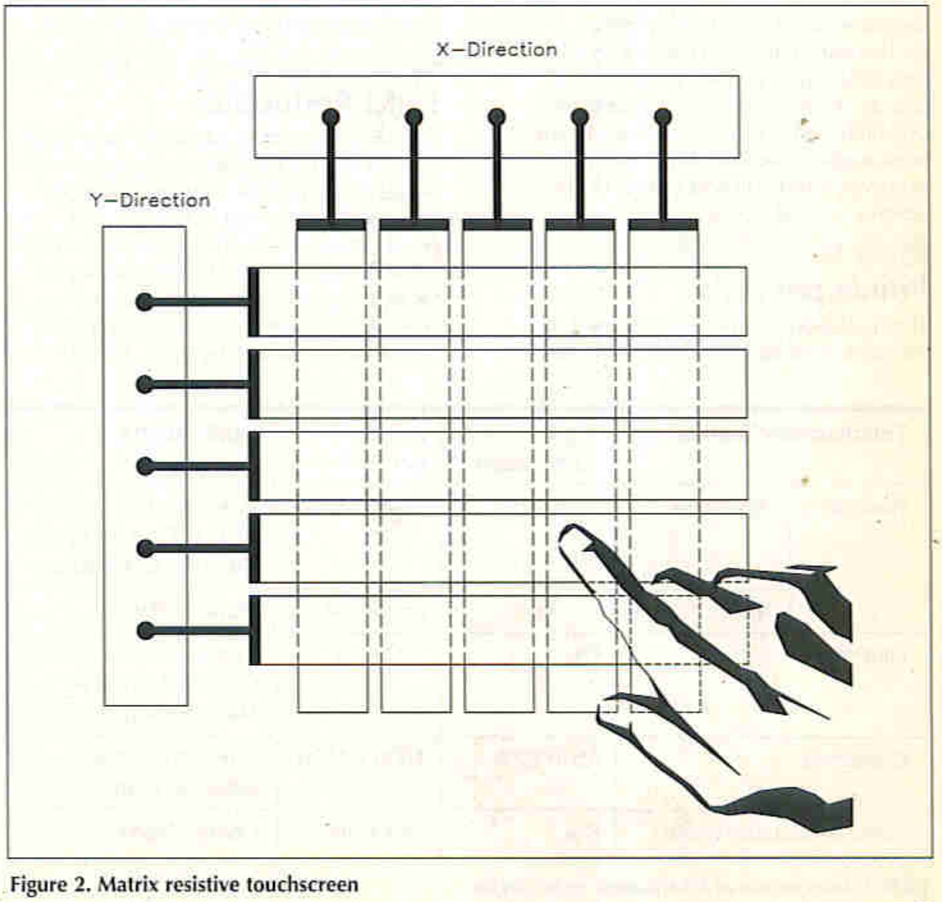
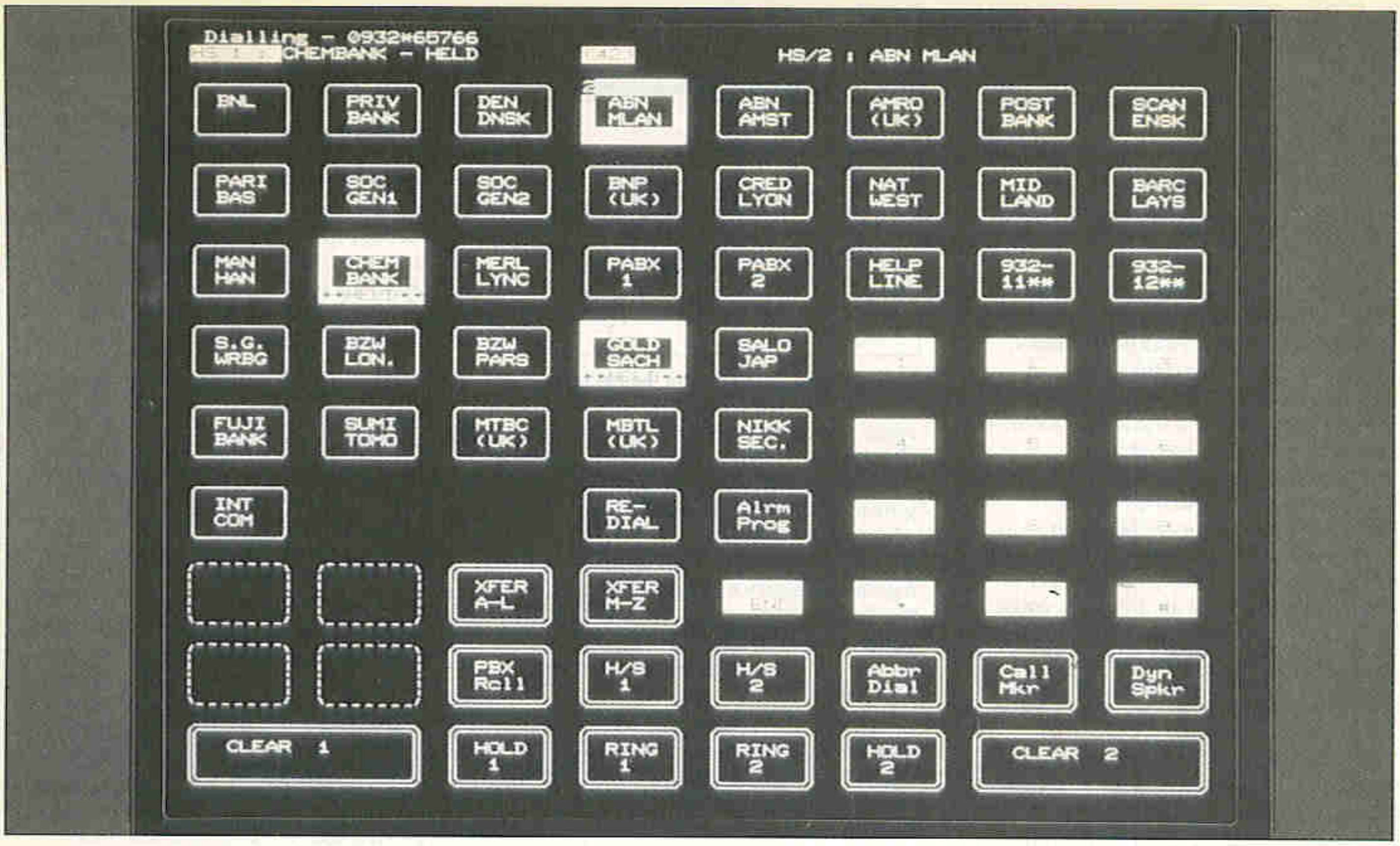


Figure 2. Matrix resistive touchscreen



An example of a touchscreen display.

some of the energy from the transmitted wave. The pattern expected by the receiver is disturbed and so the controller measures the effect on the wave to determine the X and Y locations of the point of contact.

But SAW touchscreens are unsuitable for dirty and dusty environments as foreign particles can sometimes be detected as an input and are liable to upset the tuned circuits. Unlike the other three technologies, SAW screens are not susceptible to mechanical degradation and offer reliable operation and a long service life.

The principal characteristics by which a touchscreen is defined are resolution, optical clarity, environmental resistance, durability and cost. Mention has already been made of the latter three points, however, resolution and optical clarity deserve consideration.

Points per Axis

The resolution of a device is defined by the number of individual points on the touchscreen, which can be differentiated by the host microprocessor. Table 1 outlines the main features of each of the touchscreen systems described; the resolution of each type of device displayed in the third column is measured in points per axis. The most coarse is the infra-red screen, suitable only for menu type applications; at the opposite end of the scale, analogue-resistive designs often allow several thousand points per axis of resolution and are ideally suited to software which would otherwise require a mouse.

Light Reduction

By placing an additional screen in front of a visual display unit, some absorption will inevitably take place. In many instances this is slight and is not noticeable, but equally there are many applications where a loss of quality may cause problems. As Table 1 indicates, the worst offenders are resistive touchscreens, reducing the light output from monitors by up to 40% in some instances. The ideal in this aspect are infra-red devices, since they surround the screen, do not obstruct it and cause loss of light output.

Application

Actual industrial applications of touchscreens are rare, since many manufacturers are reluctant to opt for a system which has yet to be fully proven. The false start which occurred in the mid-eighties has introduced a mood of scepticism – that said, several design companies exist promoting the value and appeal of touchscreens as an integral part of a computer system. Several manufacturers have taken the confident step and have integrated touchscreens into their existing systems. Two notable companies include Carter-Voce Ltd., incorporating touchscreens as part of their public address networks, and British Telecom, employing touchscreens in their telephone exchange desks for stock exchange trading.

The beauty of touchscreen systems is that they allow complex equipment to be mastered in a fraction of the time, compared with conventional methods. Modification to existing systems does not entail changing extensive control panels but simply relies upon a new software upgrading. By allowing effective communication between the human operator and computer system, touchscreens are increasingly entering previously unexplored environments. The resurgent interest is prompting manufacturers to explore the possibilities, resulting in systems which can be operated with ease by both novice and expert alike. And one step closer to making computers literally accessible to everyone.

Touchscreen Technology		Light Absorption	Points per Axis	Applications
Resistive	Analogue	15 to 40%	4096 x 4096	Graphical Work Mouse Type Programs Complex Operations
	Matrix		256 x 256	Menu Software
Infra-red		0%	100 x 80	Control Rooms Process Monitoring Menu Software
Capacitive		15 to 20%	1000 x 1000	Process Control Industrial Plant
Surface Acoustic Wave		8%	550 x 380	Control Rooms

Table 1. Comparison of touchscreen technologies

Radio Astronomy continued from page 61.

that the source of much of the radio energy of galaxies and nebulae is synchrotron radiation, caused by fast-moving electrons spiralling in magnetic fields. The radio galaxy Centaurus A is one which has been extensively studied.

It is considered that the colossal energies radiated in the radio frequencies by these 'radio galaxies' is attributable to an immense black hole, which sucks material into its ultra-intense gravitational field. As matter is absorbed into its structure, frictional heating of atoms takes place to create an accretion disc around the immediate structure of the black hole. This is a highly unstable structure, however, and ultra-hot matter is considered to be ejected into various jets and lobes. Such a black hole would have an 'event horizon' – a spherical boundary within which photons captured by the black hole would not be able to escape.

The great ability of such black holes to act as transformers of energy comes from the likely 'astronomical' value of their masses. It has been estimated that to sustain some of the highest observed radio emission powers, masses in the region of 10^8 solar masses are involved with an accumulation of mass at the rate of about 2 solar masses per year. This matter may be sucked in from dust clouds, stars in a galaxy which wander close to the galactic centre, or a number of other mechanisms. The study of such phenomena, however, is in its infancy. What is understood is that a radio galaxy is a transformation of energy at a virtually incomprehensible level. This transformation takes place between gravitational energy and that of electromagnetic radiation.

The quasar 3C 418 has been extensively studied using the MERLIN facilities and also the VLBI system linked to European radio telescopes in Holland and Germany. With quasar objects, the factor sought is not increasing sensitivity, but improved resolution of the central radiating object.

Conclusion

The very nature of radio waves enables them to reveal fundamental details about the universe. They can, for example, indicate the presence of Milky Way stars otherwise obscured by dust clouds. They can also detect objects which are so remote that they cannot be optically resolved. They can be used to detect the extent of hydrogen gas clouds and the kinematics within star systems and galaxies. They can also measure the remnants of the radiation associated with the Big Bang, which is thought to have ushered in the current phase of cosmic evolution.

Future thoughts in radio astronomy now relate to establishing space-based observatories over very long base lines. Such designs, which will deliver phenomenally fine resolution, could be located between satellites, or between the earth and a moon-based station.

It is curious to think that as their increasingly sensitive instruments observe ever-distant galaxies, observers are in fact glimpsing backwards in time closer to the time of the Big Bang, which is generally considered to have taken place about 15 billion years ago.

Due to the fact that even light (travelling at approximately 3×10^8 metres per second) takes considerable periods to negotiate such distances, it is important to realise that what is being read of distant galaxies could be no more than an image of what they once were.

By comparison, man's bubble of radio waves is only some 200 light years in diameter – spreading out from his patch in the milky way.

As higher and higher resolutions are achieved in scanning the universe, there becomes more and more to look at. This is the scientific paradox that becomes more and more apparent as it advances still further; NASA scientists are still analysing data from the Viking missions – never mind the European Space Agency and its comparatively recent 1986 Giotto probe into Halley's Comment. As science finds ways to obtain knowledge, we discover a universe which is filled with correspondingly increasing levels of complexity.

Despite this, Radio Astronomy is only sixty years old and as it matures, its ability to shed light on age-old problems gains momentum.

References

1. The Jodrell Bank Telescopes, Bernard Lovell, Oxford University Press, 1985.
2. Observing the Universe: a New Scientist Guide: Edited by Nigel Henbest, Basil Blackwell, 1984.

Acknowledgments

Acknowledgments are due to the Mullard Radio Astronomy Observatory at Cambridge, and to Jodrell Bank in Cheshire, for providing photographic material.

NEXT issue

In next month's super issue of 'Electronics – the Maplin Magazine', there are some really great projects and features for you to get your teeth into! The January issue is on sale December 4th, available from Maplin's regional stores, and newsagents countrywide, and of course by subscription (see page 22 for details). To whet your appetite, here's just a taster of some of the goodies on offer:

TAKING TOLL OF TRAFFIC JAMS

The January 1992 issue of 'Electronics' carried an article, by David Holroyd, describing the QEII Bridge that links Essex with Kent, augmenting the 4-lane Dartford Tunnel. The article gave some background and historical information on a new toll-collection system known as AVI – Automatic Vehicle Identification. In next month's issue, Stephen Waddington takes a closer look at AVI, how it works and its implications for the future.

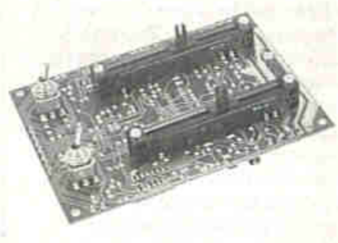
AUTORING

One of the most difficult sounds to simulate in plays and films is a telephone which must ring on cue, and stop ringing when picked up. Finding a 'mock' telephone that rings with the exact timing cycle of a BT telephone is even more difficult, and so in the January issue you'll find full constructional details of 'AutoRing', a clever device that will cause most types of BT plug-in telephone to ring when required. Also ideal for practical jokes and telephone testing, AutoRing can be made to simulate an American ringing sequence if so desired.

VINTAGE RADIO

In the second part of this series, we look at the various themes that your collection can take. Amateur or professional? Domestic or military? In the end, it's all down to what appeals to you. Your career could be the dominant influence. Alternatively, your interest could be triggered by no more than a love of bygone craftmanship, or the unmistakable character of the thermionic valve.

DUAL FADER MODULE



The Dual Fader Module is intended as a 'building block' for use in high-quality mixing systems. Being voltage-controlled, it is a lot quieter than conventional types – as slider noise (normally noticeable after a few hundred hours use) becomes irrelevant, not being in the signal path.

THE FIRST PICTURE SHOW

Facsimile transmission wasn't always just a neat little box tucked away in the office corner. Forty years ago, the equipment required for the transmission and reception of images via a telephone circuit would have filled a fair-sized room. This special feature, by Greg Grant, traces the history of facsimile from the late nineteenth century to the present day, and contrasts the old technologies with the new.

PROGRAMMABLE PULSE GENERATOR (PPG)

A useful circuit, with pulse width adjustable from 0 to 999µs (or 999ms depending on the flick of a switch). Highly accurate, this low-cost PPG is ideal for providing test signals and calibrating oscilloscopes.

RADIO CONTROLLED CARS

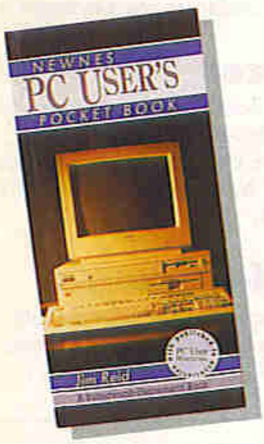
Trevor Tennant returns with more top tips for racers of radio control models – covering areas as diverse as battery charging and gear ratios. Referring primarily to the Traxxas range of vehicles, the information in this article will put you in good stead for your next race meeting!

ELECTRONIC DICE

Most board games involve a random element, usually obtained from a 'throw of the die'. This electronic version contains two such die that are activated by the push of a button. The outcome is shown on two LED displays (one for each die) – clear for everyone to see, and no way of cheating!

Plus of course there's all the usual regulars for you to enjoy!
'ELECTRONICS – THE MAPLIN MAGAZINE'
BRITAIN'S BEST SELLING ELECTRONICS MAGAZINE

NEW BOOKS



PC User's Pocket Book

by Jim Reid

The majority of business computers are classed as PC-compatible, that is, they are either IBM PCs or machines that are compatible with them. All these computers follow the same basic rules of operation.

To get the best out of these machines, programmers and advanced users need to understand how the the computers work. This book takes you inside the computer, showing you how each component functions and how it may be used to best effect. Each section is illustrated by a small segment of machine code. Full reference tables on PC features, interrupts, video modes, etc. are included.

The book is based on the IBM PC range, including the 8086, 80286, 80386 and 80486 models. The information in the book is relevant to all true IBM-compatibles; anywhere that incompatibilities may cause problems is highlighted. Versions of DOS up to and including DOS 4 are also covered.

As well as providing instruction in the programming of the computer, the book can also be used as a reference guide to the inner workings of the machine. It should appeal to all programmers and computer enthusiasts and, since most commercial programs are written or adapted for the PC compatibles, it is relevant to programmers at all levels. Also relevant to the PS/2 range.

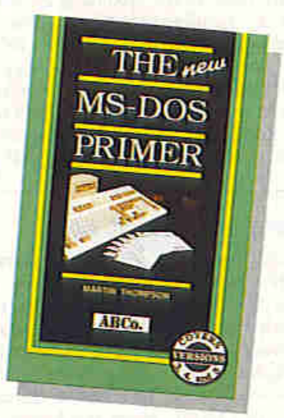
Contents include the basics of assembly language programming, instruction sets, ROM BIOS and DOS interrupts, keyboard and screen operation, date and time services, sound generation, disk architecture, DOS file handling and directories, and communications.
1991. 352 pages. 197 x 93mm hard cover, illustrated.

Order As WZ51F (PC Users Pocket Bk) £12.95 NV

The New MS-DOS Primer

by Martin Thomson

MS-DOS, Microsoft's Disk Operating System, has become the world standard for microcomputers. It is the software that turns your machine into a functioning computer. Covering MS-DOS versions 3, 4 and 5, this book is written for the beginner. It uses simple straightforward language and everyday examples to teach the most frequently used features of MS-DOS. The chapters are short and logically organised, each ending with a summary emphasising the main concepts covered. The mystery is

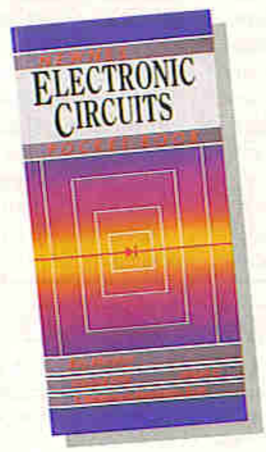


removed and technical jargon is avoided wherever possible.

Whatever computer with MS-DOS you use, you will need to master the basics of its operating system to take advantage of all its capabilities. Perhaps most importantly of all, the book covers disk formatting and the storage of files on disks. This will give you control over your own files, enabling you to copy, rename, delete and move them from disk to disk. The making of security copies is fully covered, so that you can insure against the loss of your valuable data. Guidance is given on how to avoid the destruction of your data by computer viruses, and what to do if your computer becomes infected.

With this book you will learn how to use MS-DOS and release the power of your computer.
1991. 223 pages. 215 x 135mm, illustrated.

Order As WZ52G (New MS-DOS Primer) £8.50 NV



Electronic Circuits Pocket Book

Volume 1

by Ray Marston

A vast range of linear ICs is now readily available for use by both amateur and professional design engineers and technicians. This information packed book is a single-volume applications guide to the most popular and useful of these devices, and presents a total of 625 diagrams, tables, and carefully selected practical circuits, backed up by over 50,000 words of highly informative text.

It deals with many strictly linear ICs such as op amps, audio preamplifiers, power amplifiers, signal conditioners and power supply regulators, etc., as well as various 'hybrid' configurations, which use a mixture of linear and digital devices, such as the 555 timer IC, bargraph display drivers, CCD delay lines, function and waveform generators, phase-locked-loops (PLLs), and power control ICs.

Each subject is treated in an easy to read, concise, highly practical and non-mathematical manner. Each chapter deals with a specific type of device or a class of circuit, by firstly explaining the basic principles of its subject and then going on to present the reader with a wide spectrum of applications circuits and tables, each covered by adequate text.

Great emphasis is placed on practical 'user' information and circuitry throughout, and most of the ICs and other devices used in the practical circuits are modestly priced and readily available, with universally recognised type numbers.
1991. 336 pages. 197 x 95mm hard cover, illustrated.

Order As WZ49D (Elec Circuits) £12.95 NV

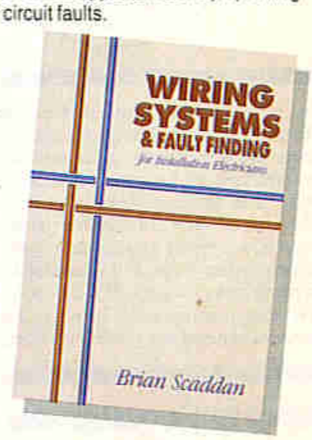
Wiring Systems and Fault-Finding

For Installation Electricians

by Brian Scaddan

This book is written for the installation engineer and deals with an area of expertise with which many technicians, students and do-it-yourselfers experience difficulties in practice. It will be particularly welcomed by all those, including both installation and plumbing contractors, self-employed heating engineers and the home electrician, who need to be able to trace faults in circuits whether they be domestic, commercial or industrial systems.

The book covers the interpretation of wiring circuit diagrams, wiring systems and the principles and practice of testing for fault diagnosis. Diagrams which are closely linked with comment and explanation lead the reader from the basic symbols to circuit and wiring diagrams, through more complex circuitry and various types of wiring systems, to the logical and methodical approach to the pinpointing of circuit faults.

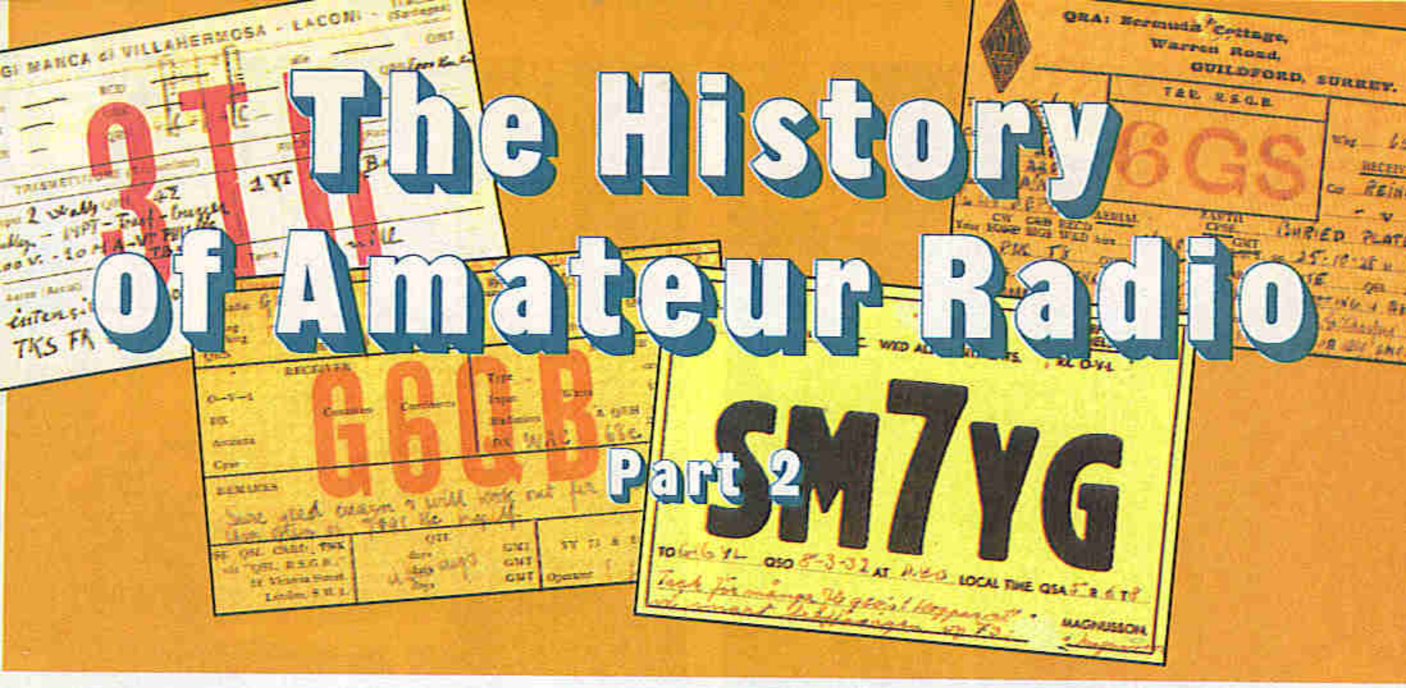


Consequently the main aim is to help the reader to approach the drawing and interpretation of electrical diagrams with confidence, to understand the principles of testing and then to apply this knowledge to fault-finding in electrical circuits.
1991. 96 pages. 210 x 145mm, illustrated.

Order As WZ50E (Wiring Systems) £9.95 NV

The History of Amateur Radio

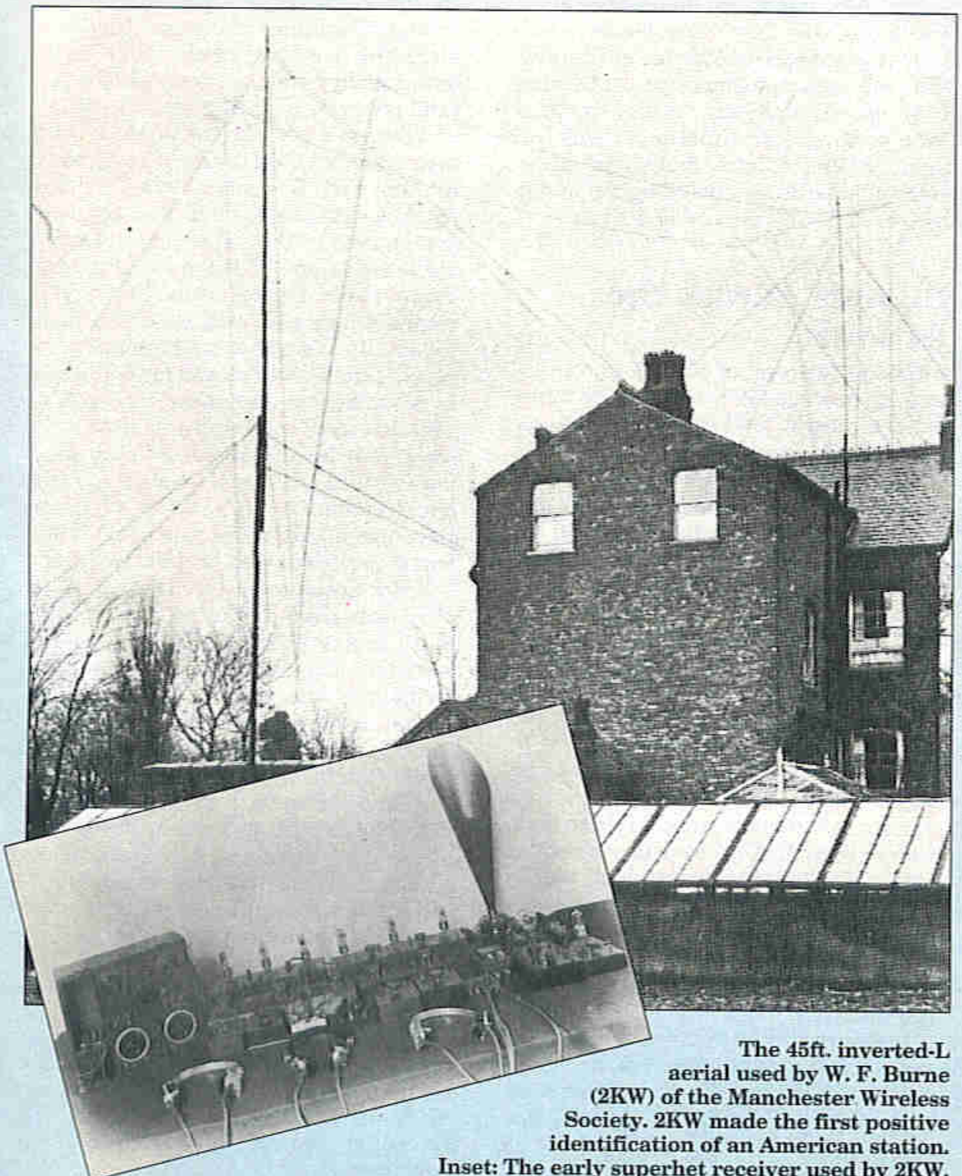
Part 2



by Ian Poole (G3YWX)

The years before the First World War had seen wireless established as an important means of communication. After the first experimental licences were issued, experimenters had also proved their worth by helping to push back the frontiers of this new technology. However, these licences were very restrictive because the authorities were concerned about security and the improper use of wireless. Then, as the First World War broke out, all experimental licences were suspended and operation ceased.

Once the war had finished and the Armistice had been signed, it took some time for life to return to normality. However, interest in wireless started to grow very quickly. Soon people were calling for the reintroduction of amateur experimental licences. Initially the government was not interested in issuing such licences, even for receiving. Soon the pressure started to increase, with a number of periodicals campaigning the cause of the amateurs. At the time the government responded by making a statement saying that the conditions for amateur licences were still under consideration. This slowness may have been as a result of continued concerns over security.



The 45ft. inverted-L aerial used by W. F. Burne (2KW) of the Manchester Wireless Society. 2KW made the first positive identification of an American station. Inset: The early superhet receiver used by 2KW.

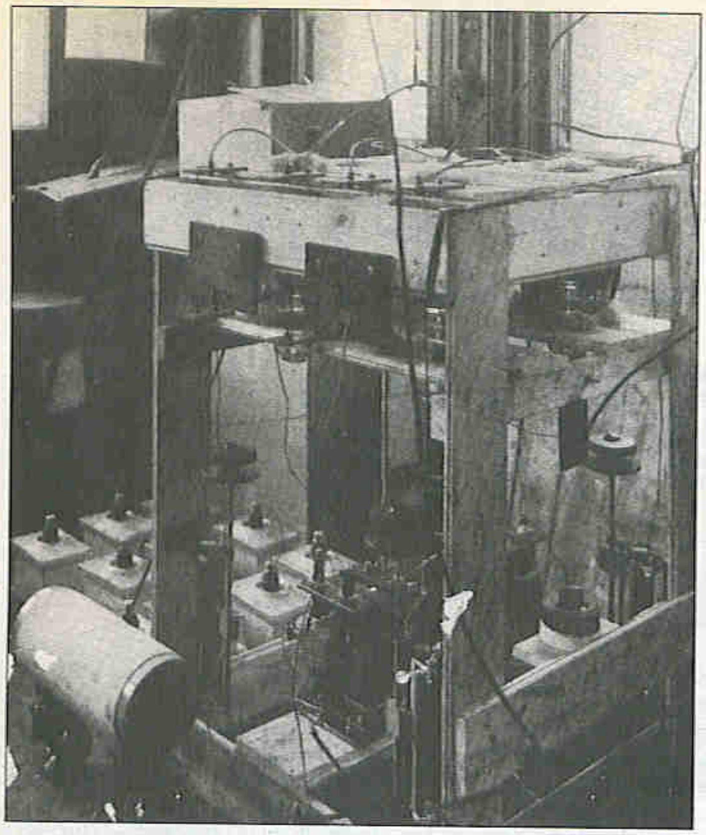
Fortunately things did start to improve before too long. The wartime restrictions which had been placed on the sale of equipment related to wireless started to be lifted. In April 1919 the sale of electrical buzzers was allowed. Headphones could also be bought although the purchaser had to give a written undertaking that they would not be used for wireless purposes. However, restrictions on the sale of valves remained.

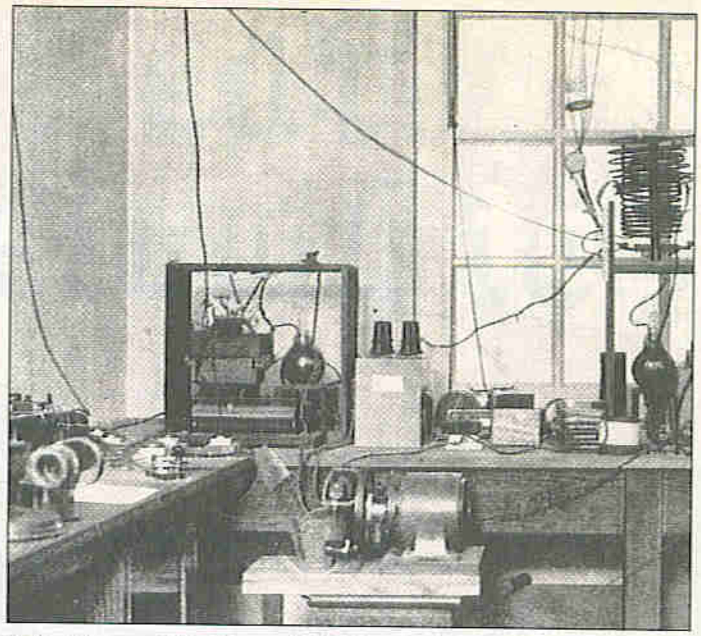
The next stage took place in October 1919 with an announcement by the Post Office saying that receiving licences were to be issued. A charge of ten shillings was to be levied and the use of valves was prohibited without special authority.

New Licences

In November 1919, the Post Office disclosed that a new Wireless Telegraphy Act would shortly be placed before Parliament, and this would permit transmitting licences to be issued again. The conditions for these licences were outlined – like the pre-war licences they were still experimental, unlike those issued in the USA which were true amateur licences. In view of this, applicants had to demonstrate that they needed a transmitting licence to perform a number of predetermined experiments. In addition to this, a wireless theory examination would have to be passed as well as a morse sending and receiving test.

Finally, in the middle of 1920, the first new licences were issued. Again, callsigns were allocated but, unlike the old ones which consisted of three letters, the new ones commenced with a number followed by two letters. Initially the number "2"





Left: The specially-licensed 1kW transmitter, 5WS, used by the RSGB (then the Wireless Society of London) for the first transatlantic amateur broadcast. The Manchester Wireless Society, with their station 5MS, were also 'trying for America'. To this day, nobody is quite sure who was heard first!
Above: The Mill Hill (London) station. Here, during an October night in 1924, a Mr Goyder (2SZ) broke another record by making contact with New Zealand.

was used, but later other numbers were used as more callsigns were issued.

The first licences issued had many restrictions. The power was limited to only ten watts, while operation was limited to the 180 and 1000 metre bands. Limitations were also placed on the hours of operation, as well as the other stations with whom you could contact.

Not everybody who applied for a licence received a full transmitting licence. If the Post Office thought that the experiments detailed in the licence application did not justify a full licence, they would issue what was known as an 'artificial aerial licence' – whether you passed the requisite examinations or not. These allowed the holder to build and test transmitters but only into a dummy load or 'artificial aerial', which would absorb the power of the transmitter and not radiate it. Having been issued with an artificial aerial licence, it was possible to apply for a full licence at a later date.

Back On the Air

During the first few months after the first licences were issued, activity was fairly low as there were very few active stations. In addition to this, most of those who were licensed were in the process of building their equipment. This was very varied in nature, ranging from spark transmitters through to fairly sophisticated (at the time!) apparatus using war surplus valves.

Whilst many stations were preparing to go 'on the air', the licence conditions were changing. Some of the restrictions were removed after representations from various clubs and societies, including the Wireless Club of London (which was later to become the Radio Society of Great Britain).

Unfortunately, not all the changes were to the advantage of radio amateurs. Commercial interests wanted (increasingly) valuable spectrum space, particularly on the longer wavelengths which could be used for long-distance communication. As a result, amateurs were given the use of the short-wave bands which were thought to be of little use at the time. This was a great disappointment because they only had access to wavelengths longer than 275 metres by special arrangement. In fact, British amateurs were allowed to use wavelengths of 440 metres and 1100 metres for a while.

Signals Across the Atlantic

Although the level of activity in the UK was low during 1920, this was certainly not the case in the USA. Here amateur radio was becoming very popular and a very large number of licensed stations were active. These stations were allowed to use powers of up to 1kW, after all, the USA encompasses a vast area. Soon reports were heard of long-distance contacts being made on the short-wave bands and these fuelled speculation that contacts across the Atlantic might just be possible.

To see if this could be done a series of tests were organised to take place in February 1921. They aroused a great deal of interest and a lot of publicity was given to them in the radio press. In these tests stations from the USA were to transmit at specific times. Special codes and messages would be used to ensure that messages had been genuinely copied. Unfortunately no signals were heard even though a large number of stations in the UK were listening.

Despite the failure of these tests, many people still thought that the Atlantic could still be spanned, many reasons being cited for the failure of the first set of tests. For example, the Americans believed that British operators were inexperienced in long-distance work and that their equipment was not sufficiently sensitive. The British side, meanwhile, reasoned that the American transmissions were not long enough (3 minutes at any one time), and that the weak signals were being swamped by harmonics generated by powerful commercial radio transmitters.

Whatever the reasons another set of tests was organised to take place between 8th and 17th December 1921. This time the Americans sent one of their amateurs over, a man by the name of Paul Godley. He brought one of the new Armstrong Supersonic Heterodyne (superhet) receivers over with him. He first tested a location in Wembley, but he found it too noisy. Then Godley moved his equipment to a location at Ardrossan in Scotland. This was ideal because it was close to the sea and away from man-made sources of interference. To complement this excellent location Godley erected a massive Beverage aerial, which consisted of 850 feet of wire strung up on 12ft. high poles.

Prior to the main tests some preliminary ones were conducted in the States and Canada to select the stations best suited for long-distance communications. By limiting the number of stations participating it was hoped that excessive interference caused by the operation of too many stations could be minimised.

When the main tests started Godley managed to pick up his first station just after midnight on 9th December. Although he only decoded the callsign – 1BCG during the first night he managed to copy a full message a couple of days later.

Fortunately for British pride, the success was not just limited to the Americans. In fact it was later discovered that the first positive identification of an American station was made by a British station 2KW during the early hours of 8th December, using much more modest equipment!

Atlantic Contacts

Once it had been discovered that signals could be heard across the Atlantic the next stage was to see if signals could be transmitted back to America with the possibility of a two way contact. To accomplish this many preparations had to be made. It was felt that the transmitter power of 10 or 25W then permitted by the British Post Office was insufficient. Accordingly some special high power permits were issued, and some special stations were set up. Even so others with ordinary licences were invited to participate as well.

The dates for the tests were fixed for 12th to 21st December 1921. However, one of the stations with a high power permit located in Manchester managed to hear a Californian station about three weeks before this. Whilst they did not manage to make two-way contact, it was a new world distance record.

Preliminary tests were again carried out in America, just as they were during the previous experiments. British stations were encouraged to listen, and a good number of American stations were heard.

The results of the main tests were somewhat disappointing. The station 5WS, a high-powered station set up by the Wireless Society of London in Wandsworth was the only station to be positively identified in the States. Even then no contact was made, possibly because of the high level of activity from America causing interference and confusion.

This failure meant that another set of tests were scheduled for the January of the following winter. However, a Frenchman, Leon Deloy from Nice, arranged some private tests before this and succeeded in making contact with two American stations on 27th November 1923. Whilst this was a tremendous achievement it was even more important because it had been made on a wavelength around 100 metres, and not 200 metres which had been used for the previous tests.

Fortunately it did not take long for a British trans-Atlantic contact to be made. On 8th December the British station 2KF made a contact lasting over 2½ hours.

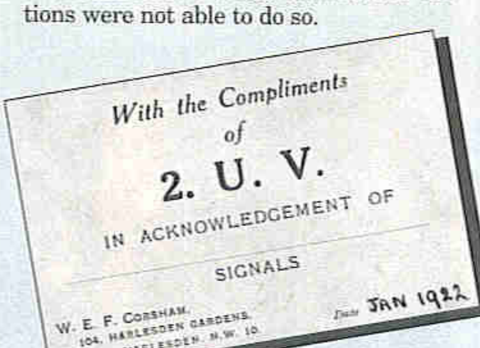
Frontiers Pushed Back

Once these first trans-Atlantic contacts had been made, many other amateurs succeeded in making contacts as well. It was also quickly realised that shorter wavelengths, of around 100 metres or less, often provided better communications than those around 200 metres. With people beginning to understand a little more about propagation on these wavelengths, more distant contacts were starting to be made. On 18th October 1924, Mr Goyder (2SZ) at the Mill Hill School in London broke another record by making contact with New Zealand. Again this contact was made during the night.

With these successes still hitting the headlines, many were encouraged to try even shorter wavelengths and it was soon discovered that long-distance contacts could be made during the day. The first trans-Atlantic daytime contacts, made in February 1925, were maintained every day for over a month.

Service to Others

Whilst the value of the short-wave bands was quickly grasped, there were few commercial stations operating during the few years that followed. This enabled radio amateurs to provide a valuable service, maintaining communications in a number of circumstances where commercial stations were not able to do so.



Reportedly the first QSL card sent in Europe, if not the world, by Bill Corsham (2UV).

One example occurred in 1925 when the Mill Hill School station 2SZ was able to maintain contact with an Arctic expedition when all other means failed. In the same year, another British amateur named Gerald Marcuse (2NM) performed the same service, for the Hamilton-Rice exploration of Brazil.

QSL Cards

In the early days of radio it was very common for amateurs to write a letter to confirm the contact, especially when communication had been made over a considerable distance. From this came the idea of having a card printed specially for the purpose. Some cards were printed by American amateurs for the trans-Atlantic tests of 1923.

Their use grew rapidly, and shortly after their introduction the name QSL card was adopted – QSL coming from the international 'Q' code meaning "I confirm reception". With the considerable growth in the number of cards being sent, a bureau system was inaugurated. Using this system, cards could be sent by the individual stations to the bureau in bulk. From here they could then be forwarded to other stations, or the bureaux of other countries when sufficient numbers had accumulated. By using this system it was possible to save a huge amount of money on postage, although it did take somewhat longer for cards to reach their destination. However, the system has been so successful that it is in use more than ever today.

Callsign Prefixes

Once international and intercontinental communications had become established, it became obvious that some method of identifying the geographical location of a station, from its callsign, was needed. Before this was done, it was quite possible for stations in different countries to have exactly the same call letters.

In the USA, they had gone part of the way to alleviating the problem, at least in their own country. They had adopted a system of call areas. In each different call area, the callsign would start with a different number. As a result, it was possible to identify the approximate area of the States in which the station was located.

Before any official moves were set in motion to solve the problem, many amateur stations had added a prefix letter to their callsigns to identify their country of origin. British stations would use G for Great Britain making a callsign 2AA into G-2AA. French stations used F; and those from the USA used a variety of letters; U for USA, N for North America or A for America.

As there were no real international bodies for radio regulations the first ideas were implemented unilaterally. In fact it was in October 1924 that the British Post Office agreed to the idea of using a prefix, and that G could be used for British amateurs. Fortunately, once the first few countries had implemented the idea, others soon followed suit.

Amateur Bands

By proving their worth, amateurs found their slice of the spectrum in the short-wave bands (once thought to be of no value) under threat from commercial interests. Accordingly, in October 1927 an international conference was held in Washington, for the purpose of allocating the available spectrum to prospective users. Naturally, the amateur allocations were drastically reduced but despite this, sufficient space was retained as can be seen from Table 1. In fact the allocations made to amateurs at this conference form the basis of many bands still used today.

A collection of early low-power valves.

The Amateur Bands Allocated in the 1927 Washington Conference.

1715kHz	–	2MHz
3·5MHz	–	4MHz
7MHz	–	7·3MHz
14MHz	–	14·4MHz
28MHz	–	30MHz
56MHz	–	60MHz

Table 1.

Broadcasting

Apart from proving the worth of the short-wave bands, radio amateurs also played a key role in the start of regular broadcasts.

February 1920 saw the beginning of experimental broadcasts from the Marconi Company in Chelmsford, Essex. This was followed in 1922 by the first broadcast from 2MT, and shortly afterwards 2LO was set up. These were the first stations set-up purely for broadcasting.

However, at this time, little consideration had been given to the idea of international broadcasting. Not surprisingly, amateurs with their experience in long-distance communications were keen to experiment. In the early-20's there were no laws relating to the broadcasting of recorded material, so it was possible to broadcast virtually anything!

Gerald Marcuse (2NM) saw the need for short-wave broadcasting and applied for a high power licence for this purpose. The Post Office granted it to him, and in September 1927 he started broadcasting internationally. He soon found that he had a large audience for his broadcasts of home made programmes, records, and re-transmissions of 2LO.

Late in 1927 the BBC started their experimental Empire Service, using the callsign 5SW from a transmitter in Chelmsford. This continued until a permanent Empire Broadcasting station was opened in Daventry (East Midlands) at the close of 1932. Using this station, all parts of the British Empire could receive broadcasts from the UK at some time of the day.

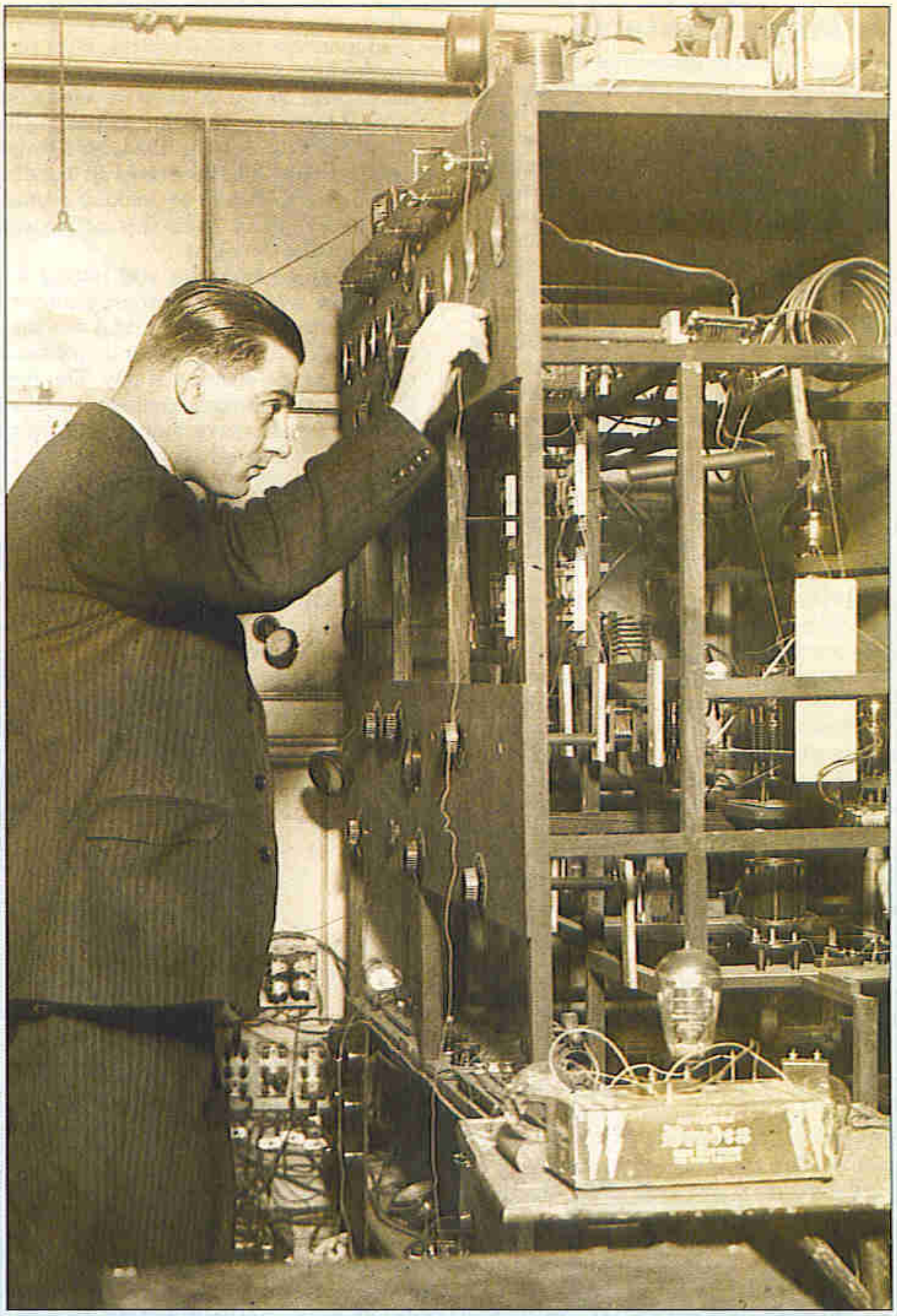
Marcuse continued his broadcasts until late in 1928. By this time, he had proved that international broadcasting was viable.

1930s

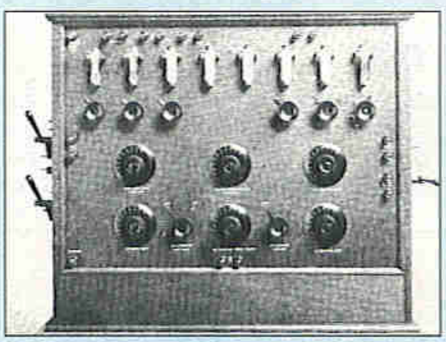
The period of the 1930s saw many changes in amateur radio. Many were associated with improvements in technology. The tuned radio frequency (TRF) receivers started to give way to the superior superhet. Transmitters were also improved; oscillators did not drift as much and circuits became more stable and easier to use. All-valve equipment was, by then, standard; in fact, the Post Office had ceased issuing licenses for spark transmitters in 1924. Experiments were performed with new types of transmission. Morse and AM were standard but a few pioneering amateurs tried SSB.

Licence conditions changed slightly. Some of the more established amateurs were able to use up to 150W, but most still had permits for only 10 or 25W. There were a large number of artificial aerial licensees, with 'call' signs consisting of a figure 2 followed by three letters.

Despite these restrictions, the number of radio amateurs grew. By 1938 there were just over 2,700 full licences in force, together with about 2,200 artificial aerial ones. Amateur radio was growing rapidly, but it would not be long before the development of the hobby would be halted again.



Enthusiastic London amateur J. W. Mathews (6LL) operating his 20/40 metre transmitter in 1933. Note the 250W output valve, which can be seen in the centre right of the picture.



Some amateurs took as much trouble with the physical appearance of equipment as they did with the electronics. This magnificent superhet receiver was built by W. K. Alford (2DX) in the mid-twenties for Gerald Marcuse (2NM).

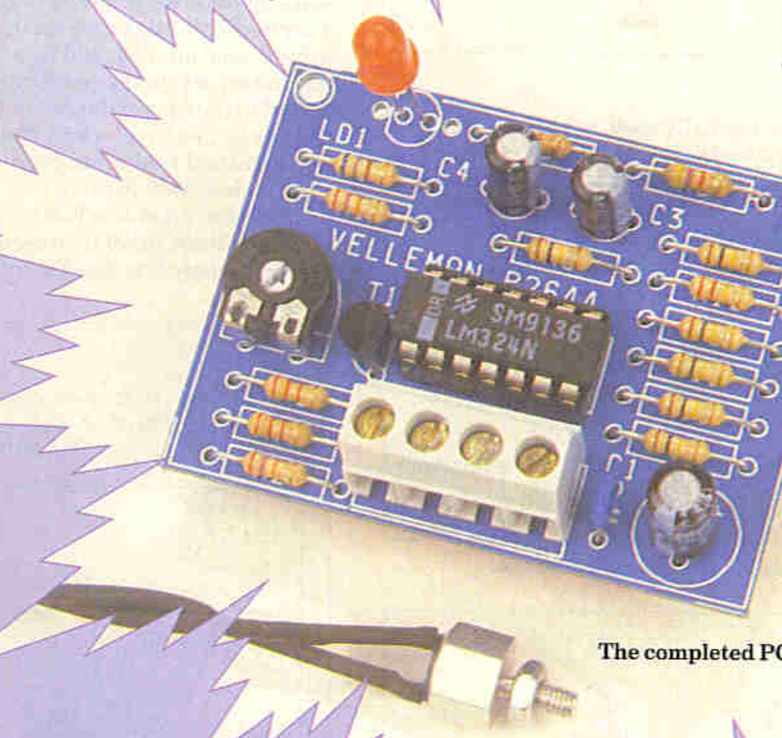
Acknowledgments

Acknowledgments are due to Mr G. R. Jessop and the Radio Society of Great Britain for the loan of valuable archive material, some of which is reproduced here. The photographs in question, and a fascinating insight into early amateur experiments, can be found in Mr Jessop's superb book, 'The Bright Sparks of Wireless', published by the RSGB.

FROST INDICATOR

PROJECT RATING 1

Text by Martin Pipe and Nigel Skeels



The completed PCB.

FEATURES

- Adjustable Indication Threshold
- Runs from a 9V Battery or 12V Vehicle Electrical System
- Low Cost
- Ideal Beginners' Project

APPLICATIONS

- Provides warning of dangerous driving conditions
- Helps you to prevent water pipes from freezing and bursting
- Temperature warning for cold stores
- Greenhouse frost alert
- General remote temperature sensing

This circuit can be used in any application where an indication of a preset temperature threshold is required. In some instances, such temperatures may cause problems (icy roads, dead plants, etc.); in others, they are essential (cold stores, freezers, and so on). The project comprises a main PCB and a sensor. The latter is bolted to a convenient location within the area to be monitored – which could be, for example, the rear bumper of a car. Indication of low temperature is by means of an LED. The more time the LED spends in the 'on' state, the colder it is! This LED can be brought away from the PCB and installed somewhere more appropriate (such as the dashboard), if required. It is also possible to fit an extra indicator, such as a low current buzzer or bulb, but the total current drawn must not exceed 20mA.

Circuit Description

As can be seen from Figure 1, most of the circuitry is based around IC1, which contains four Op-amps referred to as A1 to A4. The first Op-amp, A1, together with T1 and associated components, are configured as a constant-current source – although it appears at first glance to be a voltage source. T1 also provides a small degree of positive temperature compensation. T1's reference voltage is set by potential divider R1/RV1/R3; this allows the temperature range, over which indication is required, to be set.

The constant current is supplied to the temperature sensor, TH1, a thermistor with a negative temperature coefficient (when the temperature falls, its resistance increases). Across the thermistor is developed a voltage that is proportional to its resistance, and hence the temperature (i.e. the voltage decreases when the temperature drops). This voltage is fed to the non-inverting input of A2, which acts as a buffer – this is important, as loading would otherwise occur, upsetting operation of the constant-current source. A2 provides a voltage gain of about 3 for the next stage – a comparator based around A3. First, A2's output is 'cleaned up' by R8 and C3, a simple passive low-pass filter. A3 then 'compares' it with that from A4 which, together with its associated components, constitutes a low-frequency (approximately 2Hz) sawtooth oscillator.

Specifications

Supply voltage:	9 to 15V DC
Supply current:	25mA
Sensor:	NTC thermistor
Completed PCB dimensions (without LED):	56mm(W) x 20mm(H) x 40mm(D)

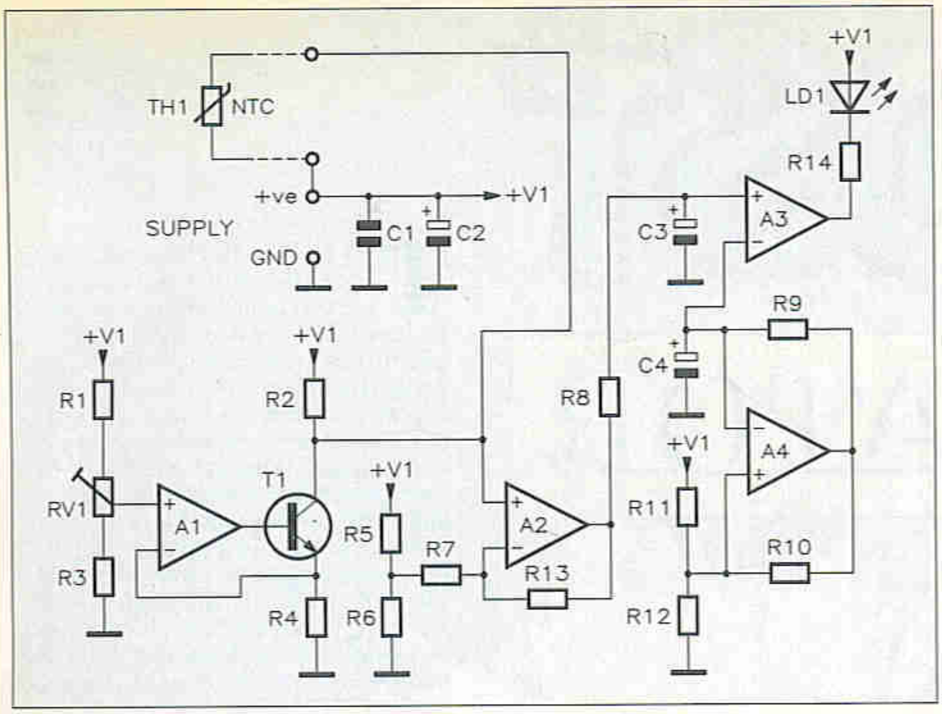


Figure 1. Circuit diagram.

If the temperature is greater than approximately 3°C (37°F), then the temperature-related voltage from A2 will exceed that of the oscillator. As a result, the comparator output will be high, and so the (active low) LED will remain unlit.

If the temperature ranges between −3°C and +3°C, then the temperature – dependent voltage will periodically drop below that of the oscillator output from IC4, causing the comparator output to go periodically low and switch on the LED. Note that the LED will flash at the oscillator frequency in this range; as the temperatures decrease towards −3°C, the flash period of the LED will become longer. Once the temperature drops to −3°C, the LED will remain on. These operational states are summarised in Table 1.

PCB Construction

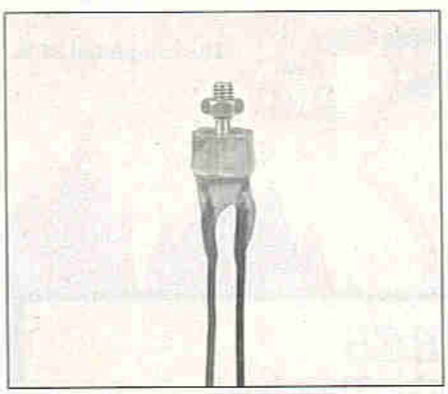
Construction is straightforward, and full details are given in the leaflet supplied with the kit. If you are new to project building, refer to the Constructors' Guide (order separately as XH79L) for helpful practical advice on how to solder, component identification and the like. Order of construction is not particularly important, although it is generally better to fit the smaller components first since the larger items may obstruct areas of the PCB, making assembly trickier. Be sure to insert the electrolytic capacitors the correct way round; in addition, note that their leads will need pre-forming before they can fit neatly to the board prior to soldering. When fitting the terminal block, ensure that the terminals are facing away from the PCB – otherwise you will face problems when the time comes to wire up the sensor and battery! The orientation of IC1 is also critical; note that this component is fitted in an IC socket. The socket, rather than the IC itself, should be soldered in place – the IC should be inserted just before testing.

The LED can be fitted to, or installed remotely from, the PCB. In the latter case two larger pads/holes, adjacent to those normally used, are provided on the board for the installation of PCB pins or wires. Pins are preferred however, as their use will save wear and tear on the PCB track pads.

After completing assembly, it is prudent to check your work – finding any incorrectly-placed components could save considerable time and expense later on. Other gremlins to watch out for include solder bridges/whiskers and poor joints. Finally, clean the solder side of the PCB with a suitable solvent to remove any fluxes and solder whiskers, and insert IC1 ready for testing.

+3°C and higher	LED off
+3°C	Flashes with short intervals
0°C	LED flashes regularly
−3°C and lower	LED continuously on

Table 1. LED indication states..



Close-up of sensor, showing the resin waterproofing.

Preparation of the Sensor

As the sensor is going to be mounted outside, it is important to ensure that the connections to it are going to be water-tight. This can be achieved by encasing its lead-out wires in resin. Please note that the resin is not included in the kit. Before connecting the wires, ensure that they are long enough to reach the PCB. (It is preferable to fit the PCB as near as practically possible to the sensor, as the LED can be installed remotely.) The resin also helps to provide the connections with mechanical strength – another advantage. The area of the sensor's body that makes contact with the mounting surface must, of course, remain uncovered as far as possible.

Power Supply

The power supply is the next consideration; this should provide between 9 and 15V DC, with a minimum supply current of 25mA. A PP3 battery will suffice, or the Frost Indicator could be run from a car's electrical system. As reverse-polarity is not incorporated, it is critical that you connect it up properly! If installed in a car (assuming negative earth), the negative (−) terminal should be attached to its chassis, while the positive (+) is connected to the part of the car's 12V supply that becomes 'live' when the ignition key is turned to the 'on' position. If the unit is destined for use in a car, it is advised that an in-line fuseholder (fitted with a 100mA fuse) is inserted in the positive supply line (see Figure 2) – bear

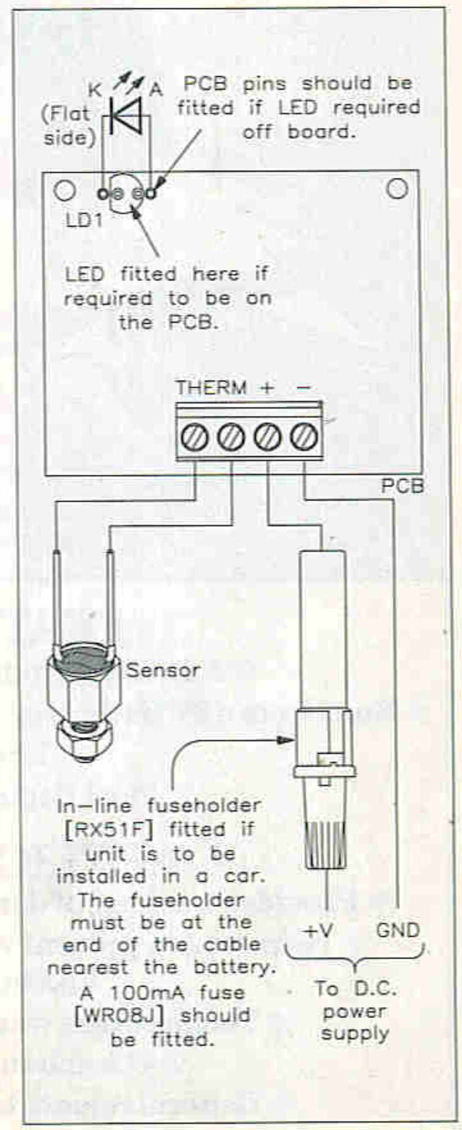
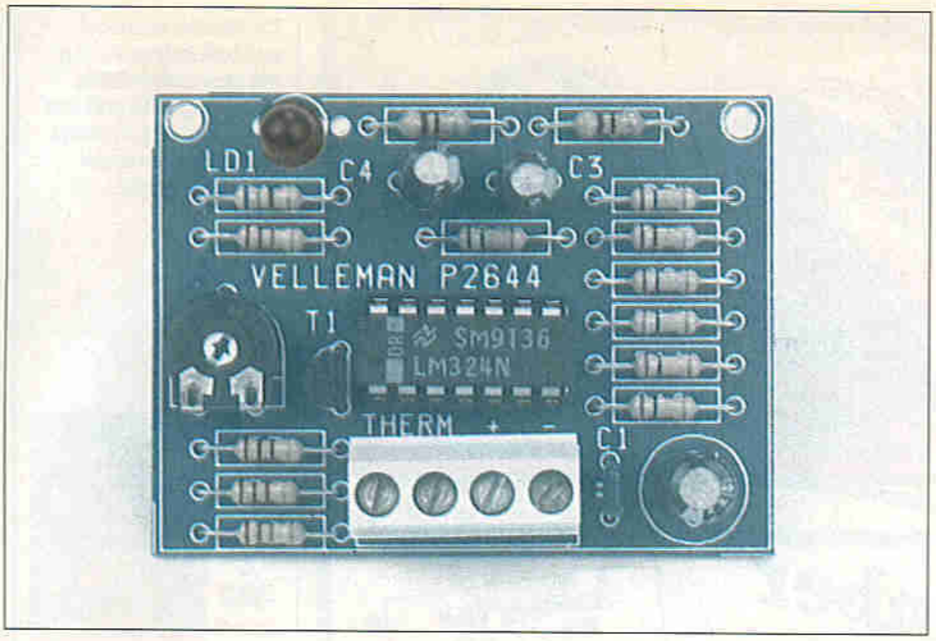


Figure 2. PCB connections.



Component side of the Frost Indicator PCB.

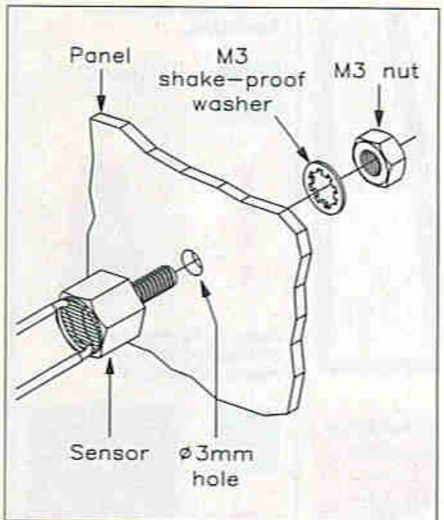


Figure 3. Mounting the sensor.

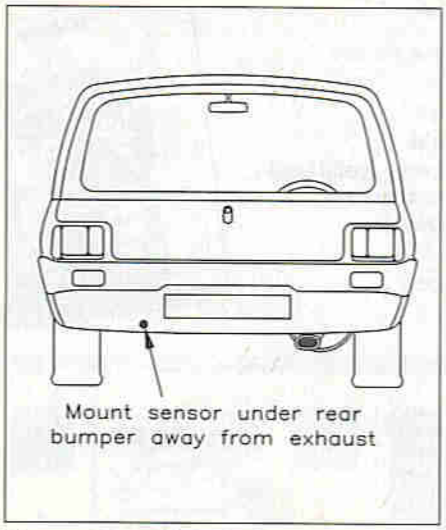


Figure 4. Installing the sensor.

in mind the massive currents produced by car batteries, and their potential hazards. Note that the fuseholder must be installed at the end of the cable nearest the battery.

Calibration

The sensor and power supply should be connected up as shown in Figure 2. Once checked IC1 should be inserted, and the unit then powered up ready for calibration. The alignment process is very simple, requiring only a container filled with ice. The sensor is buried in the ice and left for a minute or so, to 'acclimatise'. RV1 should then be adjusted so that the LED flashes regularly (with its 'on' time equal to its 'off' time). If problems are experienced when adjusting RV1, then R2 should be substituted for a 2k2 resistor. Depending on how RV1 has been set up, the Frost Indicator could be used to monitor a different range of temperatures.

Installation

The sensor can be mounted on the surface to be monitored by means of the 3mm screw integrated into the sensor housing. Drill a 3mm hole through the surface, and attach the sensor as shown in Figure 3. It is important not to install the sensor in a position where false readings may be caused. When fitting to a car, for example, the best position for the sensor would be under the rear bumper, on the opposite side to that of the exhaust – see Figure 4.

The PCB should be mounted in a suitable box, bearing in mind the environmental conditions to which it may be exposed. A wide range of boxes may be found in the current Maplin Catalogue.

FROST INDICATOR PARTS LIST

RESISTORS: All 5% Metal Film (Unless specified)

R1, R2	27k	2
R3, R4	2k2	2
R5, R6	4k7	2
R7 to 12	100k	6
R13	220k	1
R14	680Ω	1
RV1	1k Preset	1
TH1	6k8 NTC Thermistor	1

CAPACITORS

C1	100nF Monolithic Ceramic	1
C2	100µF Electrolytic	1
C3, C4	4µ7F Electrolytic	2

SEMICONDUCTORS

T1	BC547 or similar	1
IC1	LM324	1
LD1	Red 5mm LED	1

MISCELLANEOUS

	14-pin DIL Socket	1
	4-way PCB Terminal	1
	PCB	1
	Instruction Booklet	1

OPTIONAL (Not in Kit)

*R2	2k2 0·6W Metal Film resistor	1	(M2K2)
	PCB Pin 214	1 Pkt	(FL21X)
	M3 Isoshake Washer	1 Pkt	(BF44X)
	Double Bubble Sachet	1	(FL45Y)
	In-Line 1¼in. Fuseholder	1	(RX51F)
	100mA 1¼in. Fuse	1	(WR08J)
	Twin-Core Bell Wire	As Req.	(XR39N)
	Box	Application dependent	
	Constructors' Guide	1	(XH79L)

* see text

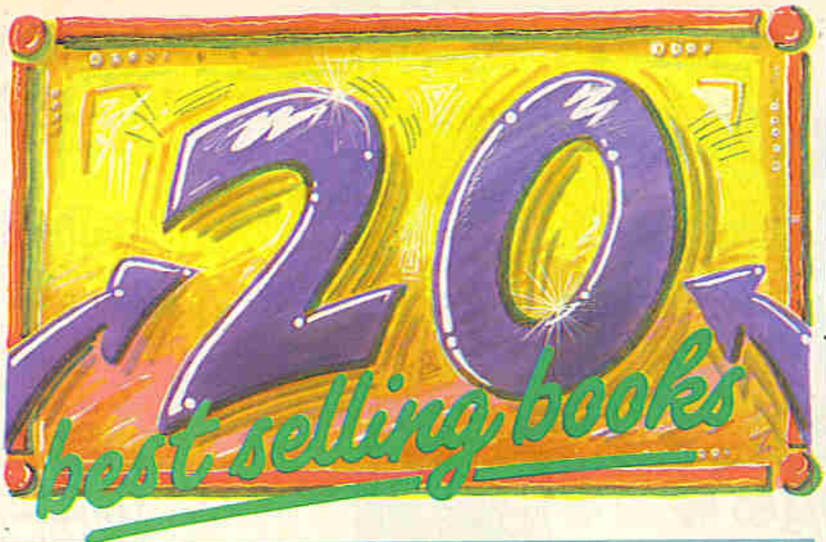
The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available in kit form only.

Order as VE04E (Frost Indicator) Price £8.45.

Please Note: Some parts, which are specific to this project (e.g. PCB, thermistor) are not available separately.

These are our top twenty best selling books based on mail order and shop sales during September '92.
Our own magazines and publications are not included in the chart below.



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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. P70.*

Previous Position: 1.

Price £2.95.

2 NO CHANGE

IC555 Projects, by E.A. Parr *(LY04E) Cat. P76.* Previous Position: 2. **Price £2.95.**

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The Complete VHF/UHF Frequency Guide, by B. Laver. *(WT70M) Cat. P86.* Previous Position: 6. **Price £5.95.**

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International Transistor Equivalents Guide, by Adrian Michaels. *(WG30H) Cat. P66.* Previous Position: 5. **Price £3.95.**

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