No 35

ELECTRONICS

The Maplin Magazine

IR £1.85

DEC '89-JAN '90 · £1.20

Bring fresh air into your home or office with our easy-to-construct air ioniser!

Full construction details for a NICAM 728 stereo TV sound decoder project.

Serial format translator computer add-on for receiving RTTY.

ROM Expansion board for the digital speech projects.

Features on Autoguide, power supplies, ADC's and DAC's, plus a free to enter competition!

12

9 770957 545015

Stereo TV Sound Decoder

Look Inside!

CONTENTS

DECEMBER 1989 TO JANUARY 1990 VOL.9 No.35

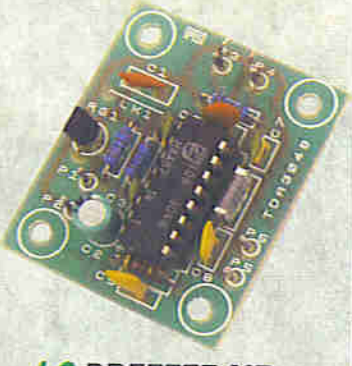
EDITORIAL

In this edition of 'Electronics' we present the NICAM 728 decoder board. This project will enable you to decode the NICAM stereo sound signals being transmitted by various ITV companies and to hook-up to your stereo hi-fi system and hear the fabulous sounds. Just think! Top of the Pops in stereo! This edition is also packed with features and other projects, like the 'Breeeze' air-ioniser which will refresh the negative ions in your office or home giving you that 'wide-awake' fresh air feeling. A couple of issues back we introduced the Digital Speech Module, which was highly acclaimed and created a lot of interest, now we present an add-on which expands the memory capacity allowing different sentences and phrases to be selected. The Serial Format Translator continues the series of projects for the RTTY enthusiast.
Features include a look at the new 'Rock Circus' in London and 'Autoguide' which is an intelligent traffic navigation system. There are also interesting articles on ferrofluids, distortion measurement and much more.
Read on and enjoy!

R.T. Smith

Editor Roy Smith **Technical Editors** Dave Goodman, Chris Barlow, Gavin Cheeseman.
Technical Author Robert Ball.
Consultant Author Alan Simpson.
Technical Artists John Dudley, Lesley Foster, Paul Evans.
Art Directors Peter Blackmore, Martin King.
Art Assistants Eugene Francis, Graham Smith, Danny Shadrake, Phillip Fey.
Print Co-ordinators Brian Lauezzari, Martin Needs.
Published by Maplin Electronics plc.
Typesetting by Inline Design Systems Ltd., 258a London Road, Hadleigh, Benfleet, Essex SS7 2DE.
Colour Separations by Stirling Graphics Ltd. 16-22 West St., Southend, Essex SS2 6HJ.
Printed by SVP, Caerphilly, Mid Glam. CF8 3SU.
Distributed by Spotlight Magazine Distribution Ltd. 1-11 Benwell Rd, London N7.
Mail Order P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone Retail Sales: (0702) 554161. Retail Enquiries: (0702) 552911. **Trade Sales:** (0702) 552961.
Cashtel: (0702) 552941. **General:** (0702) 554155.
Shops: See inside back cover.
Fax: (0702) 553935. **Telex:** 995695.

PROJECTS



FEATURES

REGULARS

GETTING A JOB

Software development.

IN COMPUTERS

by Alan Simpson

Here is a typical 'catch 22' situation. You want a job in computers but nobody wants you unless you have at least two years experience behind you: And you can't get that experience without a job. For non graduates in particular, getting a job in computers is not easy. This at a time when the information technology industry can't get enough recruits and users and suppliers are having to cut back on projects.

But the dramatic skill shortage could be good news – at least for the prospective recruit. It does seem that companies are having to lower standards, reduce their skill expectations and generally widen their catchment area. Opportunities in the industry, once barred to all except the well qualified or talented, are now opening, with many companies establishing their own in-house skill training schemes.

People with PC skills are finding that more and more jobs are now available at excellent salary levels. John Fox, who runs the Fox Technical Recruitment company reports that with more companies now using more personal computers, the recruitment market-place for support and service, sales, programming and project analysis is booming. In fact salaries for PC programmers now equal those paid for mainframe operations.

For those working in the desirable south east, rewards are especially good. The SE has become a victim of its own success says John. Staff shortages in the heartland of high-tech, The Thames Valley, are now so serious that companies are thinking of relocating away from the joys of Reading and Basingstoke, to the less positive delights of Bristol and the West.

Salaries say consultancy PA, although increasing at a rate of 12% a year, are still unable to attract the necessary talent. Michael Naughton, chairman of comms consultancy Applied Network Research, pin-points the factors behind the growing skill shortages. Service companies, particularly those in the leisure business are providing a strong demand: the fall in the number of school leavers: the increasing pace of high-tech development: and the determination of major IT companies to keep on the high growth track.

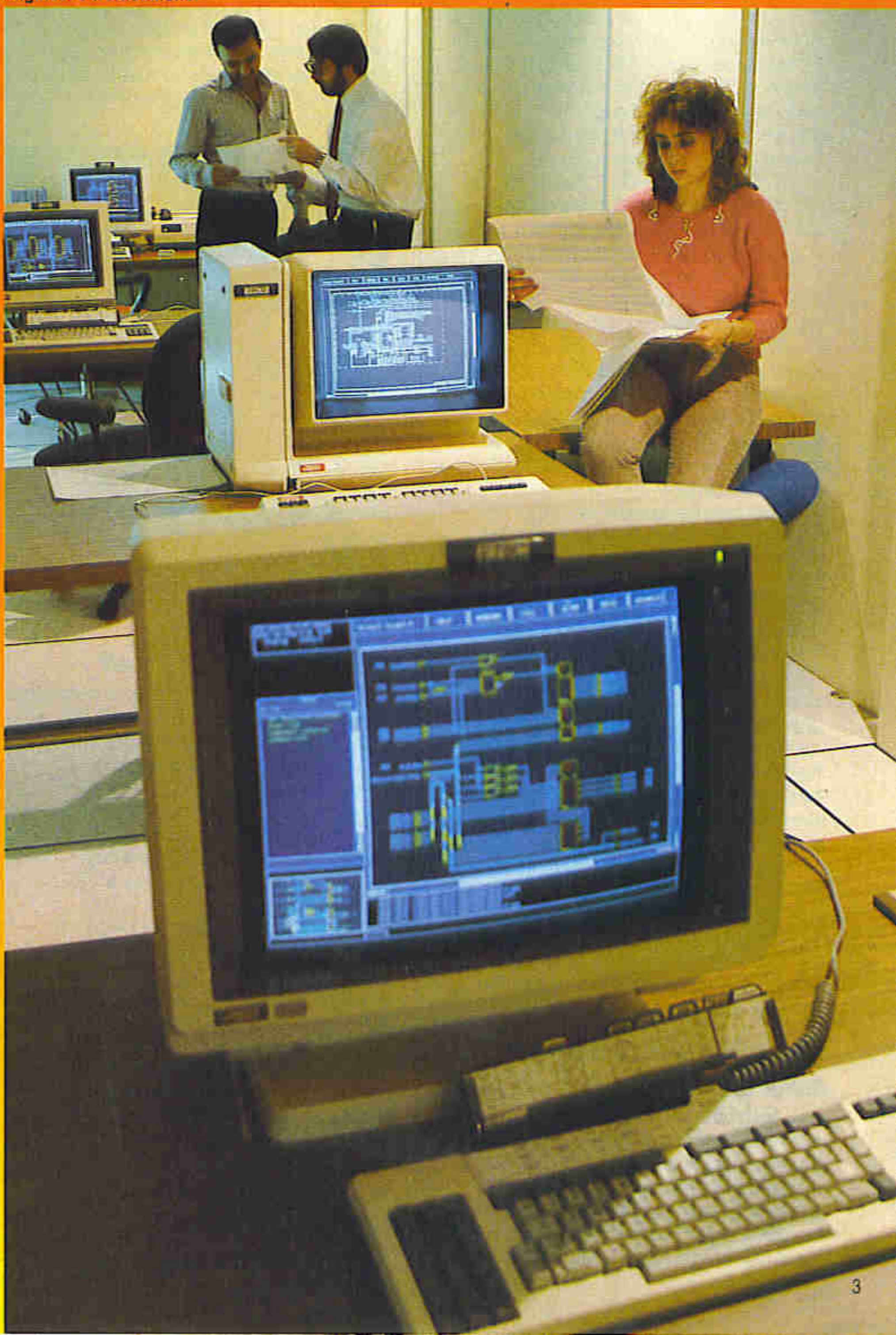
One company, British Telecom no less, has even taken major surgery steps to contain the shortages. By closing down and merging the number of computer centres it runs from 50 to around 10 by the middle 1990's, over 1500 jobs will be saved. The main purpose of the consolidation is to pool our supply of skilled people says BT. Operations staff are in heavy demand and short supply. But there is no need to worry for those 1500 workers. Even assuming there is no national wastage, all will be offered alternative jobs in BT.

Meanwhile Roy Towndrow who is responsible for ICL's Customer and Staff Training, is particularly concerned over the skill shortage. With the IT industry demand growing at between 5% and 10% per year and the supply market declining, the recruitment market-place is facing a turbulent time. "1993 will be the low spot when there will be some 25 – 30% less people emerging from education compared with the early 60's".

But John Fox comments that despite the job market boom, the two million plus unemployed are mostly unable to get a stake in the action. Many are geographically misplaced, while for others, the lack of good government training schemes is a limiting and depressing factor. However, the emergence of industry recruitment facilities, such as computer training exhibition events, special recruitment evenings, university milk-rounds and a journal IT Training are good moves says John.

Decision Time for School Leavers

As John Fox states, the fall in the number of school leavers on top of existing skill shortages, together with the gathering pace of



Engineer's workstations.

technology and the intensified global competition, are conspiring to ensure a continuing skill shortage in the years ahead.

The skill shortage is already posing problems for school leavers. Should they take up one of the many jobs available, shunning two years or more of higher education? This action could, as Andersen Consulting point out, be somewhat shortsighted as many large organisations will only take on graduates. For consultancies an ability to work with clients and to understand business problems are essential job and career factors.

But having decided to take the Higher Education route, too many of you apparently are opting for careers in accounting and finance, rather than technology, complains the PA Consultancy. Even then, those few electronic students are directing their energies in the wrong direction, according to a recent industry report. Too many students are turning their backs on sales and marketing and concentrating on careers in research and design.

Over the Job Hill

Age it seems counts a lot in the high tech world with more than 80% of employers in the PC market seeking staff between the ages of 20 and 30. The reason for this fixed age image could be that most IT managers are young and are reluctant to recruit anyone older than themselves. It is not really surprising therefore, that 25% of all DP managers rate recruitment as being their chief problem area, with retaining the right staff being their second major problem. So if you happen to be an 'over the hill' 31 year old, your only hope is for a job as a contract operator, providing that is, you have that necessary skill experience.

Presenting examples of earnings in IT is not easy. For a start, Andersen have developed a job grading structure of some 100 positions. These range from Director, Information Services, at the very top, to a rather more humble position of Trainee Word Processor Operator.

With salaries rising by a factor of 12% this alone, any stated pay scales could be quickly out of date. However as a guide junior PC programmers can expect to earn up to £12,000 while more experienced PC personnel can reach £20,000. At the same time, a senior PC programmer can expect £25,000 while sales and marketing teams can command packages worth up to £35,000. But says John Fox, salaries of senior staff in London and the SE are often 25% higher than the rest of the country. In fact John says that the pay scale for PC programmers in London now often resemble those paid to mainframe programmers in the country.

For communications personnel of course, the job picture is even more profitable, especially if you happen to have networking skills. In that case, you can almost write your own pay cheque it seems together with golden hullos and up market cars thrown in to the package.

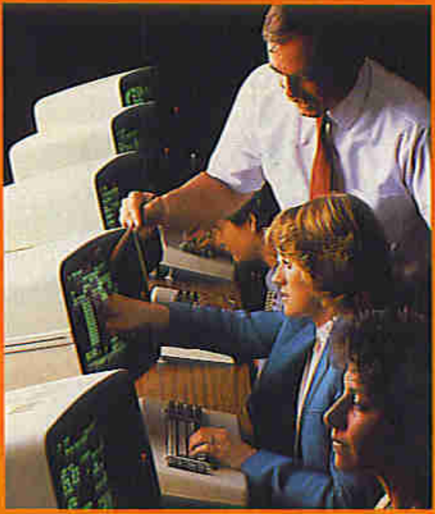
Jobs for the Boys – and Girls

Apart from the significant shortage in communications, other keen recruitment areas include UNIX-based skills and COBOL programming. There is also a growing demand from manufacturing industries who are rapidly expanding their involvement and use of IT in such areas as CAD/CAM, CIM, Expert Systems and Just In Time methodologies. In terms of prospects and challenges a job in manufacturing offers considerable scope.

But it is generally agreed that it is the graduate market where most of the action is taking place. STC for example are said to be recruiting about 500 graduates this year, while IBM are looking for up to 400 graduates on a long term employment contract together with a large intake on a fixed four year contract term.

Andersen are hoping to recruit some 225 graduates direct from universities plus 120 experienced graduates. Next year the group are increasing that target to 250 direct and 150 experienced. Digital Equipment meanwhile recognise that its people as well as its products are providing that competitive edge to customers. DEC are looking to recruit not just qualifications, but quality. Essentially the company is looking for individuals who can respond to rapid change, who can show initiative, can work in teams and have good communication abilities.

In many cases says PA, it is the recruiting company which is having to smarten up its image in order to attract suitable recruits. Matters under examination, apart from their salary policies, include in-house training and career development programmes.



Computer training.

1992 And All That

Here follows a job warning for employers. 1992 is closing up on us and so to is the international competition for skilled personnel. Engineers in particular are vulnerable (or fortunate) to being enticed away to work in the highly paid German industry. The Exodus is already under way with identified marauders including Siemens of West Germany, Thompson of France and Philips of The Netherlands.

It is however not so easy for UK companies to retaliate. Continental education courses last longer with graduates qualifying at the ripe old age of 26, and in many cases they then have to undergo two years national service. Warning signals in fact have already been raised by PA – who state that unless UK industry can get its share of talented personnel, Britain's chance of success after 1992 will be jeopardised.

Among those hit by the skill shortage are government departments and local authorities. In fact as management consultancy Sterlings believe, over 80% of local authorities in London and the SE are affected by staff shortages. This low level staffing says Rupert Armitage of Ambit Research calls for such realistic solutions as contracting out or contracting in facilities management teams, improved productivity and work reorganisation.

Could Do Better

Few industry commentators have much in the way of praise for the IT role of government or the education authorities in overcoming the skill shortage. The government appear to be relying on market forces to stimulate the change in direction from art to technology. The idea of teaching science at school will be a non-starter until the teachers themselves have the required skills.

One government minister is on record as saying that the solution is to establish a specialised IT stream allowing people to stay in IT throughout their careers without doing anything else or meeting anyone else. Not one would think, the most realistic approach for all concerned.

The skill shortage is somewhat close to home for Maplin. With the company planning continued expansion in opening local stores and general business activities including the establishment of a new central warehouse facility, positions at all levels are becoming available.

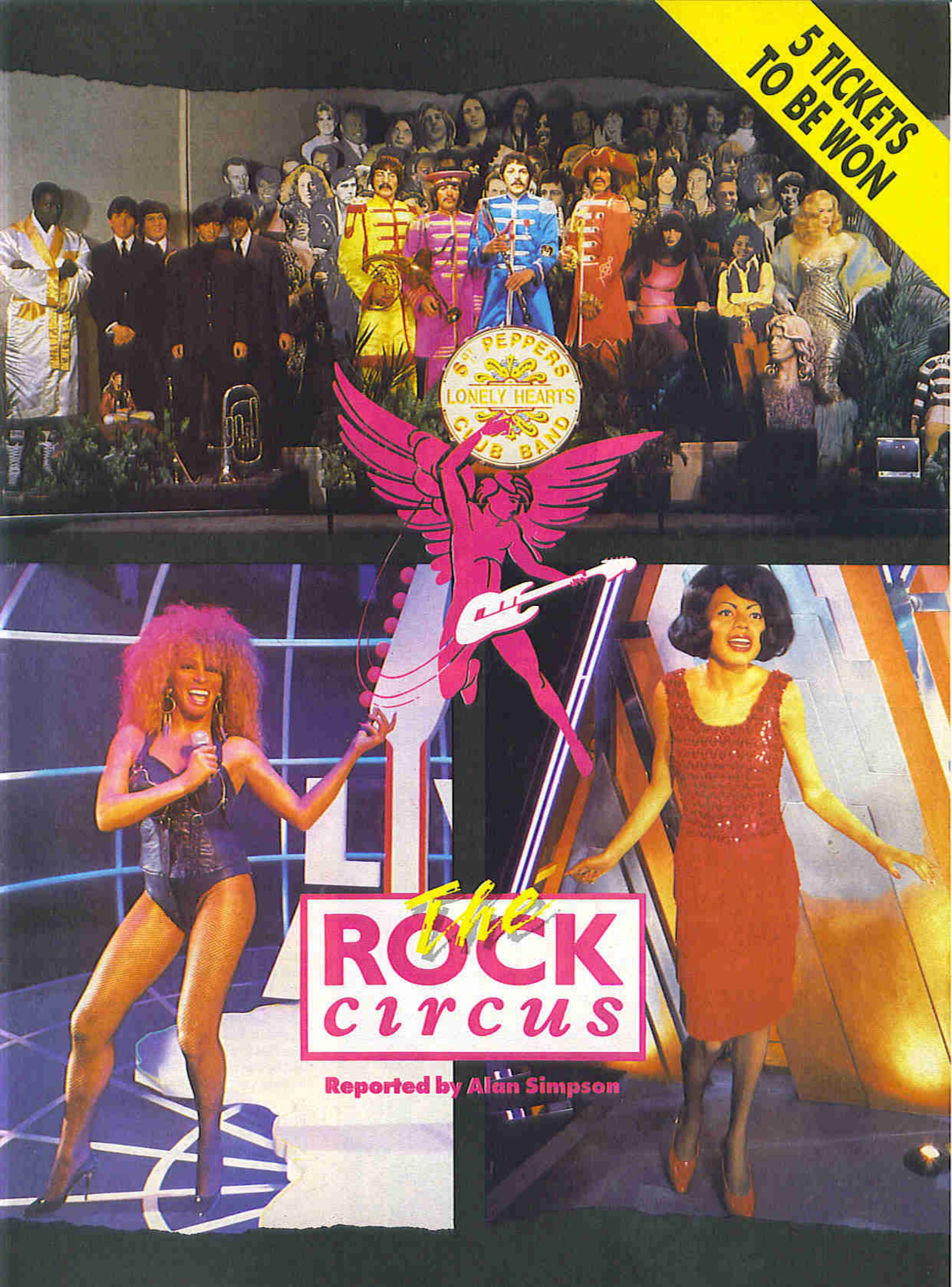
The skill shortage says Maplin's director Doug Simmons, may be good news for those seeking jobs, but it is far from good news for the company looking to recruit additional staff. In fact Doug is very worried not just for Maplin, but for the future of the country. "The quality of students emerging into the marketplace leaves a lot to be desired. Individuals are fine on given subjects, but outside that limited brief, are very poor. In particular writing and communication abilities leave a lot to be desired. Unfortunately todays education procedures are not producing a fully rounded education. A solution is perhaps for business to get more involved in education, telling teachers about the real, practical world outside".

Maplin is also worried about the reluctance of students to go into electrics, as opposed to electronics. But electricity, as all Maplin projects builders will agree, has a continuing and promising future.

Training Matters

The importance of training should never be under estimated states Sterlings. Effective training is the best investment any business can make, and if companies seek to gain value for money through efficient use of their personnel, then they must provide, as a priority, the necessary skills. In fact there can be few organisations more concerned about the skill shortage and training than Andersen Consultants. Training over the first couple of years amounts to £40,000 per person, with the initial training taking place in Chicago to ensure consistency of group standards.

For company management, the recruitment scene may well be a pain in the neck – or elsewhere. But for the prospective employee, the sky would seem to be the limit. The sky in this case could well be the job of chairman of Racal who current pay is £350,000: the head of Apple Computers, \$2.5m plus share options: and President of Compaq who pulls in a worthwhile \$1.9m. Rewards at the top are high and getting higher. Good Luck.



The ROCK circus

Reported by Alan Simpson

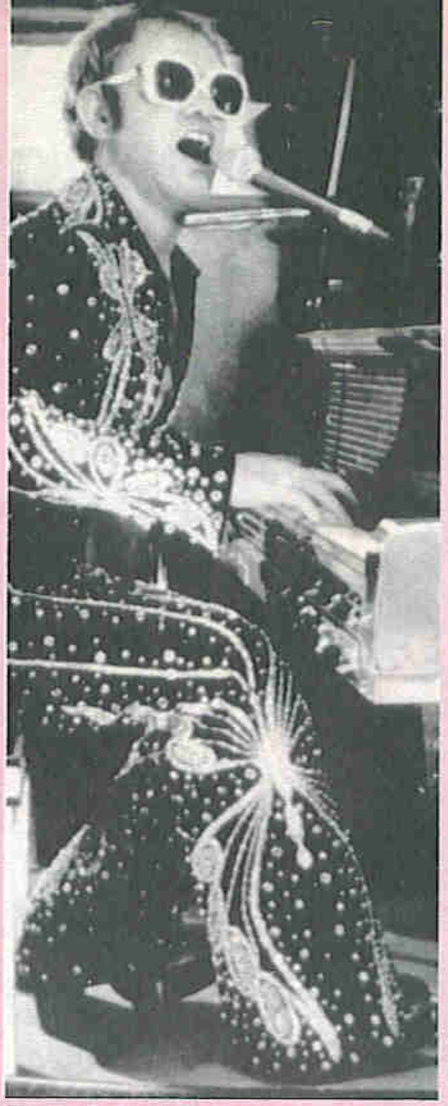
Elvis is Alive and Rocking

If your scene is more Tina Turner, Madonna, Diana Ross and The Beatles, than Henry VIII and Anne Bowlyn, then Madame Tussauds new bionic "Rock Circus" is a must for you. The aim of Rock Circus, located at the old London Pavilion, No. 1 Piccadilly Circus, is to tell the story of rock and pop from the 1950's through to the present day, using a combination of wax and moving bionic likenesses of all the big names in rock from the past four decades.

The audio animatronic figures of the stars are computer operated pneumatic figures that are full of moving electronic powered parts. The details in these figures is quite incredible – even Elvis' lip curls.

Visitors to Rock Circus wear headsets to hear the sounds of the stars – the sound is fed from a vast bank of compact disc players and then is transformed in emitters around the exhibition to high frequency sound that is then picked up by the headsets, specially designed by Philips.

Rock Circus contains the largest revolving theatre in Europe. The audience is moved round to view the three stages in turn. As well as containing audio visual techniques, as good as you would find almost anywhere, the event has also pioneered a special laser technique. Using fibre optics, one main laser is fed to a number of locations around the exhibition.



Elton belts it out!

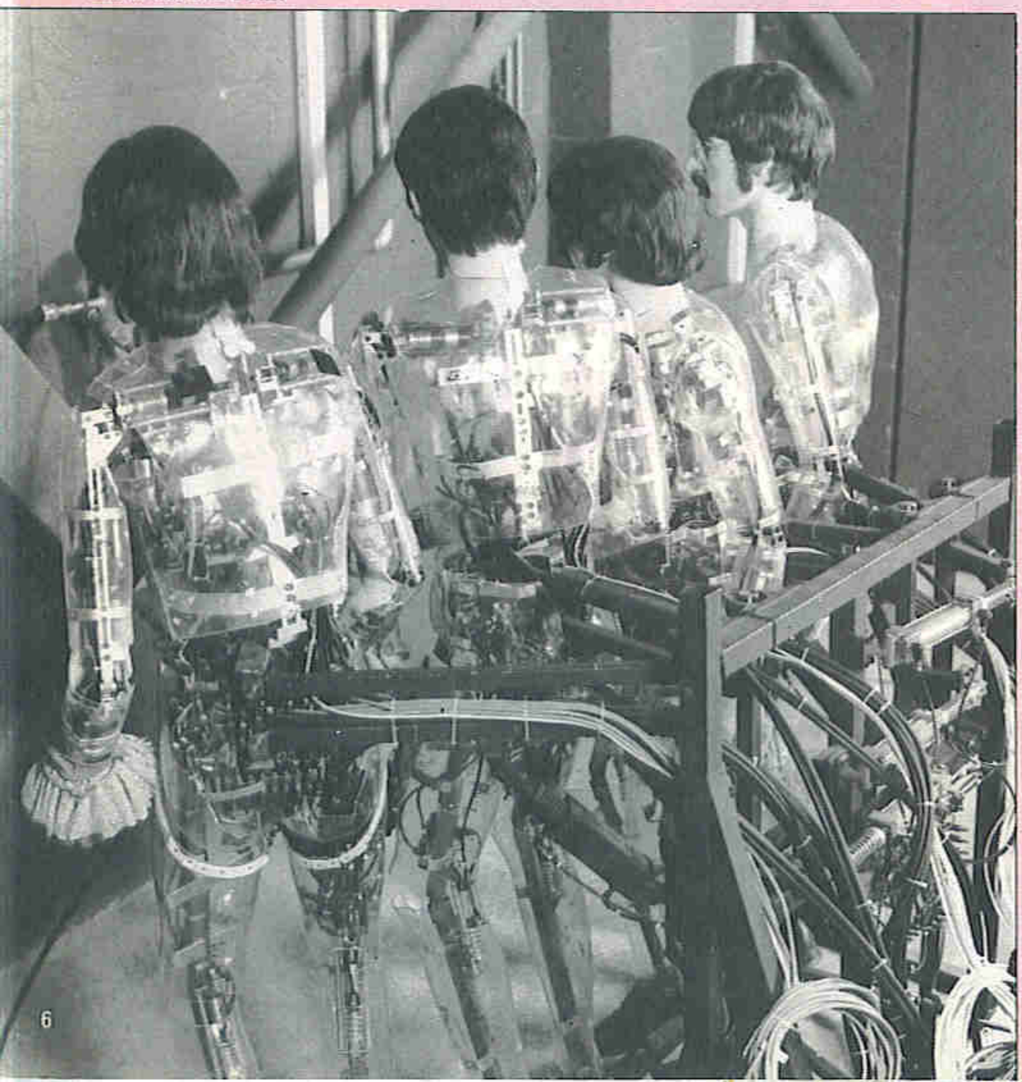
This technique incidentally, has a number of implications for use in discos and exhibitions and could greatly reduce the costs associated with these special effects. It will be interesting says Tussauds' high tech manager Andrew Tansley, to see how well electronics will stand up to twelve hours a day, 364 days a year continual use. Certainly the spot on sound is truly incredible – even the mono recorded Beatles tracks sound great.

According to Mary Scott of Selhurst, London, a keen follower and authority on all matters rock and pop, a visit to the Rock Circus is a must for any one with an interest in the history of popular music. Rock Circus will be continually updated as new stars claim their place in the music industry's Hall of Fame and Mary intends having a major input into future appearances.

A personal note for Mary and the organisers. Why no Donna Summer or 10cc? Please encourage their immediate replacement for Boy George and Johnny Rotten. But do also ensure that the astronaut-clad David Bowie, who disappears into the void singing 'Space Oddity' and the very convincing Aretha Franklin stay put – for ever.

Details: Rock Circus which is sponsored by Fuji Film, is open every day except Christmas day from 10am to 10pm. Prices are £4.20 for adults and £3.15 for children.

Inside the Fab Four.



ROCK CIRCUS COMPETITION

Enter our free lucky 'Match the Tune' draw and you and a partner could be enjoying the sights at the Rock Circus early next year!

Just study the lists below, decide which tune goes with which artiste, and send your entry to:
'Electronics – The Maplin Magazine', Rock Circus Competition, P.O. Box 3, Rayleigh, Essex SS6 8LR.
The first five correct entries out of the hat will be the winners. Don't forget to include your name and address!

The Artistes:
Jimi Hendrix, Aretha Franklin, Tina Turner, Buddy Holly, The Beatles, Elvis Presley, Rod Stewart, Eric Clapton, Elton John and Bill Haley.

The Songs:
That'll be the Day; Rock around the Clock; She Loves You; Purple Haze; Suspicious Minds, Respect; Maggie May; Benny and the Jets; Layla; What's love got to do with it.

Easy isn't it! Send your entry now!

NOW

6 ISSUES A YEAR!

There are 6 tremendous reasons why you should subscribe to Electronics – The Maplin Magazine

- ✻ Every issue is sent to you as soon as it's published, post free.
- ✻ Packed with interesting and novel projects that you can build with all components easily available.
- ✻ Many features on electronics subjects to keep you up-to-date with latest developments.
- ✻ Minimum advertising space means more pages for you to read.
- ✻ Still far cheaper than the 'Monthlies', most of which are now £1.50 or more per issue.
- ✻ Six times a year means a 50% increase in articles and projects for you to read and build.

To subscribe just send a cheque/postal order for £7.20 made payable to Maplin Electronics, P.O. Box 3, Rayleigh, Essex SS6 8LR. **OR** you can take advantage of our offer of two free issues by completing the coupon below and agreeing to pay by Credit Card or Direct Debit. The two free issues offer only applies if you use one of these two methods of payment. Simply fill in the 'Payment by Credit Card' or 'Payment by Direct Debiting Mandate' and return it to Maplin. Every time, about 1 month before your subscription is due, we will send you a letter giving details of the subscription rate for the next year and telling you the date on which we will charge your Credit Card or debit your bank account. If you do not wish to continue your subscription, you have until that date to let us know, and we will then cancel your authority to bill your Credit Card or cancel your mandate. Otherwise, if you do nothing, your subscription will continue. The authority or mandate you give us does not allow us to charge anything other than the Maplin Magazine subscription. The benefit to you is that you no longer need to remember to re-new your subscription or send off any more cheques or postal orders. Payment is made automatically.

TAKE THE NEXT TWO ISSUES OF THIS MAGAZINE FREE!!

Because we're so certain that once you've seen the Maplin Magazine you'll want to continue to receive it, we're offering to send you the next two issues free of charge with absolutely no obligation to continue. Just fill in the details below and if after receiving two issues you do not wish to continue, just let us know at least one month before the next issue is due and we will cancel your subscription. The two free issues will be yours to keep whatever you decide. If you already have a subscription, fill in the details below and we'll add two issues free of charge to your current subscription. SEND NO MONEY NOW. About 2 weeks before the third issue is due, we will charge you £7.20 for the next six issues, unless you have cancelled. This offer is not available to those already paying by Direct Debit or Continuous Credit Card or those who have stopped payment by either method within the last two years. Please start my subscription with issue 36. This offer is open to residents with U.K. addresses only.

EITHER

★ PLEASE ADD YOUR ADDRESS, SEE BOTTOM RIGHT ★

PAYMENT BY CREDIT CARD. Please charge my Credit Card Account   Access ☐ Visa ☐ American Express ☐ Mapcard ☐

I authorise you until further notice in writing to debit my CREDIT CARD account with £7.20 and in future, with any amounts which, after notification, MAPLIN ELECTRONICS PLC. may debit thereto in respect of my subscription to the Maplin Magazine.

Account No.

Signature   Date

OR

PAYMENT BY DIRECT DEBITING MANDATE in favour of Maplin Electronics plc, P.O. Box 3, Rayleigh, Essex SS6 8LR.
Direct Debit payment option is only open to customers with bank accounts in the UK including Channel Isles, Isle of Man and N. Ireland.
Please note: Instructions cannot be accepted to charge Direct Debits to a Deposit or Savings Account.

Bank Sort Code

Bank Account Number

Name of Account to be debited

The Manager

I authorise you until further notice in writing to charge my account with you any amounts which MAPLIN ELECTRONICS PLC may debit thereto by Direct Debit in respect of my subscription to the Maplin Magazine.

I will inform the bank in writing if I wish to cancel this instruction.

I understand that if any direct debit is paid which breaks the terms of this instruction, the bank will make a refund.

Signature   Date

Enter your address and Maplin customer number, if known.

Post Code

NICAM DECODER
DIGITAL STEREO SOUND FOR TELEVISION

by C.S. Barlow

Features
- ★ Single +12V power requirement
- ★ Automatic audio switching (Mono-Stereo-Bilingual)
- ★ Reverts to external audio if NICAM is not present
- ★ NICAM mode indicators

Introduction

The technique of converting an analogue audio signal into a digital representation for reproduction is well known in the form of the Compact Disc player. A similar process can be applied to the sound channel of a television signal to provide a high quality stereo sound track. In the June 1987 issue of the Maplin magazine Mr J.M. Woodgate presented an interesting article on the history and development of NICAM 728. The name NICAM is an abbreviation for 'Near-Instantaneous Companded Audio Multiplex' and the number 728 refers to the data rate (728k bit/s) at which the digital signal is transmitted. However, at that time a set of dedicated NICAM decoder chips was not readily available. Now a fully working system based upon the Toshiba NICAM chip set is described in the text and illustrations that follow.

NICAM Chip Set

As can be seen from Figures 1a & 1b there are three integrated circuits (IC). TA8662N, Quadrant Phase Shift Keying (QPSK) demodulator developed for audio subcarrier signal systems. This chip generates parallel-serial transformed digital data and required clock signals. TC6011N, Pulse Code Modulation (PCM) decoder. Receiving the digital outputs of the QPSK chip, this IC generates the digital sound data for the DA convertor, reception mode display and sound output selection. TD6710AN, 14-bit Digital to Analogue (DA) converter with dual channel audio outputs.

The three IC's are manufactured in the plastic Shrink DIP package and are only supplied in a chip-set, Maplin stock code UK95D.

Circuit Description

In addition to the circuit shown in Figure 3, a block diagram is detailed in Figure 2. This should assist you when following the circuit description or fault finding in the completed unit. All the inputs and outputs of the circuit are taken to 'Minicon' locking plug assemblies, numbered PL1 to PL7 and the same amount of 'pins' are used for test point connections, TP1 to TP7. The DC power for the unit is applied to PL1, positive to pin 1 and negative to pin 2. This supply must be within the range of 11V to 13V and have the correct polarity, otherwise damage will occur to the semiconductors and polarised components. The input voltage, decoupled by C1, C2 is only used directly to energise the relay coil in RL1 and illuminate the light emitting diodes (LED) LD5, LD6. All the other semiconductors are powered from either a +10V or +5V regulated supply, generated by TR1 and RG1. TR1 is used as a series voltage regulator with the reference voltage on its base provided by an 11V zener diode, ZD1, decoupled by C3, C4. The voltage that appears on the emitter of TR1 should be close to +10V and is decoupled by C5, C6. This voltage is passed through R2 and further decoupling is provided by C7, C8 on the input of the +5V regulator RG1. The output of RG1 is decoupled by C9, C10 and both supplies are further decoupled at regular intervals throughout the rest of the circuit. The 6.552MHz NICAM Intermediate Frequency (IF) signal is applied to PL3 pin 1 with pin 2 used to connect the screen of the input cable to ground. At this stage the NICAM signal is just one of many that are present in a television IF. Other signals include, video picture and sync, Teletext data and 6MHz FM sound. To extract only the NICAM signal an input filter comprising of C11, C13, T1 and R3, R5 is used on the gate of TR2. The other gate has a variable DC bias applied to it, derived from RV1, R4 and is decoupled to RF by C14. As the bias voltage is advanced, the amplification will increase to provide almost 20dB of gain. A second tuned circuit, C15, T2 and R7 is introduced into the drain of TR2. The low impedance secondary winding of T2 drives the input of the specially manufactured NICAM band pass filter, FL1. This device has been pre-aligned to produce the response shown in Figure 4. The output of FL1 is connected via C17 to pin 4 of IC1 the QPSK demodulator. This chip contains both analogue and digital circuits, so it requires the analogue +10V supply on pin 1 and the digital +5V supply on pin 30. Two voltage controlled crystal oscillators (VCXO) are used to produce the high accuracy timing required for the digital decoding process. The first oscillator is at 6.552MHz set by the crystal XT1 and the second is at 5.824MHz XT2. Between the demodulated carrier outputs on pins 10, 11 and the analogue inputs on pins 19, 20 is a low pass filter (LPF) comprising of two chokes, L1, L2 and four ceramic capacitors, C44 to C47. The rest of the components around IC1 are mainly used to set up resistor and capacitor (RC) timing networks for mute, AGC, carrier and clock AFC filtering. Three digital outputs are

Specification of Prototype

Power Supply Input.
Voltage: 11V to 13V DC
Current at 12V: 157mA (Stereo)
190mA (Mono)

RF Input.
Frequency: 6.552MHz
Sensitivity: 100μV
Impedance: 1kΩ at 6.552MHz

External Audio.
Input sensitivity: 100mV RMS
Input impedance: 10kΩ at 1kHz
(5kΩ Mono)

Audio Output.
Level: 1V RMS into 1kΩ
Distortion: 0.01% THD
Signal to noise: 70dB

Completed Circuit Board.
PCB Type: Double-sided plated-through fibre glass
Dimensions: 142mm x 102mm
Component height: 20mm maximum
Weight: 143g

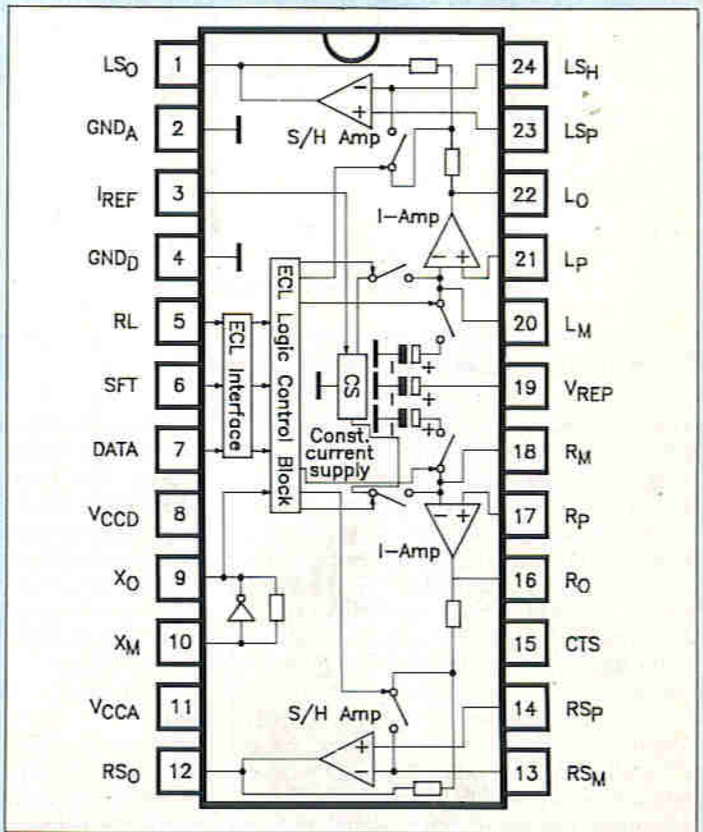


Figure 1a. TD6710AN.

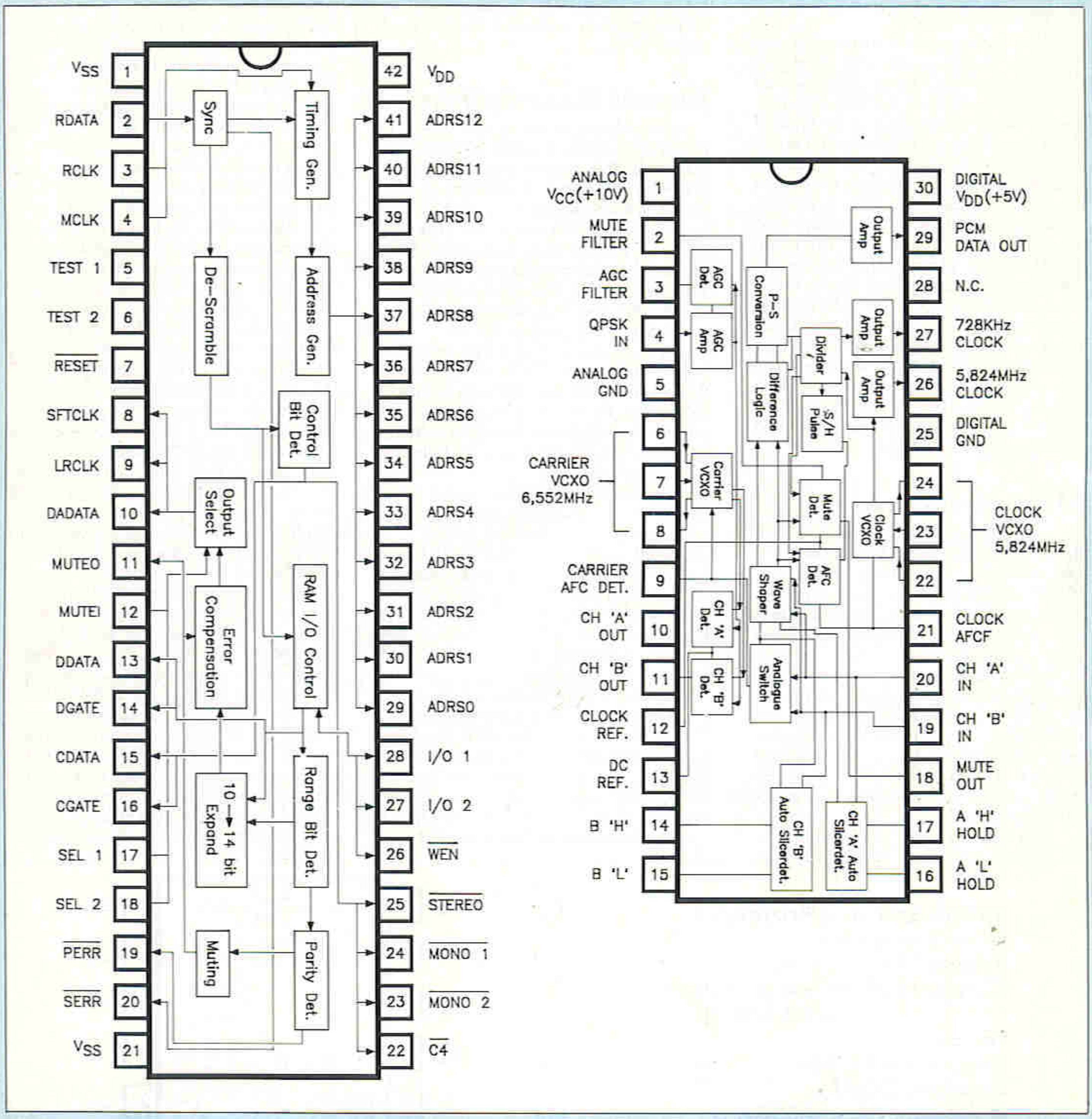


Figure 1b. TCA6011N (left) and the TA8662N.

generated by IC1. Pin 26 provides the 5.824MHz master clock (MCLK) with pin 27 producing the 728kHz data rate clock (RCLK) and finally pin 29 outputs the PCM signal which contains the companded digital stereo sound data. These signals are fed to the PCM decoder, IC2. It is this chip in conjunction with the RAM chip, IC3, which provides the selection input, mode display, mute I/O and the digital outputs required by the D/A converter, IC4. The D/A converter receives three signals, RL, right/left channel indication, SFT, shift clock for reading the serial PCM data and finally the PCM audio data. The recovered analogue stereo signal contains several high frequency by-products which must be filtered out. This is achieved by placing a 15kHz low pass filter in each channel, the frequency response of the filter can be seen in Figure 5. Additional frequency compensation, or de-emphasis is used as the transmitted audio signal has had pre-emphasis added to improve the signal to noise performance. The components responsible for this compensation are as follows:

Right channel – C67, C69, C71, R37, R40.

Left channel – C68, C70, C72, R38, R39.

Figure 6 shows both transmitted pre-emphasis and received de-emphasis frequency response curves. The filtered stereo signal then passes to relay, RL1, where the NICAM or external signals on PL5 can be selected. This relay is energised when TR3 is conducting and this condition will exist if no NICAM signal is received, or switch S1 is closed. To indicate the state of the relay two LED's are used, one green (LD5 external audio) controlled by TR3 and one red (LD6 NICAM) controlled by TR4. The stereo signals leaving RL1 then pass to IC5, a dual low noise op-amp, and the amplified low impedance outputs appear on pins 1 and 3 of PL6.

PCB Assembly

The PCB is a double-sided, plated-

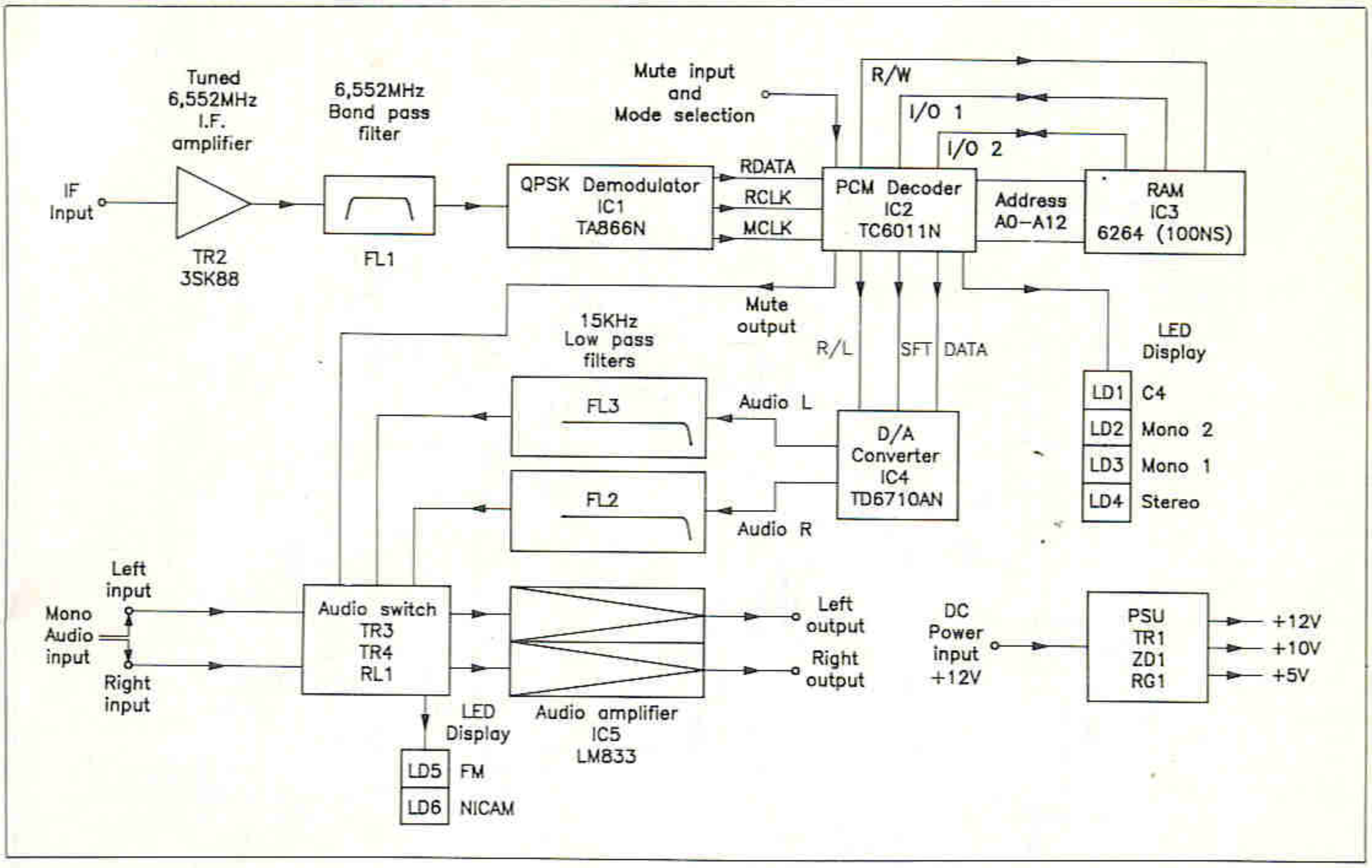


Figure 2. Block diagram.

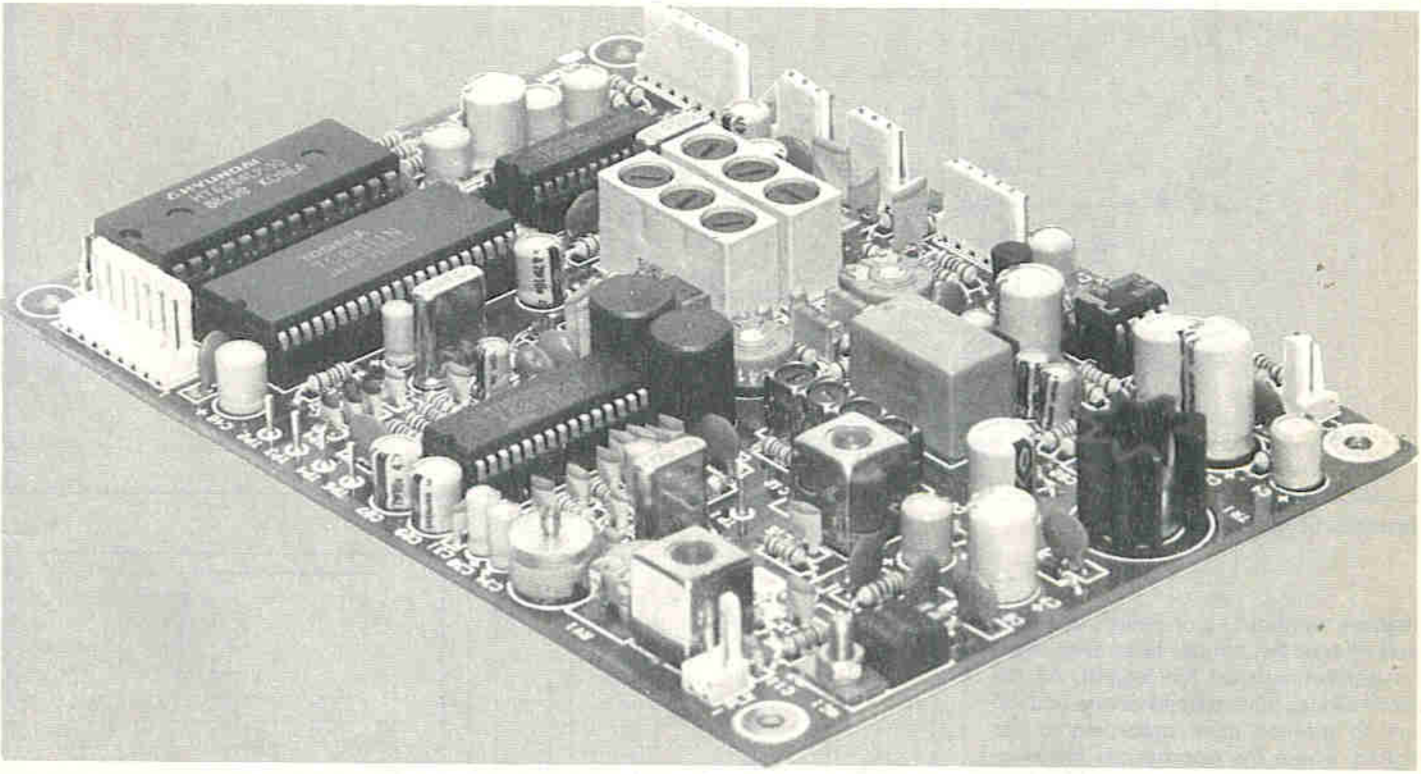


Photo 1. 'Minicon' connectors locking tags facing inwards.

through hole type, chosen for maximum reliability and stability. However, removal of a misplaced component is quite difficult with this kind of board so please double-check each component type, value and its polarity where appropriate, before soldering! The PCB has a printed legend to assist you in correctly positioning each item, see Figure 7.

The sequence in which the components are fitted is not critical. However, the following instructions will be of use in making these tasks as straightforward as possible. It is usually easier to start with the smaller components, such as the resistors. Next mount the ceramic, polyester, polystyrene and electrolytic capacitors. The polarity for the electrolytic capacitors is shown by a plus sign (+) matching that on the PCB legend. However on most capacitors the polarity is designated by a

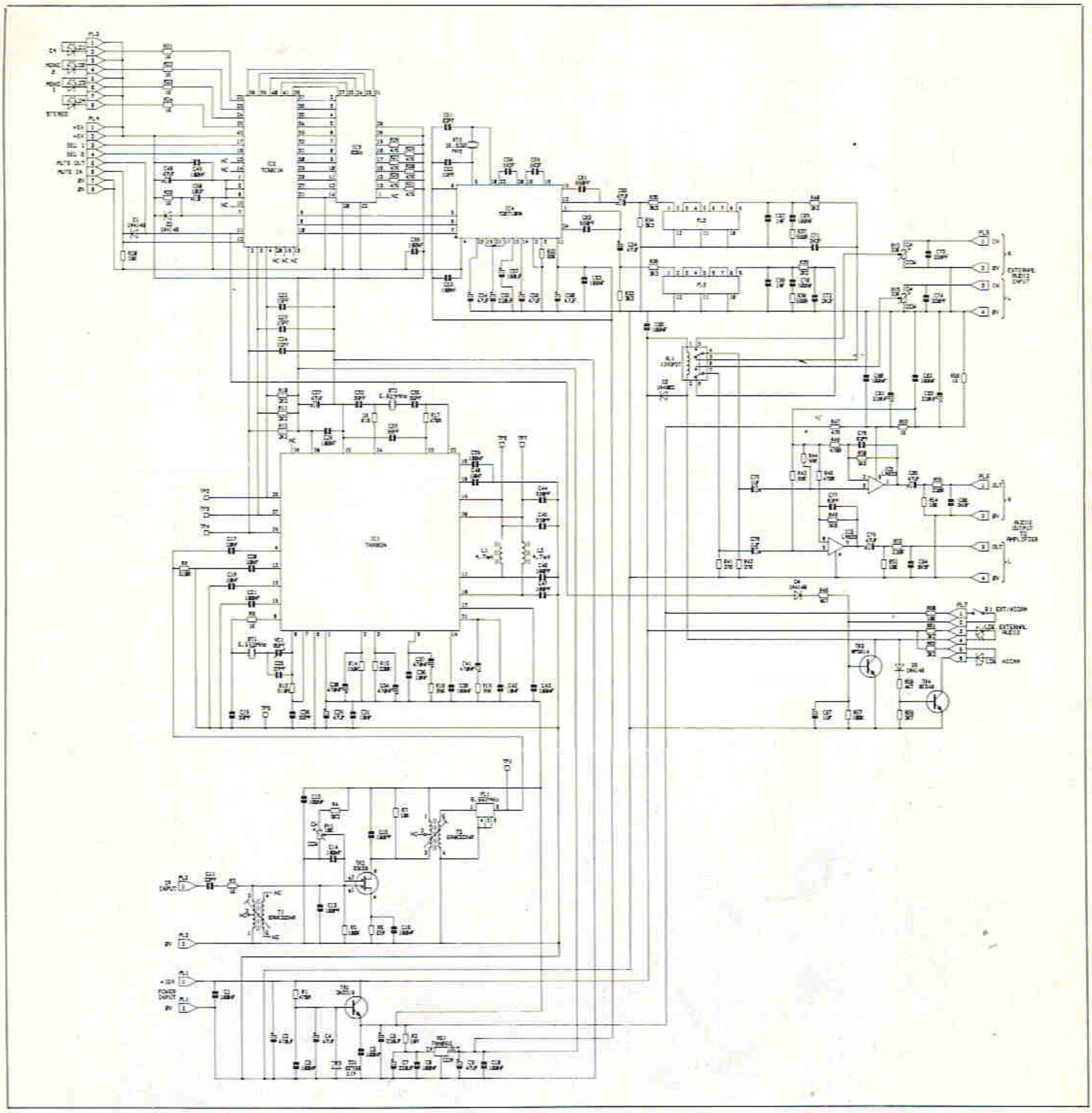


Figure 3. Circuit diagram.

negative symbol (−), in which case the lead nearest this symbol goes away from the positive sign on the legend. All the silicon diodes have a band at one end. Be sure to position them according to the legend, where the appropriate markings are shown.

Next install all the transistors, matching each case to its outline. The dual gate MOSFET transistor TR2 is a surface mounting component and is shown in Figure 8. Ensure that the device is soldered to the under side of the PCB and the transistor identification markings are facing towards the surface of the board. Next mount the voltage regulator RG1

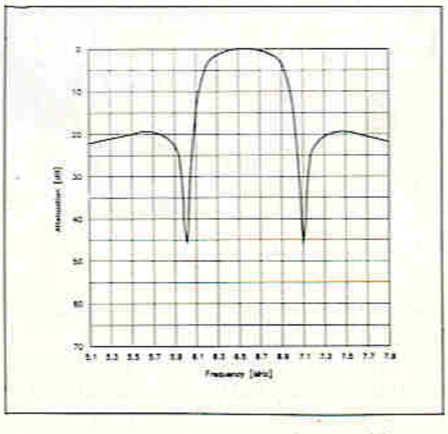


Figure 4. 6.552MHz band pass filter response.

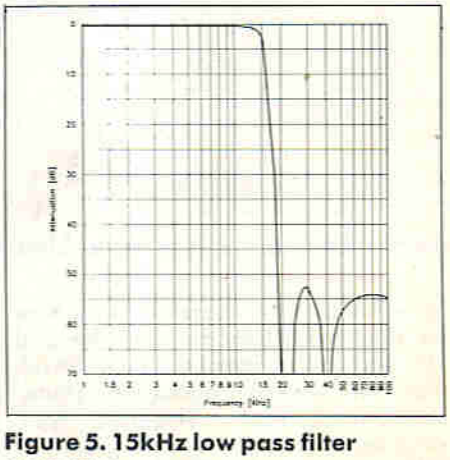


Figure 5. 15kHz low pass filter response.

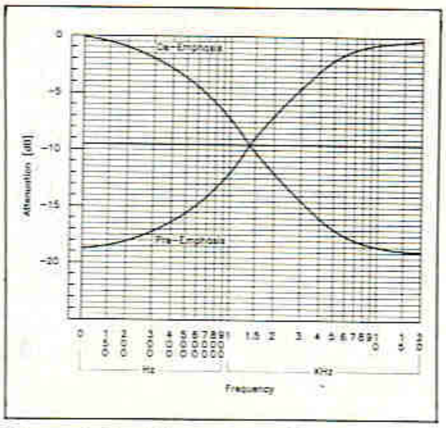


Figure 6. Pre/de-emphasis.

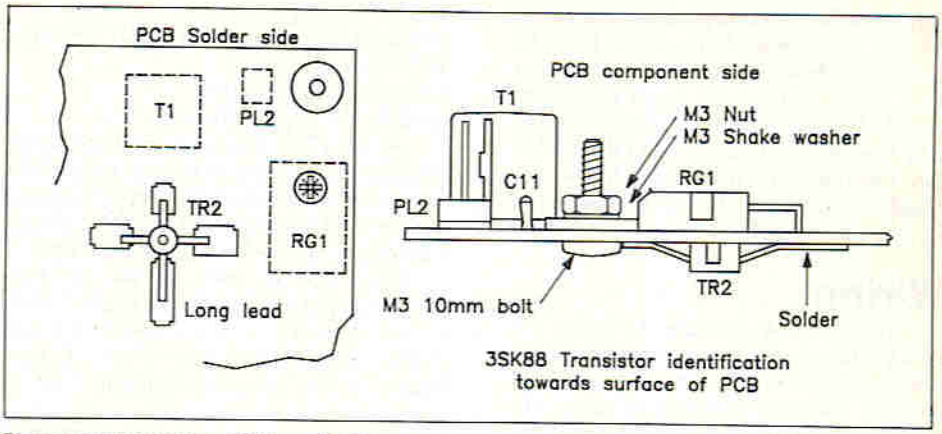


Figure 8. Mounting TR2 and RG1.

using the M3 hardware, see Figure 8. No mica washer or heat transfer compound is required on this device as it is run well within its safe working limits. When fitting the IC sockets ensure that you install the appropriate one at each position, matching the notch with the block on the legend. Unfortunately at present a supplier of the 24 pin shrink DIP IC socket can't be found, so you must prepare one using a 30 pin socket as shown in Figure 9. DO NOT install the IC's until they are called for during the testing procedure.

The RF transformers T1,2, with the filters FL1,2,3 and the relay RL1 will only fit one way, but make certain that they are pushed down firmly on to the surface of the PCB. Next install the three preset resistors RV1,2,3 and the trimmer capacitor VC1, setting them all to their half way positions. When fitting the three crystals

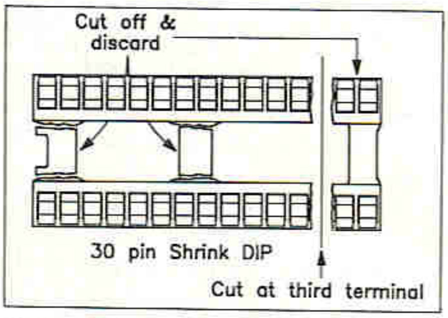


Figure 9. Preparing the 24 pin IC socket.

XT1,2,3 and the two chokes L1,2 ensure that you don't over heat them, while making sure that they are firmly on the surface of the board. Install the seven pins at the test points TP1 to TP7 ensuring that you push them fully into the board. When

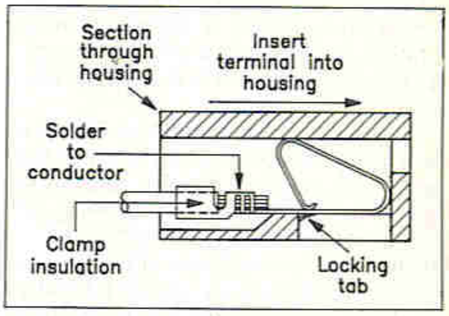


Figure 10. Fitting and inserting the 'Minicon' terminals.

fitting the 'Minicon' connectors ensure that the locking tags are facing inwards, see Photo 1. This completes the assembly of the PCB and you should now check your work very carefully making sure that all the solder joints are sound. It is also very

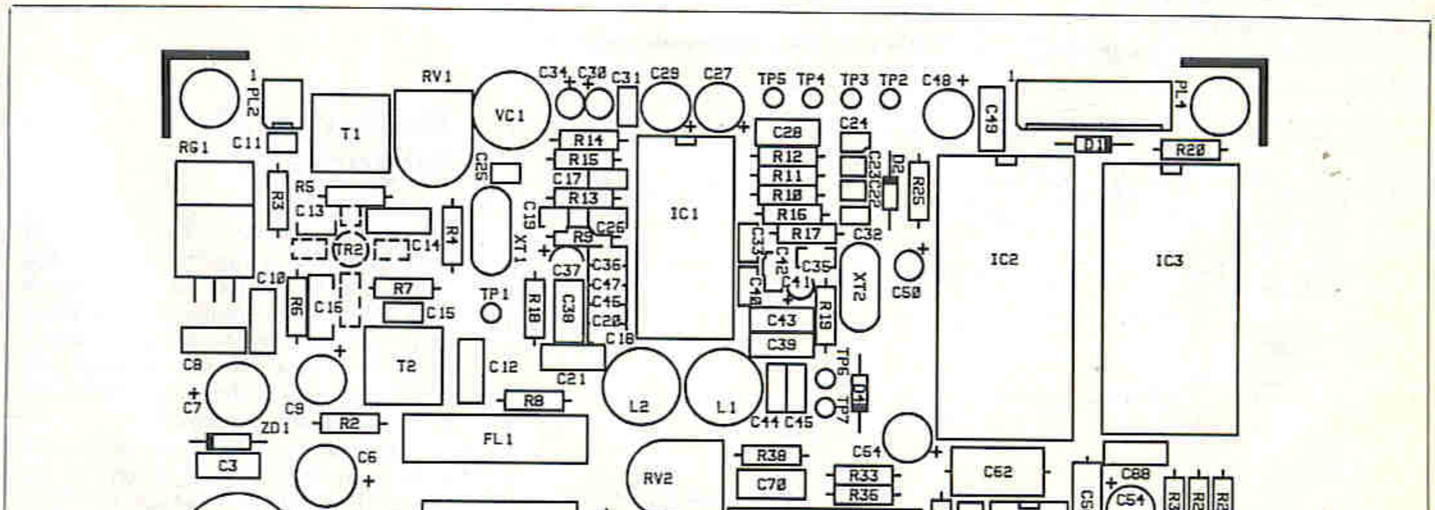


Figure 7. PCB layout.

important that the solder side of the circuit board does not have any trimmed component leads standing proud by more than 3mm, as this may result in a short circuit. Further information on soldering and assembly techniques can be found in the 'Constructors Guide' included in the Maplin kit. Photo 2 shows the completed PCB in clear detail.

Wiring

The NICAM decoder kit does not contain any hook-up or screened cables since each implementation of the unit will demand differing amounts of wire. No specific colour has been designated for each wire connection, it is entirely up to you. The use of coloured wire is to simplify matters, thus making it easier to trace separate connections to off-board components, just in case there is a fault in any given part of the circuit.

The wire connections to the PCB are made using 'Minicon' connectors and the method of installing them is shown in Figure 10. A wiring diagram showing all the interconnections is given in Figure 11. When using the screened cable ensure that the braided screen wires are twisted together and are inserted in to the correct terminal housing.

Included in the kit are six LED's LD1 to LD6 which are relatively inexpensive. However, switches are available in a wide variety of mechanical type and expense, so have not been included in the kit. Here is a list of just some of the switches suited for this project:

Ultra miniature toggle (FH97F)
Sub-miniature toggle A (FH00A)
Chrome bar toggle (YX56L)
Round-faced miniature rocker (FG84C)
Rocker (FH31J)
Miniature slide (FF77J), (FH35Q), (FF79L), (FH36P)
Round locking (FH41U)
Latch-switch 2-pole (FH67X)

All the LED's have a short lead and a flat edge on one side of its case to identify the cathode (K) connection. When wiring to them make sure to get this the correct way round, otherwise they will not light.

Plug PL4 is used to set up the selection input of the unit, see Table 1. The normal selection is shown with a 1kΩ resistor, RM1, linking pins 2 and 3, see Figure 11. This will produce mono 1 (M1) on the left channel and mono 2 (M2) on the right channel when the two channel mono (bilingual) mode is received. However, the other options can be selected by using additional resistors and switches, see Figure 11. A NICAM sound mute switch can be added and can take the form of a mechanical switch, or a TTL logic input using DM1. The audio select switch S1 can also be replaced by RM3 and DM2 to provide a TTL logic control.

This completes the wiring of the decoder and you should now check your work very carefully making sure that all the solder joints are sound.

NICAM Mode	Transmitted Control Bit				PL4 Selection Input		PL3 Display Output 0=LED on 1=LED off				PL6 Audio Output	
	C1	C2	C3	C4	Pin 3 SEL1	Pin 4 SEL2	Pin 8 Stereo LD4	Pin 6 Mono1 LD3	Pin 4 Mono2 LD2	Pin 2 C4 LD1	Pin 3 L	Pin 1 R
Stereo	0	0	0	0/1	–	–	0	1	1	1/0	L	R
Mono 2ch	0	1	0	0/1	0	0	1	0	0	1/0	M1	M1
	0	1	0	0/1	0	1	1	0	0	1/0	M2	M2
	0	1	0	0/1	1	–	1	0	0	1/0	M1	M2
Mono 1ch+Data	1	0	0	0/1	–	–	1	0	1	1/0	M	M
Data	1	1	0	0/1	–	–	1	1	1	1/0	NO SOUND	
Others	–	–	1	0/1	–	–	1	1	1	1/0		

– Either

Table 1. Display and mode chart.

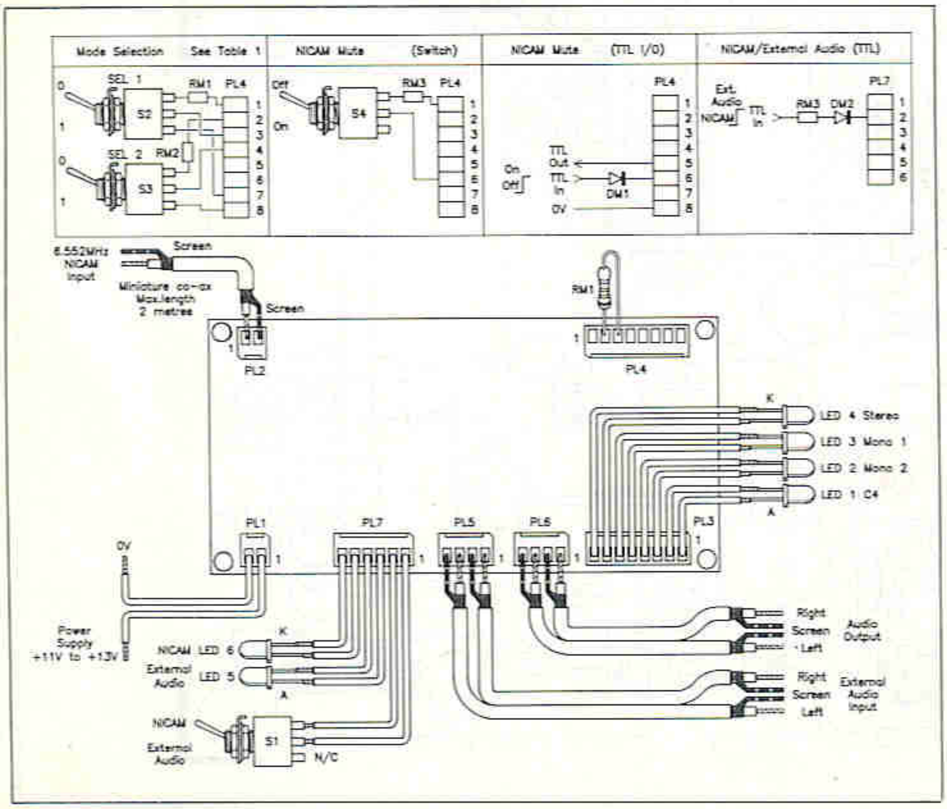


Figure 11. Wiring.

Testing and Alignment

The DC tests can be made with a minimum of equipment. You will need a multimeter and a regulated +12V DC power supply capable of providing at least 200mA. The readings were taken from the prototype using a digital multimeter, some of the readings you obtain may vary slightly depending upon the type of meter employed.

Double check that none of the IC's have been fitted into the sockets on the board. The first test is to ensure that there are no short circuits before you connect the DC supply. Set your multimeter to read OHMS on its resistance range and connect the test probes to the two terminals of PL1. With the probes either way round a reading greater than 100Ω should be obtained.

Next monitor the supply current, set your meter to read DC mA and place it in the positive line of the power supply. With switch S1 in the NICAM position a current reading of approximately 20mA should be seen and the red LED, LD6, should light up. When S1 is in the external audio position the current reading will increase to approximately 53mA with LD6 off and LD5 on. Turn off the supply and remove the test meter from the line.

Now set your multimeter to read DC volts. All voltages are positive with respect to ground, so connect your negative test lead to the ground test point TP5. Before taking any readings ensure that S1 is in the NICAM position and none of the IC's have been fitted. When the decoder is powered up, without a NICAM signal on its input, voltages present on the PCB assembly should approximately match the following readings:

TP1 = 0V	PL1 pin 1 = +12V
TP2 = +5V	PL2 pin 2 = 0V
TP3 = +5V	PL3 pin 1 = +5V
TP4 = +5V	PL3 pin 3 = +5V
TP6 = 0V	PL3 pin 5 = +5V
TP7 = 0V	PL3 pin 7 = +5V
IC1 pin 1 = +10V	PL4 pin 1 = +5V
IC1 pin 30 = +5V	PL4 pin 2 = +5V
IC2 pin 42 = +5V	PL7 pin 1 = +9.8V
IC3 pin 28 = +5V	PL7 pin 2 = 0V
IC4 pin 8 = +5V	PL7 pin 3 = +12V
IC4 pin 11 = +5V	PL7 pin 4 = +11.3V
IC5 pin 8 = +9.8V	PL7 pin 5 = +1.9V
IC5 pin 2 = +4.9V	PL7 pin 6 = 0V
IC5 pin 6 = +4.9V	

Turn off the supply and install the IC's making certain that all the pins go into their sockets and the pin one marker is at the notched end. Power up the unit and observe the current reading which should now be approximately 190mA. The external audio mode should be automatically selected in the absence of a NICAM signal.

This completes the DC testing of the decoder, now disconnect the multimeter from the unit. The alignment of the decoder can only be done using an OFF-AIR NICAM signal, see below.

Once you have an off air NICAM signal fed in to PL2 you can commence the alignment of the unit. IMPORTANT, DO NOT under any circumstance attempt to adjust the settings of the ferrite cores in FL1, 2, or 3 as these have been set up by the manufacturer. The only adjustments to make are to T1,2 and RV1, VC1. Usually there is sufficient 6.552MHz signal to make the tuning not very critical. However, as the signal gets weaker so more careful setting up is required possibly using more sophisticated test equipment. As a rule it is sufficient just to roughly set up the board as follows:

1. Set RV1 and VC1 to their half way positions.
2. Using a trimming tool, carefully adjust the ferrite cores of T1 and T2 until they are flush with the top of the screening cans. Then turn them clockwise for two and one half turns.

For a more precise alignment an oscilloscope can be connected to TP1 where the amplified 6.552MHz signal may be observed. To ensure a trouble free NICAM reception this signal level should be adjusted using RV1 to approximately 200mV peak to peak.

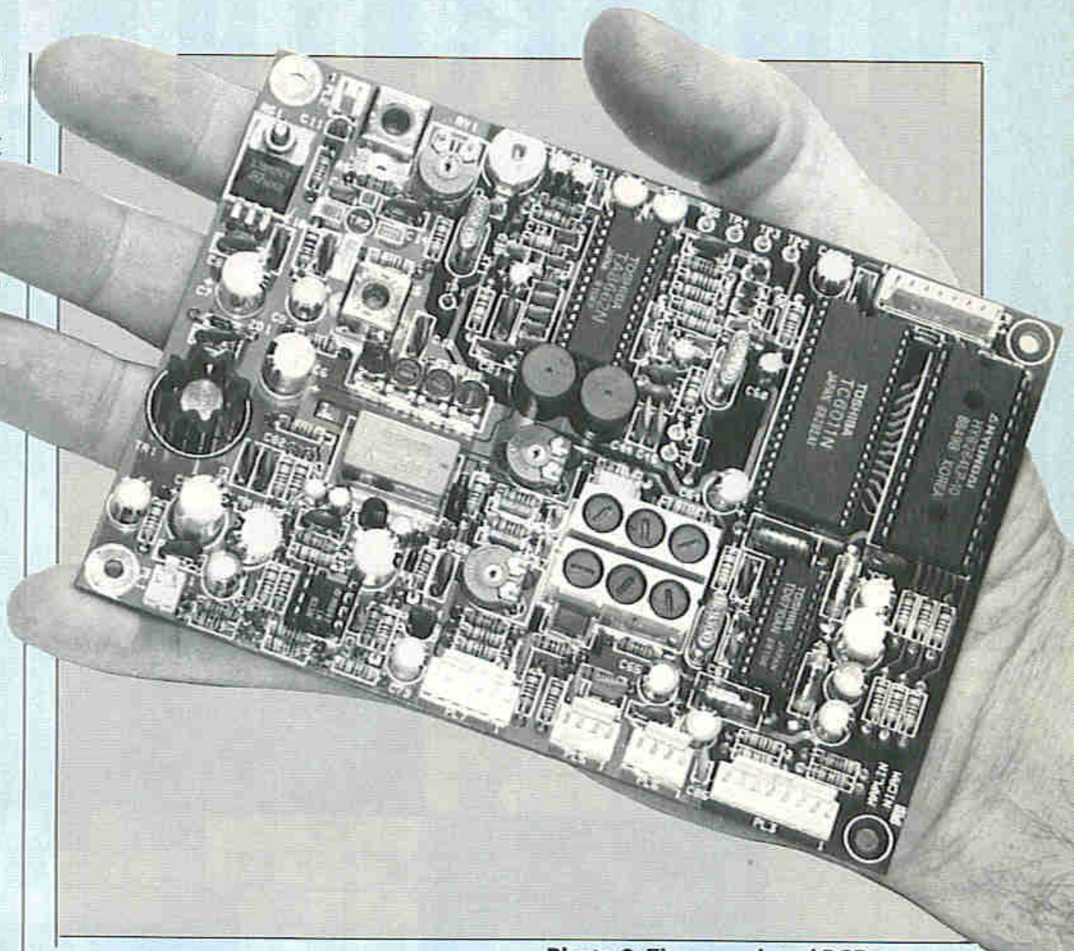


Photo 2. The completed PCB.

Using the NICAM decoder

To obtain the 6.552MHz NICAM signal it is strongly recommended that you DO NOT tap into the IF stage of a domestic television. As the extremely high internal voltages are very dangerous even when the set is switched off. Some TV's have what is known as a LIVE chassis at 240V mains, or even higher so no direct connection must be made to them. For these reasons, only properly qualified television engineers should attempt such an installation. It is recommended that a TV tuner unit which has an isolated chassis, or runs on a low voltage DC supply is used instead. Such TV tuners should already have safe outputs for video and mono FM sound for feeding to monitors.

The 6.552MHz NICAM signal should appear just after the vision demodulation and just before the 6MHz sound trap. This is usually where the 6MHz FM sound is taken off to a ceramic filter prior to being demodulated in to an audio signal. Some modern TV receivers employ what is known as 'quasi-parallel' sound reception, where the sound IF carrier is extracted after the first IF amplifier. For this type of receiver the take off point is not the same and you must seek further advice from qualified sources. Finally, the use of Surface Acoustic Wave Filters (SAW) in some receivers can make the IF too narrow, resulting in the complete filtering out the NICAM signal.

Unfortunately at the time of development only the London area Crystal Palace ITV and Channel 4 transmitters where running a trade test tape. The tape comprises a two hour programme which is replayed continuously between the hours of 0930 and 1730 daily. The NICAM mode is not controlled by the digital tape machine and will ordinarily be expected to be set to the full stereo mode (LD4 on). The format of the test programme is as follows:

1. At the start of the first half hour: IBA announcement preceded by the first four notes of the frere jacques tune. 30s of 450Hz at −12dBu in left only. 30s of

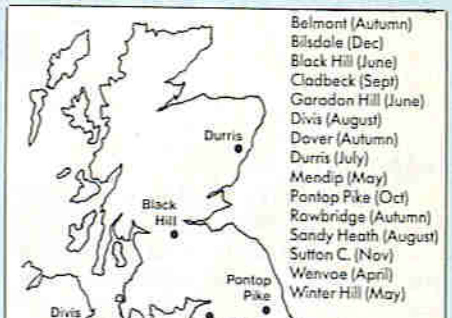


Figure 12. IBA NICAM map.

Continued on page 54.

FERROFLUIDS

By Robert Ball A.M.I.P.R.E.

Introduction

A ferrofluid is essentially a magnetic fluid, combining the properties of magnetic materials and fluids, finding numerous applications in science, industrial, commercial and medical fields. The properties of such fluids were first demonstrated during the early years of the American space program. Ferrofluids are now in common use providing hermetic sealing in difficult applications, and enhancing performance of magnetically operated devices such as stepper motors and loudspeakers.

Ferrofluids are liquids which contain specially treated magnetic particles in suspension, the magnetic particles have an average size of around 100Å (Angstrom) and are coated with a substance called a 'surfactant' which prevents the particles 'clumping together' (agglomeration) or falling out of suspension from the carrier liquid, see Figure 1. This property is extremely important and agglomeration, or fall-out, will not occur even when strong magnetic fields are applied to the highly stable ferrofluid.

In the absence of an externally applied magnetic field, the particles' magnetic moments assume random orientation, therefore the ferrofluid has no net magnetization.

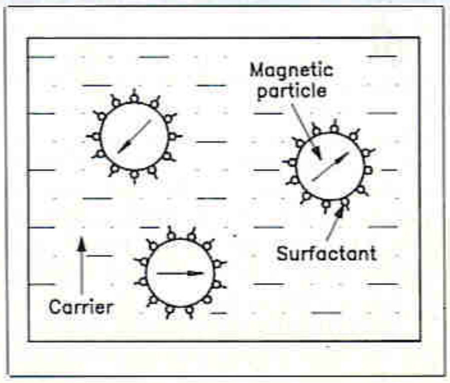


Figure 1. Components of a Ferrofluid.

Properties of Ferrofluids

Figure 2a shows the magnetisation curve for ferromagnetic solids, and Figure 2b shows the magnetisation curve for ferrofluids. It can be seen that for a ferromagnetic solid, the magnetisation lags behind the applied field. This is illustrated by the classic hysteresis curve shown in Figure 2a, where M is the magnetization of the ferromagnetic solid and H is the applied magnetic field.

However, for ferrofluids, a rather different curve is produced – as shown in Figure 2b. When the external field is applied to the ferrofluid, the magnetic moments of the particles align with the field lines almost instantaneously. The magnetisation of the ferrofluid therefore immediately follows the applied changing

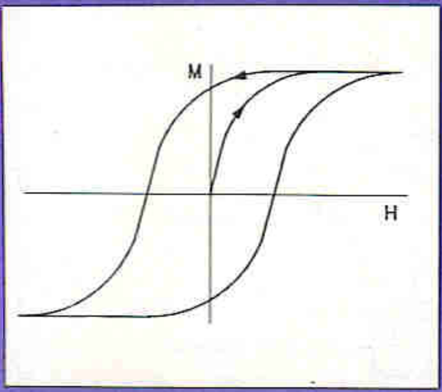


Figure 2a. Hysteresis curves.

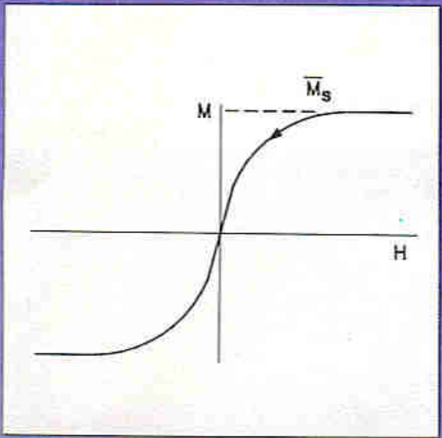


Figure 2b. Hysteresis curve.

field and when the field is removed the magnetic moments quickly fall back into random polarisation. From this behaviour it may be seen that the ferrofluid is magnetically 'soft'. Ferrofluids are defined as superparamagnetic materials, which is the property exhibited by magnetic materials when the particle size is reduced to a single-domain rather than multi-domain characteristic. This shows as very low coercivity and hence low magnetic retention, which is a highly desirable property of ferrofluids (but not so for magnetic recording media!).

The point at which magnetic saturation occurs is dependant on two variables: the nature of the magnetic material in liquid suspension and the volume of the material in the liquid. The greater the amount of magnetic material in the liquid, the higher the level of magnetic saturation of the ferrofluid. The point of saturation is indicated in Figure 2b by Ms.

The viscosity of the ferrofluid is also variable and can be specified for a particular application, i.e. whether a low or high viscosity is required. Ferrofluids are available with viscosities in the range 5cp (centipose), to greater than 25,000cp @ 27°C. the viscosity is varied by selecting the carrier liquid – as temperature rises, viscosity decreases.

The addition of the magnetic particles to the carrier liquid does not unduly change the mechanical, physical and chemical properties of the unadulterated liquid. Generally ferrofluids using organic carrier liquids are non-conductive and offer good lubrication properties.

The magnetic properties of ferrofluid gives rise to very distinct effects when the ferrofluid is subject to a magnetic field. When exposed to a uniform magnetic field, the magnetic moments align with the field lines. However when the ferrofluid is exposed to a gradient field, the particles are subject to a force which will move the fluid (not just the particles in suspension), to the place of highest field strength. The property of the liquid as a whole being controlled by a magnetic field allows very precise positioning of the fluid by a magnetic field. The force with which the ferrofluid is held in position is dependant on the gradient of the external magnetic field and the magnetic properties of the fluid itself. This is illustrated in Figure 3, the strength of the field exerted on the ferrofluid is dependant on the distance between the magnet and the ampoule.

A magnet placed in ferrofluid will be levitated by the force produced around it, see Figure 4a. If a non-magnetic object is placed in ferrofluid and a magnetic field is applied, the force produced within the ferrofluid will tend to expel the object from the ferrofluid, see Figure 4b. The expulsion force is dependant on the strength of the magnetic field and the magnetic properties of the fluid itself.

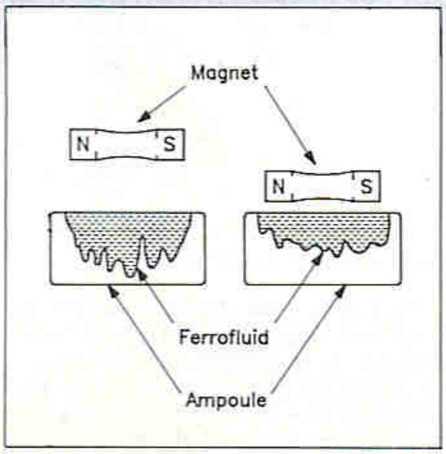


Figure 3. Ferrofluid attracted to a magnetic field.

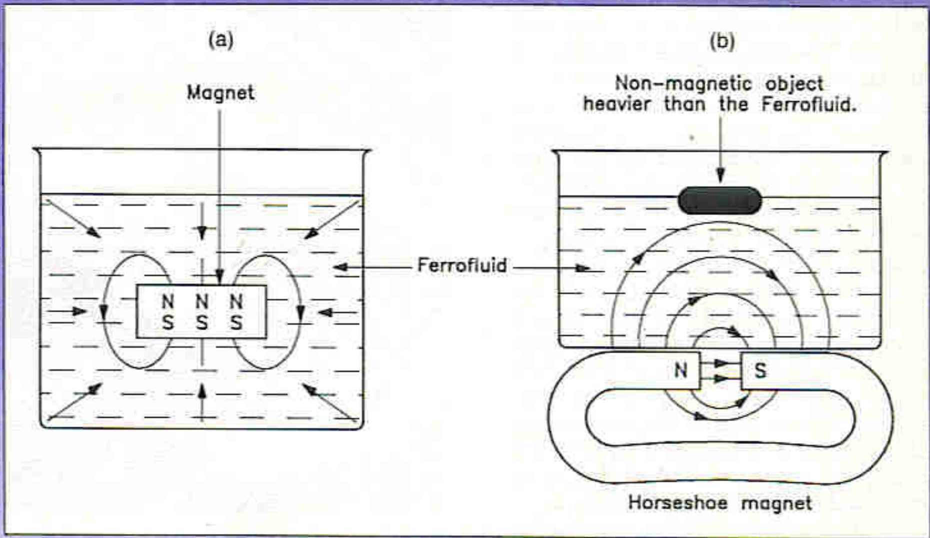
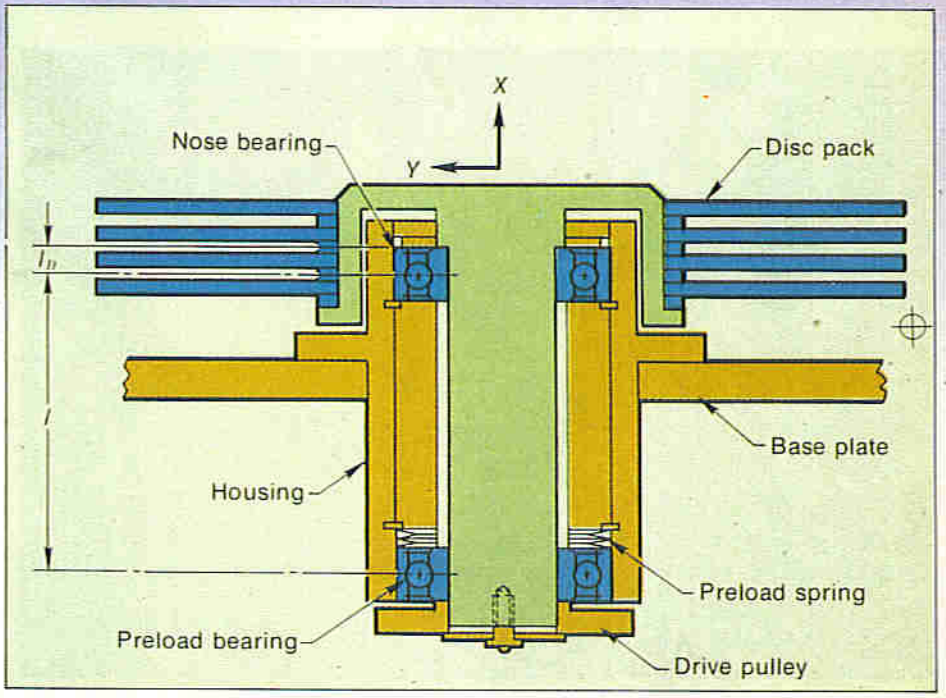


Figure 4. Levitation of a magnet and a non-magnetic object.



Hard disc-drive spindle seal.

Applications For Ferrofluids

Loudspeakers – One of the most familiar applications of ferrofluids is in loudspeakers, where the fluid is used to fill the air gap between the pole pieces and voice coil, see Figure 5. The ferrofluid serves several purposes. The ferrofluid dramatically improves cooling of the voice coil by a factor of five times, this increases power handling and reduces thermal transient failures. For a given power handling, a loudspeaker using ferrofluid will be smaller in size than a loudspeaker without ferrofluid. Due to the cooling effects, the voice coil impedance is maintained at a more constant value. Because of the viscous nature of ferrofluids, ringing and resonances are reduced as a result of the damping effect. The presence of the ferrofluid also tends to centre the voice coil preventing rubbing of the voice coil against the pole pieces.

Inertia Dampers – Ferrofluidic inertia dampers may be found in stepper motors, used to reduce settling time, noise and vibration. The damper, see Figure 6, is a hermetically sealed unit that is attached to the motor shaft and contains an assembly of a piece of steel and a permanent magnet. This magnetic structure is held in suspension by the levitational properties of ferrofluid, contained within the non-magnetic damper housing. The damper operates using the shearing effect between the damper housing and the suspended structure, which resists motional change (Newton's first law). Energy absorbed is dissipated in the form of heat. The overall result is smoother operation of the system. Stepper motors utilising this type of damper may be found in computer disk drives (head positioning motor) and in X-Y drafting plotters.

Sealing Devices – Ferrofluids can be used to form seals on rotary shafts using

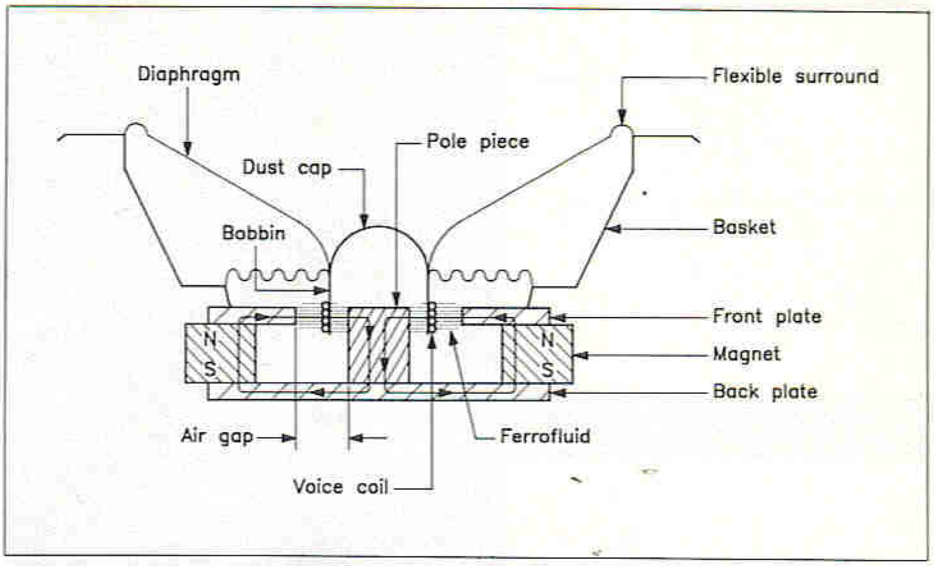
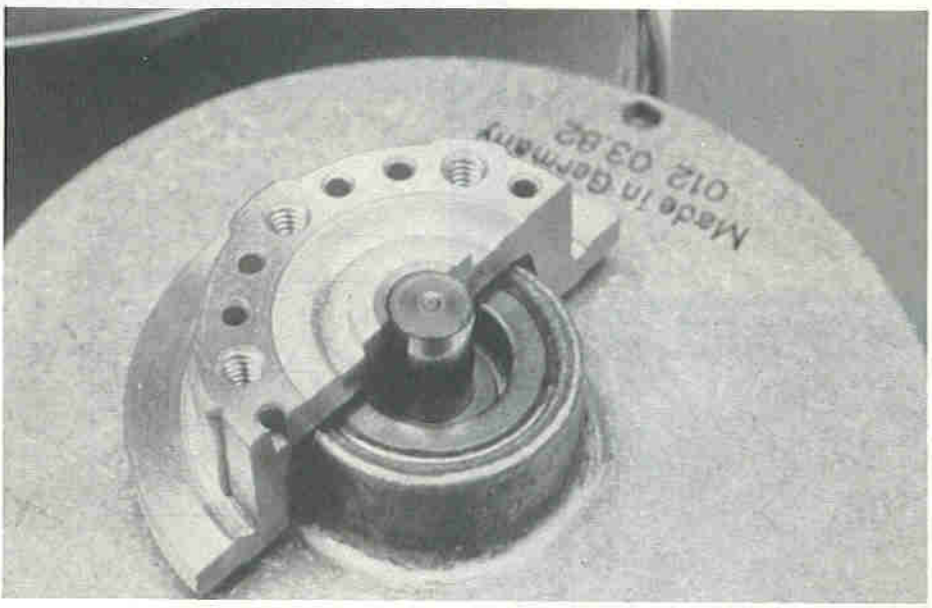
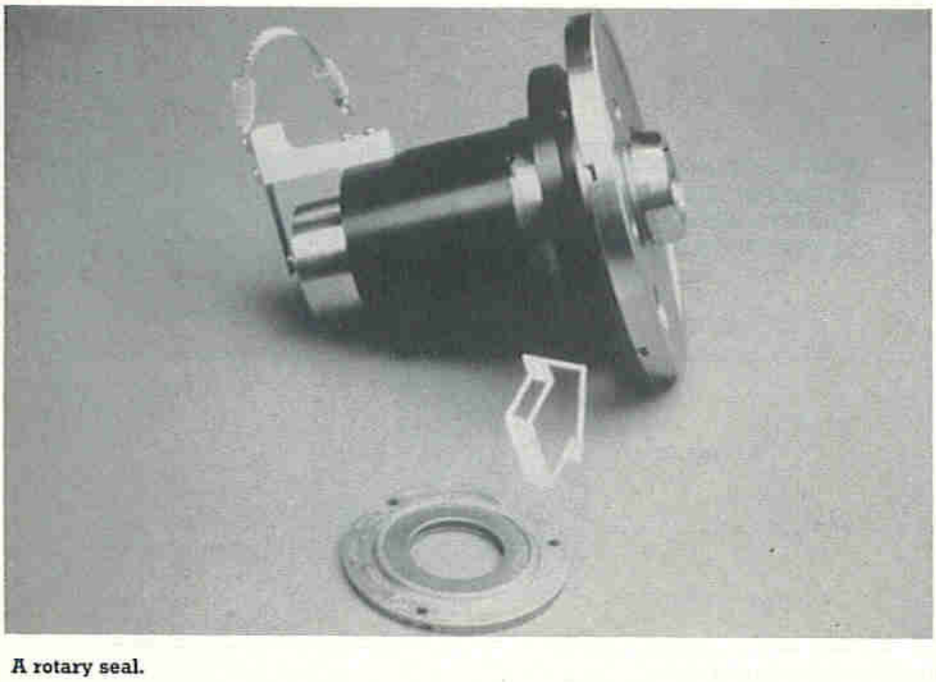


Figure 5. Loudspeaker components.



Cut-away section showing seal.



A rotary seal.

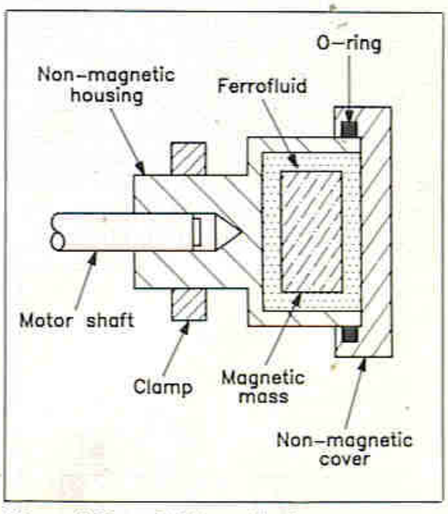


Figure 6. Ferrofluid enertia damper.

a magnetic liquid barrier, literally a ferrofluid 'O' ring! The liquid seal has very low drag on the shaft and leakage through the seal is so insignificant it cannot be measured. The shaft seal assembly is formed from a permanent magnet and magnetic focussing pieces adjacent to the poles, this creates a complete magnetic

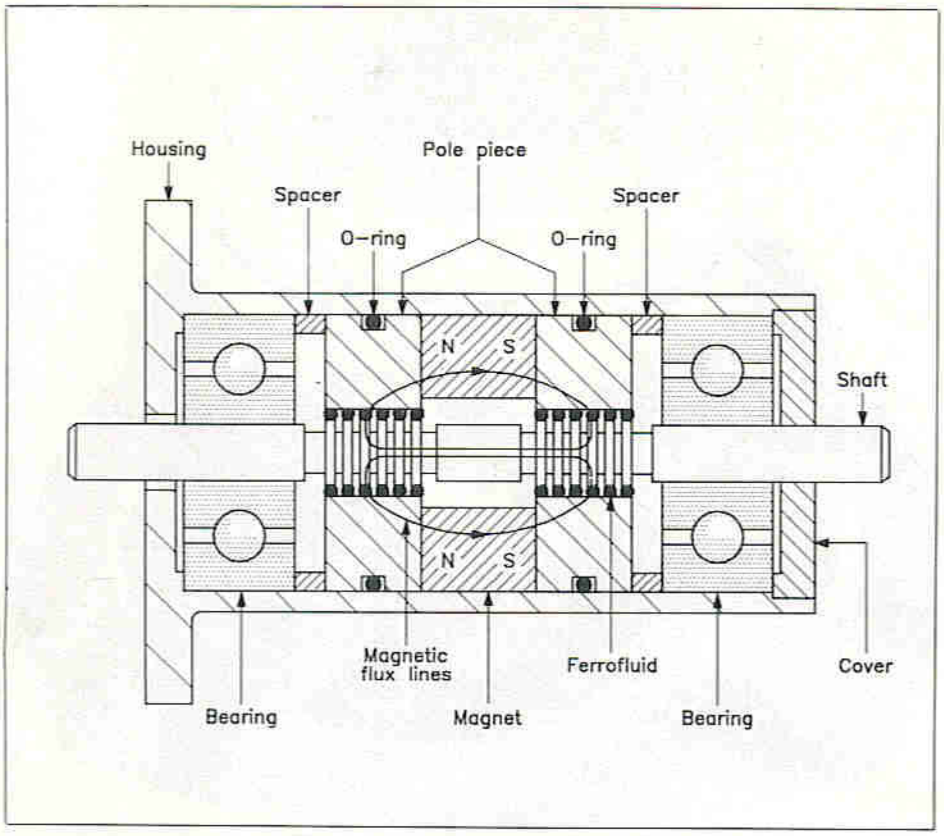


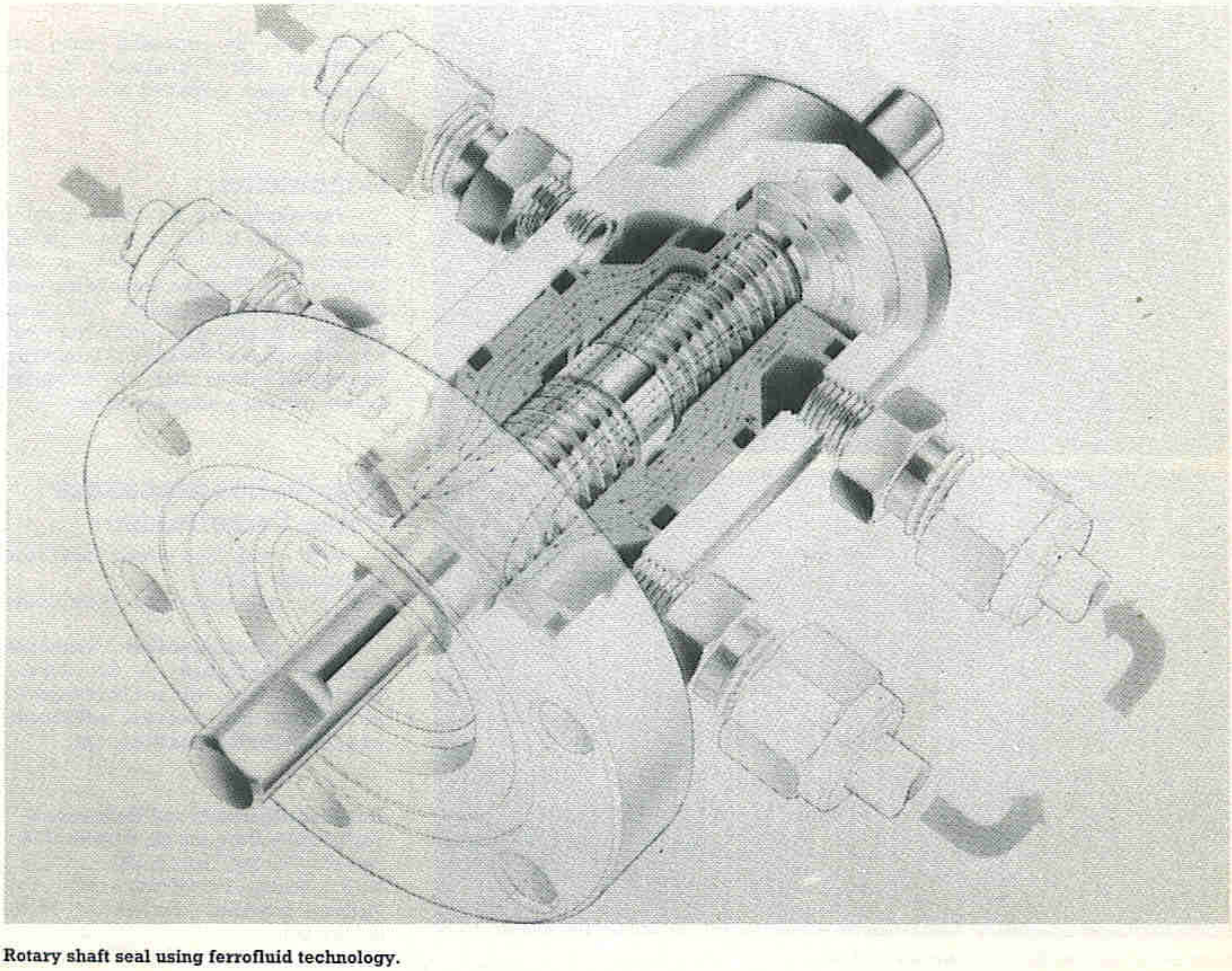
Figure 7. Ferrofluidic rotary shaft seal.

circuit through the air gap between the rotary shaft and the pole pieces and can be seen in Figure 7. Ferrofluid is used to fill the gaps and provide the seal, thus prevents the passage of gases and other contaminants. The magnetic field holds the ferrofluid in place – even when the assembly is subject to mechanical shock, vibration and heavy loading.

This type of rotary seal provides the necessary interface between normal ambient conditions and a controlled or clean environment. Ferrofluid seals find applications in semiconductor manufacturing equipment and also in Winchester hard disk drives to seal the disk drive spindle, preventing contamination from dust and other 'nasties' that could cause a catastrophic head crash.

Magnetic Signature – Since ferrofluids have very small particle size, they may be used for observing the domain patterns produced in many different types of magnetic media, for example magnetic tape and disks.

Measurement – Ferrofluids have found applications in various measurement applications, one of these being measurement of cooling channel wall thickness/hole diameter in turbine blades, see Figure 8. The channels are filled with



Rotary shaft seal using ferrofluid technology.

ferrofluid and using an eddy current measuring device, dimensional detail may be resolved to an accuracy of better than one thousandth of an inch.

Ferrofluids also find uses in bio-medical applications where they are used for selective separation of viruses and bacteria. Ferrofluids have also been applied in industry for densimetric separation, where materials of different density may be separated using the levitational effect produced by the ferrofluid when subjected to a gradient magnetic field.

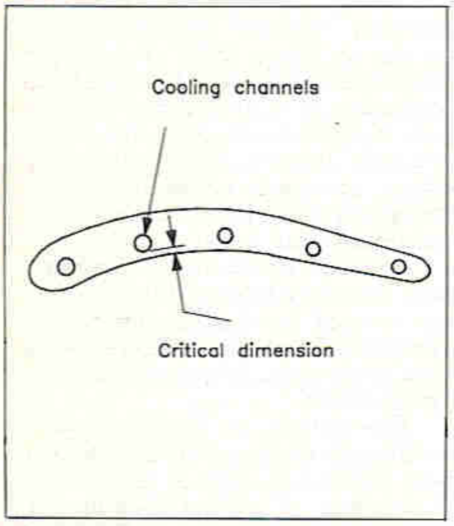
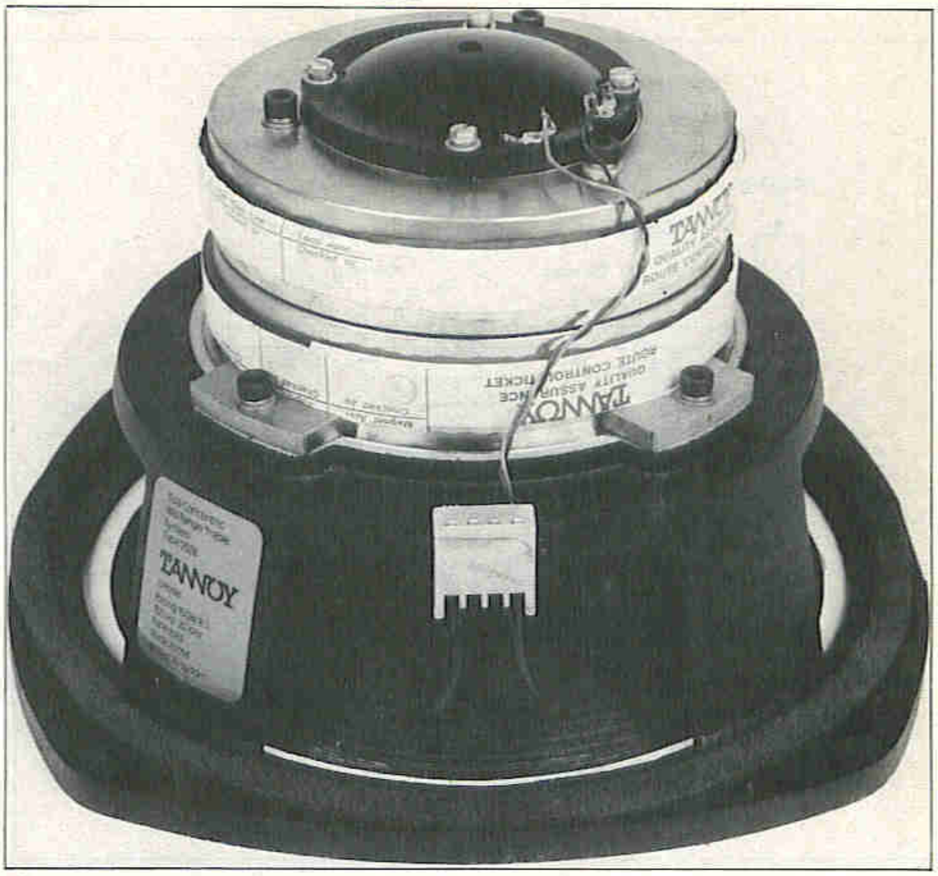
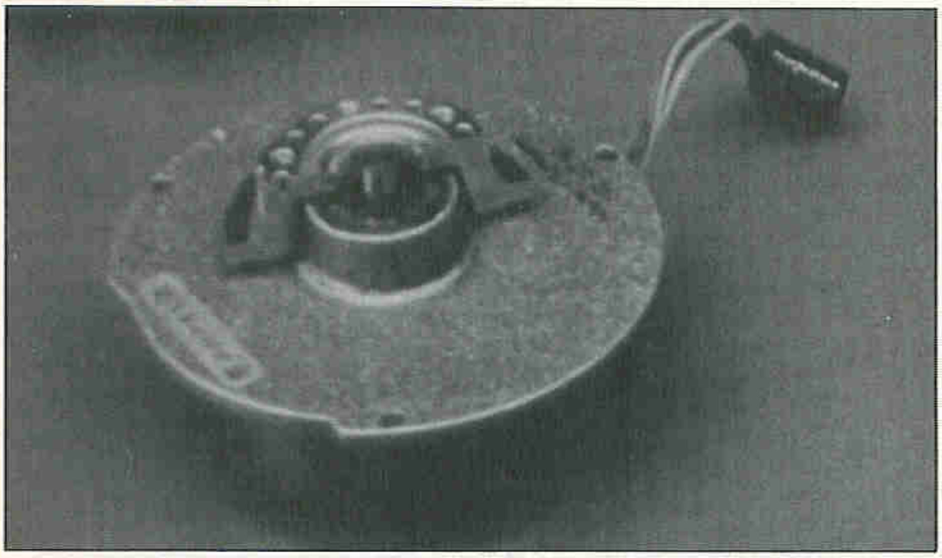
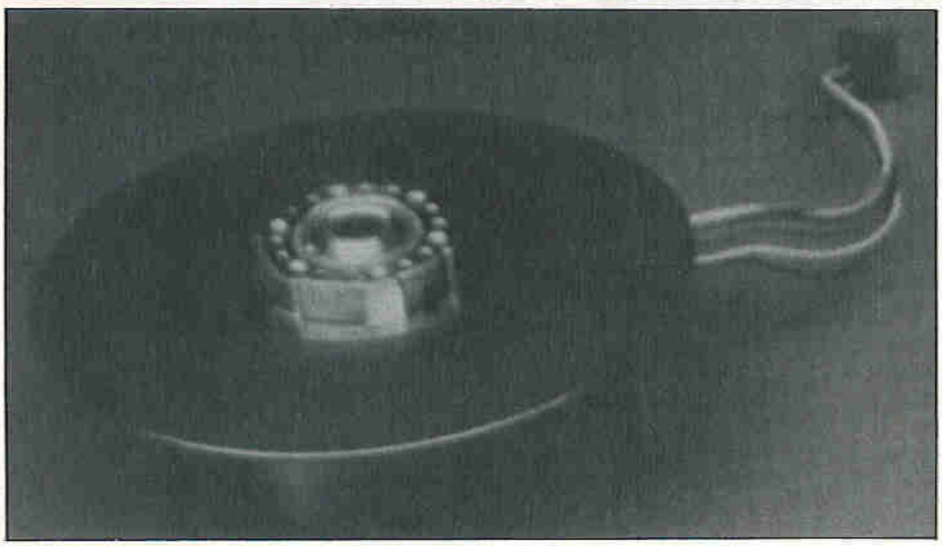


Figure 8. Turbine blade.



Tannoy loudspeaker which incorporates ferrofluids.





Examples of seals used in Winchester disc-drives.

Conclusion

Ferrofluids can be used to solve many different problems where normal techniques cannot be used or are inappropriate. The main areas being; heat transfer, sealing, damping, lubrication and specialist detection, applications that take advantage of the special properties that magnetic fluids offer, with the ability to have precise positional control.

Maplin Loudspeakers Using Ferrofluids:-

50W 4 inch high fidelity mid-range loudspeaker YN26D.
70W 3½ inch mid-range loudspeaker YP13P.

These two loudspeakers incorporate ferrofluid technology in the manner described in the article and have superior performance and technical advantages over non-ferrofluid loudspeakers.

Acknowledgements and References
Ferrofluidics Corporation, Nashua, USA.
Ferrofluidics Ltd, Oxford, UK.
Mr R. J. Boulton, Ferrofluidics Ltd.
Pictures provided courtesy of Ferrofluidics Ltd.
Materials and Design Vol. VIII No. 4.

THE LAMENT OF THE ENGINEER'S WIFE

PART 2 – THE ENGINEER'S WIFE AND NEW TECHNOLOGY

by Marion Hearfield

Those of you read my previous lament on the plight of being the non-engineering wife of an engineer, will be relieved (or amazed) to know that I am still married to that engineer and my father-in-law still talks to me. I suspect that it might be because those two engineers are planning to write about the trials of having a non-engineer wife/daughter-in-law. If this is the case, I will leave the country. In the meantime, here is the remainder of my lament. Whilst you read it I will be looking for my passport.

I know I am not an engineer, but now we have the new technology why do we still keep the old technology? Is it just in case it comes back into fashion again, liked flared jeans? Not even that, I realise. It's because it might just come in handy one day. 'It' can be anything from a book on illnesses in parrots to ten lengths of copper pipe and a box of assorted valve holders, and anything you can think of in between, if our house is anything to go by. My non-engineer's life is filled with baffling questions about why engineers behave the way they do. How do they get away with it? And why do they *never* throw anything away?

We moved house recently because we needed more space. I could easily justify moving the tea-chests of seasoned timber, old picture frames and empty Kilner jars which have accompanied us to each of our last three houses. Anyone would agree that it would be foolish to throw these away. But why do we also keep tea-chests of transformers, small bits of metal, large bits of metal, unidentified half-finished circuit boards, finished but finished-with circuit boards, wartime radio sets, small loudspeakers, large loudspeakers, even cinema loudspeakers (and they are extremely large), switches, relays, boxes of valves (valves?) and old television sets? I detect my father-in-law's influence, and his "have this because it might be useful", (see Figure 1) whenever I go down the cellar.

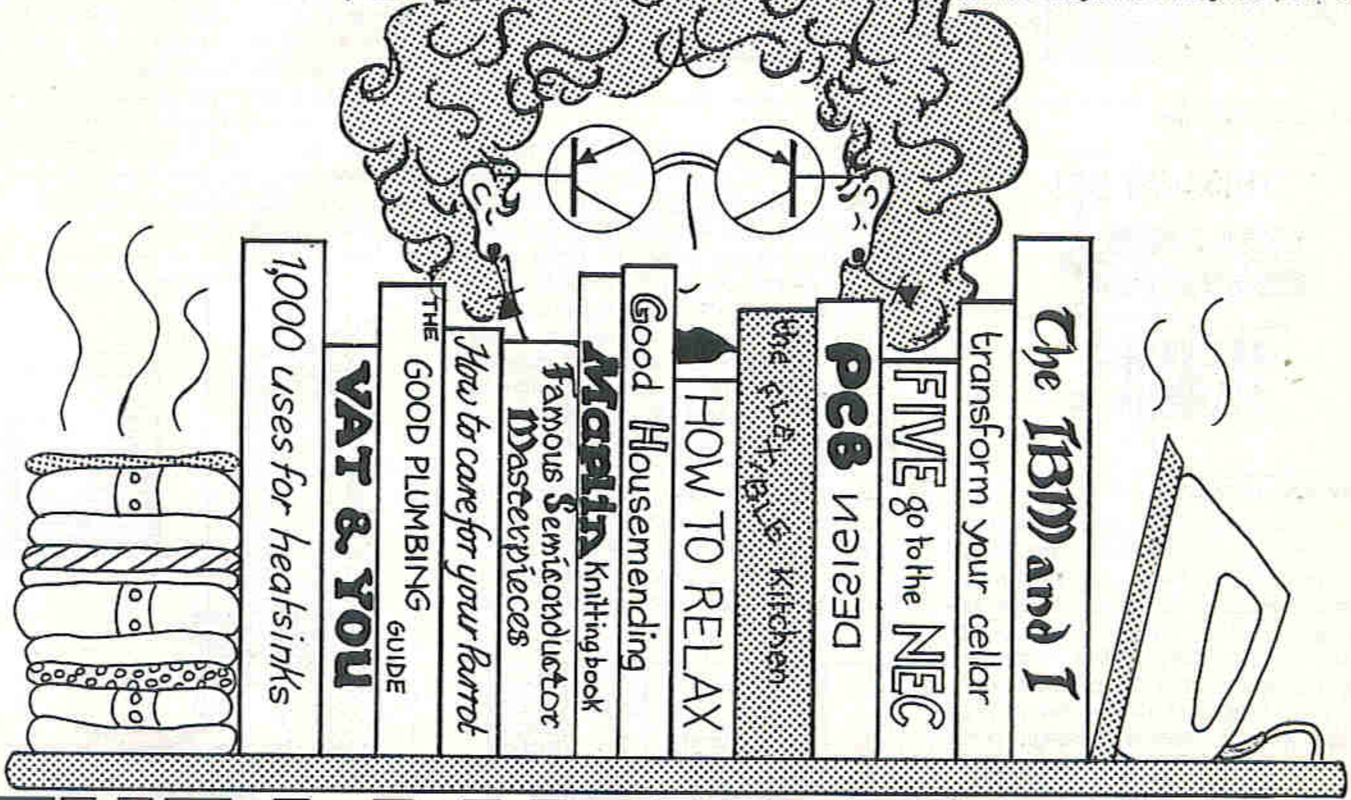
If these things are supposed to be so useful, why haven't they all been used by now? I can honestly say that I have never thrown anything away without holding a full conference with all interested parties. Almost inevitably the feeling of the meeting is on the side of caution, so we keep it, just in case. It is even more exasperating when the engineer needs some particular thing and says "I remember I had one of these in 1973; I know I wouldn't have thrown it away – have you seen it?" Why should *I* have seen it! Storage retrieval systems take on a whole new meaning in our house.

I do wonder how the engineer contrived to be abroad on business for the weeks leading up to each of our two most recent house moves. Might it have been because of those lurking tea-chests? I know that logistics is one of my departments, but going to Los Angeles and Hong Kong so that I could get on with the planning seems a bit drastic.

And when I was designing a new kitchen for this house I thought that last I had a real chance to exploit new materials and new technology. But then I remembered that the sink would have to cope with occasional splashes of ferric chloride from the PCBs we make, as well as potato peelings, so white was out and stainless steel was in.

In our business we do a lot of prototyping, hence those printed circuit boards. Since I got 'O' level Art in 1961 and the engineer didn't even take Art because he was too busy taking terrifying subjects like Physics and Chemistry, PCBs are another of my departments. Why does it take much longer to plan a single-sided track layout than it ever did to build a nice noisy ratsnest of wiring? Why did I track the logic circuits upside down in my first complicated PCB artwork (see Figure 2) and not find out until we had made the board and started to put the IC's in? Does that explain why the engineer wanted PSpice for Christmas, rather than Old Spice?

New technology, even comes through our letterbox. Why do we get so many technical magazines through the post? Espe-



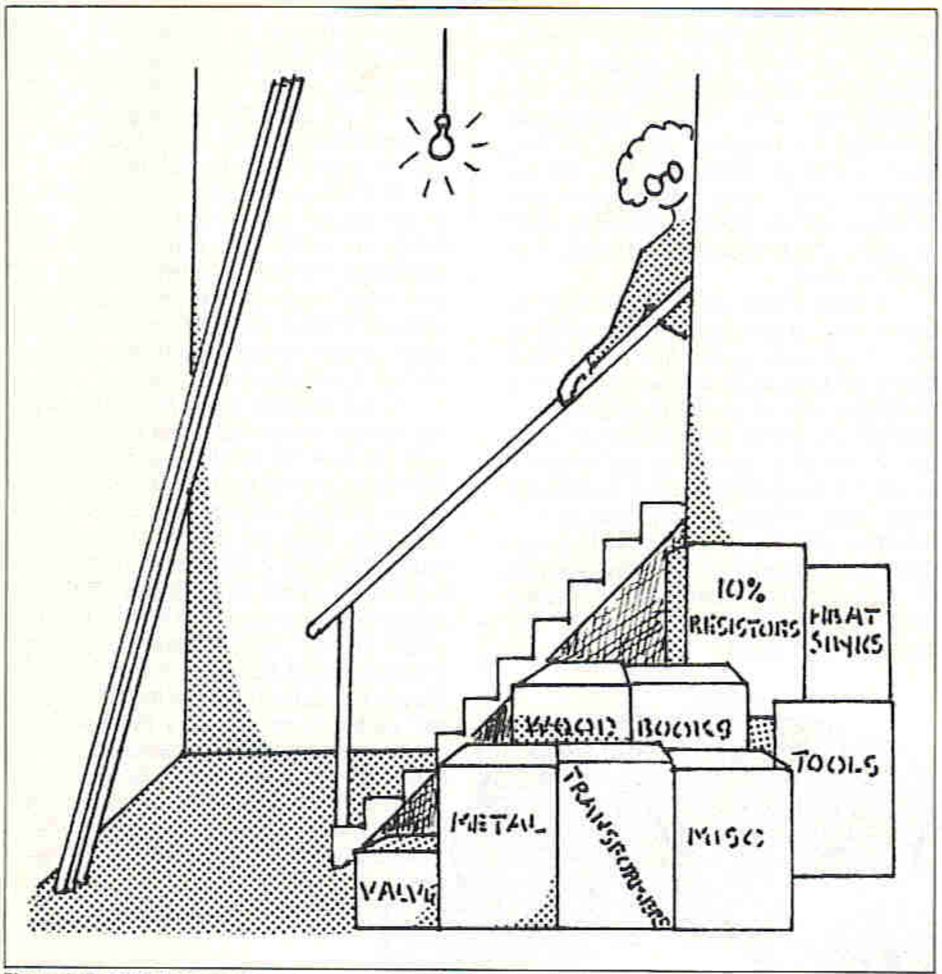


Figure 1. Bargain basement!

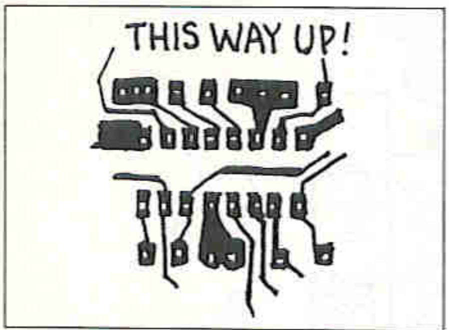


Figure 2. Memory jogger!

cially, why do we get two copies of the ones we don't want? And when we fill in the (really quite useful) Reader Enquiry cards, why are we sent catalogues for office furniture as well? My office is perfectly adequate. It contains a desk, filing cabinet, computer table, shelves on two walls, a swivel chair (from which I can reach all these things) and me (see Figure 3). There isn't enough room for another chair, never mind an executive coat stand or an ergonomically curved work-station in stylish high-impact plastic. We get enough high impact from the hammers of all those plumbers, joiners and builders installing their new technology in our old house, without needing any more.

The recent technical magazines are stored (temporarily, I hope) on the hall windowsill waiting for another filing cabinet in which to keep the useful parts (see Figure 4). We never know what we will be asked to do next, so every few months we tear out and keep any article which has a remote connection with our work, and quite a few which do not. I know I've said it before, but *why* do engineers never throw anything away?

And of course we have to keep ourselves up-to-date with new technology. When we go to trade exhibitions, why do the staff on the stands always assume that I am just along to carry the bags? I know I am, but why should they? Properly briefed, I can hold a coherent conversation on a dinner party level (informed but not in depth) about most things. Why do I always get asked about working voltages or clock frequencies? I know the difference between plain flour and self-raising flour, but why should I also be expected to know the difference between SRAM and DRAM? I suppose self-raising flour is dynamic in its way, but some knowledge comes hard when you're not born to it.

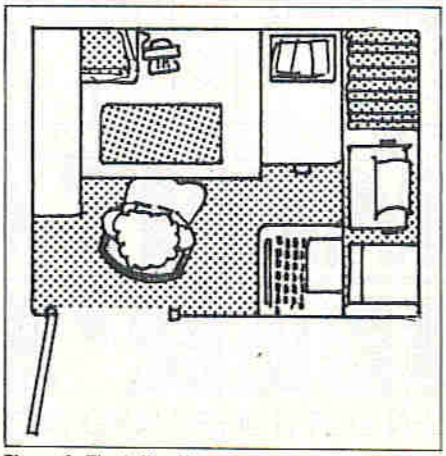


Figure 3. The 'office'!

And, by the way, why don't the marketing men at exhibitions ever give away anything useful? We're up to our knees in keyrings, personalised luggage labels, notepads, footballs and throw-away pens (which we should throw away, come to think of it). What about offering paint brushes or gardening gloves?

Now that we have a few PC's scattered around the house, why must we feel that we have to use computers for everything? We analysed the housekeeping as a way of introducing me to spreadsheets; that was a very salutary lesson. We also found out that we had missed the best time, from a tax point of view, to change my car. I'd rather not have known that. We calculated heat losses for the new central heating system, prepared speeches for the children's school debating society (then we had to do it for their friends, too). I produced the accounts for the school PTA for years, because we had this Apple.

Which reminds me – some time ago we returned from a year of living (and working) in California. We had bought the Apple over there because the dollar rate was so good. But why did we bring the computer home in a suitcase, and leave the new bedding and towels and clothes and kids' toys to be shipped by sea and arrive six months later?

Whilst on the subject of business trips abroad, why did the engineer go to the Far East on a cost reduction exercise for a client, when it was the engineer's wife who had wrestled with the circuit diagrams and identified, listed, counted and costed the hundreds of components involved? I did get a pretty kimono out of it, but it would have been nice to choose it myself. Still, I was supposed to be busy keeping everything else ticking over while the engineer was away.

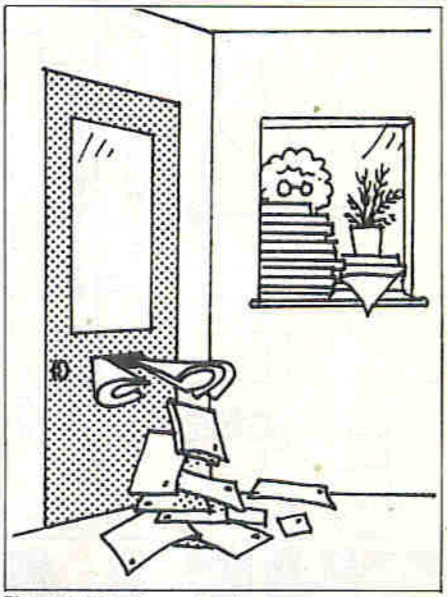


Figure 4. Literature galore!

I am constantly amazed by the different approach to life which I have seen in engineers. I'm quite used to doing five different things at once, and I seem to have a built-in clock which suddenly tells me to save the work on the computer because it's time to collect the kids. This ability is wrongly seen as scatterbrained by engineers of my acquaintance, but it's honestly the only way I know to make sure that everything gets done more or less on time.

Engineers however can completely ignore clocks (and calendars: my birthday this year will be on the same day it was last year, but it will still come as a terrible surprise). Food and sleep and evenings with friends can threaten deadlines or concentration, usually both. We are used to being told that people have an attention span of three minutes, or half-an-hour, or whatever, depending on what they are doing.

Engineers are the only people I know who have an attention span close to infinity, though software-writers comes a close second. My deadlines are hardly ever more than a few hours away: shops, meals, dishwasher, washing machine, vacuum cleaner, children, even the engineer, all need regular attention. Because of this, I can only immerse myself in a project if I have set my watch alarm to remind me of the next deadline. And I can't ignore it. I just have to stop what I am doing and go on to the next job. But all of these insignificant and boring activities make it possible for engineers to remain in their ivory towers. (The engineer points out that scientists live in ivory towers – engineers build them).

So I am constantly bemused by engineers' obsession with work. It seems to be impossible to get their full attention without making them lose the sequence of ideas chugging through their heads, so that they have to start all over again (see Figure 5). Do

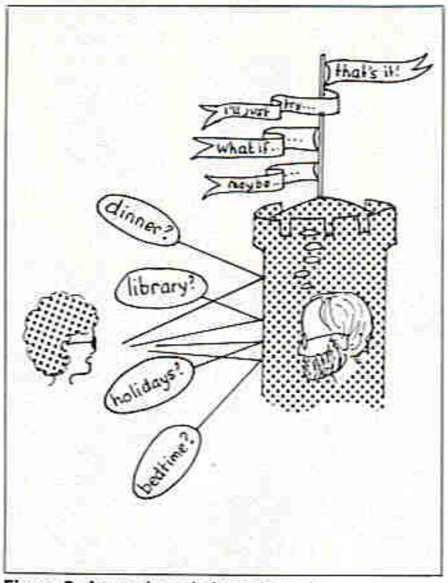


Figure 5. An engineer's ivory tower!

the eyes of husbands in other professions regularly glaze over in the middle of dinner, halting all other activity? We think we are having a normal family dinner-time conversation, but the problems that were bugging the engineer in his lab are still in his head in the dining room, and clever answers occasionally pop up demanding to be written down, *now*. So conversation stops until a clipboard is found, usually under a pile of trade magazines. Then we try to remember what the rest of us were talking about.

Can anyone tell me why engineers always have to solve design problems with such complicated solutions? Being a simple soul, I would try the easy ones first, but then I am not an engineer. Every modification seems to need five more resistors and three more capacitors; sometimes even another IC and six more resistors and three diodes which have to go on a daughter board because the main board is full. And why do these mods always happen *after* the PCB has been made?

All engineers know that problems are easier to identify and solve if they can talk them through. In our business, I am usually the other half of such conversations. But why does the solution always become obvious to the engineer when he is half way though explaining the problem to me? I can usually only understand one word in three, and my grasp of the concepts involved is no more than hazy. Why do my simple-minded questions sometimes make him pause, then ignore me completely because he has thought of a possible way through to where he wants to be? I get quite fed up at hardly ever hearing the end of the original problem, even though I didn't understand it in the first place.

So here I still am, struggling with a technology which I might finally understand when the rest of the world is using sub-nanosecond optical computers. What started me off on all of this was *thinking* while doing the ironing. There's another pile waiting, so I'd better go and get on with it. I'll listen to the radio this time.

MAPLIN'S TOP TWENTY KITS

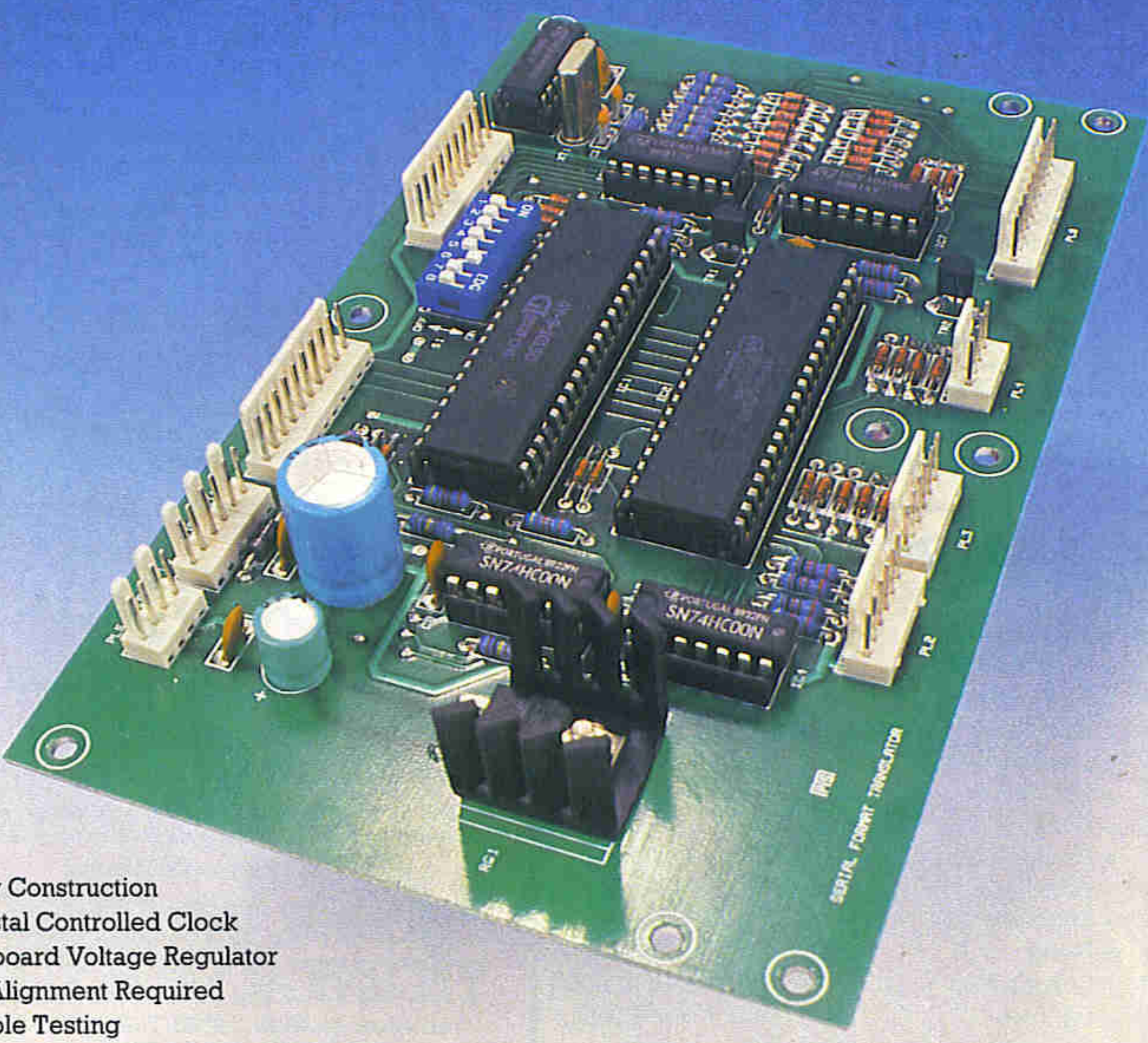
THIS MONTH	LAST MONTH		DESCRIPTION OF KIT	ORDER CODE	KIT PRICE	DETAILS IN PROJECT BOOK
1.	(2)	▲	150W Mosfet Amplifier	LW51F	£18.95	Best of E&MM
2.	(1)	▼	Live Wire Detector	LK63T	£3.95	14 (XA14Q)
3.	(4)	▲	Digital Watch	FS18U	£1.98	Catalogue
4.	(3)	▼	Siren Sound Generator	LM42V	£3.95	26 (XA26D)
5.	(12)	▲	15W Amplifier	YQ43W	£5.95	Catalogue
6.	(13)	▲	PWM Motor Driver	LK54J	£8.95	12 (XA12N)
7.	(11)	▲	Mini Metal Detector	LM35Q	£5.25	25 (XA25C)
8.	(5)	▼	I/R Prox. Detector	LM13P	£9.95	20 (XA20W)
9.	(6)	▼	Car Battery Monitor	LK42V	£7.95	Best of E&MM
10.	(10)	▲▼	Partylite	LW93B	£9.95	Best of E&MM
11.	(7)	▼	Car Burglar Alarm	LW78K	£8.95	Comp 2 (XC02C)
12.	(16)	▲	Logic Probe	LK13P	£11.95	Comp 2 (XC02C)
13.	(9)	▼	8W Amplifier	LW36P	£4.95	Catalogue
14.	(14)	▲▼	Watt Watcher	LM57M	£3.45	27 (XA27E)
15.	(8)	▼	U/Sonic Car Alarm	LK75S	£18.95	15 (XA15R)
16.	(15)	▼	Stereo Pre-amp	LM68Y	£5.25	33 (XA33L)
17.	(17)	▲▼	I/R Remote Switch	LM69A	£18.95	33 (XA33L)
18.	(–)	▲	27MHz Receiver	LK56L	£9.95	13 (XA13P)
19.	(–)	▲	27MHz Transmitter	LK55K	£9.95	13 (XA13P)
20.	(18)	▼	50W Amplifier	LW35Q	£16.95	Catalogue

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

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

SERIAL FORMAT TRANSLATOR

Part three of a series on receiving and transmitting radioteletype (RTTY).
by Chris Barlow G8LVK



- ★ Easy Construction
- ★ Crystal Controlled Clock
- ★ On-board Voltage Regulator
- ★ No Alignment Required
- ★ Simple Testing

Specification of Prototype:

Computer Format:	Serial
Data Output to Computer:	TTL
Data Input from Computer:	TTL
DTR Output to Computer:	TTL
Baud Rate:	300,600,1200
Number of Stop Bits:	1,1.5,2
Parity Select:	None,Even,Odd
Bits/Character:	5,6,7,8
AFSK Demodulator/Generator Format:	Serial
Data Output to Generator:	TTL
Data Input from Demodulator:	TTL
Baud Rate:	45.5,50,75,100,110,150,200,300
Number of Stop Bits:	1,1.5,2
Parity Select:	None,Even,Odd
Bits/Character:	5,6,7,8

DC Specifications:

Power Input:	+8V to +15V
Current Drain at 12V:	60mA
Regulated Power Output:	+5V (250mA Max)

Printed Circuit Board:

Type:	Double-Sided Fibre Glass
Dimensions:	161mm x 102mm

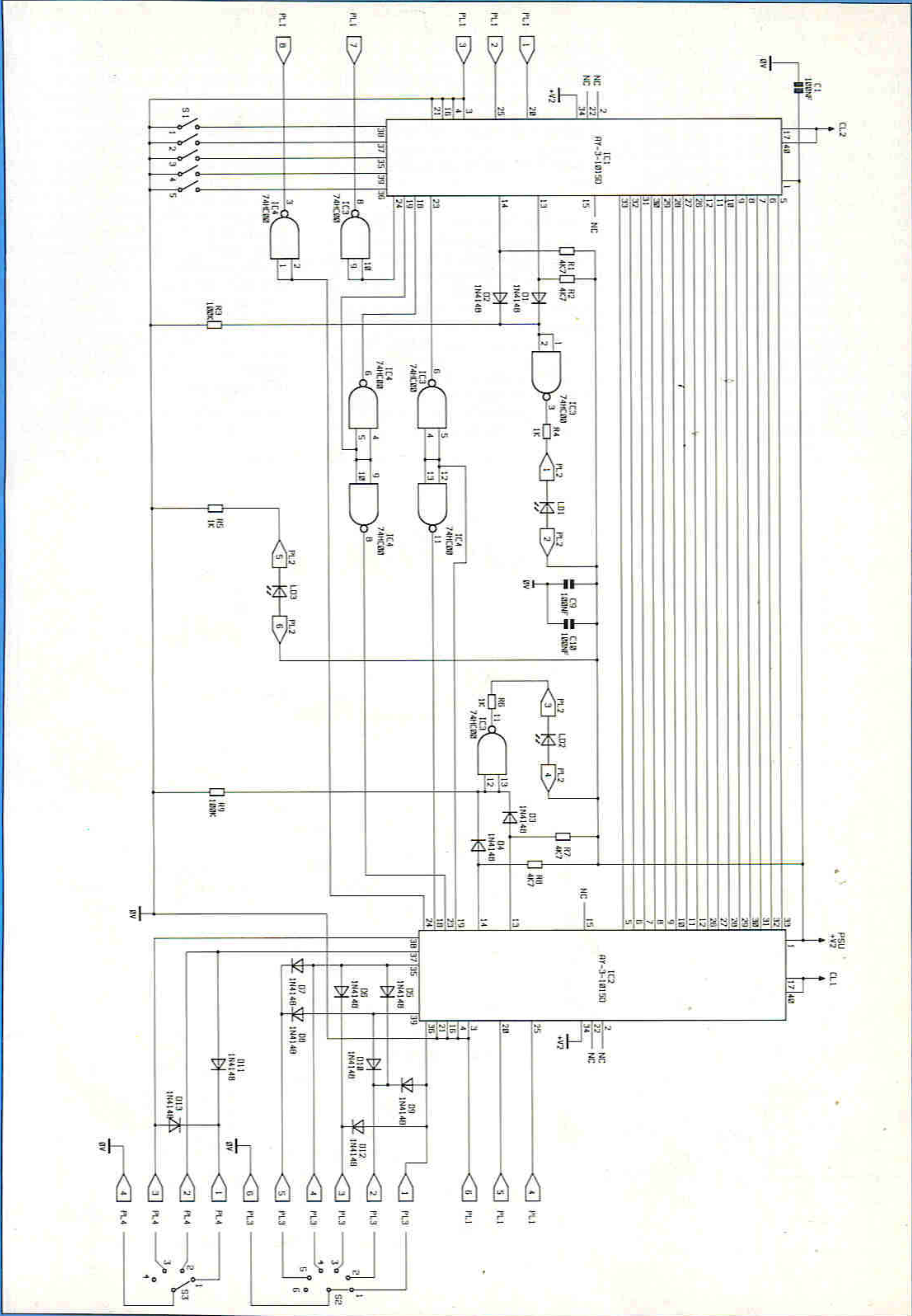


Figure 1a. Circuit Diagram.

Introduction

In Part 1 an RTTY demodulator was presented based upon the XR-2211 PLL decoder IC and Part 2 described the addition of an audio bandpass filter used to reject interfering signals which could overload the system. The serial data output from the decoder is at TTL logic levels at baud rates of 45.45 or 50 used by radio amateurs, with commercial stations tending to use 50 or 75 baud. The RTTY data format uses five data bits per character with 1.5 stop bits. However, this somewhat antiquated format and slow baud rate is not to be found on all computers which have a serial I/O port. It is for this reason that the serial format translator project has been developed to convert the slow five bit data in to a more acceptable format as used by modern day computers. RS232C signal levels have also been adopted by the majority of computer manufacturers, so the addition of an RS232C to TTL level converter may be required to interface the translator to your computer. Due to the variations in computer hardware/software it is not possible to produce a wiring diagram and program listing which would be common to all machines. The hardware wiring and test software in this artical is for use with an IBM PC or clone computer running Microsoft (GW) Basic. An RTTY receive and transmit program is available on a 5¼in disk, Maplin stock code (JR40T) at £9.95

Circuit Description

A circuit diagram detailing the complete unit is shown in Figure 1a and 1b. The DC supply entering the unit on PL11 must have the correct polarity, positive on pin 1 and negative on pin 2, otherwise damage will occur to the semiconductors. To prevent this, diode D1 has to have the positive supply voltage applied to its anode before the DC power can pass to the rest of the circuit. The main supply decoupling is provided by C8 with C7 giving additional high frequency suppression. Two DC output plugs, PL9 and 10, have been provided for powering other modules used in the RTTY system. The voltage output will be 0.5V to 0.7V less than the input voltage on PL11 and the total DC current drain must not exceed 250mA. This voltage (+V1) is also used to power IC's 5,6 and 7 with the remainder of the IC's supplied from the +5V (+V2) regulated supply produced by RG1. The regulator is mounted on to a heatsink so that it can drive the translator circuit and provide up to 250mA at +5V to any extra circuits connected to PL5 and 6. Capacitor C5 is used to provide the main decoupling on this rail with C6 suppling additional high frequency decoupling. As can be seen in Figure 2 there are some more capacitors decoupling both the +V1 and +V2 supply rails. Capacitors C1, 4, 9 and 10 are distributed over the circuit board to prevent the build up of electrical noise from stage to stage.

All the timing signals used in the circuit are derived from a master clock,

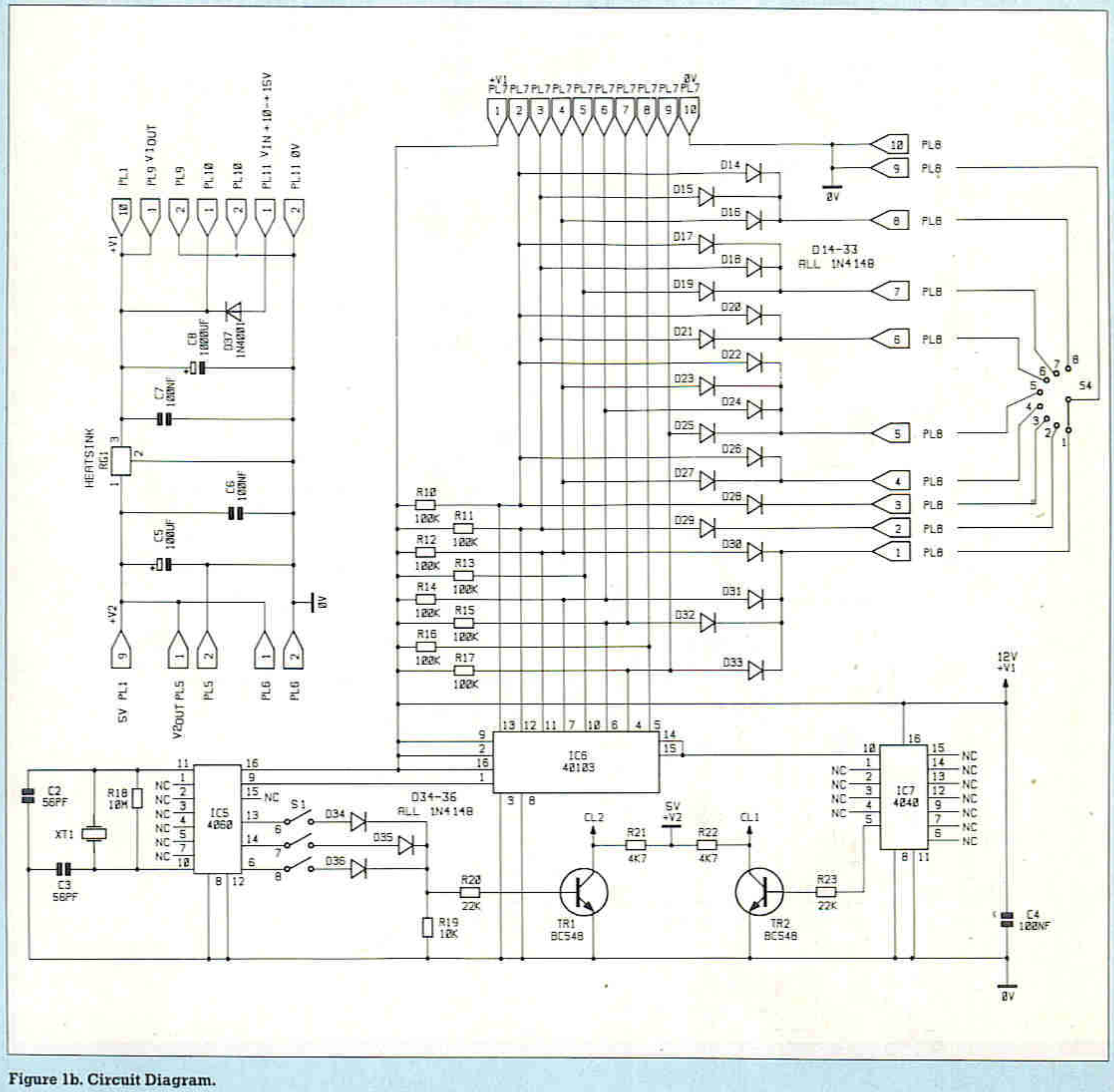


Figure 1b. Circuit Diagram.

IC5 pin number	Divider	Switch S1	Output Frequency
6	128	8	19.2kHz (1200 baud)
14	256	7	9.6kHz (600 baud)
13	512	6	4.8kHz (300 baud)

Table 1. Setting the Baud Rate between the Translator and the Computer.

IC5, referenced to a 2.4576MHz quartz crystal XT1. Because of the basic high accuracy of this crystal no trimming capacitor is required and its operating frequency is set by two 56pF ceramic capacitors C2 and C3. A buffered clock output appears on pin 9 of IC5 which provides the timing signal for the programmable divider IC6. IC5 also has a number of fixed divided outputs. Three are used to drive the clock input of IC1 which sets the baud rate between the translator and the computer as shown in Table 1.

Three diodes, D34 to D36, are used to prevent any damage that would occur to the divided outputs if more than one switch were closed. Before the clock signal CL2 is fed to IC1 it must first be converted from the +12V CMOS logic level in to a +5V TTL level. This is achieved by feeding the signal through TR1 via R19 and R20 with R21 as its collector load. The other clock signal CL1 is treated in the same way, passing through TR2 via R23 with R22 as its collector load. CL1 sets the baud rate of the incoming and outgoing RTTY data, so has to be controlled to a much finer degree than CL2. This is achieved by using a programmable divider IC6 with its division code set by the switched diode matrix D14 to D33 and S4. However, this code can also be set by applying an eight bit +12V CMOS logic word on to PL7. The 100kΩ resistors R10 to R17 are used as pull-ups so all eight inputs are held at logic 1 when not in use. The code for any given division is as shown in Table 2.

The signal on pins 14 and 15 are narrow pulses which are not suitable for driving the clock input of IC2, they must first be converted in to a square wave. This is achieved by IC7 which divides the signal by a factor of 16 and produces the correct clock waveform on pin 5. The divided frequencies appearing on this pin are as shown in Table 3.

At the heart of the circuit are two Universal Asynchronous Receiver and Transmitter (UART) chips IC1 and IC2. Each UART is a Large Scale Integration (LSI) subsystem which accepts binary characters from either a terminal or computer and receives/transmits that character with appended control and error detecting bits. All the characters contain a start bit, 5 to 8 data bits, 1, 1.5, or 2 stop bits and either odd/even or no parity. In order to make the UART's truly universal, the baud rate, bits per word, parity and the number of stop bits are all externally selected.

The baud rate of each UART is set by the frequency of the clock applied to pins

IC6 pin number	4	5	6	7	10	11	12	13	Clock out pin 14,15
PL7 pin number	9	8	7	6	5	4	3	2	Pin 1=+12V, 10=0V
Maximum division	1	1	1	1	1	1	1	1	9.6000kHz
Minimum division	1	0	0	0	0	0	0	0	1.2288MHz
45.5 baud	0	1	0	0	1	0	1	1	11.648kHz
50 baud	1	1	1	1	1	1	0	1	12.800kHz
75 baud	1	1	1	1	1	1	1	0	9.200kHz
100 baud	1	1	1	1	1	0	1	0	25.600kHz
110 baud	0	1	1	0	1	0	1	0	28.248kHz
150 baud	1	1	1	1	1	1	0	0	38.400kHz
200 baud	1	1	1	1	0	1	0	0	51.200kHz
300 baud	1	1	1	1	1	0	0	0	76.800kHz

Table 2. The Division Codes of IC6.

17 and 40. Pin 17 is the receiver clock input and 40 is the transmitter clock, both frequencies must be 16 times the desired baud rate. The serial format of the UART on the computer side IC1 should not have to be adjusted very often since the format of the computer's serial I/O port is set by software. For this reason the set up switches need only be accessible from inside the unit and are mounted on the circuit board. The switch module S1 is an eight way Dual In Line (DIL) unit and the function of each section is shown in Figure 2. Sections 1 to 5 are connected to pins 35 to 39 of IC1 and the functions are as follows:

Switch section OFF = Logic 1 ON = Logic 0.

Pin 35 = No Parity. A logic 1 on this lead will eliminate the parity bit from the transmitted and received character.

Maximum division	=	600Hz
Minimum division	=	76.8kHz
45.5 baud	=	728Hz
50 baud	=	800Hz
75 baud	=	1.2kHz
100 baud	=	1.6kHz
110 baud	=	1.76kHz
150 baud	=	2.4kHz
200 baud	=	3.2kHz
300 baud	=	4.8kHz

Table 3. The Divided Frequencies on pin 5 of IC7.

Pin 36 = Number of Stop Bits. A logic 0 will insert one stop bit and a logic 1 will insert two stop bits. The combined selection of two stop bits and five bits per character will produce 1.5 stop bits.

Pin 37 and 38 = Number of Bits per Character. These two leads will be decoded to select either 5, 6, 7 or 8 data bits per character.

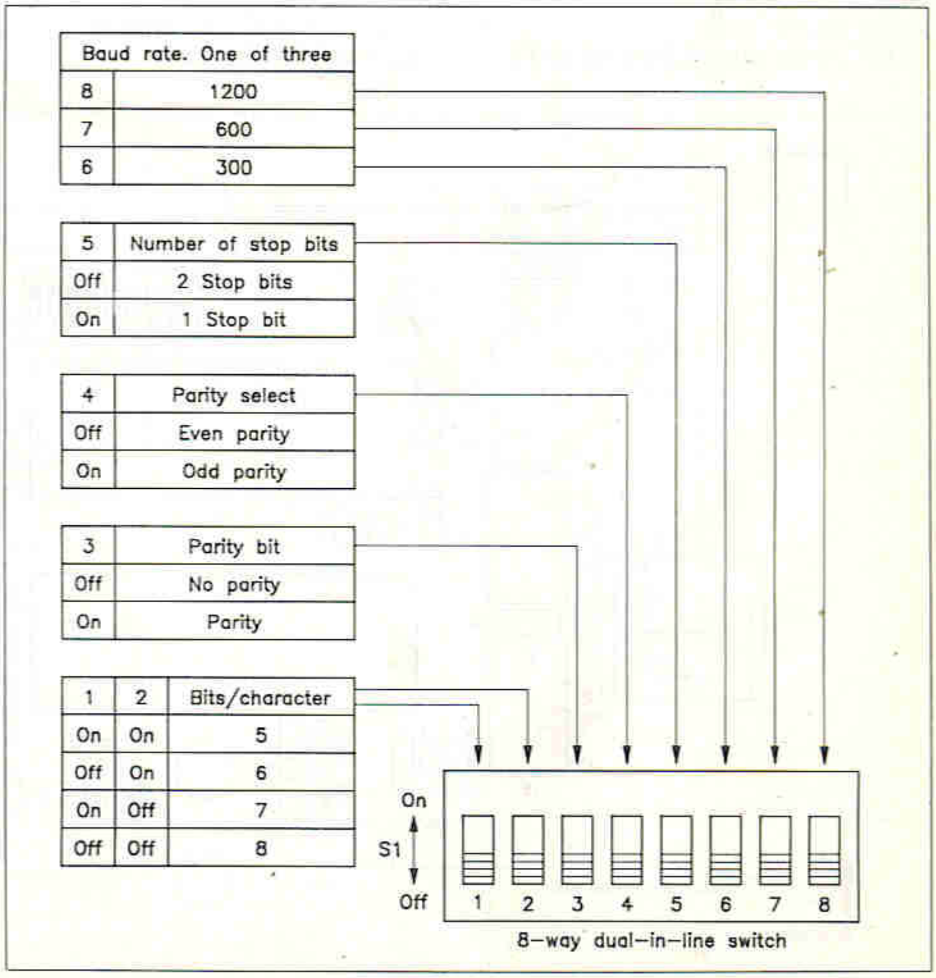


Figure 2. Computer Serial Format Select Switch S1.

Pin 37	38	Bits per Character
0	0	5
0	1	6
1	0	7
1	1	8

Pin 39 = Odd or Even Parity. A logic 0 will insert odd parity and a logic 1 will insert even parity.

Switch sections 6, 7 and 8 are used to select the baud rate from the clock circuit IC5.

The UART IC2 on the RTTY side will have its format altered more frequently as it receives differing sources of RTTY signals. For this reason its format set-up controls must be readily accessible to the user and the rotary front panel switches S2, 3 and 4 makes this possible. The logic pattern on pins 35 to 39 of IC 2 are set by the switched diode matrix D5 to D13 with S2 setting the parity, stop bits and S3 controlling the bits per character. S4 is used by the clock generator IC6 to select the baud rate of IC2.

When the UART receives a serial character, with the correct format, on pin 20 it is converted in to an eight bit parallel word on pins 5 to 12. The opposite condition occurs in the transmitter section of the UART where the data on pins 26 to 33 is converted in to the serial output on pin 25. As can be seen from Figure 1 the parallel output data lines from UART are connected to the input lines of the other. This has the effect of converting one serial format on the computer side in to a different one on the RTTY modulator/demodulator side.

Each UART has a number of data traffic control input/output signals which change state over the receive and transmit cycle as follows:

Pin 19 is the data available line and it goes to a logic 1 when an entire character has been received and transferred to the receiver holding register.

Pin 18 is the data available reset input and a logic 0 will cause pin 19 to go low.

Pin 23 is the data strobe input for the transmitter holding register and the data is sent on the rising edge of the strobe.

Pin 24 is the end of character line and it goes to a logic 1 each time a full character is transmitted. It remains at this level until the start of transmission of the next character.

To obtain the correct sequence of events, the control signals must be inverted using sections of IC3 and IC4. Pin 3 of IC4 is used to provide the Clear To Send (CTS) signal to the computer and pin 8 of IC3 supplies the CTS to the peripheral device. However, this line is not used by the RTTY system and only the CTS on pin 8 of PL1 is used by the computer.

Two error outputs are provided by each UART. Pin 13 will go to a logic 1 if the received character parity does not agree with the selected parity and pin 14 will go to a logic 1 if the received character has no valid stop bit. These two signals are combined using diodes D1 and D2 then inverted by IC3 to drive the light emitting diode (LED) LD1. This indicator will light every time a parity or framing error occurs between the computer and translator. An identical circuit comprising of D3, D4, IC3 and LD2 is used to indicate errors on the received RTTY signal. This LED will light when the selected format does not closely match the received signal and this condition is normally caused by selecting the wrong baud rate. The final LED LD3 is simply used as a power on indicator and will light when the +5V (+V2) supply line is present.

PCB Assembly

The PCB is a double-sided fibre glass type, chosen for maximum reliability and stability. However, removal of a misplaced component is fairly difficult so please double-check each component type, value and its polarity where appropriate, before soldering! The PCB has a printed legend to assist you in correctly positioning each item, see Figure 3.

The sequence in which the components are fitted is not critical. However, the following instructions will be of use in making this task as straightforward as possible. It is usually easier to start with the smaller components, such as the resistors. Next mount the ceramic and electrolytic capacitors. The polarity for the electrolytic capacitors is shown by a plus sign (+) on the PCB legend. However, the majority of electrolytic capacitors have the polarity designated by a negative symbol (−), in which case the lead nearest this symbol goes away from the positive sign on the legend. When soldering in the crystal XT1 be extremely careful not to over heat it as this may damage the device.

All The diodes have a band at one end to identify the cathode (K) lead. Be sure to position them according to the legend, where the appropriate markings are shown. Next install the voltage regulator RG1 and its heatsink using the M3 hardware. When fitting the IC sockets ensure that you match the notch with the block on the board. DO NOT install the IC's until the testing stage!! When fitting the 'Minicon' connectors ensure that the locking tags are all facing the correct way, see Figure 3 and Photograph 1.

Finally install the eight-way DIL

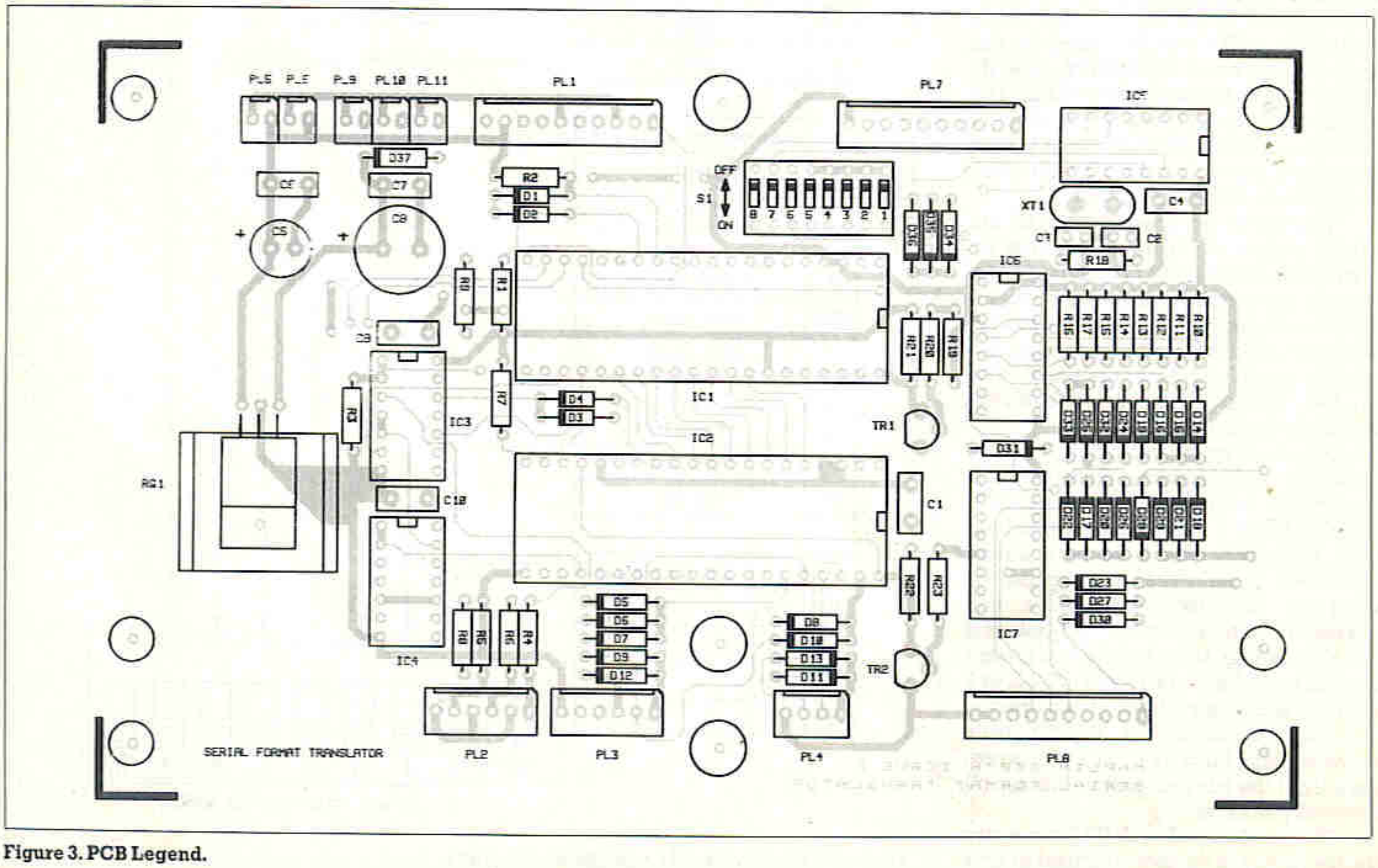


Figure 3. PCB Legend.

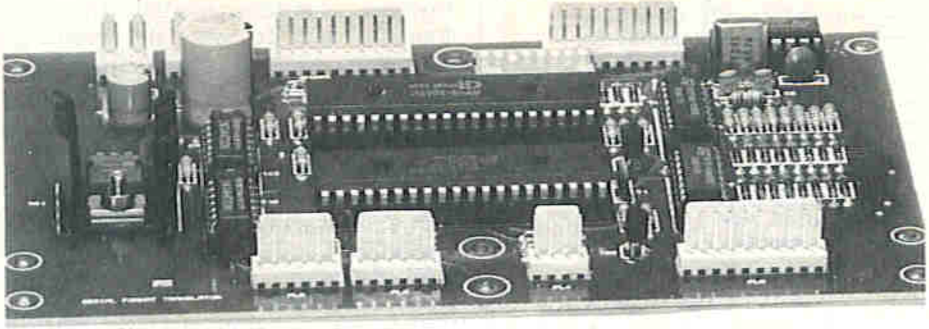


Photo 1. The Completed PCB. Note that all the Connector Tabs face one way.

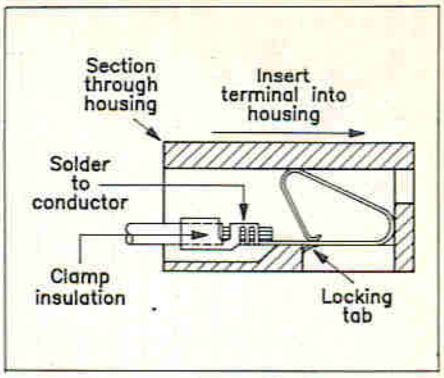


Figure 4. Fitting and Inserting the 'Minicon' Terminals.

switch S1 as shown in Photograph 1. This completes the assembly of the circuit board and you should now check your work very carefully making sure that all the solder joints are sound. It is also VERY IMPORTANT that the solder side of the PCB does not have any trimmed component leads standing proud by more than 3mm, as this may result in a short circuit. Further information on soldering and assembly techniques can be found in the 'Constructors Guide' included in the kit.

Final Assembly

No specific box has been designated for the project as your finished unit could contain several different PCB's. However, the translator board fitted nicely in to the instrument case type 3502 (stock code YN33L), see Photographs 2 to 5. The additional connectors and hardware are listed under 'Optional' in the kit parts list. Once you have completed the mechanical assembly of the unit you should check your work very carefully before proceeding to the wiring stage.

Wiring

If you purchase the kit (stock code LM94C) it should contain a one metre length of ten-way ribbon cable. No specific colour has been designated for each wire connection, it is entirely up to you. The wire connections to the PCB are made using 'Minicon' connectors and the method of installing them is shown in Figure 4. A wiring diagram showing all the interconnections is given in Figure 5 and the additional wiring for the RS232C to TTL converter is shown in Figure 6. Finally, referring to the rotary switch assembly diagram in Figure 7 set each switch as follows:

S2 = 6 Way
S3 = 4 Way
S4 = 8 Way

This completes the wiring of the translator and you should now check your work very carefully making sure that all the solder joints are sound.

Testing

All the DC tests can be made with a minimum of equipment. You will need a digital, or analogue multimeter and a regulated +12V power supply capable of suppling up to 300mA.

Before you commence testing the unit set the PCB and front panel switches to the following positions:

S1 = 1 to 5 OFF, 6 ON, 7 and 8 OFF.
(300 baud, No parity, 8 bits/character, 2 stop bits) see Figure 2.
S2 = Position 1, no parity, 1 stop bit.
S3 = Position 1, 5 bits per character.
S4 = Position 1, 45.5 baud.
S5 = Power OFF.

Remember none of the IC's should have been installed at this time. The first test is to measure the resistance on the power input pins of PL11. With the meter leads either way round a reading of greater than 10kΩ should be present. Next, select a suitable range on your meter that will accommodate a 100mA DC current reading and place it in the positive power line (pin 1 of PL11). Connect your +12V power supply and switch on, a current reading of approximately 10mA should be observed. Switch off the unit and remove your multimeter from the DC power line. Set the meter to read DC volts. Connect its positive test lead to PL5 pin 1 and its negative lead to pin 2. If all is well a reading of approximately +5V should be obtained. Switch off the unit, then remove your meter from PL5 and reconnect it in the positive supply line.

Next install the IC's making certain that all the pins go into the socket and the pin one marker is at the notched end. When the power is switched back on the current reading should now be in the region of 60mA. Turn off the supply and remove the test meter from the power line.

Again set your multimeter to read DC volts. All voltages are positive with respect to the 0V ground, so connect your negative test lead to a convenient ground point on the translator. When the translator is powered up, without a demodulator or computer connected to it, the voltages present on the PCB assembly should approximately match the readings shown in Table 4.

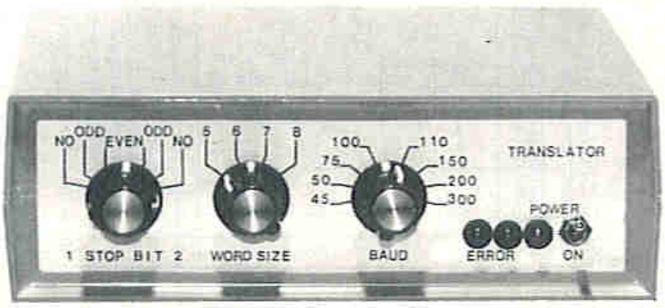


Photo 2. The Prototype Box Front.

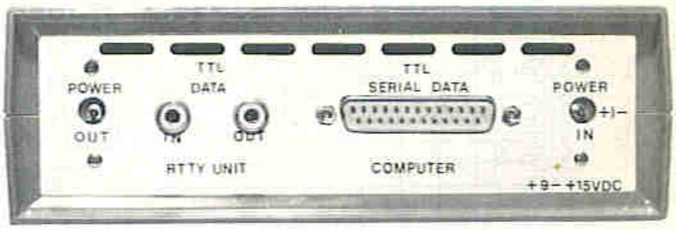


Photo 3. The Prototype Box Back.

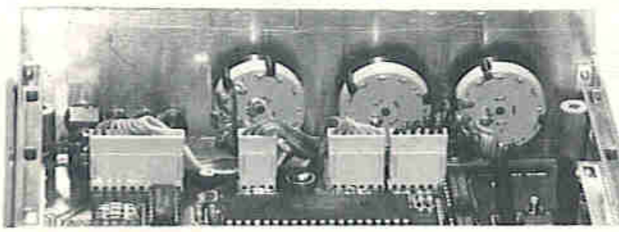


Photo 4. Inside the Box Front.

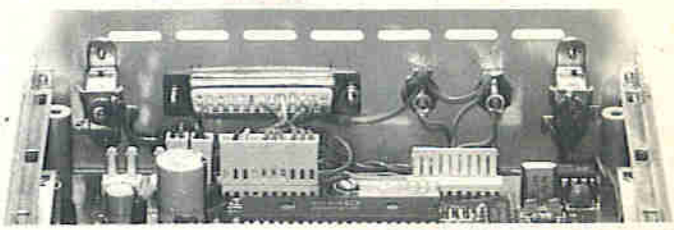


Photo 5. Inside the Box Back.

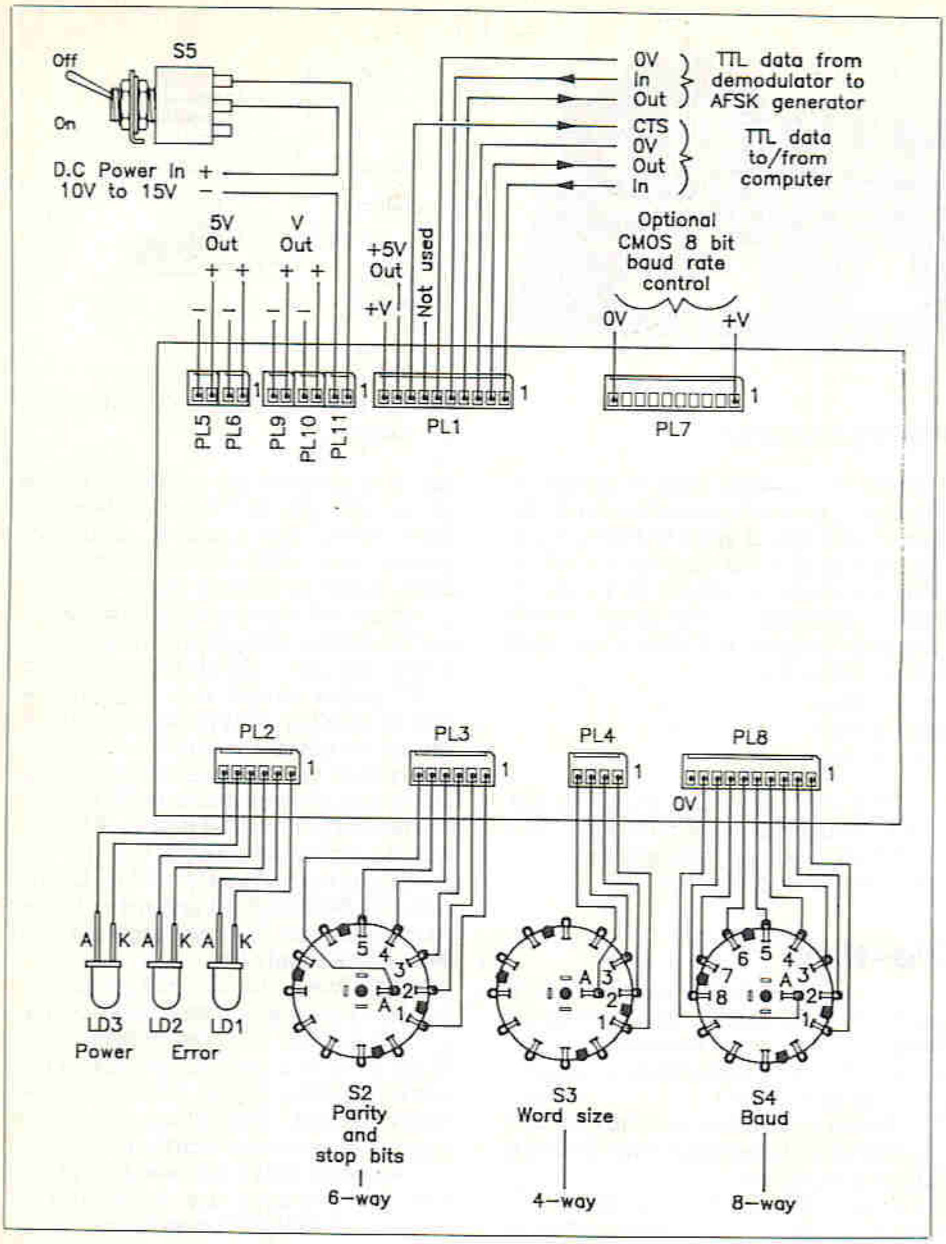


Figure 5. Wiring Diagram.

This completes the DC testing of the translator, now disconnect the multimeter from the unit. To make the following frequency tests a digital frequency counter, or similar test instrument must be used.

This completes the hardware tests. However, before running the loop test software check the following:

1. S1 (PCB switch) = 1 to 5 OFF, 6 ON, 7 and 8 OFF.
2. S2 (Parity/stop bits) = Position 6, no parity, 2 stop bits.
3. S3 (Word size) = Position 4, 8 bits per character.
4. S4 (Baud rate) = Position 8, 300 baud.
5. Check the wiring to your computers serial port, see Figures 5 and 6.
6. Do not connect an RTTY demodulator or AFSK generator to the translator.
7. Place a temporary link between pins 4 and 5 of PL1.

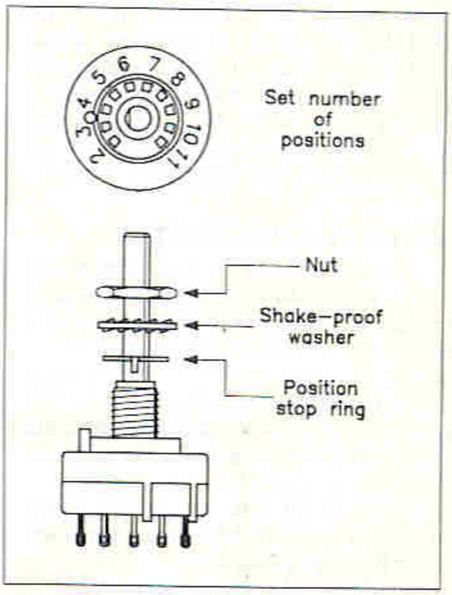


Figure 7. Setting the Number of Ways on a Rotary Switch.

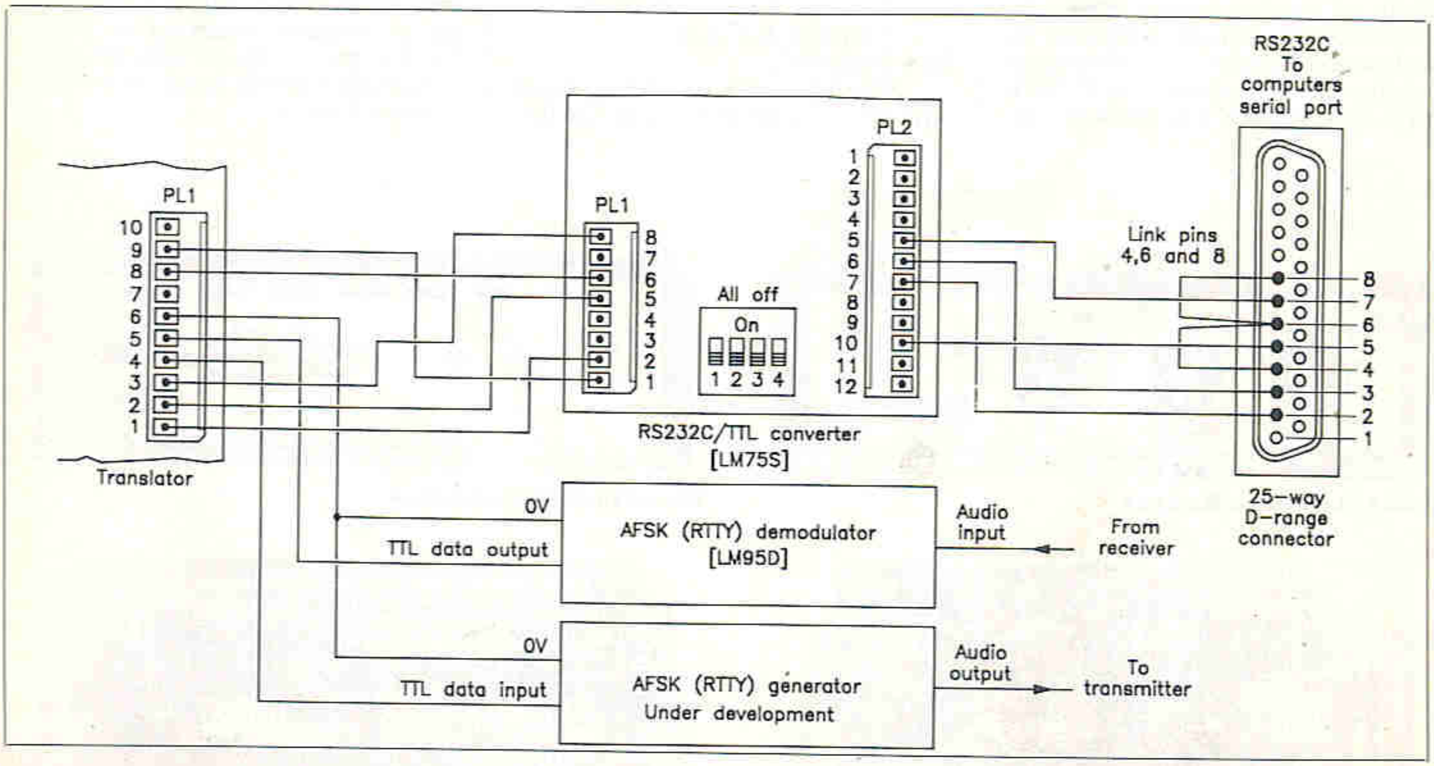


Figure 6. TTL to RS232C Wiring Diagram.

Minicon connector PL1 to 11 DC Tests.

PL1		**PL2**		**PL5,6**		**PL9,10**	
1 =	+5V	1 =	+5V	1 =	+5V	1 =	+11.3V
2 =	+3.5V	2 =	+5V	2 =	0V	2 =	0V
3 =	0V	3 =	+5V				
4 =	+3.5V	4 =	+5V	**PL11**			
5 =	+5V	5 =	+3.3V	1 =	+12V		
6 =	0V	6 =	+5V	2 =	0V		
7 =	0V						
8 =	0V						
9 =	+5V						
10 =	+11.3V						

PL3: S4 Position.	**1**	**2**	**3**	**4**	**5**	**6**
1 =	0V	+0.6V	+0.6V	+5V	+5V	+5V
2 =	+5V	0V	+5V	+5V	+5V	+5V
3 =	+5V	+0.6V	0V	+5V	+5V	+5V
4 =	+5V	+0.6V	+0.6V	0V	+0.6V	+5V
5 =	+5V	+0.6V	+5V	+5V	0V	+5V
6 =	0V	0V	0V	0V	0V	0V

PL4: S3 Position.	**1**	**2**	**3**	**4**
1 =	0V	+5V	+5V	+5V
2 =	+0.6V	0V	+5V	+5V
3 =	+0.6V	+5V	0V	+5V
4 =	0V	0V	0V	0V

PL7: S4 Position.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 =	+11.3V	+11.3V	+11.3V	+11.3V	+11.3V	+11.3V	+11.3V	+11.3V
2 =	+11.2V	+11.2V	+0.6V	+0.6V	+0.6V	+0.6V	+0.6V	+0.6V
3 =	+11.2V	+0.6V	+11.2V	+11.2V	+11.2V	+0.6V	+0.6V	+0.6V
4 =	+0.6V	+11.2V	+11.2V	+0.6V	+0.6V	+11.2V	+11.2V	+0.6V
5 =	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V	+0.6V	+11.2V
6 =	+0.6V	+11.2V	+11.3V	+11.2V	+0.6V	+11.2V	+11.2V	+11.2V
7 =	+0.6V	+11.2V	+11.2V	+11.2V	+11.3V	+11.2V	+11.2V	+11.2V
8 =	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V	+11.2V
9 =	+0.6V	+11.2V	+11.2V	+11.2V	+0.6V	+11.2V	+11.2V	+11.2V
10 =	0V	0V	0V	0V	0V	0V	0V	0V

IC1 to 7 DC Tests.

IC1,2		**IC3,4**		**IC5**		**IC6**		**IC7**	
1 =	+5V	7 =	0V	8 =	0V	2 =	+11.3V	8 =	0V
3 =	0V	14 =	+5V	12 =	0V	3 =	0V	11 =	0V
4 =	0V			16 =	+11.3V	8 =	0V	16 =	+11.3V
16 =	0V					9 =	+11.3V		
21 =	0V					16 =	+11.3V		

Table 4. Test Voltages.

Frequency Tests (Square Wave).
IC5, Pin 9: 2.4576MHz

IC1, Pin 17,40:

S1 Position.	**6**	**7**	**8**
Baud Rate.	300	600	1200
Frequency.	4.8kHz	9.6kHz	19.2KHz

IC2, Pin 17,40:

S4 Position.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Baud Rate.	45.5	50	75	100	110	150	200	300
Frequency.	728Hz	800Hz	1.2kHz	1.6kHz	1.76kHz	2.4kHz	3.2kHz	4.8kHz

Table 5. Frequency Tests.

When the keyboard loop test program (Listing 1) is running it should perform as follows: As a key is pressed, that character should appear on the screen and with S4 set at 300 baud the keyboard buffer should clear faster than you can type. However, as the baud rate is reduced down to 45.5 the buffer may overflow as your typing speed increases and the computer may produce a warning sound. If this warning is ignored typed characters will be lost and eventually an error message may appear. If S1 fails to match the configuration set by the OPEN command in the program then corrupt data may also appear and LD1 should light.

When the second loop test program is running it should print on the screen the message held in TX$, see Program listing 2 line 80. The speed that the text appears is directly related to the baud rate selected by S4. This is because the computer takes note of the CTS input of its serial interface and the next character will not be sent until the last one has cleared the translator.

This completes the computer loop testing of the translator, now remove the link from PL1 and connect your RTTY demodulator/generator as shown in Figure 5 and 6.

Using the Translator

As can be seen from Figure 8 the translator is just part of the complete RTTY system. The demodulator (stock code LM95D) which appeared in the June to July '89 issue of the magazine is required to convert the received audio tones in to serial TTL data. An optional audio bandpass filter (stock code LM93D) can be added to help reject interfering signals, see the August to September '89 issue. If your computer has an RS232C serial port then you will require the TTL/RS232C converter (stock code LM75S), see the April to May '89 magazine. For licensed radio amateurs an AFSK tone generator is currently under development

Continued on page 55.

```
10 REM ★ Maplin Translator Test Program One ★
20 REM ★ Link Pins 4 and 5 of PL1 ★
30 REM ★ Set S1 As Follows: ★
40 REM ★ 1 to 5 OFF ★
50 REM ★ 6 ON ★
60 REM ★ 7 and 8 OFF ★
70 KEY OFF:CLS:LOCATE 1,1
80 OPEN "COM1:300,N,8,2" AS #1
90 ON COM(1) GOSUB 150
100 COM(1) ON
110 REM ★ Transmit Characters From Keyboard ★
120 TX$=INKEY$:IF TX$="" THEN 110
130 PRINT #1,TX$;
140 GOTO 110
150 REM ★ Display Received Characters ★
160 IF LOC(1)<1 THEN RETURN
170 RX$=INPUT$(LOC(1),#1):PRINT RX$;:RETURN
```

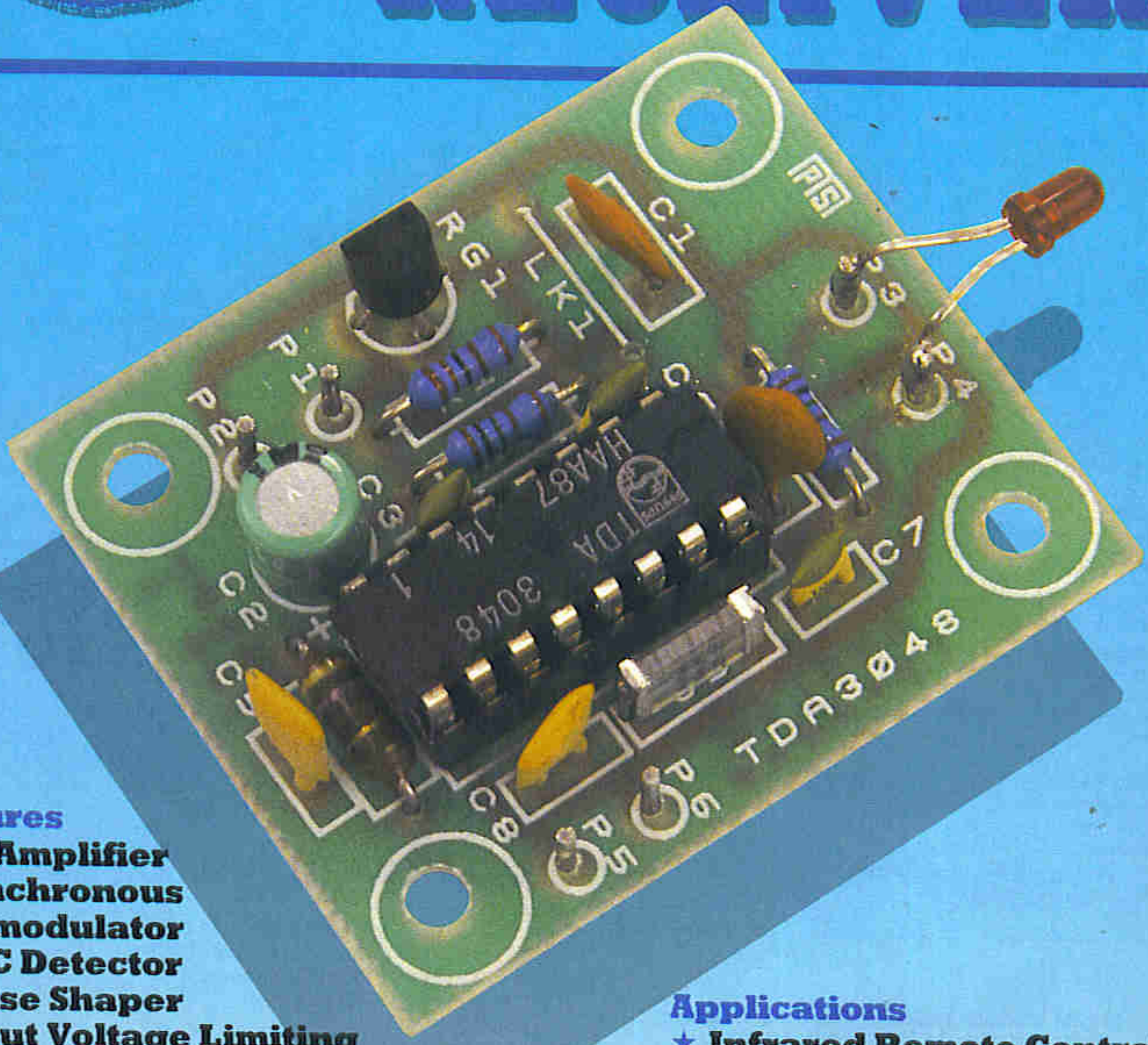
Listing 1. GW Basic/PC Keyboard Loop Test.

```
10 REM ★ Maplin Translator Test Program Two ★
20 REM ★ Link Pins 4 and 5 of PL1 ★
30 REM ★ Set S1 As Follows: ★
40 REM ★ 1 to 5 OFF ★
50 REM ★ 6 ON ★
60 REM ★ 7 and 8 OFF ★
70 KEY OFF:CLS:LOCATE 1,1
80 TX$="Maplin Serial Format Translator Loop Test."
90 ST=LEN(TX$)
100 OPEN "COM1:300,N,8,2" AS #1
110 ON COM(1) GOSUB 200
120 COM(1) ON
130 PRINT #1,""
140 REM ★ Transmit Characters ★
150 FOR T=1 TO ST
160 PRINT #1,MID$(TX$,T,1);
170 NEXT T
180 PRINT #1,""
190 GOTO 150
200 REM ★ Display Received Characters ★
210 IF LOC(1)<1 THEN RETURN
220 RX$=INPUT$(LOC(1),#1):PRINT RX$;:RETURN
```

Listing 2. GW Basic/PC Message Loop Test.

DATA FILE

TDA3048 INFRARED RECEIVER



Features

- ★ HF Amplifier
- ★ Synchronous Demodulator
- ★ AGC Detector
- ★ Pulse Shaper
- ★ Input Voltage Limiting
- ★ Low Current Consumption
- ★ PCB Available

Applications

- ★ Infrared Remote Control
- ★ Low Speed Infrared Data Reception

General Description

The TDA3048 is a complete infrared receiver, suitable for the reception and demodulation of 100% amplitude modulated signals. Typical applications include the reception of low speed data and infrared remote control. The device includes a high frequency amplifier, limiter, synchronous demodulator,

Parameters	Conditions	Min	Typ	Max
Supply Voltage		4.7V		5.4V
Supply Current			2.1mA	
Input Signal	Peak to Peak, 100% AM, Frequency = 36kHz	0.02mV		200mV
Output Signal	Output High	4.5V	4.9V	
	Output Low		0.1V	0.5V
Output Current		75μA	120μA	
Pulse Shaper Output Current				10mA
Operating Temperature		−25°C		150°C

Note: Above specification based on 5V supply and ambient temperature of 25°C.

Table 1. Typical electrical characteristics of the TDA3048.

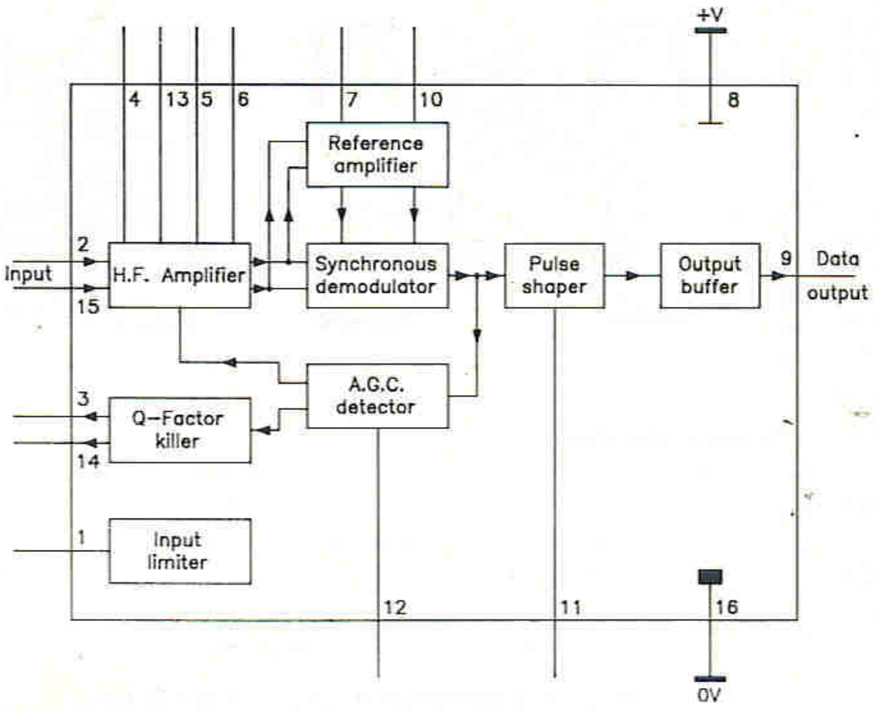


Figure 1. TDA3048 block diagram.

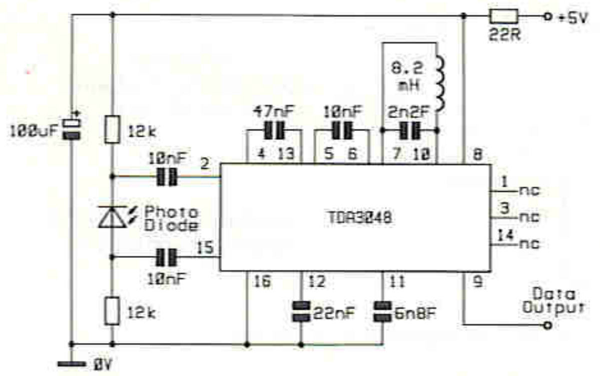


Figure 2. Typical wide-band infrared receiver.

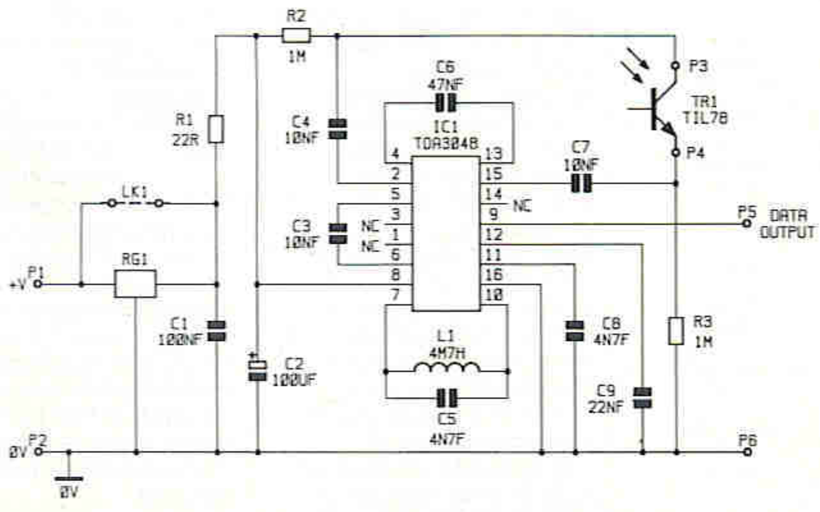


Figure 3. Circuit diagram.

AGC detector, pulse shaper and output buffer. Figure 1 shows the IC block diagram and Table 1 shows some typical electrical characteristics for the device. The device can be used in both narrow and wide-band applications; the circuit diagram of a typical wide-band infrared receiver is shown in Figure 2.

IC Circuit Description

Input signals are initially fed to a high frequency (HF) amplifier. The HF amplifier consists of three DC amplifier stages connected in cascade to give an overall gain in the region of 83dB. Gain control starts in the second stage of the amplifier and is then transferred to the first stage as the second stage limits; this helps to maintain an optimum signal to noise ratio. Two negative feedback loops are incorporated in the design to prevent excessive offset voltages in the DC coupled amplifier. After initial amplification the signal is applied to both the synchronous demodulator and the reference amplifier.

Signals from the HF amplifier and the reference amplifier are multiplied by the synchronous demodulator. The reference amplifier exhibits approximately 0dB voltage gain and effectively acts as a limiting stage. The output signal from the demodulator is fed to the AGC detector and pulse shaper.

The AGC detector consists of two NPN transistors arranged as a differential pair. Peak signals from the demodulator are detected by the AGC circuit and an internal integrator capacitor removes any noise pulses. The output from the AGC detector is amplified and fed to the 'Q-factor killer' and the first and second stages of the HF amplifier.

A separate differential pair connected in parallel with the AGC circuit comprises the pulse shaper. The output of the pulse shaper is determined by the voltage across the capacitor connected to pin 11 of the IC and this voltage is applied directly to the output buffer. The buffer incorporates a hysteresis circuit to protect against excessive voltage spikes at the output. The output voltage is typically 4.9V peak to peak and is active low.

When the device is used in narrow band applications it is necessary to reduce the selectivity of the input; this is especially the case when large signals are present. The IC incorporates a 'Q-factor killer' which can be directly coupled to the input for use in narrow band circuits.

IC Power Supply Requirements

The TDA3048 operates from a 5V DC power supply with a typical current drain of around 2mA. It is important that the supply is adequately filtered to prevent the introduction of noise into the system. High frequency decoupling should be as close to the device as possible to prevent external noise pickup.

Printed Circuit Board

A high quality printed circuit board is available for a basic, wide-band infrared receiver using the TDA3048. The circuit diagram is shown in Figure 3 and Figure 4 shows the layout. A link option is provided so that the circuit may be used with or without on-board voltage regulation. When using the module without on-board regulation, fit link LK1 (if the circuit is being used in this configuration do not fit RG1); however, if on-board voltage regulation is required, RG1 should be fitted and LK1 should be omitted. When the circuit is used without on-board regulation, the supply voltage to the module must be between 4.7V and 5.4V. If the regulation is used, the module will operate over a wide range of supply voltages between 7V and 30V.

Power supply connections are made to P1 (+V) and P2 (0V) and the demodulated data output is taken between P5 (data) and P6 (0V). Phototransistor, TR1 is connected between P3 (collector) and P4 (emitter).

The circuit is suitable for use with 100% amplitude modulated signals (a pulse or square wave modulating a carrier). A typical example of a suitable transmission format is shown in Figure 5. If a simple carrier is received (without modulation) the data output will change from high to low and remain in this state as long as the transmission is being received.

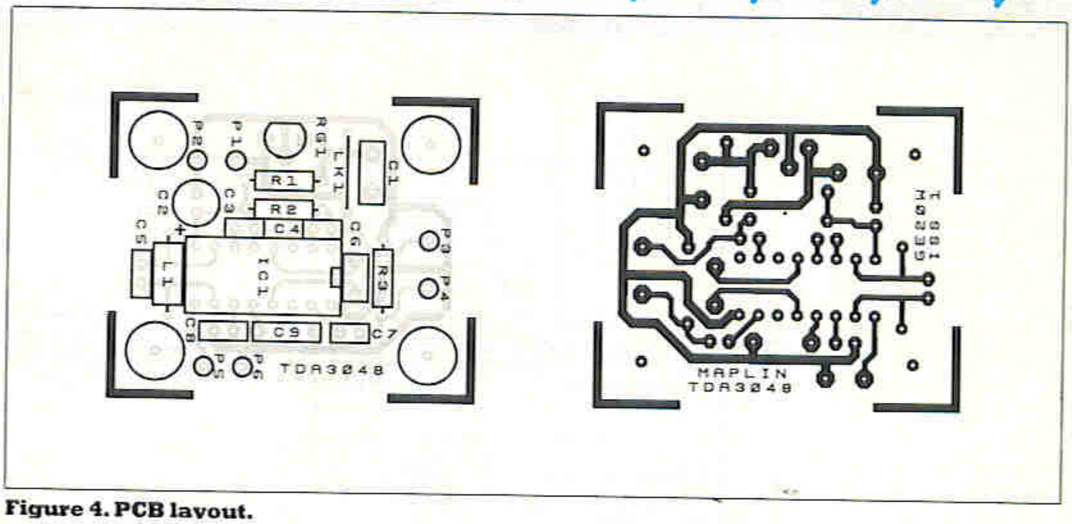


Figure 4. PCB layout.

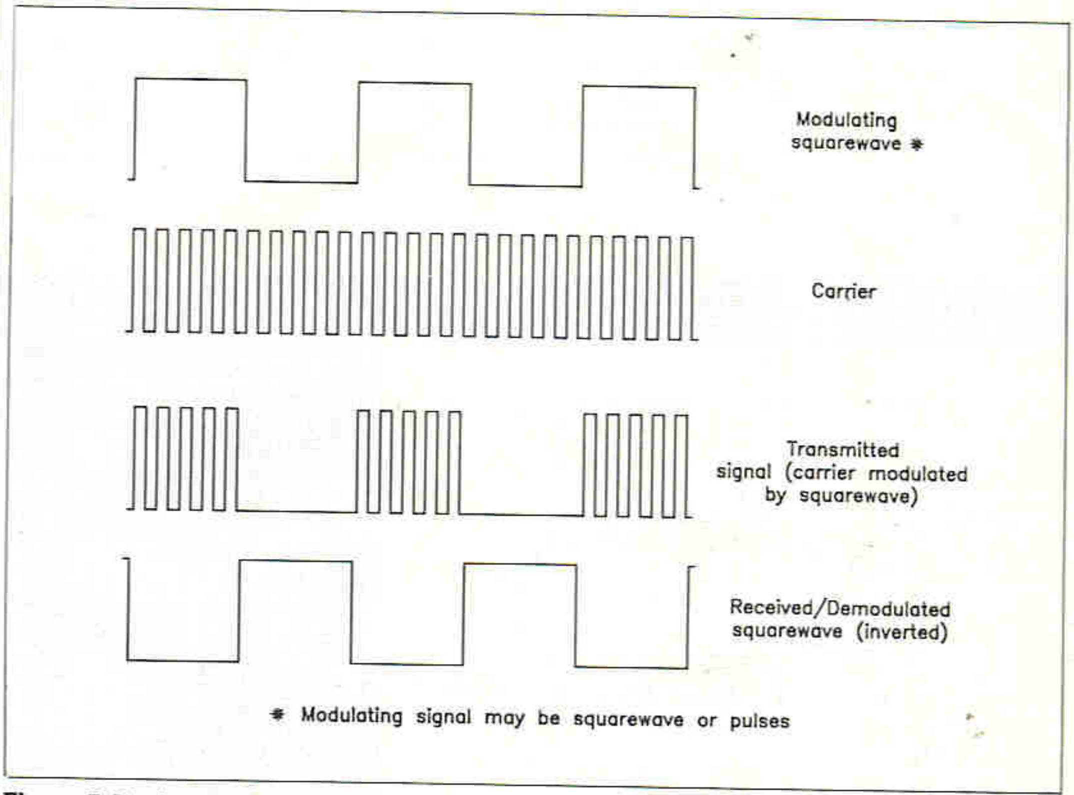


Figure 5. Typical example of a suitable transmission format.

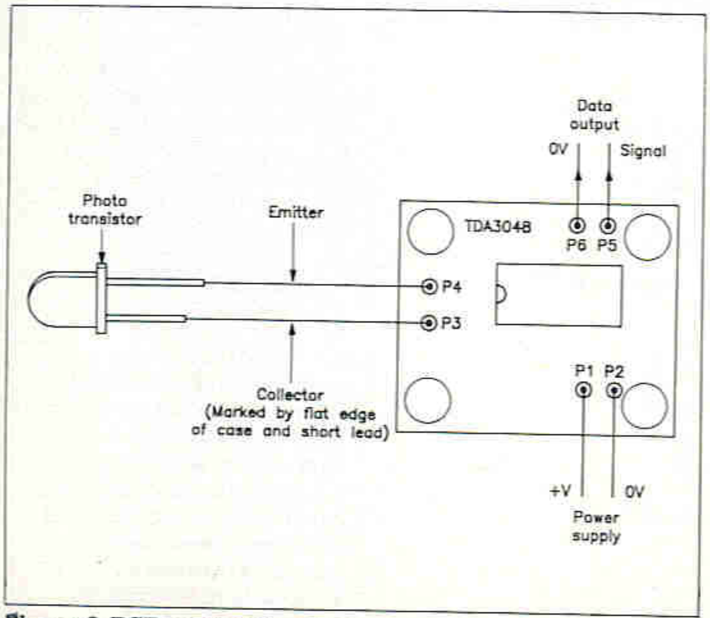


Figure 6. PCB wiring diagram.

Continued on page 47.

COMPUTERS IN THE REAL WORLD

Part 3 By Graham Dixey *C.Eng., M.I.E.E.*

Introduction

We saw in the last part of this series that signals generated in the real world to represent the quantities that we wish to measure and control are usually quite different from those that the computer requires. In short, they are analogue signals whereas the computer requires a digital input. In order to make the computer accept data that represents the input quantity, the analogue signal has to be converted into the appropriate digital form, for example, 8-bit binary. Similarly the only type of signal that the computer is able to generate directly for control purposes is a digital one. If the control device is an analogue type, as it often is, then the computer's digital output must be converted to an analogue form acceptable to the analogue controller. There are exceptions, such as stepper motors which can generate linear or rotary movement in direct response to a digital signal from the computer. The principles and applications of these will be discussed in a later article.

The two types of conversion process mentioned above are known, respectively, as: 'analogue to digital' conversion, requiring the use of an 'Analogue to Digital Converter' (ADC): and 'digital to analogue' conversion, requiring the use of a 'Digital to Analogue Converter' (DAC). There are a number of different principles involved and, hence, a variety of possible circuits for both types of converter. Some of these will now be discussed, as well as how they themselves interact with the computer in order to pass the required data back and forth.

Sampling the Input

There is a tendency in a discussion of this sort to think of the analogue quantity as being constant in value, an assumption that may well not be true. In fact, even when the quantity that is being measured and controlled is temperature, this is bound to vary somewhat even if at a very slow rate. Some quantities, such as velocity and acceleration, may vary extremely rapidly. If, at some instant in time, the analogue input is converted to a digital equivalent, all that has actually been done is to express the signal's digital value 'at that instant only'; it may well be quite different a short time interval later. Figure 1 should make this quite clear and also illustrate why the analogue input must be converted at successive instants of time so as to keep track of the varying nature of the signal.

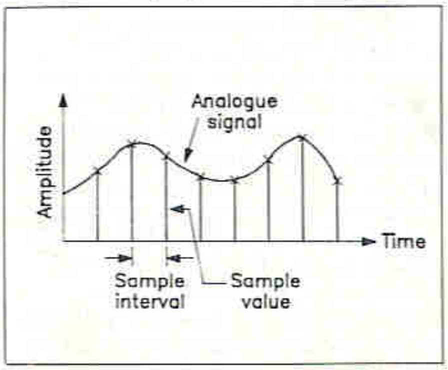


Figure 1. An analogue signal is sampled at regular instants of time, these samples being individually digitised.

Note that several conversions are made for every cycle of the input waveform; a sinewave input is shown in this figure, but the principle is correct whatever the nature of the varying analogue input voltage. This process of converting 'samples' of the input at successive times is, naturally, called 'sampling'. The more samples that are taken during the period of the input, the more accurately does the digital data represent the nature of the analogue signal. Obviously there is a limit to the number of times a signal can be sampled in any given time period; also, the higher the frequency of the analogue input, the more difficult does it become to sample it often enough.

Quantisation

Because a digital signal changes in a series of steps rather than continuously as does the signal analogue, the digital values will quite often not coincide exactly with their analogue counterparts. They will approximate to them in some degree, the closeness of the approximation being determined by the number of bits of the digital value. For example, if the converter has only four bits, there will be only 16 possible digital values. This situation is shown in Figure 2. Each of the dotted lines corresponds to a digital value being exactly equivalent to the analogue value plotted horizontally. The process of approximating to an analogue voltage in this way is called 'quantisation' and the discrete levels are called 'quantisation levels'.

The larger the number of bits, the more quantisation levels there will be and the better the approximation. For example, an 8-bit converter will have 256 quantisation levels, a 10-bit converter will have 1024 levels and so on.

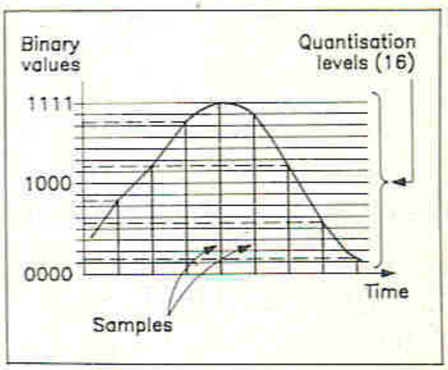


Figure 2. The heights of the samples may not always correspond exactly to a binary value; approximation then occurs.

Full Scale Range, Quantisation Levels and Resolution

A moment's thought should reveal that, since the analogue signal will always have a maximum value, this in turn must correspond to a maximum digital value. For example, an 8-bit converter may be designed so that the maximum value of the analogue input is limited to +5V. Then the lowest digital value (00000000) will logically correspond to an analogue voltage of 0V. At the other end of the scale, the full digital value of 11111111 will correspond to +5V. From this one can easily work out the analogue voltage difference between one digital value and the next, known as the 'quantisation interval'.

For example, if there are 256 quantisation levels (including zero) there will be 255 steps between them. If the full scale range of the analogue voltage is from 0V to +5V, the quantisation interval will be 5/255 = 0.0196V or 19.6mV. The practical significance of this is that it expresses how closely one can get to an accurate equivalent of the analogue input. The term used to describe this is 'resolution'. Resolution can be expressed as a fraction e.g. 1 in 255 or as a voltage as above.

It is interesting to consider what happens if an analogue signal is first put through a process that converts it into a series of digital samples and then put through the reverse process that converts these samples back into an analogue signal. Would you expect to end up with an exact replica of the original analogue signal? Figure 3 shows that this will certainly not be true, especially if the converter uses only a small number of bits. In this figure a series of digital samples of a sinewave are taken which, when converted back, produce a corresponding series of steps; this is the re-constituted analogue waveform. A quite marked difference is evident between the original and re-constituted waveforms. There is an amplitude fluctuation now that was not present in the original signal; this higher frequency variation is given the name, 'quantisation noise'.

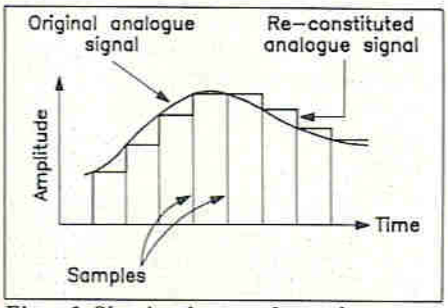


Figure 3. Showing the type of error that occurs when a digitised analogue signal is reconstituted.

Sample-and-Hold Circuits

The reason for needing sample-and-hold circuits can be appreciated by asking the question, 'how long is an instant of time?' It is rather like the old question, 'how long is a piece of string?' Obviously there is no specific answer. The relevance of this question is that any conversion process takes a finite length of time. While this conversion is taking place the signal may well be varying in amplitude. It is hardly reasonable to ask the converter to digitise a sample at a specific instant of time and then to change that value during conversion! The answer is to 'freeze' the sample prior to conversion, this process taking negligible time compared with the conversion time that follows. Then the converter does its job and produces the digitised sample, after which the analogue sample is released and a new sample frozen. The reason for calling the circuit that performs this vital task a 'sample-and-hold' circuit should now be obvious.

Figure 4 shows a sample-and-hold circuit in which an FET switch is used to connect the buffered analogue input voltage to the 'hold' capacitor during the brief duration of the sampling pulse. The hold capacitor is also buffered in order to reduce the possibility of leakage during the conversion period.

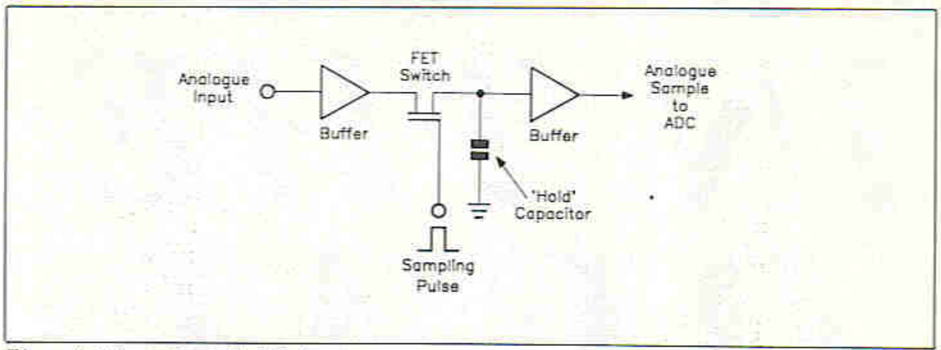


Figure 4. A 'sample-and-hold' circuit.

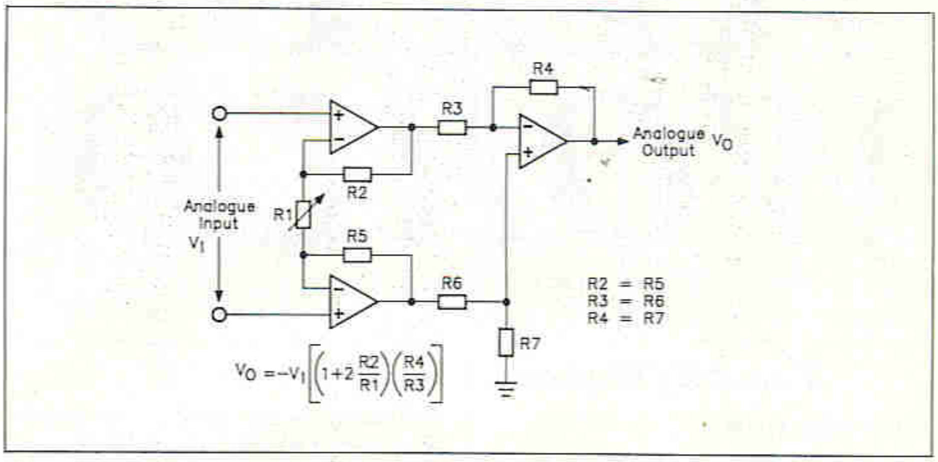


Figure 5. Typical instrumentation amplifier used to 'condition' an analogue signal prior to sampling.

Signal Conditioning

This is the term given to a process carried out on the analogue signal prior to converting it into digital form. Under this heading may be included such processes as 'linearising', 'offsetting', 'noise-reduction' and 'amplification'. Lack of space precludes a discussion of all these but Figure 5 shows a circuit for an instrumentation amplifier which will raise the signal level to that required in order to achieve the full-scale value referred to previously. Since it is a differential amplifier it will, in fact, provide the last three types of conditioning listed. The full-scale analogue voltage is related to the maximum analogue signal to be handled by the formula given in this figure. With this circuit it is feasible to obtain any voltage gain value between unity and 10,000. The resistor pairs R2/R5, R3/R6 and R4/R7 should be matched as accurately as possible. This leaves resistor R1 as the one most convenient for varying to obtain the required gain.

Multiplexed Inputs

In instrumentation applications of computers there may be a number of transducers whose outputs have to be monitored by the computer with either analysis or control to follow. A deep space probe, for example, would have many parameters to monitor and it is hardly feasible to have a separate computer for each; nor is it even necessary or desirable to provide separate ADCs, etc, for each input. What is necessary is to make each transducer link up to the computer in turn. Thus, sampling is seen at 'two levels' as it were. Not only is each analogue signal sampled continuously with respect to time, but each transducer is also sampled in turn. This process is known as 'multiplexing'. Thus, if four transducers were known as A, B, C and D, and their samples numbered as they appeared, they could be given the identities A1, B2, C3, D4, A5, B6, C7, D8, A9, etc. Figure 6 shows the idea in schematic form. The multiplexer shown in this figure contacts four switches (electronic of course) which are closed, one only at a time, in turn be a decoder circuit which is driven from a counter, the latter providing the 'channel addresses' in sequence. There isn't anything very difficult about this idea of addresses. Most likely they would just consist of the binary sequence 00, 01, 10, 11, these being easy to generate and decode.

The Converter/Computer Linkup

The object of an ADC is to provide the computer with digital data at its input/output ports. Such conversation may, however, be quite a slow process, certainly when compared with the rate at which the computer can handle data. This makes it necessary to synchronise the two rates in some way. This may be done by linking the ADC to two available input/output lines of the computer, these two lines having control functions known as START CONVERT and STATUS. These lines allow the converter and computer to perform a 'handshaking' procedure as follows.

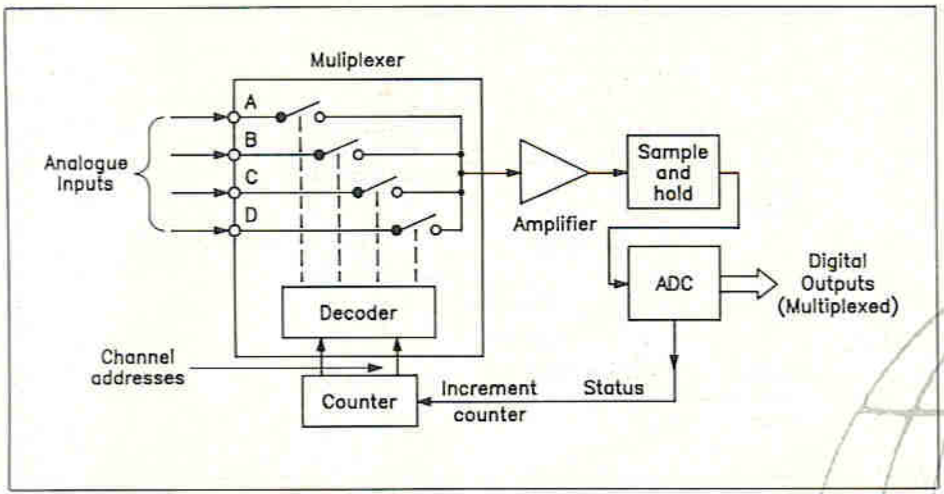


Figure 6. Multiplexing four analogue inputs is economical in terms of the hardware requirements.

The computer will initiate the conversion process by sending a pulse to the ADC, on the START CONVERT line; this is readily generated by software. At this time, when the conversion starts, the STATUS line will be taken to a predetermined logic level (either 0 or 1 depending on design) to signify that the ADC is now BUSY. At the end of the conversion process, the logic level of the STATUS line will invert to indicate that it has now returned to the READY state. The question is, 'what is the computer doing while the conversion is being carried out?'

Digital to Analogue Converters

The process of converting a digital signal to an analogue one is relatively simple, both in principle and hardware design. There are two possible methods, both being shown in Figure 7.

The method of Figure 7 (a) relies upon using resistors whose values are 'weighted' according to the columns of the binary value to be converted. Actually, the resistor values are in inverse ratio to the weightings of the binary columns, so as to produce

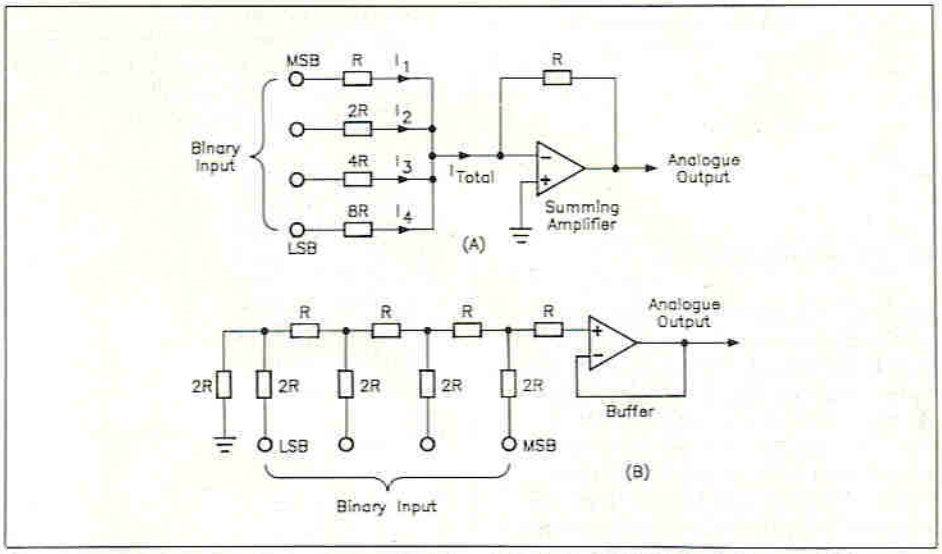


Figure 7. (a) The 'weighted resistor' type of DAC and (b) the R, 2R DAC, both shown as 4-bit converters.

There are two possibilities; either the computer is doing something else – in effect multi-tasking – or it is doing nothing, such as waiting in a loop for the READY signal to appear on the STATUS line. In the former case a special arrangement will have to be made for the computer to leave its other work at the end of conversion in order to accept the converted data. This can be done by using an 'interrupt procedure' something that will be considered in detail in the next part of this series.

The above discussion sets the background for a look at some of the variety of circuits used to convert, either way, between the analogue and digital forms of signals.

currents flowing into the junction that are in direct proportion to the column weightings. Therefore, since a 4-bit binary number is weighted 8421, the current I1 in resistor R1 is twice the current in R2, four times that in R3 and eight times that in R4, for the cases when the input is a logic 1. The output voltage V_O is proportional to the binary number input, thus achieving the required conversion. The op-amp is used as a 'summing' amplifier in this example. Although it may not be an obvious drawback, this circuit has the disadvantage of requiring a wide range of different resistor values, especially with 8-bit and 10-bit converters. This would not matter so much if the design was intended to be built discretely, but present practice is to use thin-film or thick-film resistor techniques.

The R,2R ladder network DAC of Figure 7(b) overcomes this drawback. As its name implies it uses only two different resistor values, with a simple 2:1 relation between them, no matter how many bits are converted. Only by an involved network analysis can it be shown that this circuit actually works (or by practical experiment of course!). The role of the op-amp in this case is to act as a unity gain buffer between the converter output and the analogue controller.

It should be obvious that there is little in either of the above circuits to limit their speeds. In fact, it is generally true that digital to analogue conversions are virtually instantaneous and the limitations in the system lie in the often slow speeds of the analogue to digital converters.

Analogue-to-Digital Converters

There is an interesting variety of circuits for the reverse process of analogue to digital conversion. A few of these will show how varied these principles are.

The Continuous Balance ADC

The schematic circuit for this type is shown in Figure 8.

This circuit contains a DAC within the loop, normally of the R,2R type. The function of the control circuit is to gate clock pulses to the input of the counter/register section. The latter is just a binary counter with the output buffered by a register which may have parallel or serial output (parallel shown in this case). The 'state' of the control circuit, that is whether it enables or disables the counter input pulses, is determined by the output voltage V_C from the comparator. There are two analogue inputs to the comparator, (i) the voltage V_{IN} to be converted and (ii) the output from the DAC V_P, this being the analogue equivalent of whatever binary value the counter is holding.

Assume that, initially, the counter/register has been cleared by the START CONVERT pulse; the output from the DAC is obviously zero ($V_P = 0$). Assume that a voltage V_{IN} is present that is to be converted. Therefore, $V_{IN} > V_P$ and V_C 'enables' the counter which begins to count up. The output from the DAC rises in a series of small steps as the counter value increases, until there comes a point where $V_P - V_{IN}$ and then just exceeds it. The output of the comparator V_C switches to the opposite polarity and 'disables' the counter, which then stops. The comparator output would also provide the STATUS level output to the computer. The binary value held by the counter/register is the equivalent of the analogue input. The process would repeat on receipt of a new START CONVERT pulse.

This is one of the slower types of converter. The length of the conversion process depends upon the size of the analogue input. For an analogue input voltage equal to the full scale input, the counter has to count up to its limit. An N-bit counter needs $(2^N - 1)$ clock cycles to complete the conversion. An 8-bit counter using a 1MHz clock would take $(2^8 - 1)$ microseconds, = 255μs to convert the largest input voltage.

The Dual-Slope ADC

This type of converter, shown in Figure 9, is used frequently in digital voltmeters, but is also used in computer input circuits. It does not make use of a DAC in contrast with the previous type.

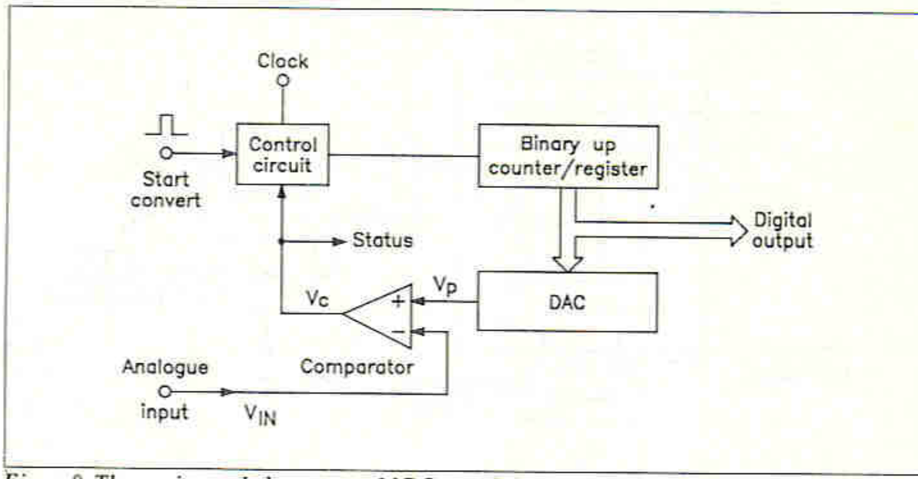


Figure 8. The continuous balance type of ADC containing a DAC within the conversion loop.

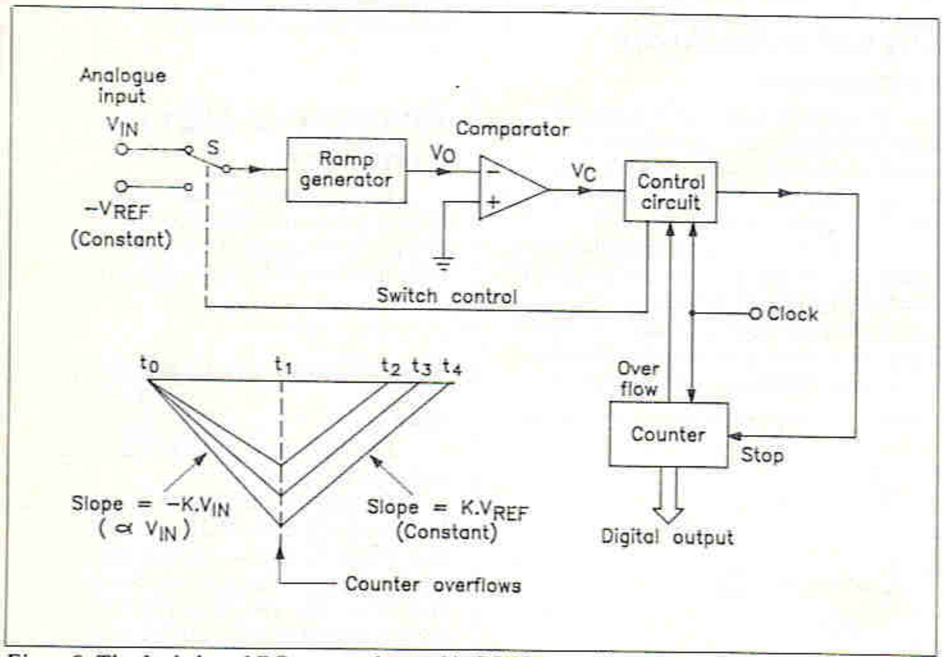


Figure 9. The dual-slope ADC, a type also used in DVMs as well as computer inputs.

To start the conversion process the switch S (an electronic one) is set to select the analogue input voltage V_{IN}; at this instant, referred to on the graph as t_0 the output V_O from the ramp generator is 0V, as a result of which the comparator output is such as to enable the counter via the control circuit; the latter, also starting from zero, commences an up-counting sequence. While this is happening the output of the ramp generator is a voltage of negative slope, this slope being equal to $-K.V_{IN}$. Eventually, the counter will reach its maximum value and, with one more clock pulse, will overflow. This latter event is detected by the control circuit which immediately switches S over to select the $-V_{REF}$ input.

Considering this instant in time when the counter has just overflowed, termed t_1, the ramp voltage has a value that is directly proportional to V_{IN} and the contents of the counter are, of course, zero. From this point in time two events commence simultaneously.

The counter begins to count up again and the output of the ramp generator rises in a positive direction, this time with a slope $K.V_{REF}$. When the ramp generator output reaches 0V the output of the comparator will invert and cause the control unit to disable the counter. The binary value held by the counter is directly proportional to the time taken for the ramp to return to zero. Since the rate at which it does so is always constant it follows that the time taken to return to zero depends upon the value of the negative voltage from which it started. Hopefully it is obvious that the latter in turn depends upon the value of V_{IN} the analogue input – hence the relation between the latter and digital output.

This type of converter suffers from the same speed limitations as the continuous balance type for the same reasons.

The Successive Approximation Register ADC

The SAR type of converter represents an ingenious way of obtaining high speed of operation without great complexity. It is an example of another type that makes use of a DAC. The schematic diagram is shown in Figure 10.

The principle is quite simple. The converter makes a 'guess' at the value of the binary number required and then makes a series of successive approximations, by a totally logical procedure, until it gets it right. A voltage comparator is used to signal when this state has been achieved. An example will make this quite clear. Suppose that the actual binary value required for an 8-bit converter is 10011011 (which of course we don't know at the moment!). The converter always makes the same guess at first, this being the mid-range value of the binary number, in this case 10000000. The comparator tells the SA logic that this guess is too low so the next Most Significant Bit (MSB) is set, giving 11000000. This is clearly too large now, so the second MSB is take out again and the next MSB set, and so on. The sequence will look like this.

Clock Pulse SAR Contents

Comparator Results.
1 10000000 Too Low
2 11000000 Too High
3 10100000 Too High
4 10010000 Too Low
5 10011000 Too Low
6 10011100 Too High
7 10011010 Too Low
8 10011011 Correct

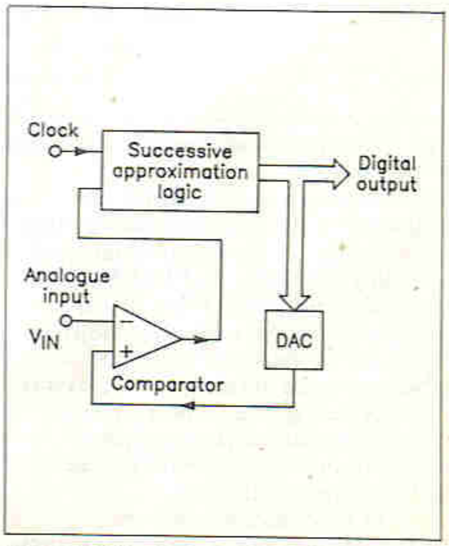


Figure 10. The Successive Approximation Register (SAR) type of ADC, offering a considerable speed advantage over the counter-based types.

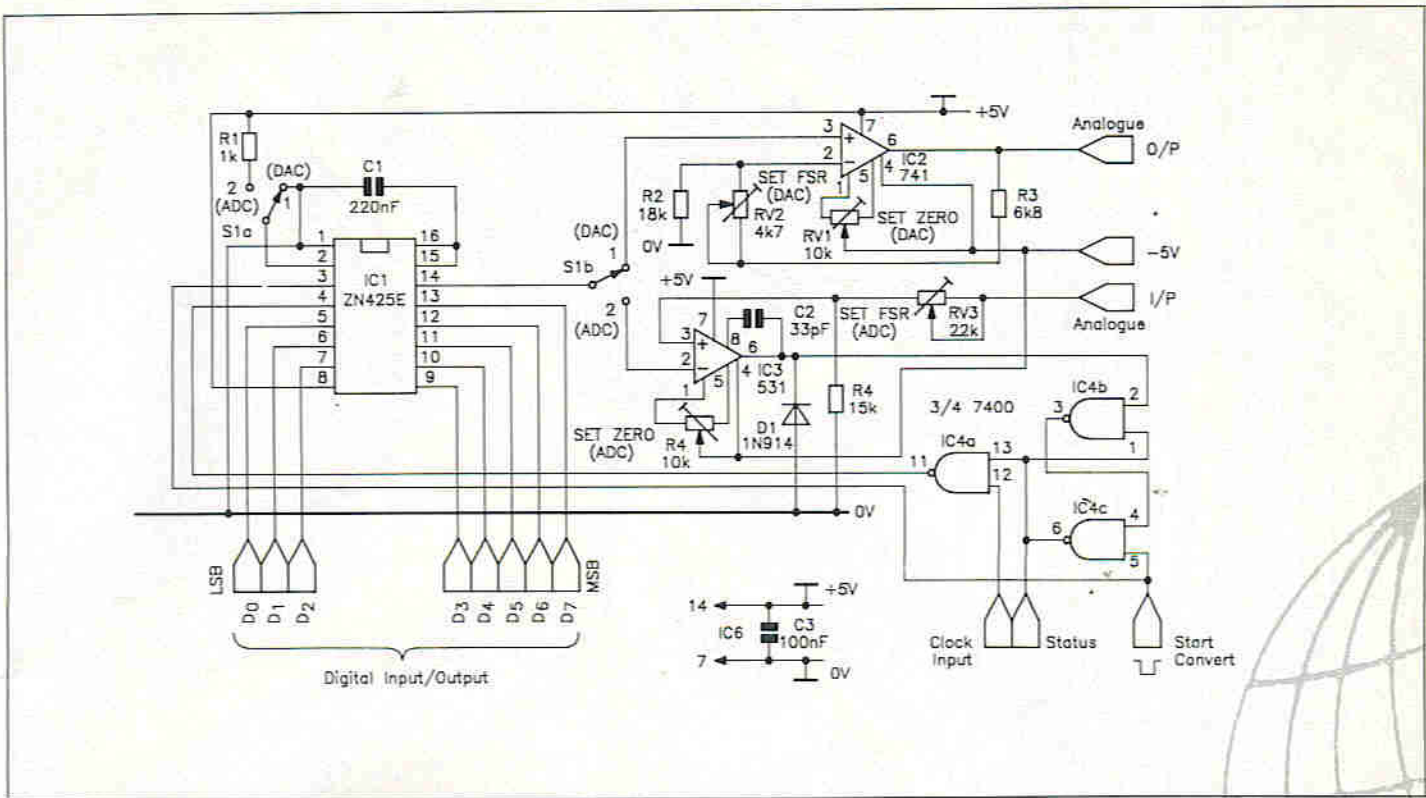


Figure 11. A design for a switched ADC/DAC using the ZN425E converter IC.

One thing that should be evident immediately is that it only took eight clock pulses to carry out the complete conversion. Some conversions will, of course, take less but none will ever exceed N, the number of bits being converted.

To emphasise the matter of speed once more, consider 12-bit converters of the continuous balance and SAR types, both using a 1MHz clock.

The maximum conversion time for the continuous balance ADC works out at $(2^{12} - 1)\mu s$, which is $4095\mu s$. By comparison the same conversion carried out by the SAR type would take just $N\mu s = 12\mu s$!

The hardware for this type of converter can be reduced by using machine code software to run the successive approximation process.

A Practical ADC/DAC Circuit

The ZN425E IC is a versatile converter chip that can be configured a either a DAC or an ADC. By simple switching it is possible to give it a dual role, though it cannot, of course, be used as both types of converter at the same time. The full circuit arrangement is shown in Figure 11. Set-zero controls and full-scale range controls are provided independently for the two halves of the converter. A negative going START CONVERT pulse is required. The STATUS output is 'high' during conversion and goes 'low' at the end of the conversion process to indicate valid data. A full parts list is included but it is left to the reader to devise his own layout.

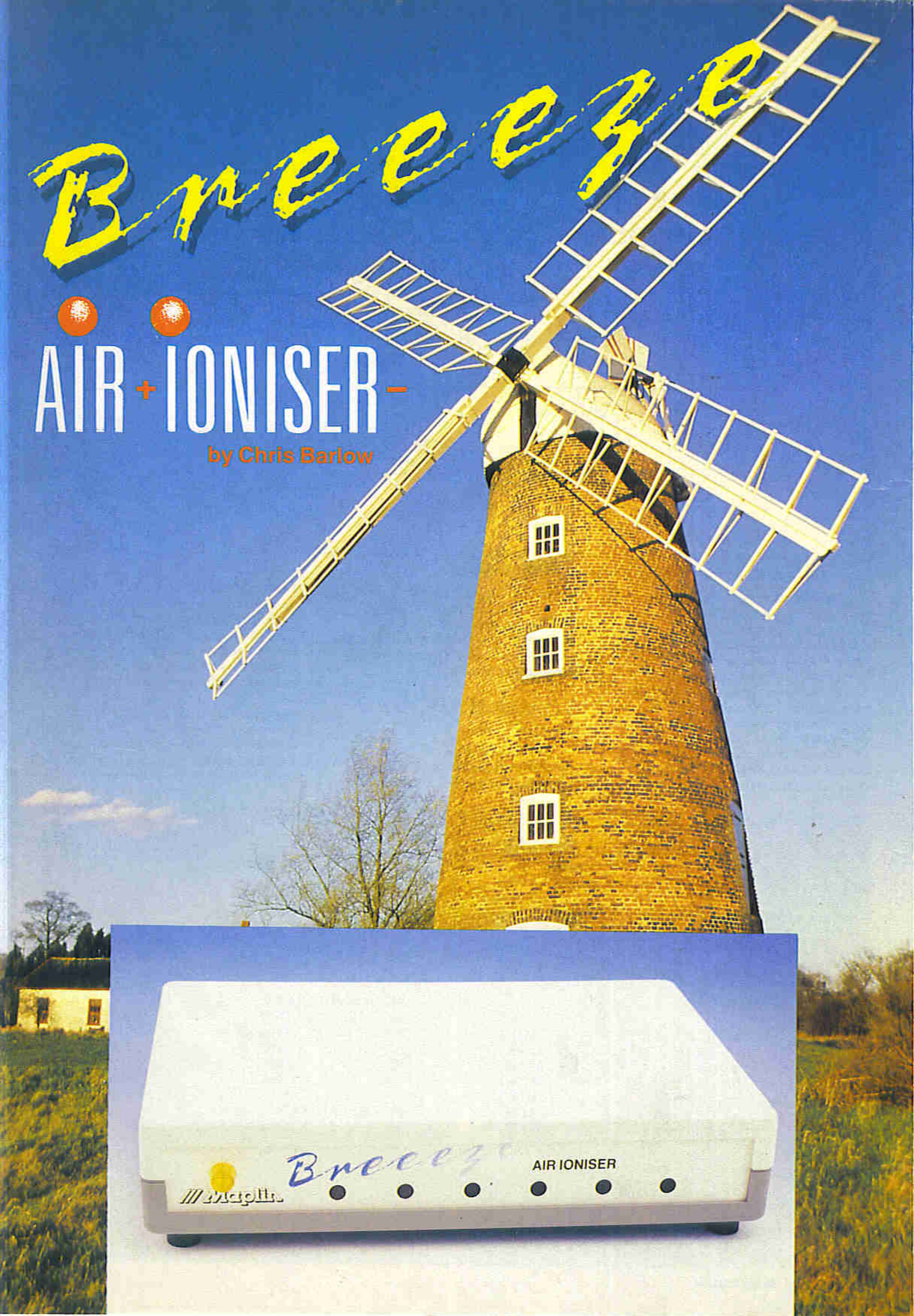
PARTS LIST FOR ZN425E SWITCHED ADC/DAC

RESISTORS		
R1	1k	(M1K)
R2	18k	(M18K)
R3	6k8	(M6K8)
R4	15k	(M15K)
RV1,RV4	10k Preset	(UH16S)
RV2	4k7 Preset	(UH15R)
RV3	22k Preset	(UH17T)
CAPACITORS		
C1	22nF Polylayer	(BX78K)
C2	33pF Mica	(WX07H)
C3	100nF Disc Ceramic	(YR75S)
SEMICONDUCTORS		
D1	1N914	(QL71N)
IC1	ZN425E	(UF38R)
IC2	741C	(QL22Y)
IC3	NE531	(WQ54J)
IC4	7400	(QX37S)
MISCELLANEOUS		
S1	Ultra Min Toggle	(FH99H)

Breeeze

AIR + IONISER –

by Chris Barlow



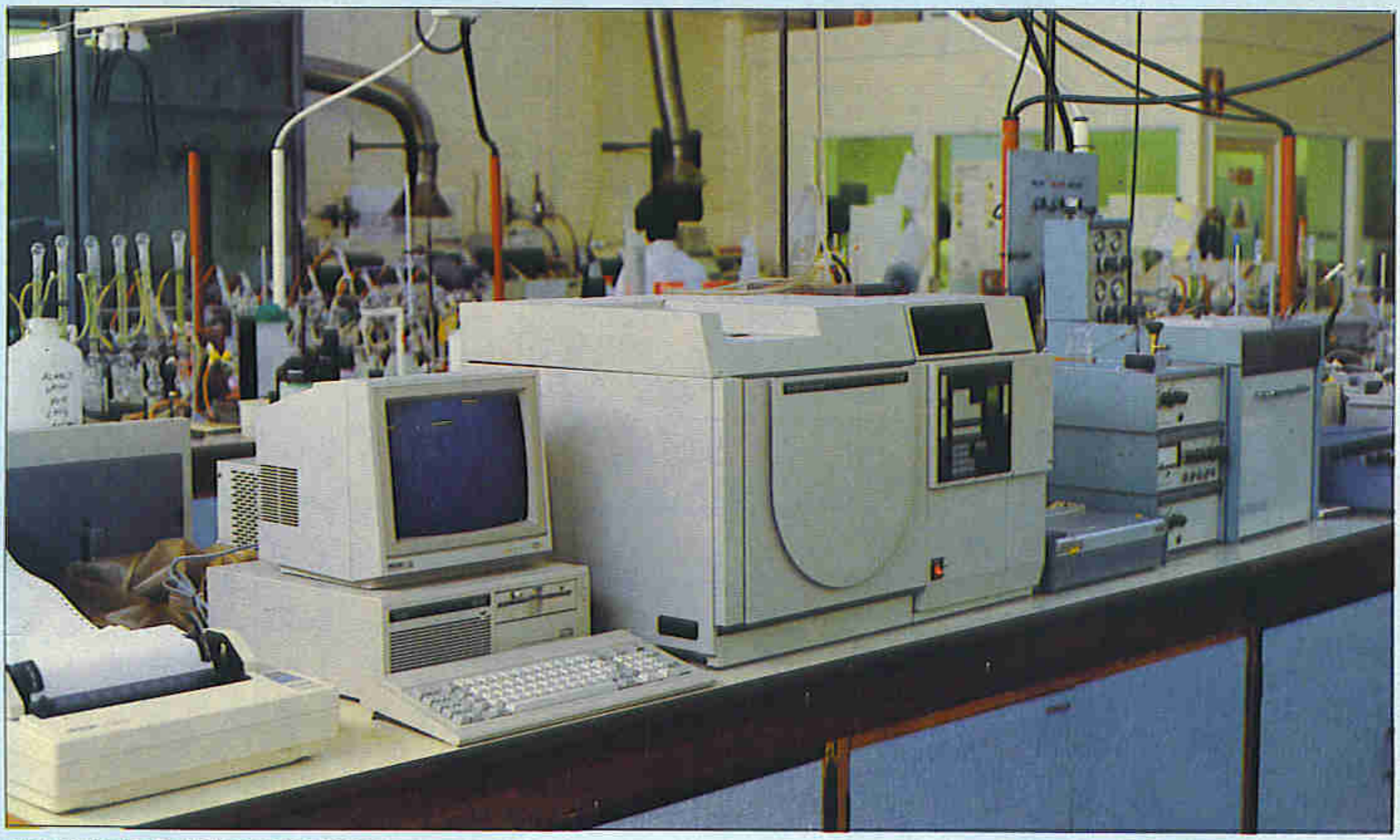


Photo 1. Inside Berridges Laboratories.

- Safety tested
- Simple construction
- Minimal wiring
- Built-in ion blinker

Introduction

In todays home environment an imbalance of ions will occur when electronic equipment is used, or synthetic materials are present. Televisions use a very high positive voltage to produce the picture and positive ions are liberated at the same time. Negative ions are generated naturally by the suns rays, wind, rain and lightning. However they have a very brief life when in the presence of synthetic materials or air pollution. To restore this ion imbalance negative ions can be electronically generated by using an air ioniser.

Safety

As this project generates very high voltages it is not recommended for absolute beginners. To maintain electrical safety the completed PCB assembly must be housed in the plastic box supplied in the kit.

When ions are generated, ozone will also be produced and under certain conditions, oxides of nitrogen may occur. To ensure the safety of the Maplin ioniser it was extensively tested by Berridge Environmental Laboratories Limited of

Electrical Specification of Prototype

DC input voltage:	+7V to +14V
DC current at +12V:	45mA
DC EHT output voltage:	−3.7kV to −6.6kV
EHT out at +12V in:	−6kV

Environmental Specification of Prototype

Ozone output:	Significantly less than Health and Safety Executive Guidelines at time of testing
Oxides of nitrogen:	None detected

Mechanical Specifications

Box material:	Two-tone grey high impact ABS
Box dimensions (WHD):	205 x 40 x 140mm
PCB material:	Single-sided fibre glass
PCB dimensions:	168 x 130mm
Max component height:	20mm
Needles:	Stainless steel
Ioniser weight:	432g

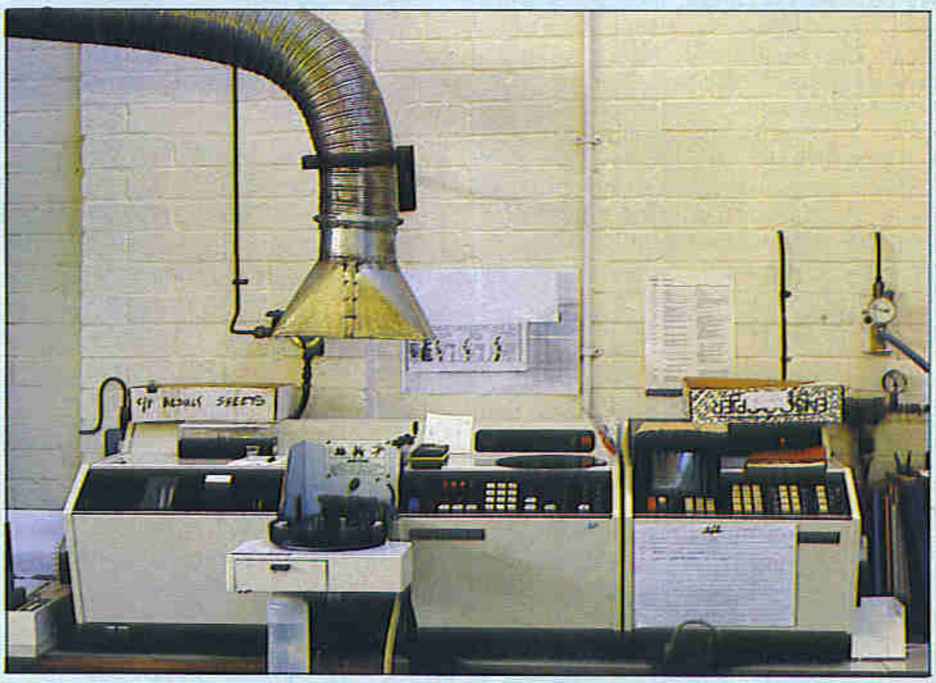


Photo 2. Inside Berridges Laboratories.

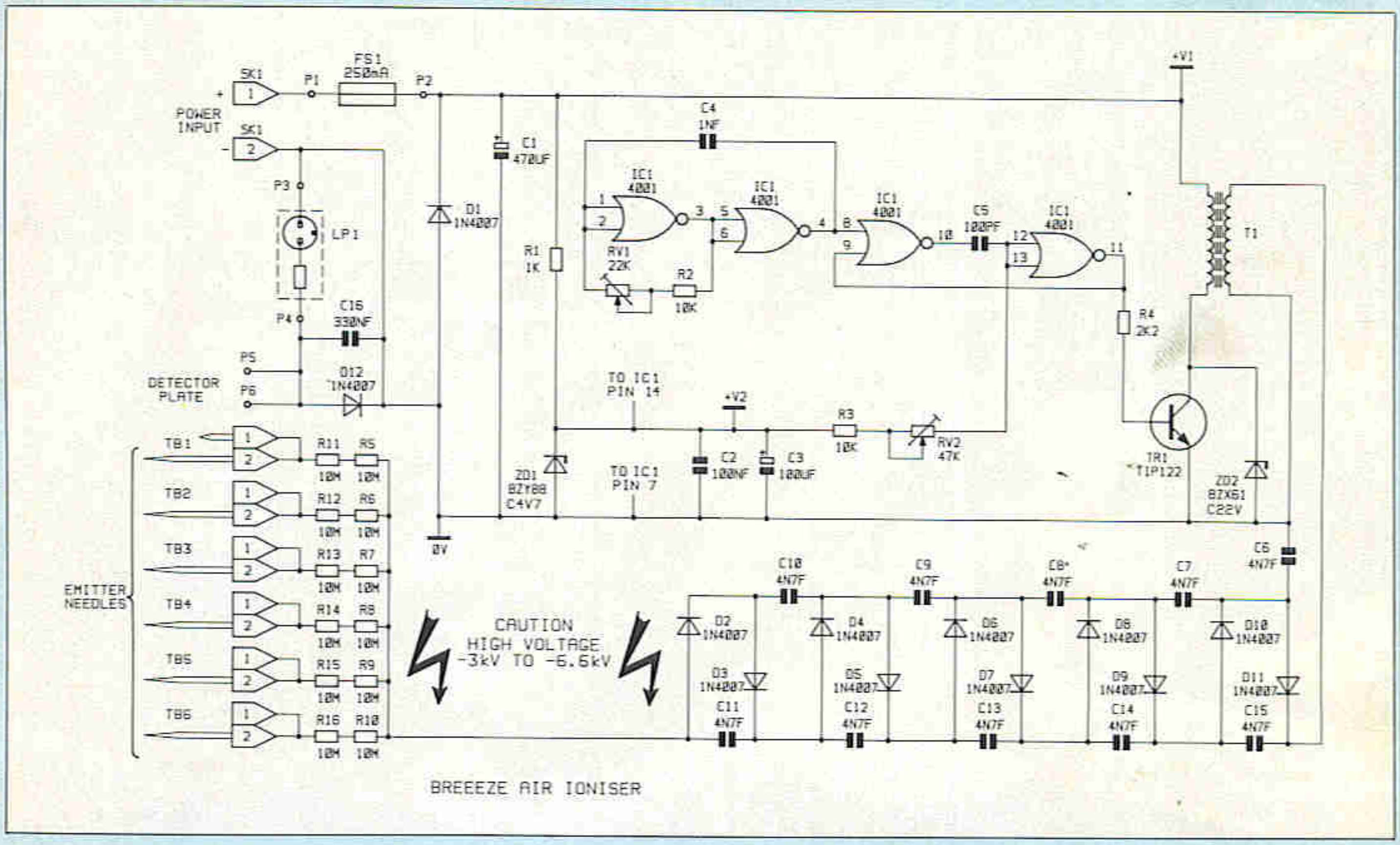


Figure 1. Circuit Diagram.

Chelmsford, Essex. Their well equipped laboratories have all the modern analytical instruments required to provide a comprehensive series of tests, see Photos 1 and 2.

The ioniser was placed in a sealed box provided with an inlet and an outlet. Using a small pump, air was drawn through the box and then through two midget impinger bubblers in series, each containing a reagent to trap any ozone or oxides of nitrogen, see Photo 3. It was found that no oxides of nitrogen were produced and the quantity of ozone was at a low level unlikely to be detrimental to health. The Health and Safety Executive issue guidelines for the amounts of a wide range of chemicals which can be present in the atmosphere without known detriment to health. The small amount of ozone produced will react with the environment and be further reduced by normal room ventilation. Therefore, under normal conditions the ioniser can be used continuously without large concentrations of ozone building up.

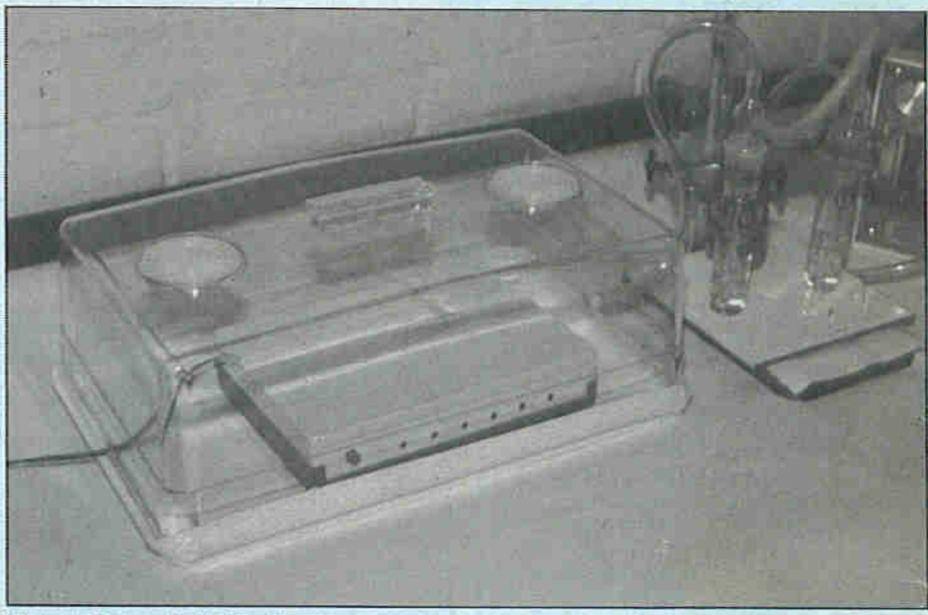


Photo 3. Ozone Test Experiment.

Circuit Description

A circuit diagram of the ioniser is shown in Figure 1 and it should assist you when following the circuit description or fault finding in the completed unit.

The DC power is applied to a 2.5mm PCB mounted socket, SK1, with the positive voltage on the centre pin and the negative to its side terminal. This supply must be within the range of 7V to 14V and have the correct polarity, otherwise diode D1 will forward conduct blowing the 250mA fuse FS1. This action will protect the semiconductors and polarised components, thus preventing damage.

Capacitor C1 provides the main supply decoupling on the $+V_1$ rail to the switching transistor TR1. Resistor R1 and zener diode ZD1 form a stabilised +4.7V supply, which is then decoupled by C2 and C3 providing a clean $+V_2$ to the integrated circuit IC1.

IC1 contains four identical circuits, two parts are used as an oscillator with the other two forming a pulse width controller. The frequency of the oscillator is set by the RC time constant of C4 and preset RV1, with R2 limiting the range of RV1. The output signal on pin 4 is a 1:1 square wave with a frequency of approximately 30kHz. However, before it drives the switching transistor TR1 its pulse width must be altered to achieve maximum voltage converter efficiency. This is done by setting up a time constant using C5 and preset RV2, with R3 limiting the range of RV2. Under normal conditions the switching pulses on pin 11 should have a duration of approximately 2μs, see Photo 4.

The output of IC1 passes via R4 to

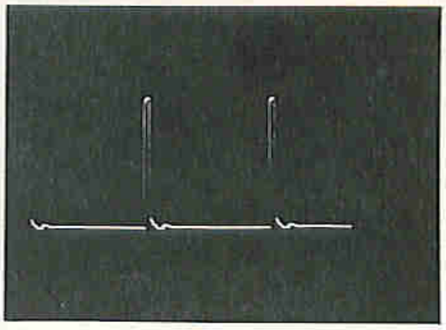


Photo 4. Oscilloscope Trace, Output pulse.

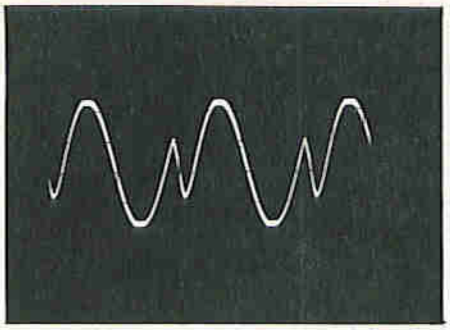


Photo 5. Oscilloscope Trace, Off Tune.

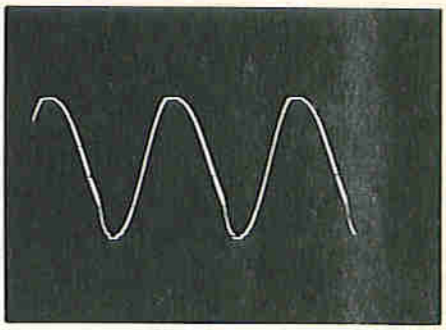


Photo 6. Oscilloscope Trace, On Tune.

the base of TR1, causing it to conduct on each 2μs pulse. This switching action pulls a current through the low impedance primary winding of T1, the resonant effect on the switching pulse can be seen in Photos 5 and 6. As can be seen from the oscilloscope traces the signal now resembles a very distorted sine wave when off tune and a cleaner one when at resonance. The amplitude of this signal is restricted by a 22V zener diode, ZD2, which limits the maximum output voltage of the ioniser and protects TR1 from any excessively high voltage spikes. T1 provides a voltage step-up of 60:1, so the 22 volts on the primary is transformed to 1320V AC peak-to-peak on the secondary.

The high voltage AC must be rectified and voltage multiplied to produce the final Extra High Tension (EHT) output of −3kV to −6.6kV. The voltage rectifier-multiplier circuit is of the classic Cockcroft-Walton configuration; where the output of each half wave rectifier, D2 to D11, is connected to the input of the next, along with the AC passing through a series of high voltage capacitors (C6 to C15). The negative EHT output is fed to six long and one short emitter needles via twelve 10MΩ high voltage resistors R5 to R16. Each long needle has two 10MΩ resistors in series with it to limit the current if a needle is accidentally touched.

The shorter needle is used to project a stream of negative ions at the detector plate (attached to P5 and P6). D12 ensures that only a negative voltage can build up across C16 and when it reaches approximately −70V, the neon indicator LP1 will light. This will discharge C16, and as the falling voltage reaches the extinguishing point of the neon, it ceases conducting. This action results in a series of brief flashes, the rate of which is directly related to the charge flow from the short emitter needle.

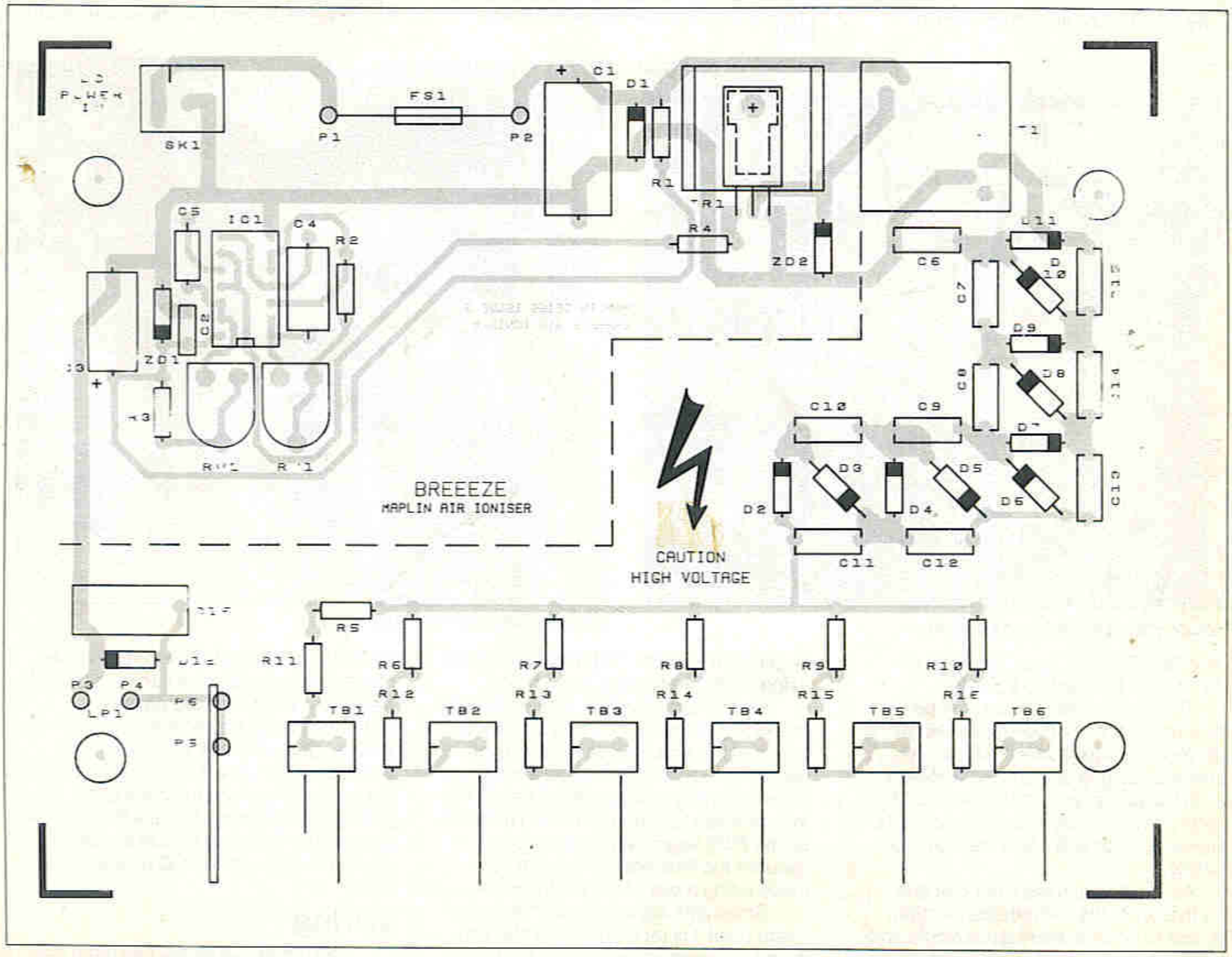


Figure 2. PCB Track and Legend.

PCB Assembly

The PCB is a single-sided fibre glass type, chosen for maximum reliability and electrical stability. However, removal of a misplaced component is quite difficult so please double-check each component type, value and its polarity where appropriate, before soldering! The PCB has a printed legend to assist you in correctly positioning each item, see Figure 2.

The sequence in which the components are fitted is not critical. However, the following instructions will be of use in making these tasks as straightforward as possible. It is usually easier to start with the smaller components, such as the resistors. Next mount the disc ceramic, polystyrene, polyester and electrolytic capacitors. The polarity for the electrolytic capacitors is shown by a plus sign (+) on the PCB legend. However, on most capacitors the polarity is designated by a negative symbol (−), in which case the lead nearest this symbol goes away from the positive sign on the legend. When fitting the 14 pin IC socket ensure that you match the notch with the block on the board. Ensure that the terminal blocks have their openings facing the front edge of the PCB before soldering them in place, see Photo 7. Next install the six pins at the sites marked P1 to P6.

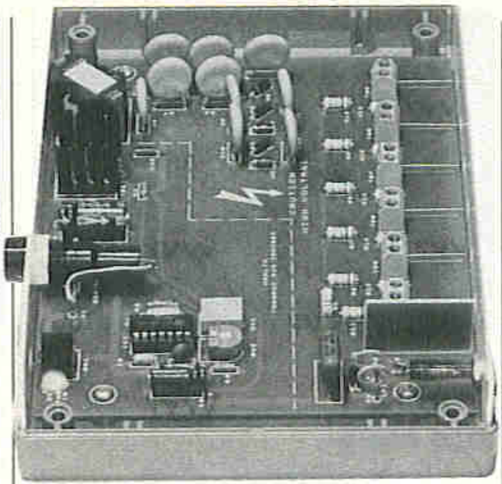


Photo 7. The Completed PCB.

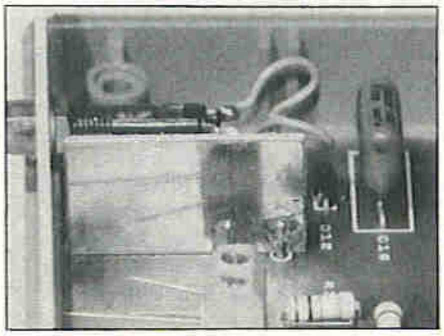


Photo 8. The Short Needle and Detector Plate.

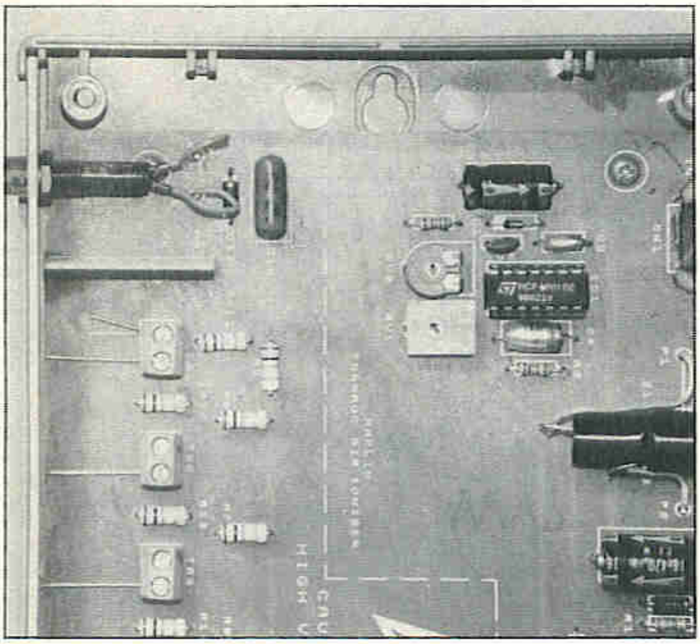


Photo 9. Wiring to the Neon Indicator.

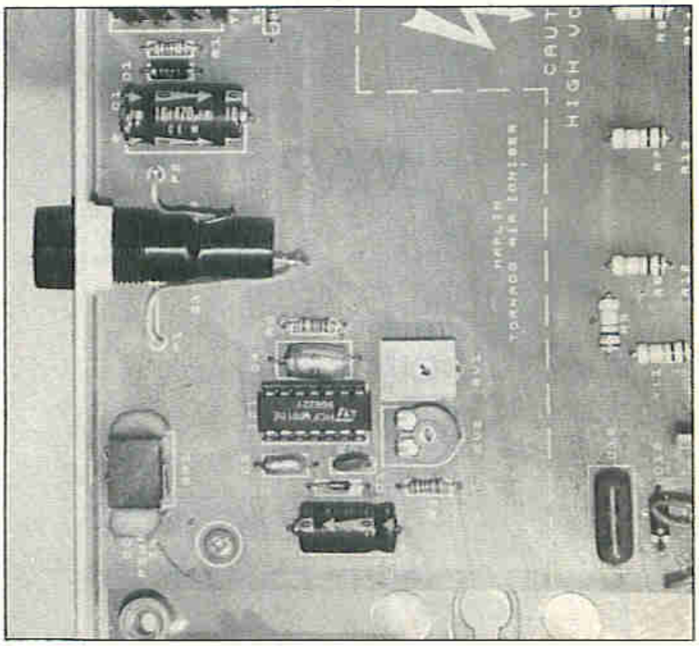


Photo 10. Wiring to the Fuse Holder.

The transformer T1 can only be fitted one way and once soldered in place additional bonding to the PCB can be achieved using epoxy adhesive. When you fit the DC power input socket, SK1, epoxy adhesive may also be used on its sides to provide additional mechanical stability.

All the diodes have a band at one end to identify the cathode connection. Be sure to position them accordingly and double check the zener diodes for the correct voltage rating. Next install the switching transistor TR1 and its heatsink using the M3 hardware, see Photo 7.

Referring to Photo 8, solder the PCB detector plate to pins P5 and P6 making sure that it is mounted vertically. Then secure the short emitter needle in TB1 so it points slightly towards the plate. All the long needles face forward along the lines on the PCB legend and when tightly secured the final positioning can be made using a pair of long nose pliers.

Since ions will be ejected from any sharp point it is recommended that you cut all the component leads in the high voltage section of the board as short as possible and use enough extra solder to form a neat, rounded joint.

This completes the assembly of the circuit board and you should now check your work very carefully making sure that all the solder joints are sound. It is also VERY IMPORTANT that the low voltage section of the PCB does not have any trimmed component leads standing proud by more than 3mm, as this may result in a short circuit. Further information on soldering and assembly techniques can be found in the 'Constructors Guide' included in the Maplin kit.

Final Assembly

Due to the high voltages generated by the ioniser which can remain even when the unit is switched off, it is imperative that the PCB assembly is housed in the plastic box supplied in the Maplin kit. This is a two-tone grey 'Verobox' moulded in high impact ABS with anodised aluminium front and rear panels. IMPORTANT NOTE: Discard the aluminium panels!

Supplied with the box are four of the following: Self-tapping screws, long bolts and plastic feet.

The PCB has four fixing holes which will only line up one way with the pillars in the dark grey half of the box. Using the four self-tapping screws secure the PCB assembly. Next, slot into position the pre-drilled white plastic front and back panels. Check that all six holes in the front panel line up with the long needles, then mount the neon indicator LP1. Finally, before fitting the fuse holder ensure that the small hole in the back panel lines up with the DC power socket SK1.

Wiring

The amount of wiring has been kept to a minimum by having only two off

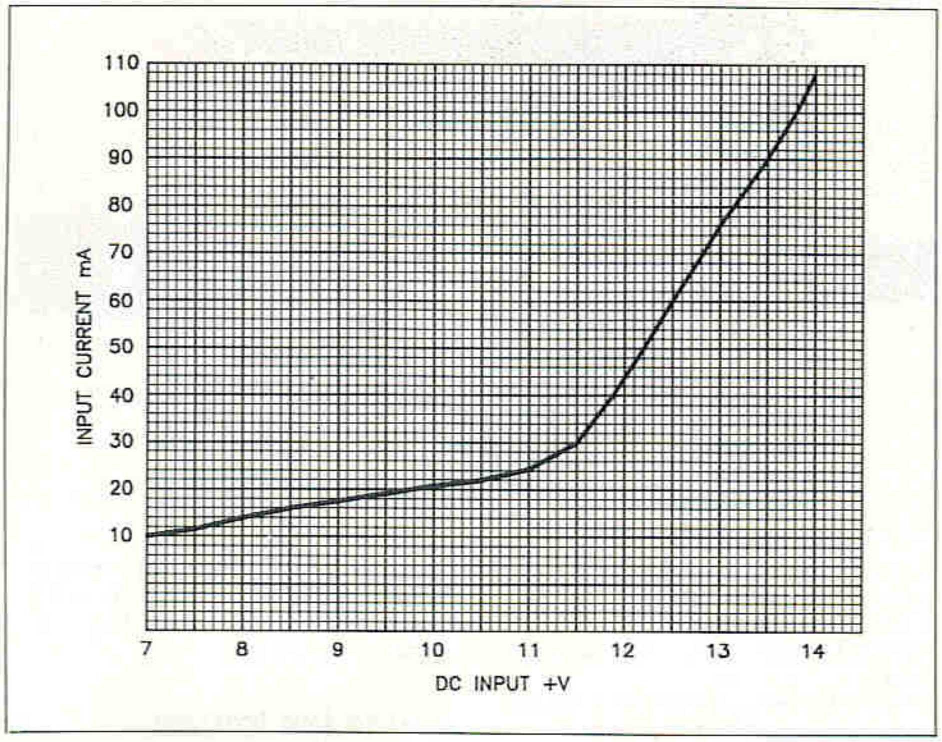


Figure 3. Power Input Characteristics.

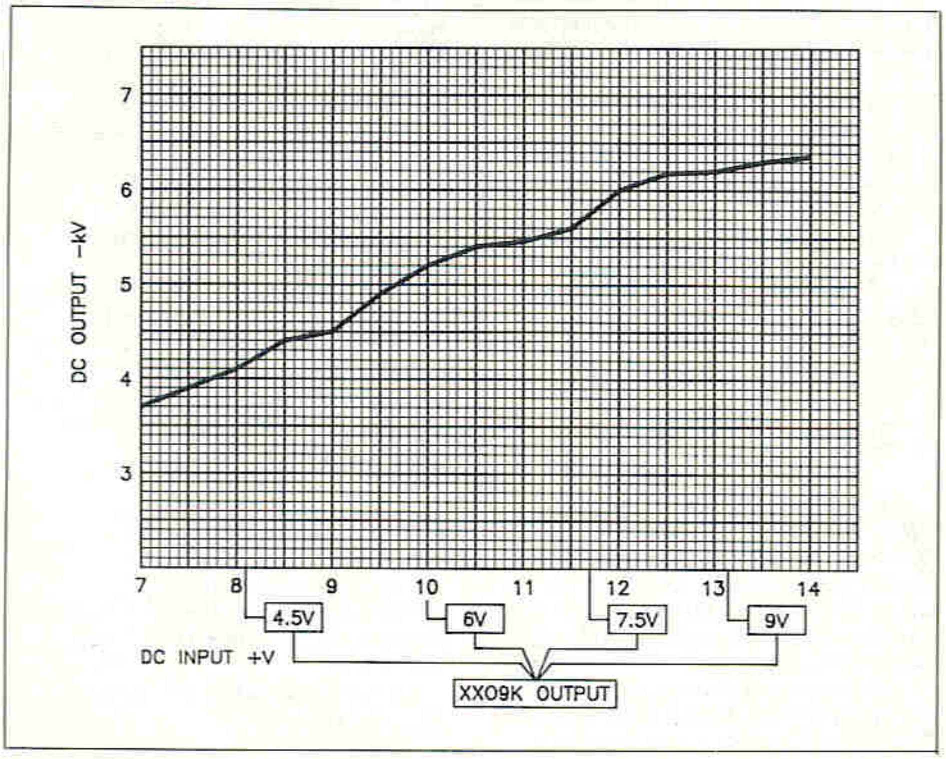


Figure 4. EHT Output Characteristics.

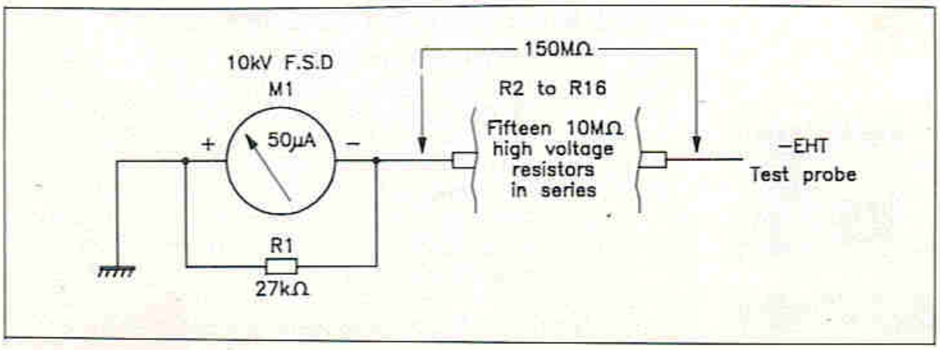


Figure 5. EHT Test Meter Circuit.

board components. Included in the Maplin kit is a one metre length of coloured hook-up wire, which should be ample to make up the following:

1. Cut two 30mm lengths and remove 4mm of insulation from each end. Next twist together the strands and tin them with solder. The neon indicator can be wired either way round to P3 and P4, see Photo 9.

2. Cut one 40mm and one 30mm length of wire and remove 4mm of insulation from each end. Next twist together the strands and tin them with solder. Using the 40mm length of wire, solder it to the end terminal of the fuse holder and P1. The 25mm length goes between the side terminal and P2, see Photo 10.

IMPORTANT NOTE: Do not fit the 250mA fuse FS1!

Testing and Alignment

All the low voltage DC tests can be made using a minimum of equipment. You will need a digital or analogue multimeter and a +12V power supply capable of providing up to 250mA. High capacity batteries and mains adaptors can be used remembering that the supply must not fall below +7V or exceed +14V. To provide the continuous current supply over a long period a 12V car battery is preferable if no mains adaptor is available. The adaptor can be either the regulated, or unregulated 300mA type (stock code YB23A or XX09K). When using the UNREGULATED XX09K the switched output settings should not be taken seriously as the output voltage will vary as the load changes. Before using the XX09K adaptor you should set the V CHANGE switch to 7.5V and ensure that the plus sign on the DC output lead is facing the plus symbol on the case (REV CHANGE). In addition, you should remove the four way multiplug replacing it with the standard length 2.5mm power plug included in the Maplin kit. When fitting this plug ensure that the marked positive lead goes to the inner connection and the negative goes to the outer body terminal (if in doubt, confirm polarity with a multimeter). Before commencing the tests set the two presets RV1 and RV2 to their half way position.

The first test is to measure the resistance on the power input pins P2 and P3. Set your digital meter to read ohms on its 2k (Diode Test) range. With the red lead on P2 and the black one on P3 a reading greater than 2k should be present. When the test leads are swopped over a reading of approximately 500 ohms should be observed. However, this test condition may be reversed when using an analogue multimeter.

Next select a suitable range on your meter that will accommodate a 300mA DC current reading. With no fuse fitted at FS1 place the red test lead on P1 and the black lead to P2. When you connect the power to the ioniser extreme caution must be observed when handling the PCB. This is because of the high voltages generated by the circuit and although there is not enough power to cause any permanent damage it can give quite a nasty jolt even when the supply is removed. To render the unit safe, this stored charge must be dumped to ground using an insulated wire link, the procedure for doing this is as follows:

1. Make certain that the power plug is removed from SK1.
2. Connect one end of the INSULATED wire to P3.
3. Connect the free end to any of the long needles for two seconds.
4. Move the free end to the detector plate at P5 and P6 for two seconds.

With a 12V power supply an initial current reading of approximately 70mA should be observed. Using a miniature screwdriver or trimming tool, carefully adjust RV1 either side of its central position to find a dip in the current reading. Repeat this procedure for RV2 returning to RV1 for a final adjustment to give a current reading of approximately 45mA. Under certain conditions a second dip may occur at the extreme end settings of each preset. This result should be ignored as the correct position should be close to the central starting point. If you are using a different supply voltage then the final current reading should be as shown in Figure 3.

The ion blinker LP1 will flash at a rate determined by the position of the short needle, its sharpness and the voltage applied to it. If the short needle is set too close to the detector plate the neon will be permanently lit and arcing may occur. To set the correct position with the ioniser running you must use a pair of long nose pliers with INSULATED handles. Refer to Photo 8 for a starting position then adjust the needle to produce one or two flashes a second.

The EHT voltage on the long needles can't be measured by a conventional multimeter. If you wish to confirm the output characteristics given in Figure 4 a simple high voltage test meter circuit is shown in Figure 5 and its construction is as follows:

1. Solder the fifteen 10MΩ high voltage resistors, R2 to R16, in series as close as possible to each other leaving the two end leads uncut.

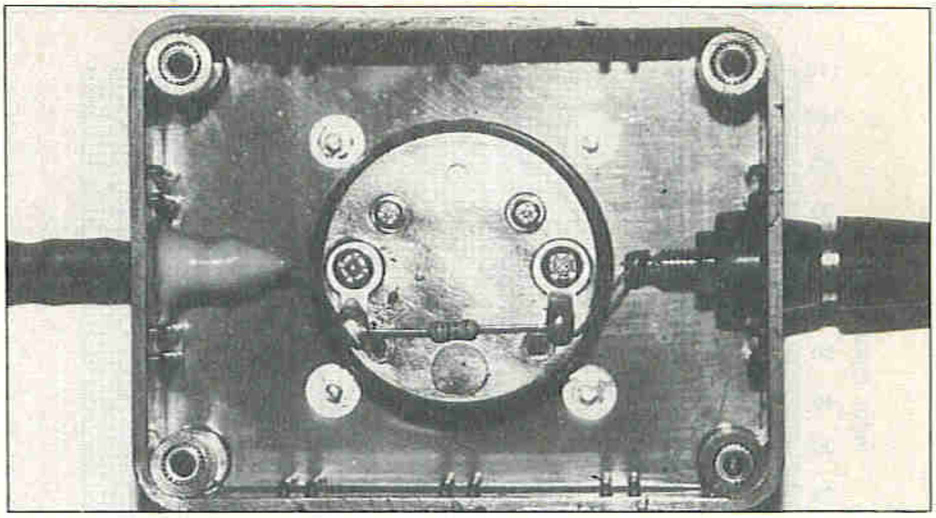


Photo 11. Building the EHT Test Meter.

2. Using three layers of heat shrink sleeving cover the resistors.
3. Prepare the box by cutting holes for the meter, terminal post and resistor chain.
4. Mount the meter and solder R1 across its terminals see Photo 11.
5. Bolt on the terminal post at the hole nearest the POSITIVE tag and wire it up.
6. Feed one end of the resistor chain into the other hole and solder it to the NEGATIVE meter terminal.
7. Fix the resistor chain inside the box using epoxy adhesive.
8. Solder the crocodile clip on one end of the extra flexible wire then fit the 4mm plug on the other.

This completes the construction of the EHT tester, see Photo 12. The scale on the panel meter is in tens with fifty at full deflection point and the following table shows the conversion into two kilovolt (kV) steps.

Meter scale:	0	10	20	30	40	50
Voltage (kV):	0	2	4	6	8	10

When using the EHT tester you should first connect the crocodile clip to P3 ensuring that the 4mm plug is firmly attached to its terminal post. The free end of the resistor chain is then carefully placed on any of the six long needles to obtain a reading.

This completes the testing of the unit and all meters should now be removed. The 250mA fuse FS1 is then fitted in to its holder and the moulded lid of the box is carefully lowered in to position. Finally fit a plastic foot on each of the four long bolts and secure the lid.

Using the Ioniser

The unit should be positioned out of the reach of young children and on a surface which can be easily cleaned. It is an inherent property of all types of negative air ionisers that they draw dust particles towards them and any surrounding objects. DO NOT use the unit in damp or steamy rooms or in the presence of any flammable gases. When used in a motor vehicle it must be switched OFF when attending petrol stations.

The needles will eventually wear out and need replacing after one or two years of continuous use. This is the only maintenance required apart from an occasional cleaning of the case using a soft cloth and a little household multi-surface polish.

Acknowledgement

Ioniser tested by Berridge Environmental Laboratories Limited, Robjohns Road, Chelmsford, Essex, CM1 3TW.

Chief Chemist David F. Evans., BSc., C.Chem., FRSC.

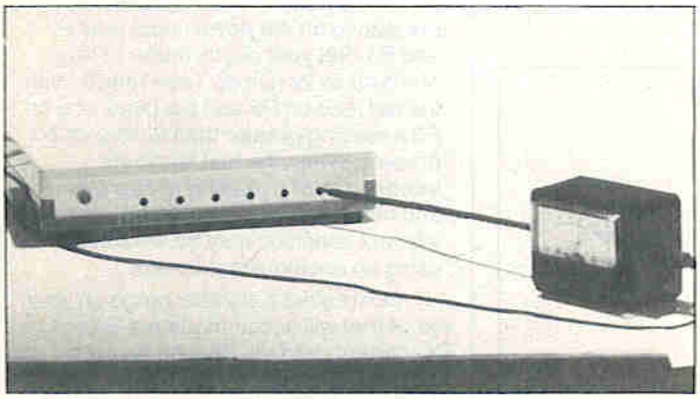


Photo 12. Completed EHT Test Meter.

EHT METER PARTS LIST

R1	27k 0.6W 1% Metal Film	1	(M27K)
R2-16	10M High Voltage Resistor	15	(V10M)
M1	2in Panel Meter 50μA	1	(FM98G)
	ABS Box MB1	1	(LH20W)
	Small Terminal Post Black	1	(FD69A)
	4mm Plug Black	1	(HF62S)
	Black Croc Clip	1	(FK34M)
	Extra Flex Black	1m	(XR40T)
	Heat Shrink CP64	1m	(BF90X)

Note: A kit is not available for the EHT Meter.

BREEEZE AIR IONISER PARTS LIST

Resistors: All 1% 0.6W Metal Film

R1	1k	1	(M1K)
R2,3	10k	2	(M10K)
R4	2k2	1	(M2K2)
R5-16	10M High Voltage Resistor	12	(V10M)
RV1	22k Hor. Ecl. Preset	1	(UH04E)
RV2	47k Hor. Ecl. Preset	1	(UH05F)

Capacitors

C1	470μF 16V Axial Electrolytic	1	(FB72P)
C2	100nF Minidisc	1	(YR75S)
C3	100μF 10V Axial Electrolytic	1	(FB48C)
C4	1nF Polystyrene	1	(BX35Q)
C5	100pF Polystyrene	1	(BX28F)
C6-15	4n7F HV Disc	10	(HY18U)
C16	330nF Polyester	1	(BX79L)

Semiconductors

D1-12	1N4007	12	(QL79L)
ZD1	BZY88C4V7	1	(QH06G)
ZD2	BZX61C22V	1	(QF61R)
TR1	TIP122	1	(WQ73Q)
IC1	4001BE	1	(QX01B)

Miscellaneous

T1	Ioniser Transformer	1	(JL94C)
	Pin 2145	1Pkt	(FL24B)
	DIL Socket 14 Pin	1	(BL18U)
SK1	PCB 2.5mm DC Pwr Skt	1	(FK06G)
TB1-6	2-Way PC Terminal	6	(FT38R)
	Heatsink	1	(FL58N)
	Isobolt M3 10mm	1Pkt	(HY30H)
	Isonut M3	1Pkt	(BF58N)
	Isoshake M3	1Pkt	(BF44X)
LP1	Lamp Min Neon Amber	1	(BK54J)
	Safuseholder 20	1	(RX96E)
FS1	Fuse 250mA	1	(WR01B)
	PCB (main)	1	(GE16S)
	PCB (plate)	1	(GE30H)
	Needle Pack	1Pkt	(JR56L)
	Box 201	1	(LL05F)
	Plastic Front Panel	1	(JR57M)
	Plastic Back Panel	1	(JR58N)
	Std Power Plug	1	(HH62S)
	7/0.2 Wire 10M Blue	1Pkt	(BL01B)
	Constructor's Guide	1	(XH79L)

Optional

	AC Adptr Unreg 300mA	1	(XX09K)

The parts listed above, excluding Optional, are available as a kit.
Order As LM97F (Breeeze Air Ioniser Kit) Price £29.95
The following items are also available separately, but are not shown in our 1990 catalogue:
Breeeze Air Ioniser PCB **Order As GE16S Price £5.25**
PCB Plate **Order As GE30H Price 60p**
Ioniser Transformer **Order As JL94C Price £7.95**
Needle Pack **Order As JR56L Price 60p**
Plastic Front Panel **Order As JR57M Price £2.98**
Plastic Back Panel **Order As JR58N Price £2.98**

Data File: TDA3048 continued from page 34.

The operating frequency of the circuit is approximately 36kHz using the component values shown in the Parts List. Operating frequency is basically determined by the resonant frequency of the tuned circuit formed by inductor L1 and capacitor C5; the corresponding L/C ratio determines the bandwidth of the receiver. Using the values shown the receive bandwidth is relatively wide and the circuit will accommodate carrier frequencies between approximately 30kHz and 40kHz with a peak in performance around the centre of this range. Receive frequency and bandwidth can be tailored to suit different applications by changing the values of L1 and C1.

For optimum performance, the TDA3048 is best driven into a high impedance, as the output current is limited to around 120μA; the device can of course drive a lower impedance with a reduction in output voltage. The TDA3048 provides an active low output; if an active high output is required, a TDA3047 (stock code UL25C) can be fitted in place of IC1. The TDA3047 is identical to the TDA3048 apart from the fact that the output is active high (both IC's have directly compatible pin-outs). Table 2 shows the specification of the prototype circuit built using the PCB and Figure 6 shows the PCB wiring diagram.

Power Supply Voltage:	With On-board Regulation	7V – 30V
	Without Regulation	4.7V – 5.4V (5V Nominal)
Current Consumption:	(12V power supply, RG1 Fitted)	5.2mA
	(5V Power Supply, LK1 Fitted)	1.98mA
Receive Frequency (Carrier):		Approximately 36kHz

Table 2. Specification of prototype (built using the PCB).

TDA 3048 INFRA RED RECEIVER PART LIST

RESISTORS: All 1% 0.6W Metal Film

R1	22Ω	1	(M22R)
R2,3	1MΩ	2	(M1M)

CAPACITORS

C1	100nF Minidisc	1	(YR75S)
C2	100μF 10V PC Electrolytic	1	(FF10L)
C3,4,7	10nF Ceramic	3	(WX77J)
C5,8	4n7F Ceramic	2	(WX76H)
C6	47nF Minidisc	1	(YR74R)
C9	22nF Polylayer	1	(WW33L)

SEMICONDUCTORS

TR1	TIL78	1	(YY66W)
RG1	78L05AWC	1	(QL26D)
IC1	TDA3047 (See text)	1	(UL25C)
IC1	TDA3048 (See text)	1	(UK84F)

MISCELLANEOUS

L1	4.7mH Choke	1	(UK80B)
	Constructors Guide	1	(XH79L)
	PC Board	1	(GE20W)
	DIL Socket 16 Pin	1	(BL18V)
	Pins 2145	1 Pkt	(FL24B)

The following item is available, but is not shown in our 1990 catalogue:
TD3047/48 PCB **Order As GE20W Price £2.25**

Maplin's 20 BEST SELLING BOOKS!

These are our top twenty best selling books based on mail order and shop sales during August and September 1989. Our own magazines and publications are not included. The Maplin order code of each book is shown together with page numbers for our 1990 catalogue. We stock over 250 different titles, covering a wide range of electronics and computing topics.

Number One

Loudspeaker Enclosure Design and Construction
by Fane Acoustics

This book contains a broad selection of cabinet designs from small-sized bass reflex cabinets to multi-way power systems. *(WM82D) Cat. P99.*
Previous Position: 1
Price £3.00

2

Getting the Most from your Multimeter, by R.A. Penfold. *(WP94C) Cat. P93.* Previous Position: 3. **Price £2.95**

3

IC555 Projects, by E.A Parr *(LY04E) Cat. P96.* Previous Position: 2. **Price £2.95**

4

Power Supply Projects, by R.A. Penfold. *(XW52G) Cat. P95.* Previous Position: 4. **Price £2.50**

5

Mastering Electronics, by John Watson. *(WM60Q) Cat. P93.* Previous Position: 6. **Price £4.50**

6

MIDI Projects, by R.A. Penfold. *(WP49D) Cat. P100.* Previous Position: 14. **Price £2.95**

7

More Advanced Power Supply Projects, by R.A. Penfold. *(WP92A). Cat. P95.* Previous Position: 9. **Price £2.95**

8

How to Use Op-Amps, by E.A.Parr *(WP29G) Cat. P93.* Previous Position: 10. **Price £2.95**

9

How to Design and make Your Own PCB's by R.A. Penfold. *(WK63T). Cat. P92.* Previous Position: 7. **Price £2.50**

10

Audio Amplifier Construction, by R.A. Penfold. *(WM31J). Cat. P98.* Previous Position: 11. **Price £2.25**

11

Radio Amateurs Examination Manual, by G.L. Benbow. *(WP87U) Cat. P101.* Previous Position: 13. **Price £5.00**

12

International Transistor Equivalents Guide, by Adrian Michaels. *(WG30H) Cat. P89.* Previous Position: 20. **Price £3.50**

13

Electronic Security Devices by R.A. Penfold. *(RL43W) Cat. P96.* Previous Position: 15. **Price £2.50**

14

Home Electrics, by Geoffrey Burdett. *(RQ22Y) Cat. P84.* Previous Position: 17. **Price £4.95**

15

Scanners, by Peter Rouse. *(WP47B) Cat. P102.* Previous Position: New Entry. **Price £7.95**

16

Towers' International Transistor Selector, by T.D. Towers. *(RR39N) Cat. P89.* Previous Position: New Entry. **Price £24.95**

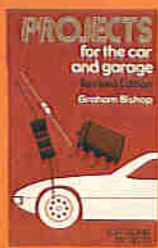
17

50 Projects Using Relays, SCR's and Triacs, by F.G. Rayer. *(RH30H) Cat. P95.* Previous Position: 12. **Price £2.95**

18

Adventures with Micro-Electronics, by Tom Duncan. *(XW63T) Cat. P93.* Previous Position: New Entry. **Price £4.75**

19

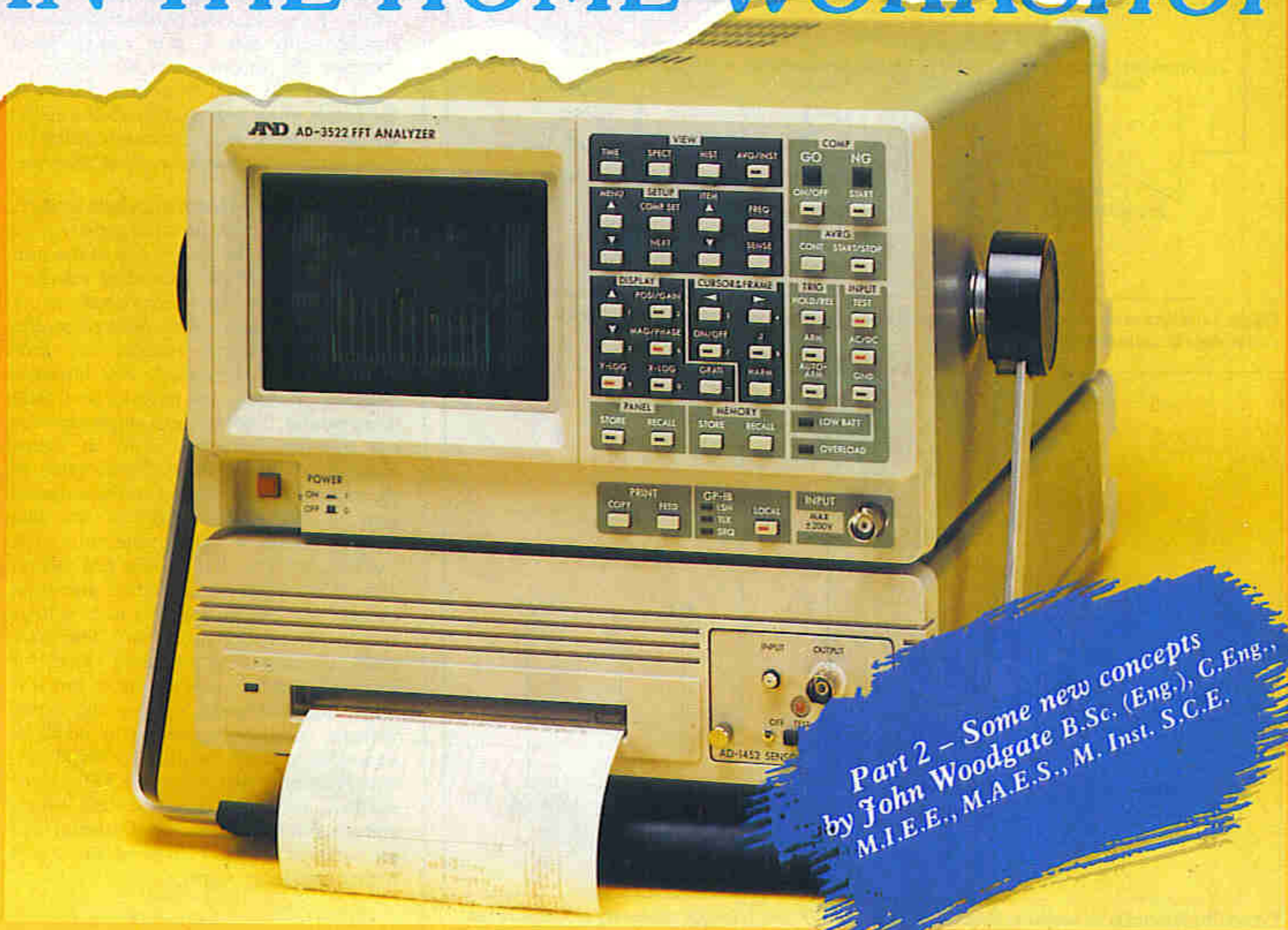


Projects for the Car and Garage, by Graham Bishop. *(XW31J) Cat. P96.* Previous Position: 16. **Price £6.95**

20

VHF/UHF Manual, by G.R. Jessop. *(WS14O) Cat. P101.* Previous Position: New Entry. **Price £8.94**

MEASURING Distortion IN THE HOME WORKSHOP



Part 2 – Some new concepts
by John Woodgate B.Sc. (Eng.), C.Eng., M.I.E.E., M.A.E.S., M. Inst. S.C.E.

Originally, this was going to be a two-part series, but the Editor has collected so many goodies for publication this Autumn, that it is going to become a three- or even four-part series. This time, we will first look at a new method of measuring intermodulation performance, and then at some basic measurement techniques and the vexed subject of dynamic non-linearities, including the dreaded TIM.

Total difference-frequency distortion (TDFD)

We have seen that intermodulation distortion measurements are valuable, because they measure the spurious signals that spoil musical reproduction, they are sensitive and they can be used for measurements at frequencies close to the limits of the amplifier pass-band. The only snag is the cost of the measuring equipment. Luckily, Neville Thiele (yes, he of the loudspeaker theory) has come up with a clever technique that uses a fairly inexpensive instrument, a practical version of which has been developed by Richard Small (yes, the 'other' loudspeaker expert). If we use as our test signal two sine-waves whose frequencies are nearly in the ratio of 3 to 2, we get the useful result that one second-order and one third-order intermodulation component fall close together in frequency. For example, suppose (as has been found useful in practice) f_1 = 8kHz and f_2 = 11.95kHz. The exact frequencies, and the amount of distortion in the signals, are not important, but the difference is. We find that the component $(f_2 - f_1)$ = 3.95kHz and the third-order component $(2f_1 - f_2)$ = 4.05kHz. We could measure both of these together, and exclude nearly all noise and hum, with the aid of a bandpass filter with a centre-frequency of 4kHz and a little more than 100Hz bandwidth. Such a filter is not too difficult or expensive to make, and the two frequencies can be generated digitally, so that their difference is accurate and constant. Because this technique measures both second and third order difference-frequencies, it is called 'Total Difference Frequency Distortion' (TDFD). It can be used at low, middle and high frequencies and, because it is a narrow-band measurement, very small amounts of non-linearity, below −90dB (0.001%) can be measured. A block diagram of this instrument is shown in Figure 3a, and the output signal spectrum in Figure 3b.

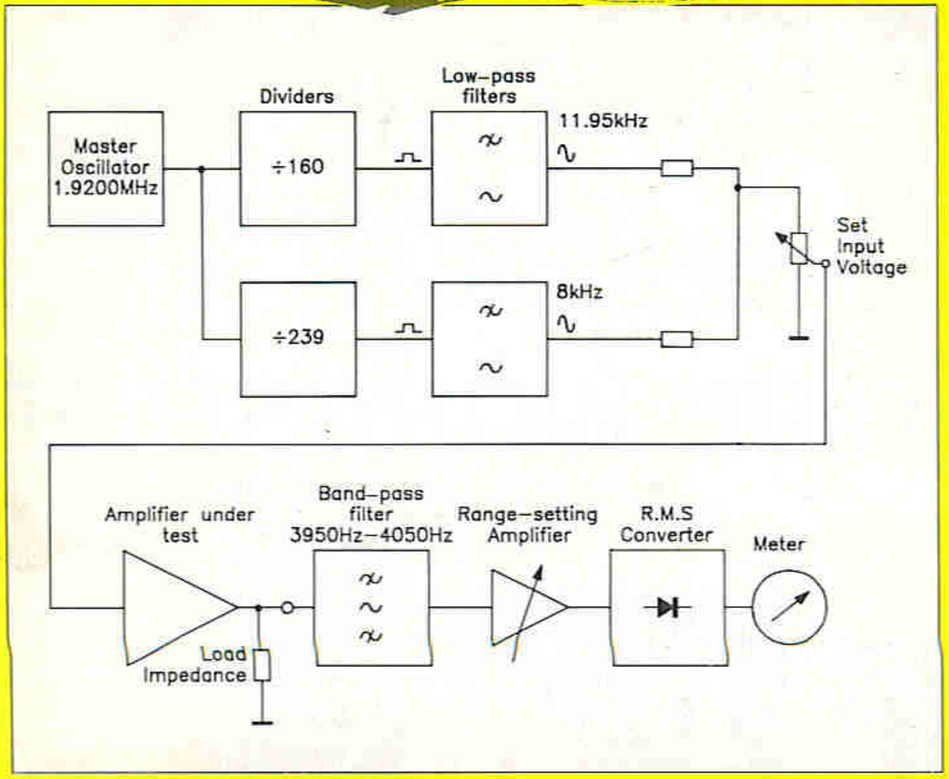


Figure 3a. Block diagram of total difference-frequency distortion meter (Dr. R. Small's design). Calibration circuits omitted for simplicity.

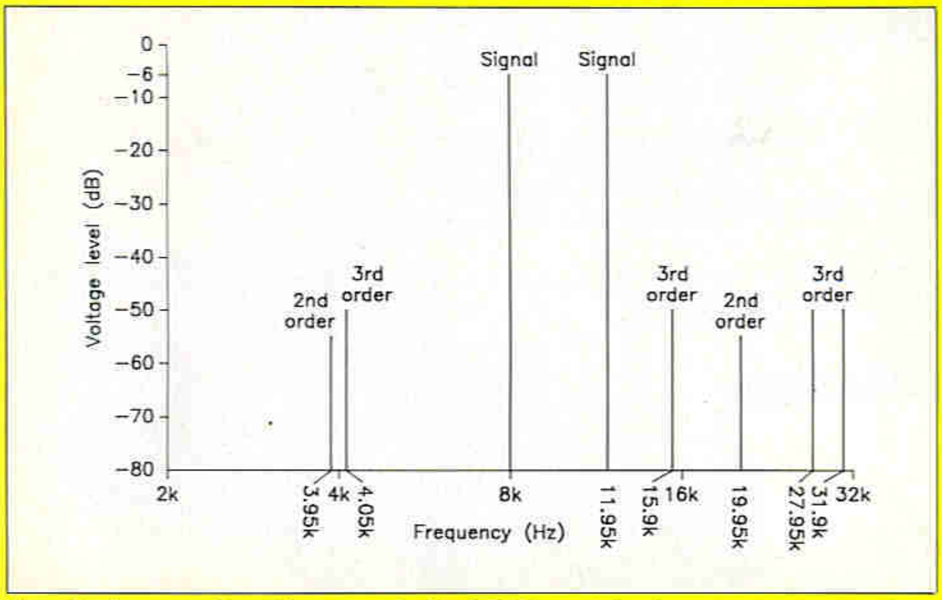


Figure 3b. Spectrum of amplifier output signal on TDFD test. It is only necessary to measure the two components close to 4kHz, together (as in the TDFD meter) or separately (with a wave, spectrum or FFT analyser) to determine the linearity of the amplifier at high audio frequencies. The high frequency products will be smaller, of course, if the amplifier frequency response rolls off.

Expressing distortion in numbers

We have been looking at harmonic and intermodulation products, and their effects on sound quality, but how do we arrive at the actual numbers? We need to know two things, if our results are to be useful. The first is the conditions under which we obtained the result. Normally, the most significant condition is the value of output signal at which we obtained the result, but other factors also come in, such as the mains or battery supply voltage and, only second in importance to the value of the output, the signal frequency.

Down with power!

We could express the value of output in terms of voltage, current or power. It is traditional to use power, but this is giving way to the use of voltage, because the distortion is more directly related to the voltage than to the power. In fact, it is a pity that power specifications were ever used for audio amplifiers, because loudspeakers don't respond to it but to either current or voltage, and this leads to much misunderstanding. Special amplifiers having the output current proportional to the input voltage are made for various purposes, and for these the output and distortion should be expressed as current. But for ordinary amplifiers, we are mostly concerned with voltage and we should therefore measure the values of output signal and distortion in terms of voltage.

We are dealing with a.c., so we could measure peak, r.m.s., or what most multimeters measure, which is 1.11 times the average value of the signal after it has been rectified, and is equal to the r.m.s. value *if* the signal is a single sine-wave. For the whole signal, we can measure either of the latter two, because unless the distortion is well over 10% they will be the same. Some digital multimeters measure true r.m.s. Peak measurements are rather too sensitive to the phase relationship between the fundamental and harmonics to be useful. To measure the harmonics alone we should really use a true r.m.s. meter (because the waveform of the combined harmonics will be far from sinusoidal), but the errors of an average-responding meter are not so large as is commonly believed, and one can be used for most measurements.

If we measure harmonics individually, we obtain the total by adding the r.m.s. values, i.e. find the square root of the sum of the squares of the individual voltages. The result is then expressed as a percentage, or in decibels referred to, the total r.m.s. output voltage, i.e. fundamental plus harmonics. For intermodulation products, we have to be a little more careful. The two-tone signal explores the transfer characteristic to an extent determined by the peak-to-peak value of the signal, which is equal to the ordinary sum of the r.m.s. values at the two frequencies ($V_1 + V_2$), not the r.m.s. sum ($\sqrt{(V1^2 + V2^2)}$). This is the real output voltage at which the measured distortion occurs, but the measured r.m.s. voltage will be less, and is irrelevant. There are rules for combining measured values for second and third order products, but it is much less confusing to give the actual voltages (perhaps expressed in decibels) measured at each frequency. For difference-frequency distortion and TDFD, the decibels are referred to the real output voltage, but for modulation distortion they are referred to the voltage of the small, higher-frequency signal.

Measurement techniques

One way of actually doing the measurement of harmonic distortion is to use the technique hinted at earlier, where the fundamental component of an attenuated version of the output is balanced out by the input signal, leaving the distortion (Figure 4a). Another technique is to remove the fundamental component by means of a notch filter (Figure 4b). Both of these methods leave all the distortion components together, and are therefore called measurements of 'total harmonic distortion' (THD). Unfortunately, along with the distortion components come (nearly) all the noise generated by the amplifier or present in the input signal, together with the mains hum. The noise and hum voltages may be comparable with, or even bigger than, the distortion, and may

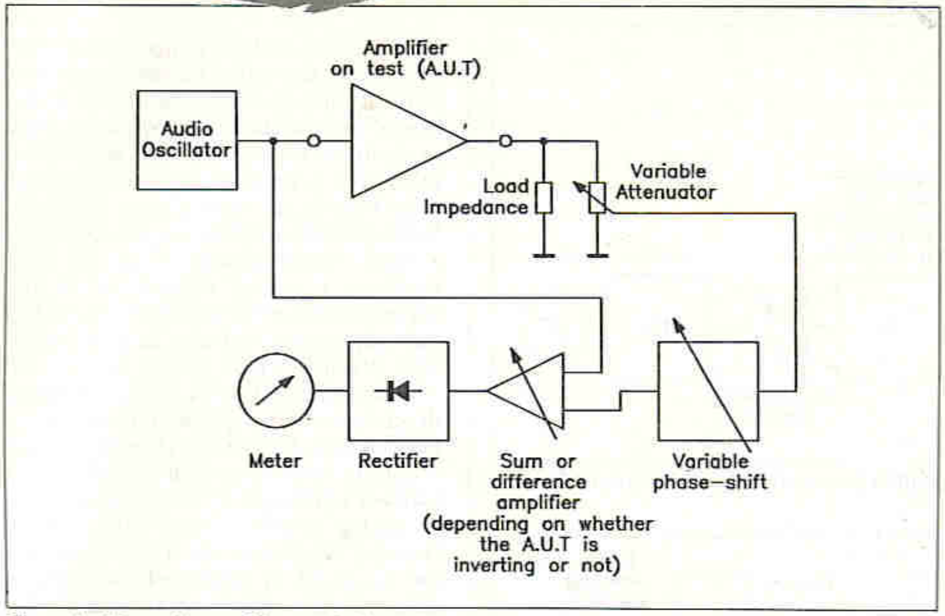


Figure 4a. Measuring total harmonic distortion by balancing out the fundamental.

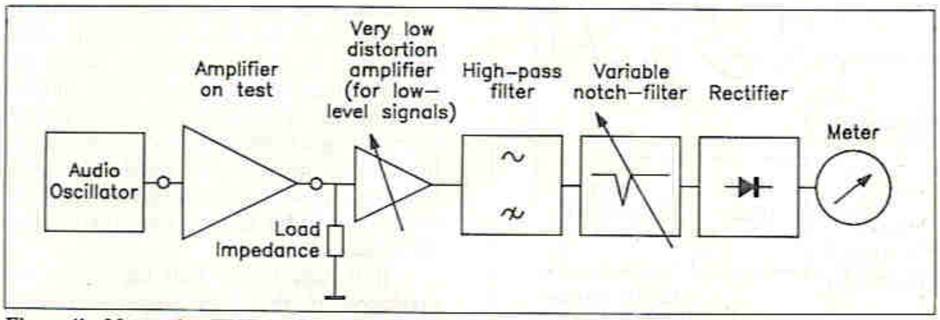


Figure 4b. Measuring THD by filtering off the fundamental. The high pass filter can be used to reduce errors due to hum when measuring above 500Hz.

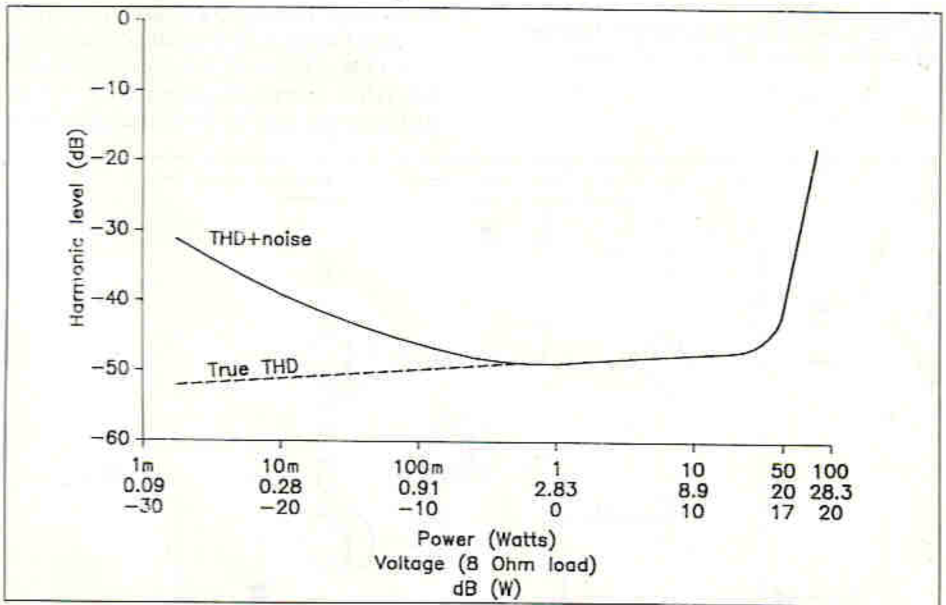


Figure 4c. Graph of THD against output for a good amplifier showing the error introduced in the value of THD by noise.

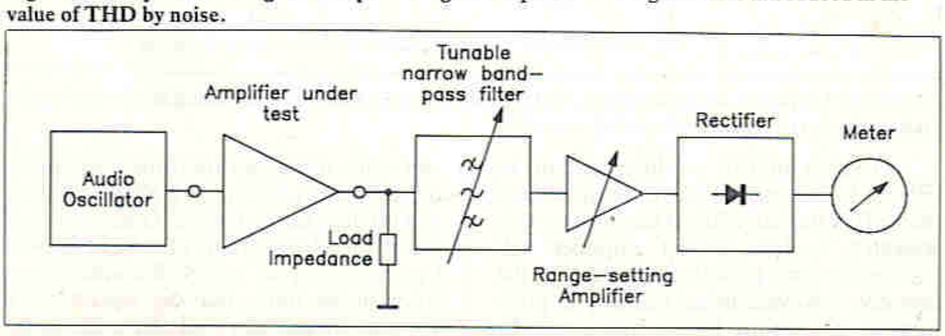


Figure 4d. Principle of band pass filter technique for measuring harmonics and intermodulation products individually. Tunable narrow band pass filters are difficult to design and expensive.

thus be a serious source of error when measuring low-distortion equipment. For this reason, I do not like this type of measurement, and would discourage its use if it were not so (relatively) easy to do. Figure 4c shows the errors that can be introduced by noise and hum. Note that this graph of harmonic distortion against output voltage has decibel (i.e. logarithmic) scales in both direction. This is the best way of plotting such curves, because the important low-output region is not squashed into the corner as it is with linear scales. The true harmonic distortion curve, without significant errors due to hum and noise, can be obtained by a better technique.

This technique is to measure each harmonic individually, using a meter preceded by a 'band-pass filter', that passes only a narrow band of frequencies around that of the harmonic to be measured (Figure 4d). Unfortunately, widely-tunable band-pass filters for audio frequencies are difficult to design, and complicated to tune. One way round this is to use the same principle as the superhet radio receiver. The audio signal is applied to a frequency-changer, whose local oscillator is tunable from say 100kHz to 120kHz. The frequency-changer is followed by an i.f. amplifier tuned to 100kHz, with a very narrow bandwidth of 10Hz or so (perhaps switchable). To measure a distortion component at 2kHz, the local oscillator is tuned to 102kHz, which produces with the 2kHz input signal an output from the frequency changer at 100kHz. The amplitude of this signal is proportional to that of the original 2kHz component, and can be measured at the output of the i.f. amplifier. Such an instrument is called a 'wave analyser' (Figure 4e); unfortunately it is slow to use and requires careful and skilful adjustment. It has largely been replaced by an improved version in which the frequency of the local oscillator is swept over a range, and the output of the i.f. amplifier is displayed as the y-deflection on an oscilloscope screen. The x-deflection is made proportional to the oscillator frequency, so that it represents a scale of audio frequencies. The i.f. amplifier output produces a vertical 'blip' at each frequency present in the audio signal, with height proportional to the strength of the component at that frequency. The display thus represents the spectrum of the audio signal, and the instrument is therefore called a 'spectrum analyser' (Figure 4f). It is easier to use than a wave analyser, but less easy to pay for! Yet another technique is to use digital methods to analyse the output signal into its component sine-waves, by means of the Fast Fourier Transform (FFT). FFT analysers with enough dynamic range for distortion measurements are also quite expensive.

All three sorts of analyser can be used for measuring intermodulation components, of course, and can therefore be used for both difference-frequency and modulation distortion measurements. They will also show up hum components (mains frequency and its harmonics, generated in the power-supply of the amplifer).

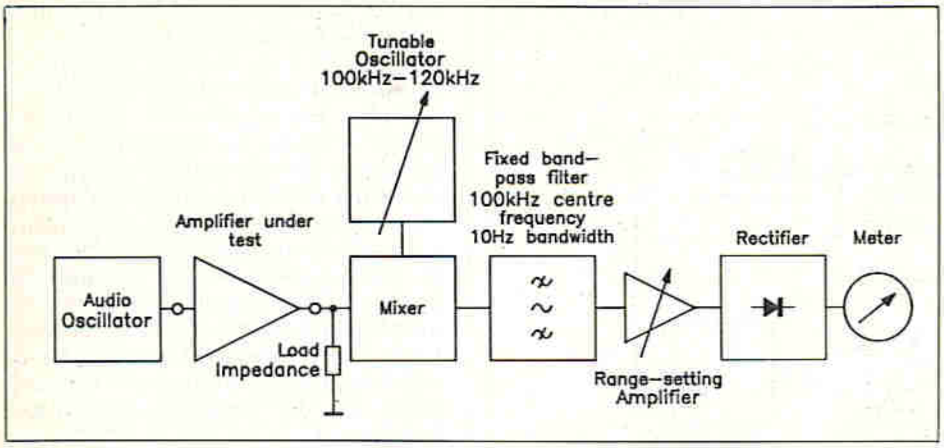


Figure 4e. One way to eliminate the tunable band pass filter is to use the superhet principle. Most wave analysers work in this way.

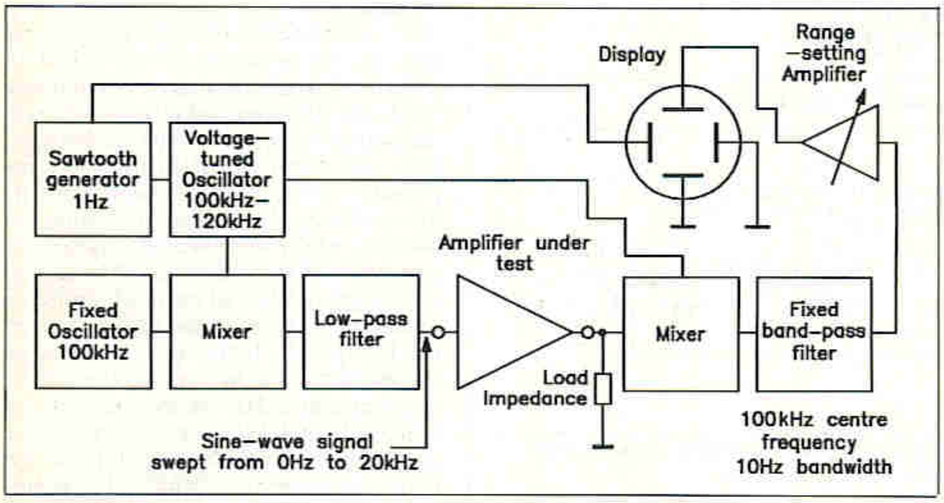


Figure 4f. The wave analyser principle can be automated by electronically sweeping the frequency of the input signal, and displaying the results on an oscilloscope screen. This instrument is a 'spectrum analyser'.

100μA. Now, in order to pass signal to the next stage, the signal current in the first transistor has to change the voltage at the base of the next stage, and in doing so it has to change the charge on C. The effective value of C is much higher than its actual value because the other plate is connected to the collector of the second transistor, and a small voltage change V at the base produces a voltage change AV in the opposite sense at the collector, where A is the voltage gain, and may be 20 or more. This is called 'Miller effect'. In fact, the effective value of C is (A + 1)C. Changing the charge on this capacitor quickly takes a lot of current, but the first transistor cannot supply or sink more than 100μA, which may not be enough. If it gives up entirely, producing so-called 'hard TIM', an interesting situation arises. The first transistor is cut-off or bottomed, so there is effectively no signal path through the amplifier, and therefore nothing to change the output, which thus stays more or less constant until the first stage comes alive again later in the signal cycle, when the negative feedback forces a very sudden catching-up. The result is that a square corner (Figure 5b) appears on the waveform! This involves the production of a burst or transient, consisting of many high harmonics. Why transient *intermodulation* distortion, then?

It is easy to see that harmonics are produced if the first stage is heavily overloaded. But it may well become quite non-linear at lower signal levels or lower frequencies, leading to a transfer characteristic like Figure 5c and producing so-called 'soft TIM'. This still produces harmonics and static intermodulation products, but the harmonics may be above the audio band

Dynamic non-linearity

So far, we have assumed that the transfer characteristic of the amplifer is fixed, but it may vary with frequency; if the gain depends on frequency, the slope of the transfer characteristic will vary with frequency. The amount of the non-linearity will also depend on frequency, partly because of the frequency characteristics of the transistors or other active devices, but also because it is almost inevitable that one or more stages within the amplifier will feed a reactive load, whose value will depend on frequency. In a practical amplifier, the transfer characteristic also depends on, for example, the temperatures of the transistors, or it may be influenced by previous signals as well as the current one!

These signal-dependent effects are called 'dynamic non-linearities', as opposed to the 'static non-linearities' we have considered before, and the best-known is 'Transient Intermodulation Distortion' (TIM). This term was invented by Dr. Matti Otala, and gave rise to much controversy, because, having measured several amplifiers that produced much TIM, Otala suggested that designers did not know about it, which upset those (few?) that did, and he further put forward techniques for avoiding TIM which proved to be sufficient, but quite a bit more stringent than necessary.

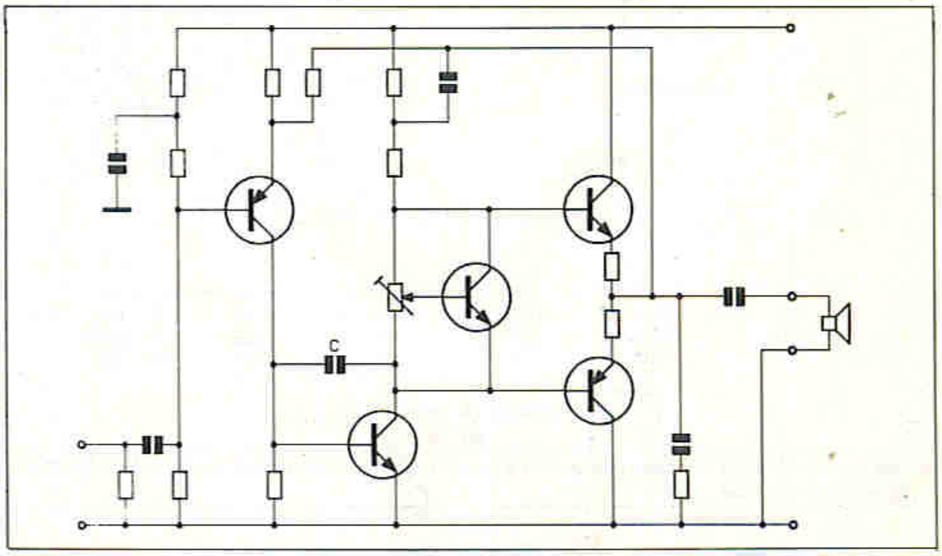


Figure 5a. Simplified amplifier circuit. TIM is caused by the first transistor being unable to charge and/or discharge capacitor C quickly enough.

The simplified amplifier circuit in Figure 5a is representative of some designs of the 60's and early 70's. The capacitor C is essential; without it the amplifier will oscillate at some high frequency due to the negative feedback being changed to positive by phase-shift in the transistors. In order to reduce noise, the first transistor is operated with a low collector current, about

and only difference-frequency distortion measurements, using two high frequencies, will disclose the distortion. Otala proposed a test signal consisting of a band-limited square wave plus a high-frequency sine-wave probe tone, but the square wave contains frequencies well above the audio band (which may be considered unfairly severe) and the output spectrum is complex

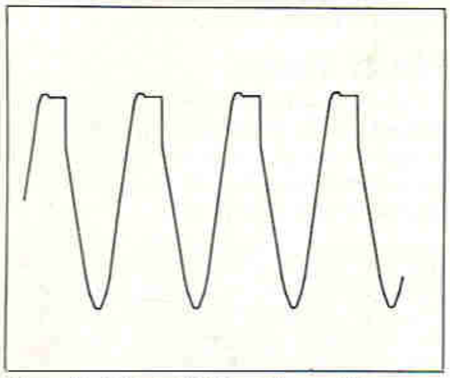


Figure 5b. Effect of TIM on the amplifier output waveform at higher frequencies, even more distortion occurs.

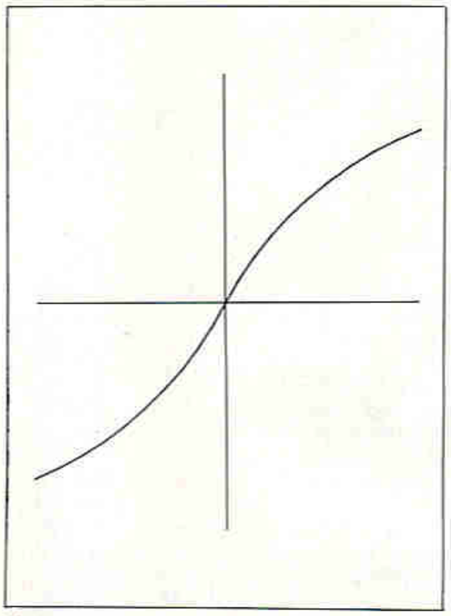


Figure 5c. Transfer characteristic liable to cause soft TIM. The popular long tailed pair input stage behaves like this.

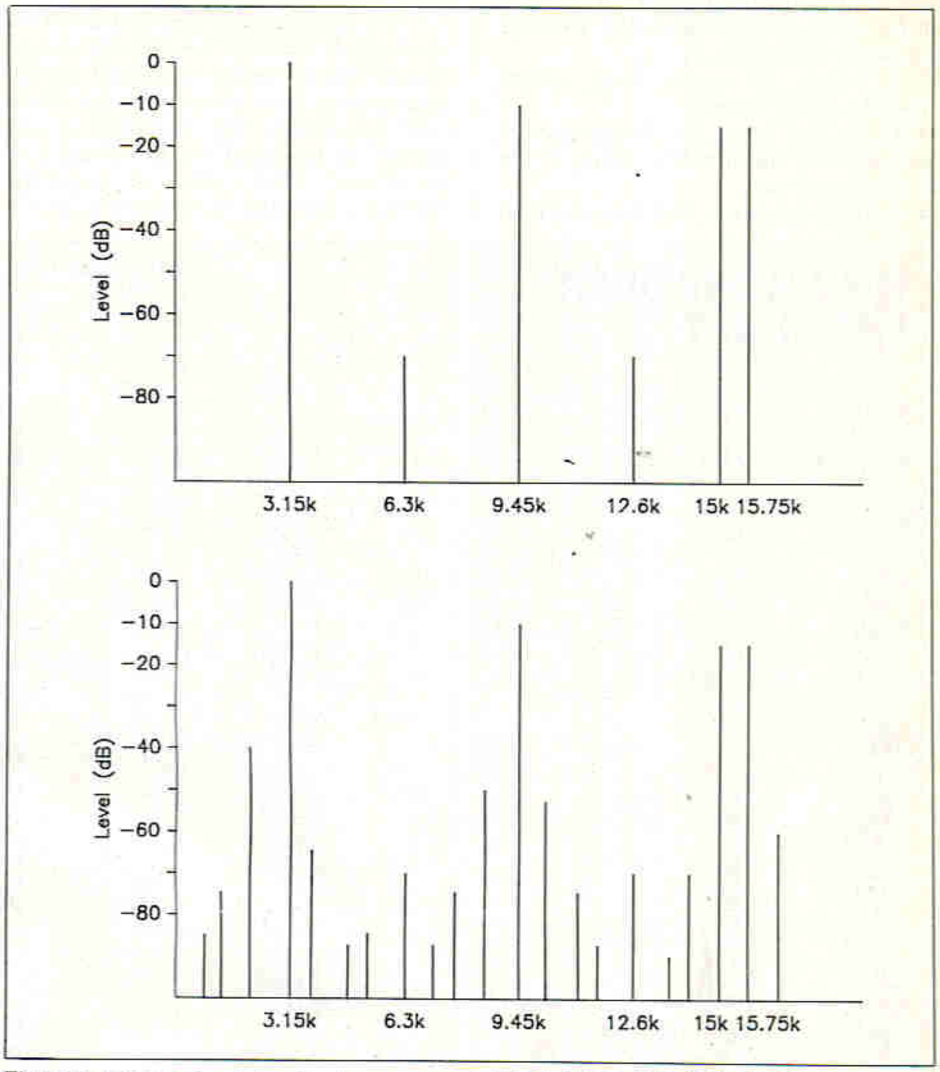


Figure 5d. TIM test input signal and output spectra. The 6.3kHz and 12.6kHz signals are due to asymmetry in the square wave generator. The complexity of the output spectrum detracts from the efficiency of the method.

A prototype TDFD meter, courtesy Dr. R. Small.

(Figure 5d). It seems better, firstly to design so as to avoid TIM and, secondly, to use difference-frequency or TDFD measurements to verify that none occurs.

At present, there is no standard method for measuring temperature effects. For a d.c. amplifier, it is quite easy to feed in a very low frequency sine-wave and a much higher frequency, and watch the distortion levels on a spectrum analyser as the low frequency cycle proceeds. Unfortunately, there is no easy technique for a.c. amplifiers, unless the l.f. cut-off frequency is very low. Apart from temperature effects in transistors, the resistance of a fuse depends on the current through it, simply because the wire gets hot, and this can easily cause distortion, particularly if the fuse is directly in the signal path, e.g. in series with the loudspeaker. Another very low frequency effect is caused by the progressive discharging of the reservoir capacitors of the power supply circuit as the load current increases, followed by gradual charging as it decreases.

Things to come

In the next part, we shall look at some basic measuring circuits and the performance of practical amplifiers at different signal levels.

NICAM DECODER *Continued from page 15.*

silence in both. 30s of 350Hz at −12dBu in right only. Lindos automated test tone sequence (SEQuence 1)

2. A variety of musics from, where possible, digital sources.

3. At the half hour: IBA announcement preceded by the first four notes of the frere jacques tune.

4. A variety of musics. The format is then repeated for the second hour.

It is expected that this service will be increasingly replaced towards the end of the service period by a NICAM service provided by your local transmitter which will accompany the broadcast vision signal. The trade test service will cease in September 1989, when a scheduled service is intended to commence and a map showing the expected date for each region is shown in Figure 12.

Next Time

In the next part of this series we will present a TV tuner unit which will allow you to receive the stereo sound via your hi-fi, but without the need to fit the NICAM decoder inside your TV set.

NICAM DECODER PARTS LIST

RESISTORS All 0.6W 1% Metal Film

R1,17,46,48	470R	4	(M470R)
R2	10R	1	(M10R)
R3,9,16,21-25, 53,56	1k	10	(M1K)
R4	8k2	1	(M8K2)
R5,57	100k	2	(M100K)
R6	22R	1	(M22R)
R7,20, 51,54,60	10k	5	(M10K)
R8,13	510R	2	(M510R)
R10-12,39,40, 61,62,RM1	2k2	8	(M2K2)
R14	150k	1	(M150K)
R15	220k	1	(M220K)
R18,19	39k	2	(M39K)
R26-31	47k	6	(M47K)
R32,43,44	68k	3	(M68K)
R33-36	3k3	4	(M3K3)
R37,38	560R	2	(M560R)
R41,42	27k	2	(M27K)
R45,58	4k7	2	(M4K7)
R47	47R	1	(M47R)
R49,50	5k6	2	(M5K6)
R52,55	220R	2	(M220R)
R59	2k7	1	(M2K7)
RV1	10k Hor. Encl. Preset	1	(UH03D)
RV2,3	22k Hor. Encl. Preset	2	(UH04E)

CAPACITORS

C1,3,5,8,10, 12,14,16,21, 28,38,39,43, 49,53,63,66, 80,82,88	100nF Minidisc	20	(YR75S)
C2	470µF 16V PC Electrolytic	1	(FF15R)
C4,9,27,29, 48,54,58,60, 64,65,79,85	47µF 16V Minelect	12	(YY37S)
C6,7,55,81,83	220µF 16V PC Electrolytic	5	(FF13P)
C11	22pF Ceramic	1	(WX48C)
C13,15,46,47	100pF Ceramic	4	(WX56L)
C17,18,20,31, 36,40,42	10nF Ceramic	7	(WX77J)
C19,32	39pF Ceramic	2	(WX51F)
C22-24,52	15pF Ceramic	4	(WX46A)
C25	27pF Ceramic	1	(WX49D)
C26,33,35	56pF Ceramic	3	(WX53H)
C30,34,37,41	470nF 63V Minelect	4	(YY30H)
C44,45,73,74	330pF Ceramic	4	(WX62S)
C50	10µF 16V Minelect	1	(YY34M)
C51,77,78	82pF Ceramic	3	(WX55K)
C56,59	1n2F 1% Polystyrene	2	(BX57M)
C57	100µF 10V Minelect	1	(RK50E)
C61,62	680pF Polystyrene	2	(BX34M)
C67,68	1nF Ceramic	2	(WX68Y)
C69,70	100nF Polylayer	2	(WW41U)
C71,72	2n2F Polylayer	2	(WW24B)
C75,76,87	1µF 63V Minelect	3	(YY31J)
C84,86	3n3F Ceramic	2	(WX74R)
VC1	65pF Trimmer	1	(WL72P)
XT1	6.552MHz Crystal	1	(UK98G)
XT2	5.824MHz Crystal	1	(UK99H)
XT3	16.930MHz Crystal	1	(UL00A)

SEMICONDUCTORS

D1,2,4,5	1N4148	4	(QL80B)
D3	1N4002	1	(QL74R)
ZD1	BZY88C11	1	(QH15R)
RG1	µA78M05UC	1	(QL28F)
TR1	2N2219	1	(QR11M)
TR2	3SK88	1	(UH63T)
TR3	MPSA14	1	(QH60Q)
TR4	BC548	1	(QB73Q)
IC1	TA8662N (INCLUDED IN CHIP-SET)	1	(UK95D)
IC2	TC6011N (INCLUDED IN CHIP-SET)		
IC4	TD6710AN (INCLUDED IN CHIP-SET)		
IC3	6264 (100ns)	1	(UL01B)
IC5	LM833	1	(UF49D)
LD1-4,6	Mini LED Red	5	(WL32K)
LD5	Mini LED Green	1	(WL33L)

MISCELLANEOUS

	Constructors Guide	1	(XH79L)
	PC Board	1	(GE22Y)
FL1	6.552MHz B.P. Filter	1	(JM93B)
FL2,3	15kHz L.P. Filter	2	(JM94C)
L1,2	4m7H Choke	2	(JM95D)
T1,2	KANK3334R	2	(FD03D)
RL1	Ultra-Min Relay 12V DPDT	1	(YX95D)
PL1,2	Minicon Latch Plug 2-Way	2	(RK65V)
PL3,4	Minicon Latch Plug 8-Way	2	(YW13P)
PL5,6	Minicon Latch Plug 4-Way	2	(YW11M)
PL7	Minicon Latch Plug 6-Way	1	(YW12N)
	DIL Skt 8 Pin	1	(BL17T)
	DIL Skt 28 Pin	1	(BL21X)
	Shrink DIP Skt 30 Pin	2	(JM97F)
	Shrink DIP Skt 42 Pin	1	(JM98G)
	Pins 2145	1Pkt	(FL24B)
	Minicon Latch Housing 2-Way	2	(HB59P)
	Minicon Latch Housing 4-Way	2	(HB58N)
	Minicon Latch Housing 6-Way	1	(BH65V)
	Minicon Latch Housing 8-Way	2	(YW23A)
	Minicon Terminal	4Pkts	(YW25C)
	Heatsink Clip-on	1	(FL78K)
	Isobolt M3 10mm	1Pkt	(HY30H)
	Isoshake M3	1Pkt	(BF44X)
	Isonut M3	1Pkt	(BF58N)

OPTIONAL

S1-4	Sub-Min Toggle A	4	(FH00A)
RM2,RM3	2k2	2	(M2K2)
DM1,DM2	1N4148	2	(QL80B)
	Trim Tool Pot Core Type	1	(BR51F)
	Miniature Coax	1Metre	(XR88V)
	Hook-Up 7/0.2 wire 10M Blk	1Pkt	(BL00A)
	Hook-Up 7/0.2 wire 10M Red	1Pkt	(BL07H)

The parts listed above, excluding Optional, are available as a kit, but are not shown in our 1990 catalogue:

Order As LP02C (NICAM Decoder Kit) Price £99.95

The following parts are also available separately, but are not shown in our 1990 catalogue:

NICAM Decoder PCB **Order As GE22Y Price £8.95**
NICAM Chip Set **Order As UK95D Price £49.95**
RAM IC 6264 (100ns) **Order As UL01B Price £5.95**
6.552MHz Crystal **Order As UK98G Price £1.28**
5.824MHz Crystal **Order As UK99H Price £1.28**
16.930MHz Crystal **Order As UL00A Price £1.28**
6.552MHz B.P. Filter **Order As JM93B Price £2.75**
15kHz L.P. Filter **Order As JM94C Price £3.45**
4m7H Choke **Order As JM95D Price 60p**
Shrink DIP Skt 30 pin **Order As JM97F Price 60p**
Shrink DIP Skt 42 pin **Order As JM98G Price 80p**

SERIAL FORMAT TRANSLATOR *Continued from page 31.*

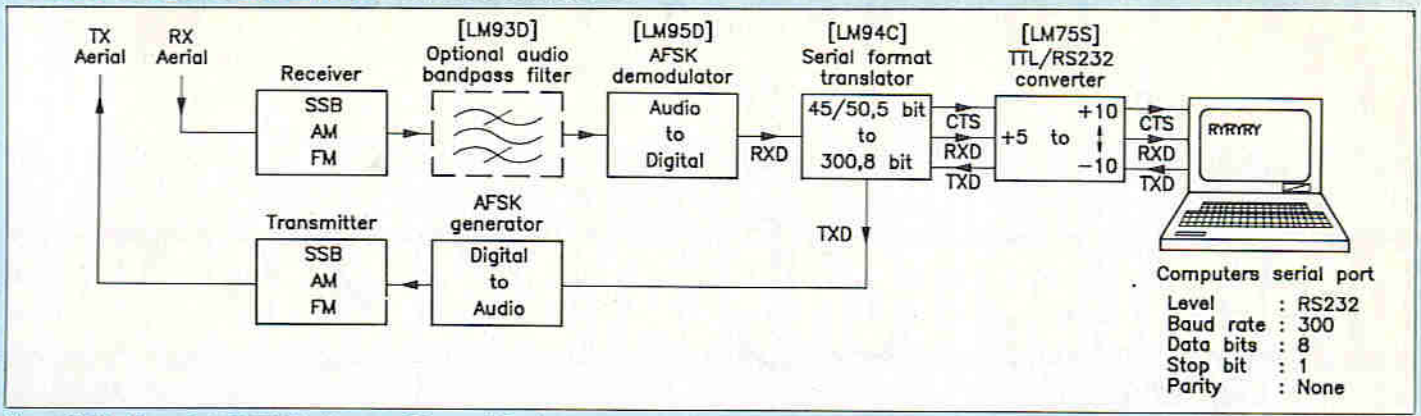


Figure 8. The Complete RTTY Recieve and Transmit System.

and will be published as the final part of the series. When each stage has been constructed and tested the system can be put together and with the RTTY software (stock code JR40T) the system will be complete. The RTTY program sets the RS232C port of the PC to 1200 baud, 8 bits per character with 2 stop bits and no parity. Ensure that the computer serial format select switch S1 is set accordingly, see Figure 2. For the majority of RTTY transmissions the parity switch S2 should be set to NO parity with two stop bits (position 6). The word size switch S3 must be in the five bits per character setting (position 1). With this combination selected 1.5 stop bits will be produced which is the correct configuration for standard RTTY signals. The control that will be used most often is the baud rate switch S4, this is because RTTY signalling speeds can be 45.45, 50, 75 and 100 bauds. In general, radio amateurs use baud rates of 45.45 or 50 with commercial stations tending to use 50, 75 or 100 baud. If an RTTY signal is not tuned in correctly or is at the wrong speed, the text will appear garbled and LD2 should light. Some radio signals sound like RTTY but can not be resolved by adjustments made on the demodulator or translator. These signals can be made up from any number of stop bits and character bits transmitted at any baud rate. In addition, the code for any given character can be almost infinite making it very difficult to resolve a non-standard RTTY message.

If you would like to learn more about RTTY, I would recommend contacting the British Amateur Radio Teledata Group (BARTG), c/o Mrs. Pat Beedie, GW6MOJ, Ffynnonlas, Salem, Llandeilo, Dyfed SA19 7NP. There are numerous books on the subject and BARTG can supply a list. I can personally recommend 'Guide to RTTY Frequencies' by Oliver P. Ferrall and published by Gilfer Associates Inc.

SERIAL FORMAT TRANSLATOR PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1,2,7,8,21,22	4k7	6	(M4K7)
R3,9-17	100k	10	(M100K)
R4,5,6	1k	3	(M1K)
R18	10M	1	(M1M)
R19	10k	1	(M10K)
R20,23	22k	2	(M22K)
CAPACITORS			
C1,4,6,7,9,10	100nF Disc	6	(BX03D)
C2,3	56pF Ceramic	2	(WX53H)
C5	100µF 16V Minelect	1	(RA55K)
C8	1000µF 16V PC Electrolytic	1	(FF17T)
SEMICONDUCTORS			
D1-36	1N4148	36	(QL80B)
D37	1N4001	1	(QL73Q)
TR1,2	BC548	2	(QB73Q)
IC1,2	AY-3-1015D	2	(WQ18U)
IC3,4	74HC00	2	(UB00A)
IC5	4060BE	1	(QW40T)
IC6	40103BE	1	(QW61R)
IC7	4040BE	1	(QW27E)
LD1,2,3	LED Red High Bright Std	3	(WL84F)
RG1	µA7805UC	1	(QL31J)
MISCELLANEOUS			
XT1	2.4576MHz MP Crystal	1	(FY81C)
S1	DIL Switch SPST Octal	1	(XX27E)
S2,3,4	Rotary Switch 1 Pole 12 Way	3	(FF73Q)
S5	Sub-Min Toggle A	1	(FH00A)
	Heatsink Vaned Plastic Pwr	1	(FL58N)
	Constructors Guide	1	(XH79L)
	PC Board	1	(GE07H)
	Knob KB4	3	(RW87U)
	DIL Socket 14 Pin	2	(BL18U)
	DIL Socket 16 Pin	3	(BL19V)
	DIL Socket 40 Pin	2	(HQ38R)
PL1,7,8	Minicon Latch Plug 10 Way	3	(RK66W)
PL2,3	Minicon Latch Plug 6 Way	2	(YW12N)
PL4	Minicon Latch Plug 4 Way	1	(YW11M)
PL5,6,9-11	Minicon Latch Plug 2 Way	5	(RK65V)
	Minicon Latch Housing 10 Way	3	(FY94C)
	Minicon Latch Housing 6 Way	2	(BH65V)
	Minicon Latch Housing 4 Way	1	(HB58N)
	Minicon Latch Housing 2 Way	5	(HB59P)
	Minicon Terminals	6 Pkts	(YW25C)
	LED Clip 5mm	3	(YY40T)
	Ribbon Cable 10 Way	1 Metre	(XR06G)
	Isobolt M3 10mm	1 Pkt	(HY30H)
	Isonut M3	1 Pkt	(BF58N)
	Isoshake M3	1 Pkt	(BF44X)
OPTIONAL			
	Instrument Case 3502	1	(YN33L)
	Self-Tapping Screw No.4 x ¼in	1 Pkt	(FE68Y)
	Power Socket 2.5mm	2	(HH86T)
	Chassis Phono Skt	2	(YW06G)
	D-Range 25 Way Plug	If req	(YQ48C)
	D-Range 25 Way Skt	If req	(YQ49D)
	D-Range 25 Way Cover	If req	(YQ50E)
	D-Range Locking Hood Plastic 25 Way	If req	(FP29G)
	D-Range Locking Hood Metallised 25 Way	If req	(JB80B)
	D-Range Locking Hood Metal 25 Way	If req	(JB02C)
	D-Range Jack Post	If req	(FP31J)
	Multi-Core 6 Way Cable	If req	(XR26D)
	Mains Adaptor Regulated DC Output	1	(YB23A)
	RS232/TTL Converter Kit	1	(LM75S)
	RTTY Program SW1 5¼in Disk	1	(JR40T)

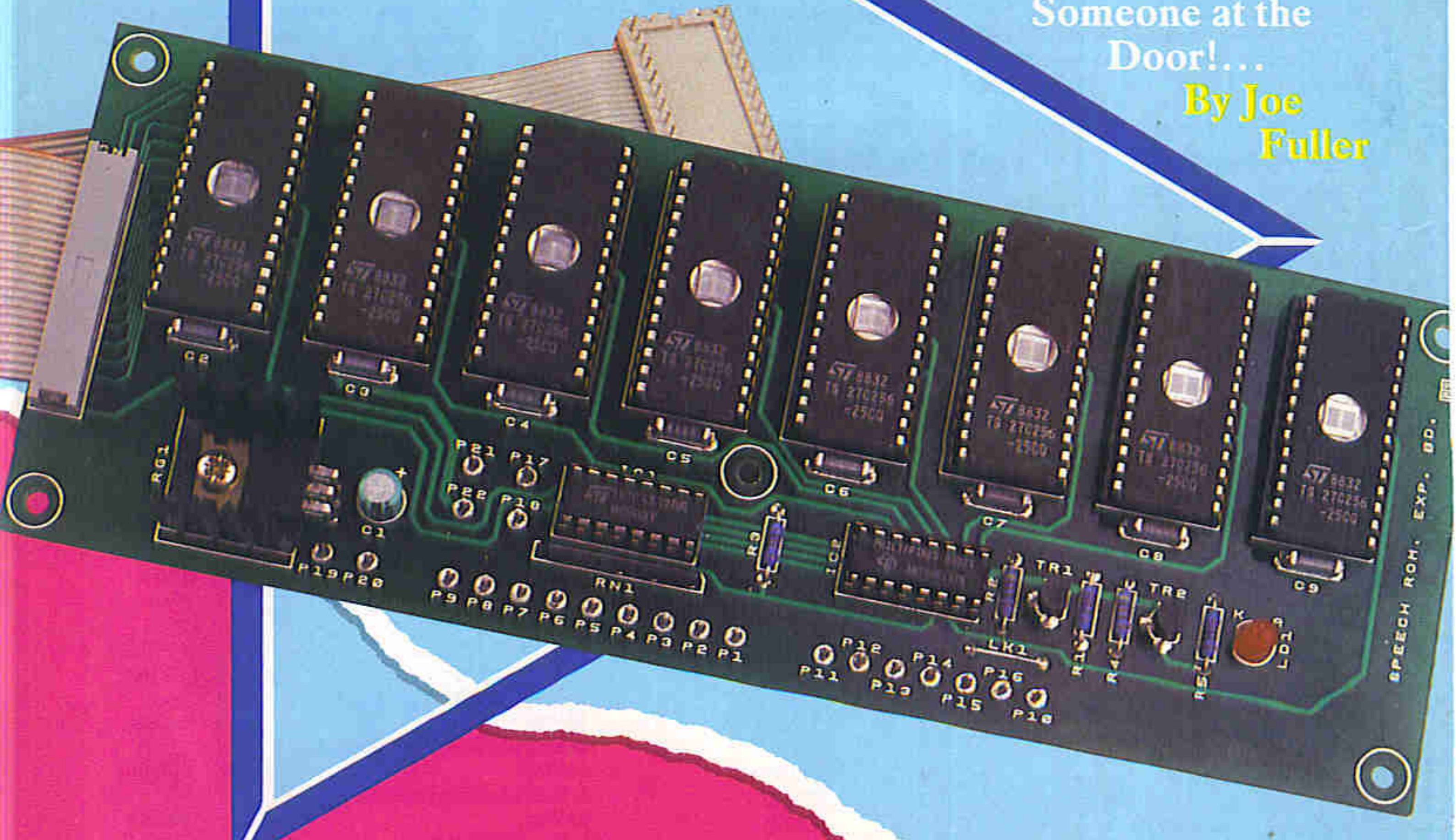
The parts listed above, excluding Optional, are available as a kit, but are not shown in our 1990 catalogue:
Order As LM94C (Serial Format Translator Kit) Price £38.95

The following items are also available separately:
Serial Format Translator PCB **Order As GE07H Price £10.95**
RTTY Program SW1 5¼in Disk **Order As JR40T Price £9.95**

ROM EXPANSION MODULE *from* DIGITAL SPEECH PLAYBACK MODULE

Alarm System Activated!...Please Fasten Your Seatbelt...Lights On...Intruder Alert... Petrol Low...Alarm System De-activated!...Water Low... Fire!... Oil Low...Please Use Emergency Exit! ... Danger!...There's Someone at the Door!...

By Joe Fuller



FEATURES

- ★ Wide Range of Applications
- ★ Up to Eight EPROMs may be used
- ★ Plugs into Playback Module
- ★ Octal or Binary EPROM Selection
- ★ Internal or External Address Latch
- ★ Status Lines & LED Indicator
- ★ Can be used with 8K 16K or 32K EPROMs

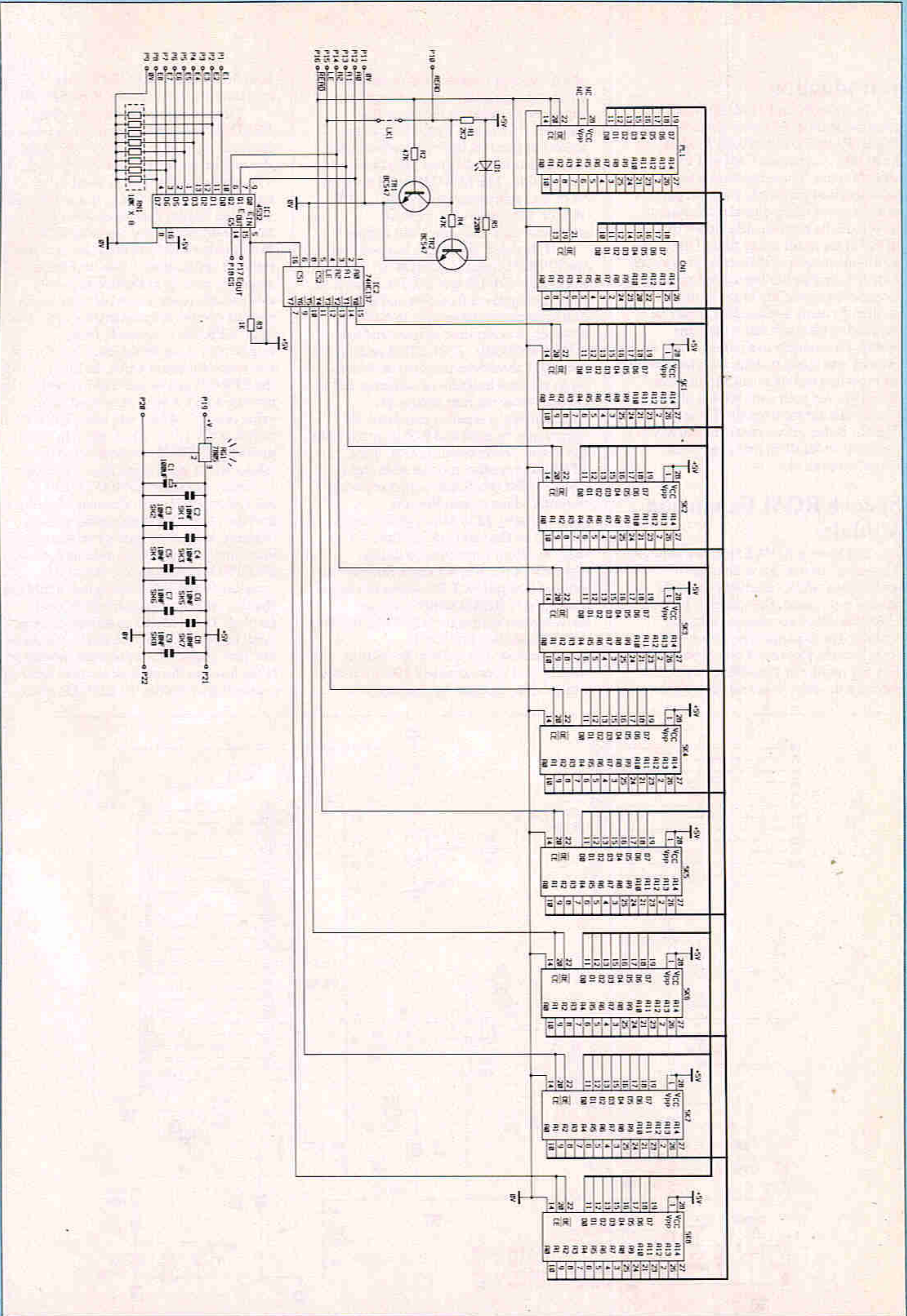


Figure 1. Circuit diagram of Speech ROM Expansion Module.

Introduction

In issues 30 and 31 of 'Electronics', constructional details were given for a Digital Record and Playback Module, EPROM Programmer Card and Playback Only Module. These modules allow the recording and playback of words, phrases and sentences using digital technology; speech can be permanently stored in EPROM for recall at any time. Due to the enormous success of this series of projects a further module has been developed to increase the versatility of the system still further. In many applications it may be required to playback more than one phrase, for example in a home or factory security and alarm system, with ham radio for repeating call signs, an annunciator device or even your own version of that famous talking car from the TV series 'Knight Rider'! If you have missed any of the issues order them now, see 'Back Issues' on page 76.

Speech ROM Expansion Module

The Speech ROM Expansion Module is intended for use in a wide range of applications where selection of speech phrases is required, the speech is held in EPROMs which are plugged into the module. The expansion module itself plugs into the Playback Only Module, this does not require any modifications to the playback module. To avoid any possibility of overloading the playback module's on-board regulator a separate regulated 5V supply is provided on the expansion module. Up to eight EPROMs can be accommodated on the expansion module, although any number less than this is permissible. The EPROMs used must all be of the same memory capacity i.e. 8K, 16K or 32K and *not* a mixture, otherwise very odd things will happen!

Note that it is strongly advised that the EPROMs used are CMOS 'C' versions, i.e. 27C64, 27C128 and 27C256. This is to keep the supply current low and hence minimise power dissipation in RG1. If, however, it is required to use standard NMOS EPROMs (2764, 27128 and 27256) then RG1 should be mounted off-board, on an external heatsink of sufficient size to conduct away the heat produced. Alternatively, a separate regulated 5V supply may be used and RG1 omitted from the board. Power consumption of the EPROM expansion module with eight CMOS EPROMs fitted is approximately 7 to 10mA whilst in standby and approximately 22 to 25mA whilst being accessed by the playback module. To reduce current consumption during playback, TR2, R4, R5 and LD1 may be omitted if required. LD1 serves as a visual indication of READ status. Current consumption with eight NMOS EPROMs fitted (dependant on type) is approximately 320 to 330mA whilst in standby and approximately 400 to 410mA whilst being accessed by the playback module. Clearly CMOS EPROMs consume much less power than NMOS!

Depending on the capacity of the EPROMs used, the link options on the playback module must be set accordingly, this will be described later in the article. The phrases will of course need to be recorded in the first place, this is achieved using the Digital Record and Playback Module in conjunction with the EPROM Programmer Card. As there are so many possible applications it was decided to make the module as flexible as possible, to this end, there are a number of different options open to the constructor. Selection of the EPROM, 1 to 8 (SK 1 to 8 respectively), can be achieved in either of two ways, Binary or Octal. In Binary mode the EPROM can be selected by feeding the module with a 3 bit binary word with a value of 0 to 7, which will select EPROM 1 to 8 (0 = SK 1, 1 = SK 2, etc.). In Octal mode the EPROM can be selected by taking one of eight input lines high (logic 1), which will select EPROM 1 to 8 (1 = SK 1, 2 = SK 2, etc.), if two or more lines are taken high, the most significant one (highest) will have priority over the other lines. Since the playback module accesses the EPROM continuously whilst it is 'speaking' the EPROM selected should not change, otherwise speech will become garbled. To avoid this an address latch is used, in the Internal latch mode, whenever the 'play' input on the playback module is taken low and the module starts to speak, a control signal latches the EPROM address

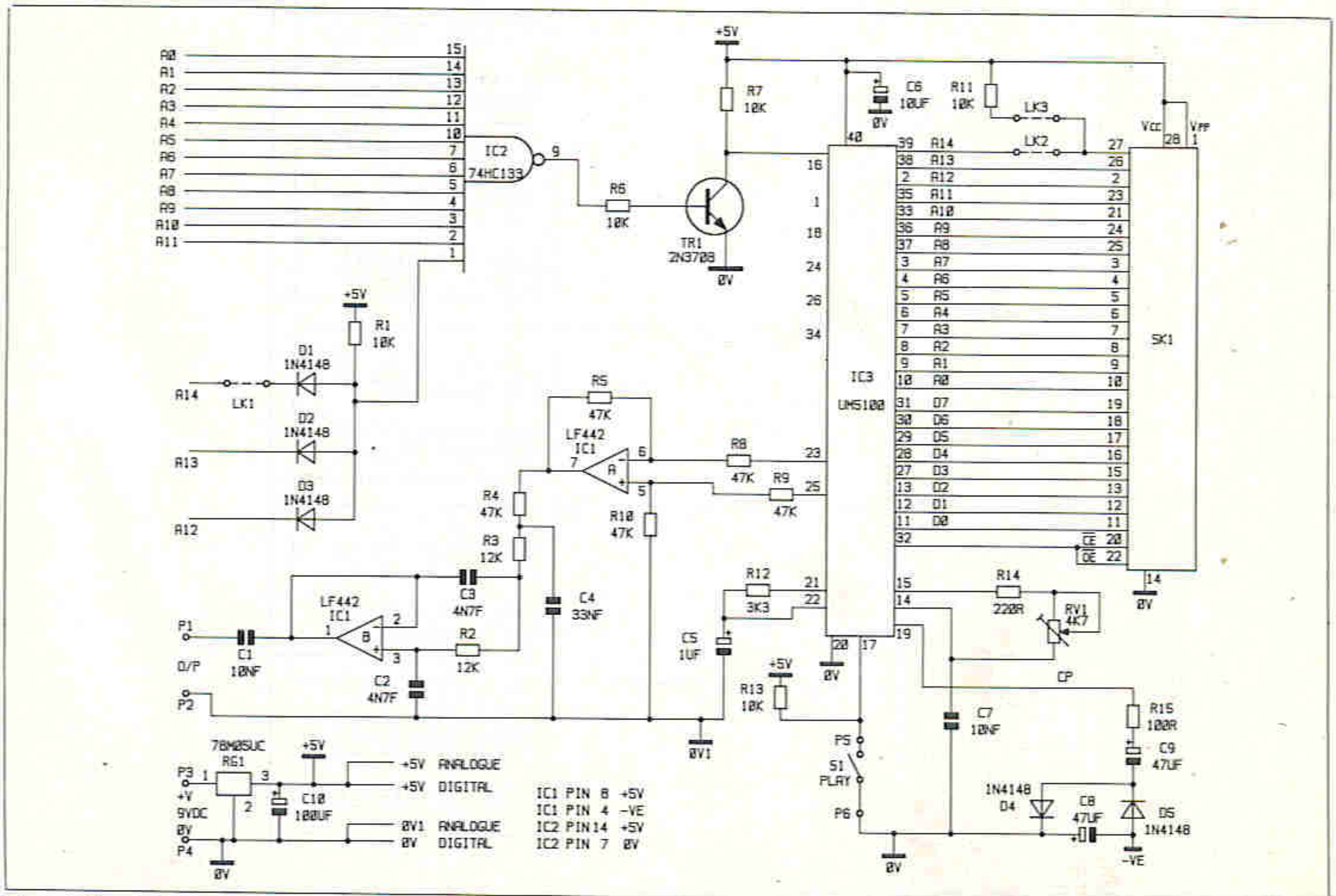


Figure 2. Circuit diagram of Playback Module.

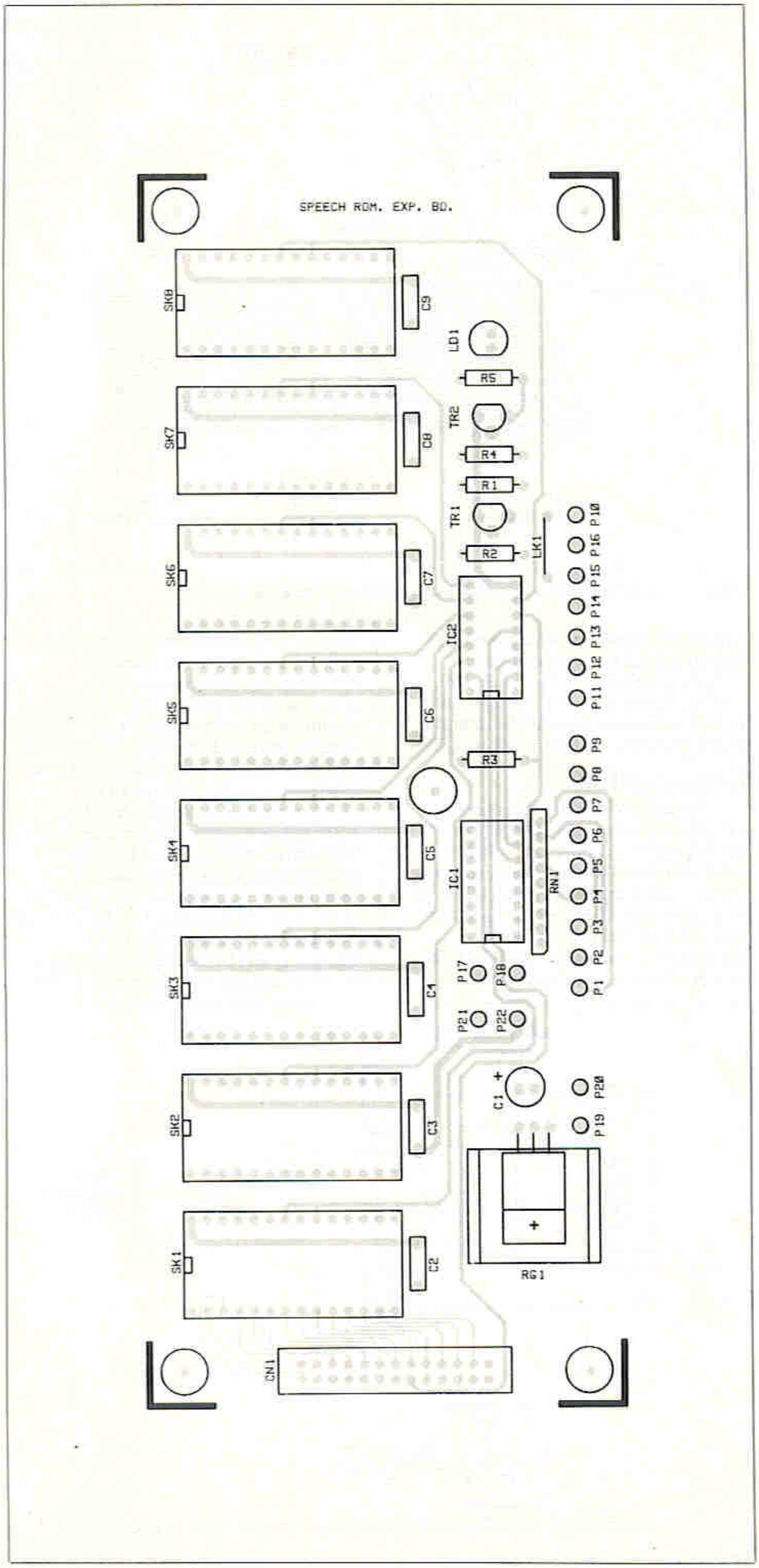


Figure 3. PCB layout.

and prevents it from changing during speech. If a new address is fed into the module it will be ignored until speech has finished. A secondary use of this is that the address need only be provided momentarily whilst the 'play' input is taken low. In External latch mode the address latch is under external control and for this reason the address should only be changed after speech has finished, to indicate whether speech has finished two status lines are provided, one active high and one active low. The READ line will be high during speech and the NOT READ will be low during speech, these lines, in conjunction with the LATCH and ADDRESS lines, may be used to facilitate control from a computer port. So as power consumption is kept as low as possible, the EPROMs are de-selected when the playback module is not speaking. Connection to the playback module is via a 28 pin DIL IDC header plug, IDC cable and a transition header, this makes interconnection very simple. Note: Whilst the DIL header is 28 pin, the transition header and IDC cable are only 26 way, this is because 2 pins are not connected. For this reason please read carefully the construction details when assembling the cable to ensure correct location of the DIL header. (The speech ROM expansion kit includes a pre-assembled IDC cable form.)

Expansion Module Circuit

The circuit shown in Figure 1, at first glance seems quite complex, but in reality it is fairly simple. Connection to the playback module is via PL1, IDC cable and CN1. PL1 is a 28 pin DIL header plug, this plugs into SK 1 on the playback module, see Figure 2 for the circuit of the playback module. Pins 1 and 28 are connected to +5V and since the expansion module has its own localized +5V supply, no connection to these pins is made. This allows use of 26 way IDC cable and a 26 way IDC transition header (CN1). All the other pins are connected, these carry address and data information, A14 to A0 and D7 to D0 respectively, device control signals OE and CE, and last but not least the 0V line. These lines with the exception of the device control signals are 'bussed' to EPROM sockets SK 1 to SK 8, so the sockets are effectively wired in parallel. Only one EPROM is allowed to place information on the data bus at a time, this is achieved using the device control pins 22 and 20 (OE and CE) on SK 1 to SK 8. Pins 1 and 28 (Vpp and Vcc) are connected to the +5V line, and pin 14 (0V) to the 0V line. IC2, a 74HC137, is a 3 to 8 line decoder/demultiplexer and latch, this device is used to select the required EPROM. A 3 bit binary word is applied to pins 1, 2 and 3 (A0 to A2), and a low to high transition on pin 4 (LE) causes the binary address on A0 to A2 to be latched. The output from the latch is fed to the decoder/demultiplexer, where the binary input is decoded to a 1 of 8 octal output on pins 15, 14, 13, 12, 11, 10, 9 and 7 (Y0 to Y7), these outputs are fed to the OE and CE pins on SK 1 to SK 8. The outputs are active low and are under control of pins 5 and 6 (CS2 and CS1), when CS2 is low and CS1 is high the outputs are active, with any other conditions on CS2 and CS1 the outputs are inactive (logic 1). CS1 is pulled high via R3. In most cases the Internal latch mode will be used (LK1 fitted), when the 'play' line on the playback module is taken low, the NOT READ line from the UM5100 will go low, this signal is found on pins 22 and 20 (OE and CE) of PL1. The NOT READ signal is fed to P16 status output and the CS2 input on IC2. The CS2 input is used to deselect the EPROMs when they are not being accessed by the UM5100. NOT READ is also inverted by TR1 to provide the READ signal, which fed to IC2 LE input, where it is used to latch the EPROM address. READ is also fed to P10 status output and is used to switch TR2, which drives D1. D1 lights when the UM5100 is accessing the EPROMs. When the External latch mode is used (LK1 not fitted) IC2's address latch is operated by an external signal applied to P15 LE. Status signals are still available on P16 and P10. IC1, a 4532BE, is a priority encoder, this device converts a 1 of 8 octal input on pins 10, 11, 12, 13, 1, 2, 3 and 4 (D0 to D7) to a 3 bit binary word output pins 9, 7 and 6 (Q0, Q1 and Q2). The octal input to the module is via P1 to P8 (D0 to D7). If more than one input is high, the most significant code is generated, for example if D1 and D3 were taken high, the output would be 011 (binary). The outputs Q0, Q1, Q2, EOut and GS are active if pin 5 (EI) is high. EI is pulled high via R3. If any of the inputs (D0 to D7) are high then pin 14 (GS) will go high, if all of the inputs (D0 to D7) are low then pin 15 (EOut) will go high. EOut and GS are routed to P17 and P18 for external use. The outputs Q0, Q1 and Q2 are fed to IC2's inputs A0, A1 and A2 to provide the EPROM address and also to P12 (A0), P13 (A1) and P14 (A2) for external use, these pins also double as binary inputs when IC1 is removed. The +5V supply is provided by RG1 a 5V 1A regulator, this device is mounted on a vaned heatsink to aid heat dissipation.

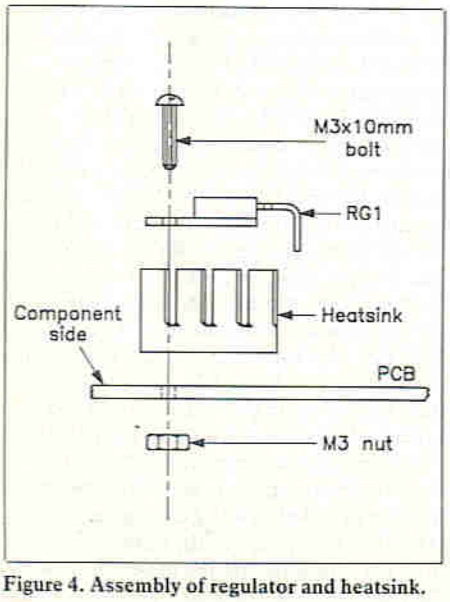


Figure 4. Assembly of regulator and heatsink.

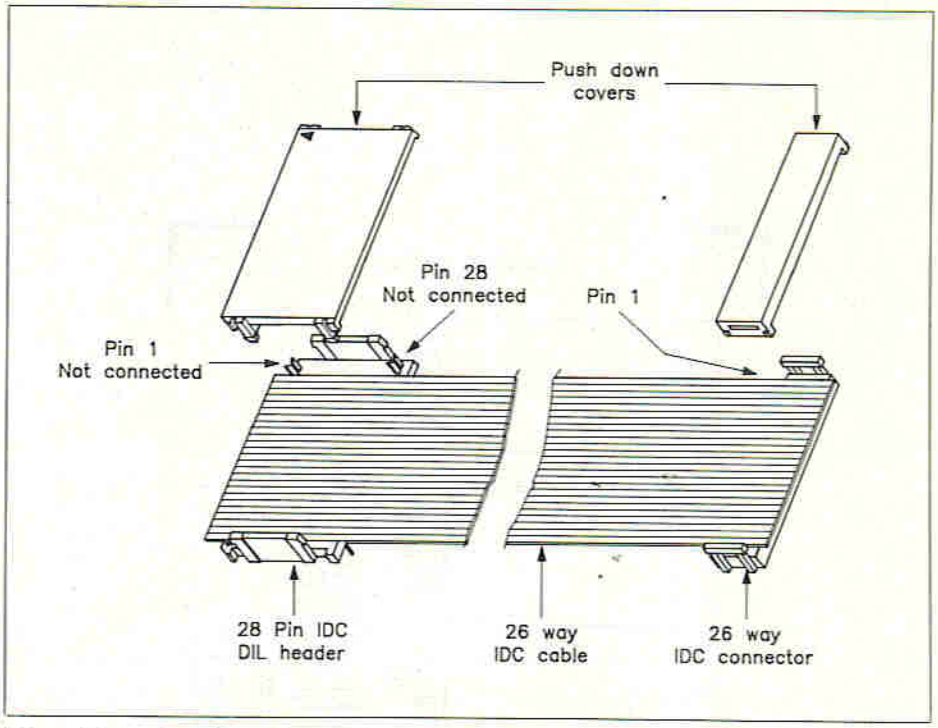


Figure 5. Assembly of IDC cable, DIL header and transition header.

Capacitors C1 to C9 provide supply rail decoupling, C2 to C9 are mounted adjacent to sockets SK 1 to SK 8. The +5V rail is available for external use on P21; care should be exercised so that the power dissipation in RG1 is not excessive.

Construction

Assembly of the module is very straight forward and should not present any difficulties. As the PCB is double sided with plated through holes, removal of misplaced components is quite difficult so please double-check each component type, value and its polarity where appropriate, before soldering! The PCB has a printed legend to assist you in locating where each component goes, see Figure 3 and refer to the parts list.

The sequence in which the components are fitted is not critical, but the following order will probably be found to be the easiest. First insert the pins (22 off!) into the track side of the board, then solder them in. Identify and fit the resistors and the capacitors, note C1 is a polarised electrolytic and must be inserted with correct polarity. Next fit the IC sockets ensuring that the orientation indicator lines up with the corresponding mark on the PCB legend, but do not fit any ICs or EPROMs. Insert the LED, transistors and fit the regulator RG1 and heatsink, see Figure 4. Referring to Figure

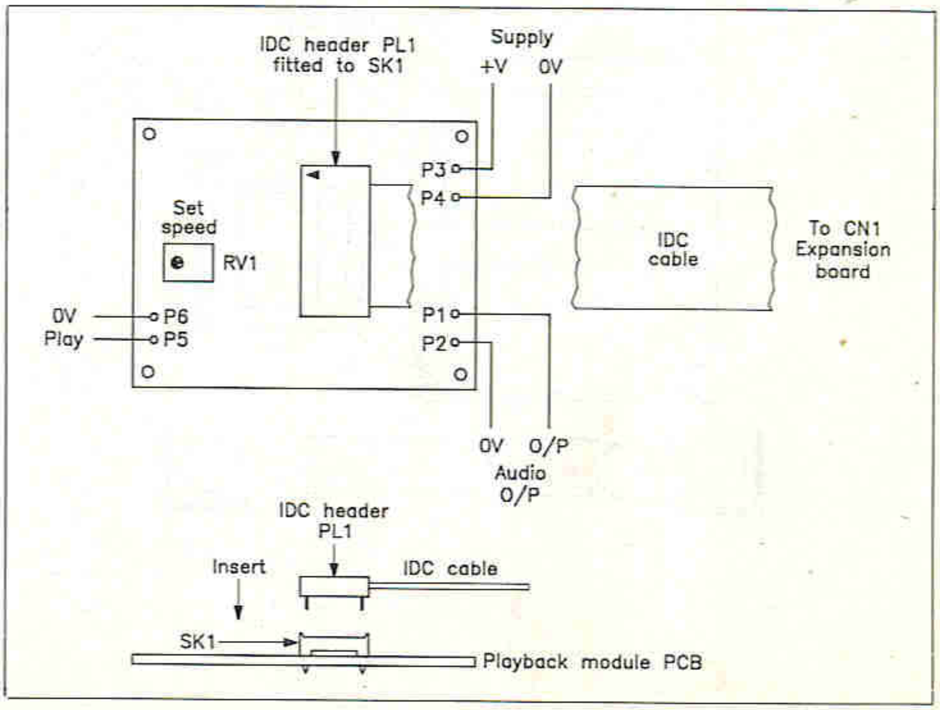
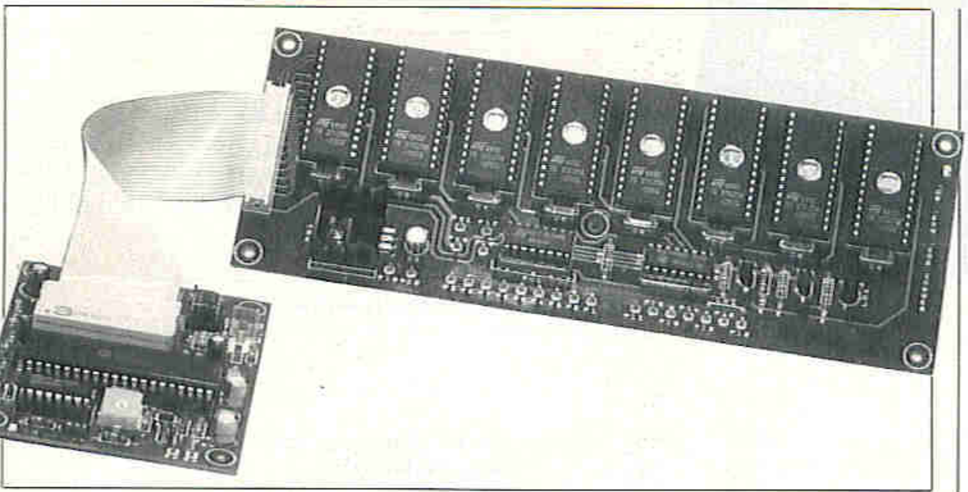


Figure 6. Connecting to Playback Module.



The ROM Expansion board connected to the Playback Module.

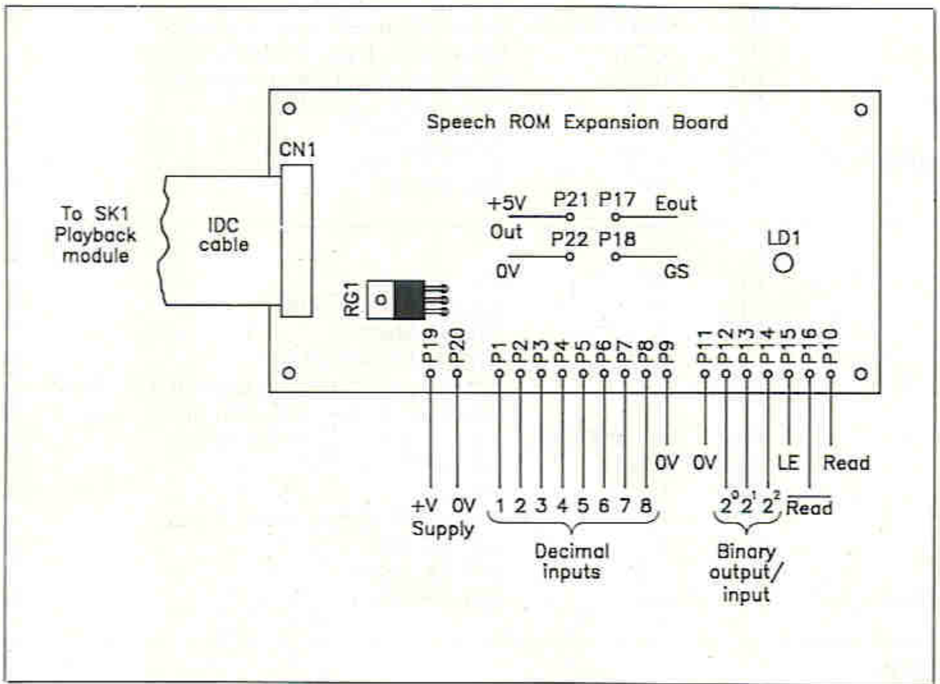


Figure 7. Connections to Speech ROM Expansion Module.

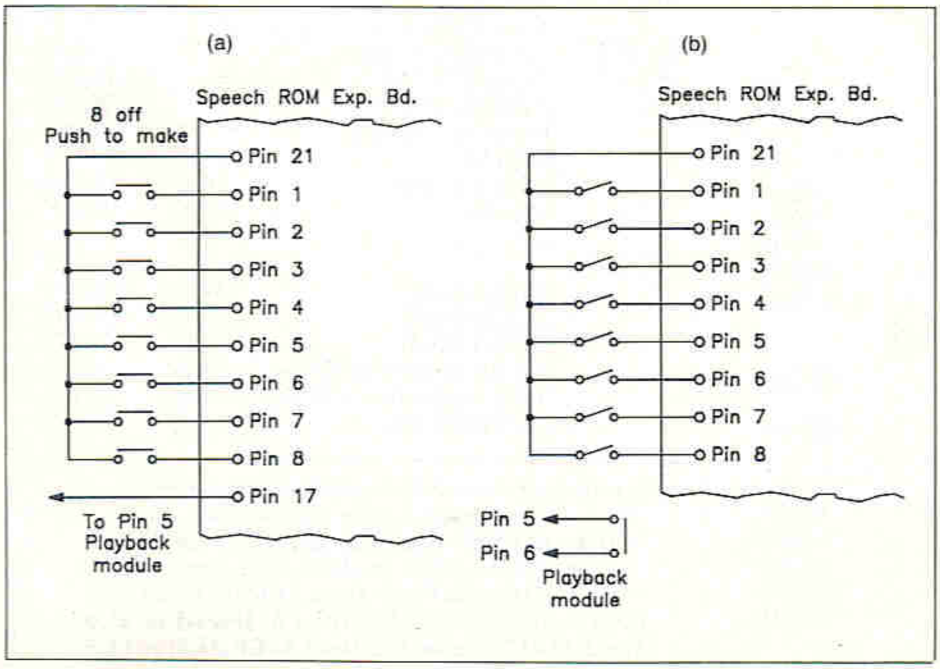


Figure 8a & 8b. Connecting switches to Speech ROM Expansion Module.

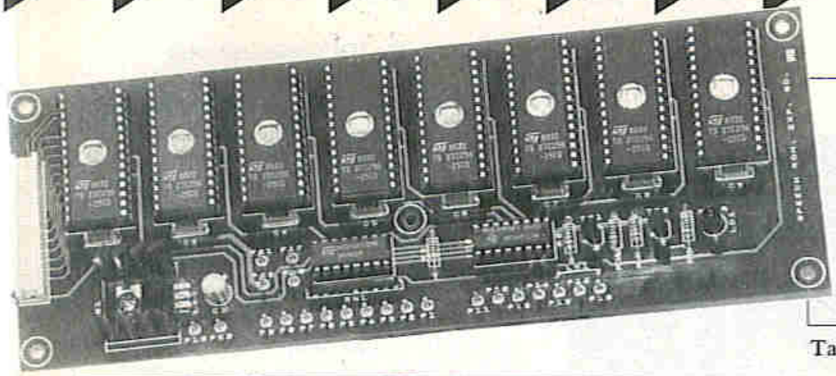
5, make up the IDC cable, ensuring correct location of the 28 pin DIL IDC header plug on the 26 way IDC cable. The PCB IDC transition header may now be soldered to the PCB. LK1 is either inserted or left out depending on whether internal (LK1 fitted) or external (LK1 not fitted) latch mode is required. Before proceeding any further, check over the board, paying special attention for splashes of solder across adjacent joints and incorrectly placed components. Check also that the component leads are properly trimmed.

Testing

The initial testing is to check that the +5V supply is functioning correctly and present on the supply pins of the ICs and sockets, this is done with the EPROM expansion module unplugged from the playback module and *without* any of the ICs or EPROMs plugged into the sockets! Connect a 7.5V to 12V DC supply to P19 (+V) and P20 (0V), and using a multimeter (analogue or digital) check there is +5V ±0.2V present on P21 (+5V out) with respect to 0V (e.g. P22). Check pin 16 of IC1 and IC2, pins 1 and 28 of SK 1 to SK 8, for +5V. Disconnect the supply and insert IC1, IC2. Insert some EPROMs programmed with speech into the vacant sockets, ensuring correct orientation and plug the IDC DIL header into SK 1 on the playback board, see Figure 6. Set the EPROM capacity selection links on the playback board to suit the EPROMs used, see Table 1. Remember, the playback module, as well as the EPROM expansion module, requires a power supply to operate; the supply can be common to both modules however. Connect a suitable amplifier to the playback board. Apply power and you should be greeted by silence. Using a flying lead, e.g. miniature crocodile lead, pull one of the octal inputs (P1 to P8) high (+5V). Momentarily connect pins 5 and 6 on the playback module. D1 should light and the unit should utter speech from the selected EPROM. When speech has finished D1 should extinguish. Now select another EPROM using the octal input and initiate playback, again speech should be heard, but should be from the new EPROM selected. Figure 7 and Table 2 show the module pin functions. Figures 8a and 8b show two ways of connecting switches to select EPROMs in octal. Figure 8a uses push to make switches and the connection from P17 automatically initiates playback, whilst Figure 8b uses SPST switches and a separate push to make switch to initiate playback.

Using the Speech System

The speech system has many different applications and the modules have been made as flexible as possible to cater for a wide range of configurations. If you have used the speech system in an imaginative or ingenious way, please send in your ideas on how you have used the modules so we can print suggested applications.



EPROM	LK1	LK2	LK3	D2
8K	UNMADE	UNMADE	MADE	REMOVED
16K	UNMADE	UNMADE	MADE	INSERTED
32K	MADE	MADE	UNMADE	INSERTED

Table 1. Selecting links on Playback Module.

Octal mode – IC1 fitted

Pin	Name	Description
P1	D0	Octal address in LSD
P2	D1	Octal address in
P3	D2	Octal address in
P4	D3	Octal address in
P5	D4	Octal address in
P6	D5	Octal address in
P7	D6	Octal address in
P8	D7	Octal address in MSD
P9	0V	Zero volt line
P10	READ	Status output, high during speech
P11	0V	Zero volt line
P12	A0	Binary address out LSB
P13	A1	Binary address out
P14	A2	Binary address out MSB
P15	LE	Status output, high during speech (LK1 fitted) Latch enable input (LK1 not fitted)
P16	NOT READ	Status output; low during speech
P17	EOut	Octal status, high on all inputs low
P18	GS	Octal status, high on any input high
P19	+V	Positive DC supply input
P20	0V	Zero volt line
P21	+5V	+5V DC output
P22	0V	Zero volt line

Binary mode – IC1 not fitted

Pin	Name	Description
P1	D0	not used
P2	D1	not used
P3	D2	not used
P4	D3	not used
P5	D4	not used
P6	D5	not used
P7	D6	not used
P8	D7	not used
P9	0V	Zero volt line
P10	READ	Status output, high during speech
P11	0V	Zero volt line
P12	A0	Binary address in LSB
P13	A1	Binary address in
P14	A2	Binary address in MSB
P15	LE	Status output high during speech (LK1 fitted) Latch enable input (LK1 not fitted)
P16	NOT READ	Status output, low during speech
P17	EOut	not used
P18	GS	not used
P19	+V	Positive DC supply input
P20	0V	Zero volt line
P21	+5V	+5V DC output
P22	0V	Zero volt line

Table 2. Pin functions of Speech ROM Expansion Module.

EPROM EXPANSION MODULE PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	2k2	1	(M2K2)
R2,4	47k	2	(M47K)
R3	1k	1	(M1K)
R5	220R	1	(M220R)
RN1	10k SIL Resistor	1	(RA30H)
CAPACITORS			
C1	100μF 10V Minelect	1	(RK50E)
C2,3,4,5, 6,7,8,9	10nF Poly Layer	8	(WW29G)
SEMICONDUCTORS			
D1	5mm Red LED	1	(WL27E)
TR1,2	BC547	2	(QQ14Q)
RG1	μA7805UC	1	(QL31J)
IC1	4532BE	1	(QW89W)
IC2	74HC137	1	(UB31J)
MISCELLANEOUS			
	Printed Circuit Board	1	(GE23A)
PL1/CN1	Spch ROM Cable Frm	1	(JP04E)
SK 1,8	28 pin DIL Socket	8	(BL21X)
	16 pin DIL Socket	2	(BL19V)
	Twisted Vane Heatsink	1	(FL58N)
	Isonut M3	1 Pkt	(BF58N)
	Isobolt M3 10mm	1 Pkt	(HY30H)
	Pins 2145	1 Pkt	(FL24B)
OPTIONAL			
	27C64 EPROM	As Req	(UH43W)
	27C128 EPROM	As Req	(UH95D)
	27C256 EPROM	As Req	(UH44X)
	IDC DIL Header Plug 28 Way	If Req	(JP40T)
	IDC Transition Header 26 Way	If Req	(FA49D)
	IDC Cable 26 Way	If Req	(XR75S)

The parts listed above, excluding Optional, are available as a kit, but not shown in our 1989 catalogue:
Order As LP05F (Spch ROM Exp. Kit) Price £17.95
The Following items are also available separately:
Speech ROM Cable Form **Order As JP04E Price £3.75**
IDC DIL Header Plug 28 Way **Order As JP40T Price £1.86**
Speech ROM Expansion PCB **Order As GE23A Price £9.95**

Air your views!

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.

Loop the Loop!

Dear Roy,
'Hearing the Good News' - letters, Issue 34
The reply to Mr. H.V. Kirby's enquiry was very comprehensive, and represents a good bit of 'first-level' research by your technical staff. However, the true situation is somewhat different, although you wouldn't be able to find this out unless you knew exactly where to enquire. First of all, the basic frequency range of induction loop systems (−3dB points) is 100Hz and 5kHz, as given in BS6083-4. At present, neither equipment or systems have to be approved by the DTI, although action would be taken if any interference was caused by the system. In due course, an approval scheme for loop systems larger than a certain area (which will exempt small systems in living areas) is likely to be introduced, on publication of DTI specification MPT1370, which is only in the draft stage at present. MPT1337 applies to induction-loop systems which use a carrier, and this equipment does require DTI approval. These systems, however, are not normally used (or usable) for communicating with hearing-aid users. The British Standards Institution has set up a panel of industry experts who are at present writing a Code Of Practice for the planning, design, installation, operation and maintenance of Audio Frequency Induction Loop Systems (AFILS). This will include quite a bit on design (when I can get around to writing it, instead of, or as well as, Maplin articles!), because it is a mysterious subject and too many people 'know' things that 'jest ain't so'. Perhaps the subject would make a Maplin article: it could be interesting to students and teachers because of the way 'text-book' physics directly leads to practical design methods.
J.M. Woodgate, Essex.

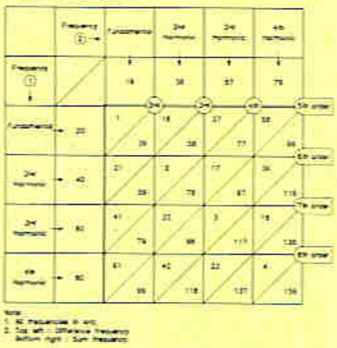
Green Ni-Cad Charger

Dear Ed,
In this 'green age' I am sure that many people would like to find a 'green' way to power their portable equipment. But attaching solar panels to everything could be difficult and may not generate a high enough current. So it could be a convenient compromise if you could publish a project using the 9V or 12V solar panel shown in the Maplin catalogue to recharge Ni-Cd batteries. I presume the circuit would be slightly more complex than simply connecting the panel to the batteries. Is there any chance of seeing a project for a 'solar charger' in the near future? I have just got a GCSE grade A in Systems Electronics and enjoy your projects and have built your Hexadrum. I am now working on your infra-red remote control device as reviewed in the last issue - but one piece of information you left out in the review was whether it could interfere with other remote control devices. I would like to use it to operate the TV booster switch (we receive Welsh channels locally and Devon channels via the booster) but I am worried in case the infra-red controls for the TV or Video recorder trigger the switch (or vice versa). Is this likely to happen? Keep up the good magazine!
Gareth Leyshon, (aged 15), Llanelli, Dyfed.

The ciruit for a solar charger is simple enough. Basically all that is needed, apart from the solar panel, is a constant current source to set the charging current and a diode to prevent the Ni-Cd batteries discharging into the charger and solar panel. Regarding the Infra-Red Remote Control Switch. The transmitter is unlikely to cause mis-operation of other infra-red controlled devices as it produces a fixed frequency burst when the button is pressed, rather than a coded data stream. The infra-red receiver uses a tone detector/PLL IC, so unless another remote control has a carrier frequency matching that of the infra-red switch transmitter, it should not cause mis-operation.

Diagramatic Intermodulation Products

Dear Sir,
I refer to the very interesting article 'Measuring Distortion in the Home Workshop'. Figures 2c and 2d on page 20 show the spectrum of 262Hz and 330Hz, followed by that of 19kHz and 20kHz. I think that with that method of presentation it is not very easy to see how the particular frequencies are derived. For many years I have used a system of deriving intermodulation products from two signals, which I used specifically in the design of frequency converters, so that it is easy to see where there is likely to be trouble before getting down to the practical side of things. I have produced two layouts for the frequencies used in the original article, which give all the frequencies generated up to the 8th order products. From the chart



it can be readily seen which harmonies are producing which frequencies. Please note on the chart that the top left of the diagonal is the Difference frequency and the bottom right is the Sum frequency.
R.G. Morris, Cheltenham, Glos.

Vain Search for Time

Dear Sirs,
It is possible to purchase, at a reasonable price, a programmable clock-radio with the ability to programme a present alarm and have a display of both time and present alarm time? I have looked through the Maplin catalogue in vain for such a circuit. The only timers available seem to be of the '555' type, albeit somewhat more sophisticated at the top end of the range but having no display facility. I wonder if it is possible to build a timer circuit from items in your catalogue. The sort of features I would like to incorporate are as follows:-
Digital LCD - 12 hour clock would be sufficient. On/Off timer function. Timer able to operate with up to, say, 12 hour delays. i.e. ability to programme an interval time rather than a time of day. Output able to drive a small relay for external circuit operations. Indication of time function. Ability to run more than one timer at once.
To change the subject, I notice that you are expanding your Company's interest in Radio Control Cars. I have read in some of the specialist publications about pulse chargers for Ni-Cd batteries. I wonder if there is any possibility of ELECTRONICS including any articles on these types of charger to enlighten those of us eager to know what goes on inside these glittering and seemingly overpriced boxes of tricks. Maybe then I can go and build one! Keep up the good work.
C. Bradburn, Kibworth Beauchamp, Leics.

Over the years, Maplin have presented various different designs for clocks. With the cut-throat prices of commercial products it is not always viable to produce DIY equivalents. Programmable timers are different in this respect and there are certainly possibilities of timer projects in the future. An article on pulse chargers, sounds like a good idea to me, if any readers are 'in the know', drop us a line.

Making Movies

Dear Sir,
I, like many thousands of people in this country, am a keen Videographer and electronics enthusiast, yet I feel as if we are all missing out on some great project ideas. Editing from a camcorder to VHS requires the use of colour correctors, fade/wipe units with combined audio mixers - yet 'Electronics' has never mentioned any such units. Mixing titles from a computer to video could also be possible using so called 'genlock' units yet once again nothing has appeared on your pages. Videography is booming at the moment - just check out the latest camcorder sale figures, so how about it? You could start with a simple detail enhancer and build up to a full Edit suite! Please don't force us to buy commercially available units at sky high prices.
D.L. Roberts, Crosby, Liverpool.

The area of electronics associated with video is extremely interesting, and in recent years a number of ICs have become available to simplify designs for video equipment. With the cost of video cameras and recorders falling, a lot of people are interested in this field. As such we are investigating video related projects. Watch this space!

Target Practice

Dear Sir,
I wonder if your readers, of which I am one, would help me with a project I am working on. I am trying to develop a system whereby when any target, be it a person, wall, post, is at a range of approx. 2 feet, the circuit is triggered, that is, at a maximum of 2 feet. I have tried numerous circuits, I.R. transmitters and receivers, ultrasonic transmitters and receivers, also ultrasonic movement detector circuits, all with little success. Of the circuits already attempted I did achieve some success but the range of 2 feet is very important for my intended application. I would be grateful for any ideas which may assist in my projects and circuits would be welcome.
C. Bevan, Rhondda, Mid. Glamorgan.

An ultrasonic system would probably be the best, but to get accuracy at these distances you need to increase the frequency from 40kHz up to at least 200kHz. Then you have the problem of finding a transducer that will operate at that frequency. They can be made, but we don't know of any manufacturer currently making such a device. (What a waste of effort that answer was – Ed.)

Examining Radio

Dear Sir,
Course for Radio Amateurs Exam - May 1990. There will be a course for the Radio Amateurs Exam to be held at Newark Technical College, Chauntry Park, Newark, Notts, starting in September 1989 on Monday evenings from 7 - 9 p.m. The course tutor is myself, Alister Morrison G4YZG and at present the course fee has not been finalised. For further details, interested readers can contact Bert Drury G1UMK at the college on 0636 705921.
Alister Morrison G4YZG, Newark, Notts.

Dear Alister, if you're running the course; who's Bert? P.S. Since the course fee is not yet decided, please add a small – but not too small – indeed one might almost ask for a generous – sum, for our being kind enough to print your ad in the letters column. All monies raised should be sent to yours truly, Sidney Harber, The Bahamas W.I. Please mark the envelope "Personal and Confidential... and Cash"!

Strengthening the Field

Dear Sir,
The Maplin catalogue features a wide range of radio/TV aerials and associated brackets, lashings, masts and amps, etc. that go with them. It also features a useful section giving information and data on transmitter sites, frequencies and power outputs. This is all very useful for the amateur aerial installer. To complement this, would it be possible to feature, possibly as a project, some kind of field strength meter to assist in the proper alignment of an aerial? Waddya think? Thoroughly enjoy the magazine by the way!!
M. Ashby, Luton.

It certainly seems like a good idea to do a field strength meter as a project, the suggestion is now travelling along the grape-vine (no telephones or fax machines round here!) to the lads in the lab.

TAKE YOUR PICK COMPETITION!

For an annual subscription to 'ELECTRONICS – the Maplin Magazine' you could win one of these super prizes!

B

PROFESSIONAL 6-CHANNEL MIXING DESK
A high quality 6-channel professional stereo mixer with graphic equaliser.

A

TRIPLE TRACE 20MHz OSCILLOSCOPE
Precision laboratory oscilloscope. 3-channels – 3 traces.

REMOTE CONTROLLED COMPUTERISED 12-BAND GRAPHIC EQUALISER Relax in your favourite chair with complete control over the sound from your hi-fi. **C**

D

LASER TUBE, PSU AND CONTROLLER
Laser light is used in disco's and displays as well as finding educational and scientific applications in schools and laboratories, it is also capable of producing holograms.

E

VHF FM 2M 45W TRANSCEIVER
Designed primarily for mobile use but also able to give excellent service as a base station.

AN ANNUAL SUBSCRIPTION (£7.20) IS THE BEST WAY TO COLLECT 'ELECTRONICS' AND YOU CAN START YOUR COLLECTION NOW!

HOW TO ENTER OUR "TAKE YOUR PICK" COMPETITION

1. Order your subscription using the coupon below.
2. Identify the 3 well known electronics components taken in 'close-up' and write your answers in the space provided.
3. Complete the Supplementary question in no more than 20 words.



1 .... 2 .... 3 ....

Supplementary
I would like you to include an article or feature on:

....

....

....

(in no more than 20 words)

Please start my subscription to ELECTRONICS The Maplin Magazine from the Feb/March issue. Enclosed is my cheque P.O. for £7.20 made payable to MAPLIN ELECTRONICS PLC or debit my Access, Visa, American Express or Mapcard account.

In the event of a tie, the best answer in the opinion of the judges to the Supplementary question will be the winner.

P.S. This offer obviously extends to our valued current subscribers who wish to extend their existing subscription but they must use this order form provided. If you wish, a photocopy of the order form will be acceptable.

CHOOSE WHICH ONE OF THE SUPER PRIZES YOU WOULD LIKE IF YOU WIN OUR COMPETITION BY TICKING THE APPROPRIATE BOX

A ☐ B ☐ C ☐ D ☐ E ☐

PLEASE RETURN YOUR ORDER WITH REMITTANCE TO:
THE EDITOR, 'TAKE YOUR PICK COMPETITION',
P.O. BOX 3, RAYLEIGH, ESSEX SS6 8LR.

Name ....
Address ....
.... Postcode ....
Credit Card Account No. ....
Signature .... Date ....

New Subscriber ☐ Subscription Renewal ☐ Customer Number (if known) ....

TERMS AND CONDITIONS
Competition closes Monday 18th December 1989. Subscriptions received using the order form provided and showing the correct answers will be entered into the competition when the "Supplementary" will come into operation. No cash alternative will be available. The winning subscriber will be announced in the April/May edition of ELECTRONICS - The Maplin Magazine. The judges decision will be final.

ELECTRONICS BY EXPERIMENT

Part 11 by Graham Dixey C. Eng., M.I.E.E.

Introduction

Power supplies are essential elements of almost everything electronic. Apart from testing the response of passive networks, there is very little that can be done, experimentally, without them. The requirement for power varies widely with the nature of electronic equipment though, nowadays, most circuits need a low voltage, moderate current source of power that is ripple and noise free and held close to its nominal value over the likely range of load current. Today's experimenter is fortunate in that he can produce a variety of high performance power supplies, suitable for the needs of a wide range of circuits at very modest cost. Furthermore, due to the ready availability of a wide selection of IC regulators, such supplies are not especially complex. A single IC has now replaced what, in the earlier, discrete component version amounted to a substantial number of components. Thus, integration has reduced both cost and complexity while increasing reliability. Nowadays, stabilised power supplies are no longer considered a luxury but are accepted as the norm as a matter of course. Indeed the integrated circuit technology that made them so cheaply available itself demands their use since its power requirements are often that much more critical.

Unregulated Supplies

There is still the occasional need for the simpler, unregulated (that is, unstabilised – since the two words mean exactly the same thing) type of power supply. In fact, in general, the stabiliser is an 'add-on' circuit to what is simply a mains-derived, unregulated source of direct voltage. It is, therefore, entirely relevant to investigate the basic ideas behind the unregulated supply first, before going on to look at the more sophisticated, stabilised version. In an unregulated supply no attempt is made to stabilise the output voltage against possible fluctuations in mains input voltage or load current. As a result, any increase or decrease in the mains input will cause a proportionate change in the d.c. output. Also, because of internal resistance in the power supply (resistance of transformer windings for instance) an internal volt drop occurs that is proportional to load current. Since this internal volt drop subtracts from the total d.c. voltage available to give the net output voltage, any variation in the load current must cause a change in the output voltage.

Figure 1 shows a 'regulation characteristic' for an unregulated power supply. It is nothing more than a graph of output voltage plotted against load current. The chain horizontal line represents a 'perfect' power supply in which there is no change at all in the output voltage, no matter how large a change occurs in the load current. This is the ideal at which the stabilised supply is aimed. The solid line shows how the output voltage falls when the load current increases and represents the performance of a practical supply with

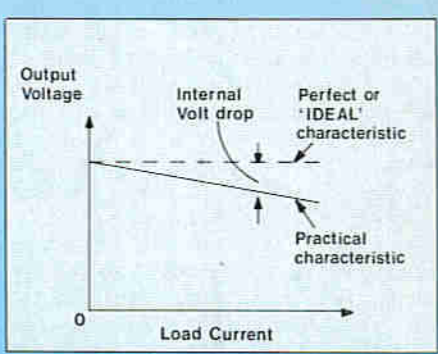


Figure 1. Regulation characteristics for ideal and practical power supplies – representing stabilised and unstabilised supplies respectively.

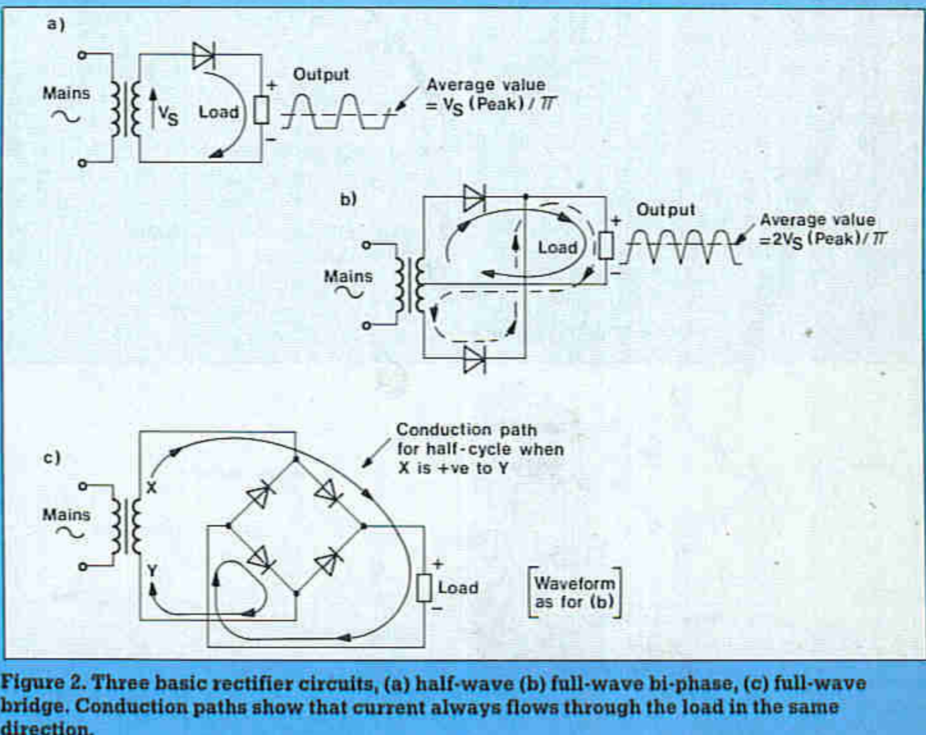


Figure 2. Three basic rectifier circuits, (a) half-wave (b) full-wave bi-phase, (c) full-wave bridge. Conduction paths show that current always flows through the load in the same direction.

some internal resistance; the larger this resistance, the steeper the slope of the line. At any particular value of load current the difference, measured vertically, between these two lines is the value of the internal volt drop in the power supply.

Figure 2 shows three unregulated power supply circuits. Figure 2(a) shows the simplest possible type, which consists of a step-down mains transformer – to provide a lower value of alternating voltage, and a single diode – to rectify the a.c. to produce d.c. This type of circuit is termed 'half-wave' since the diode only conducts on alternate half-cycles of the alternating secondary voltage. The output from this type of rectifier is shown also. There is a limited range of applications for this type of supply since the output is not pure d.c. and has a mean value that is rather less than a third of the peak secondary voltage. Figure 2(b) shows a full-wave circuit of the type known as 'bi-phase'. This uses two diodes, one conducting on one half-cycle of the supply and the other conducting on the other half-cycle. This was the standard arrangement with valve-type supplies but is less used nowadays. It requires a pair of equal secondary windings (or a centre-tapped secondary). The full-wave bridge rectifier circuit of Figure 2(c) is more or less today's standard rectifier circuit. Not only does it need only a single secondary winding but the bridge of four diodes is a readily available, single component, stock item. The waveform for the output of a full-wave rectifier is shown, from which it can be seen that all half-cycles are utilised, the negative supply half-cycles being inverted by the arrangement to 'fill in' the gaps between the positive half-cycles.

Consequently, the output voltage for a full-wave rectifier is twice that for the half-wave type, about 0.63 times the peak secondary voltage. This is approximate because there is a volt drop of about 0.6-0.7 volts across a conducting diode. In the case of the bridge rectifier there are always two diodes conducting in series. Consequently, the voltage lost across a rectifier of this type is 1.2-1.4V; nonetheless, it is still the most used arrangement.

That the circuits of Figure 2 do produce a rectifying action should be evident by tracing the current paths through the load for each polarity of the secondary voltage considered separately. It is always in the same direction. The output of these circuits actually contains two voltage components, the d.c. value which is the average value of the rectified half-cycles, and a 'pulsating' or alternating component which does nothing useful. This alternating component has a frequency equal to the supply frequency (50Hz in U.K.) in the case of a half-wave rectifier, and equal to twice the supply frequency (hence 100Hz in U.K.) in the case of full-wave rectifiers.

The Reservoir Capacitor

It has been stated that the output of either type of rectifier is pulsating rather than pure d.c. It is possible to convert this pulsating waveform to a fairly steady value by following the rectifier (Figure 3) with a high value of electrolytic capacitor, 1,000-10,000μF being typical. When the power supply is first switched on the first half-cycle of voltage out of the rectifier charges the capacitor up to its peak value. If there wasn't quite enough time during this half-cycle for the capacitor voltage to reach this peak value fully, then the next half-cycle would top it up further, until the capacitor voltage had reached a steady value equal to the peak rectifier voltage. If no load current is drawn, the capacitor voltage will remain steady at this value and the output will be true d.c., that is a voltage of constant value approximately equal to the peak value of the secondary voltage. However, since in practice a load will be connected, this load will draw some current from the reservoir capacitor. As a result, its voltage will fall by an amount dependent upon the amount of charge that it has lost; the greater the load current the greater the drop in capacitor voltage. This charge will be replaced during the next half-cycle of voltage from the rectifier since there will be a short time interval near the peak of this voltage when it exceeds the capacitor voltage. Current will then flow from rectifier to reservoir capacitor in order to 'top it up'.

The voltage across the reservoir capacitor under normal conditions of load current being drawn is not constant but has a fluctuation due to the regular partial discharge and charge of this capacitor. This variation is known as the 'ripple voltage' and its value increases as the load current increases. The waveform of this ripple voltage is shown in Figure 3. It is usual to specify the ripple voltage by its peak-to-peak value.

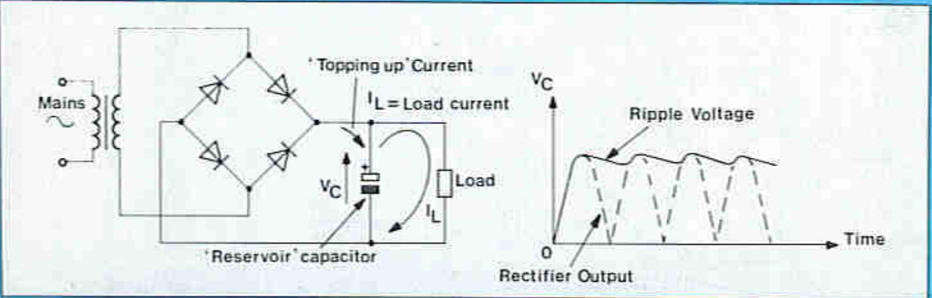


Figure 3. Bridge rectifier with reservoir capacitor. At the peak of each half-cycle the load current drawn from the reservoir is replenished by the output of the rectifier, giving rise to a fluctuation known as 'ripple'.

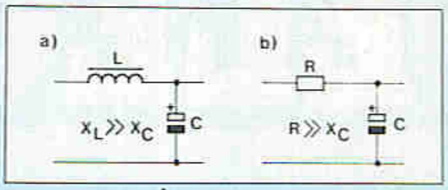


Figure 4. Low-pass filters used to reduce ripple voltage, (a) LC type (b) RC type. Filter is included between reservior capacitor and load.

Obviously the reservoir capacitor has improved the quality of the output voltage but is not a complete solution since there is always some residual ripple on top of the d.c. output voltage. Whether the amount of ripple in the output is acceptable depends upon the particular application. The ripple can be reduced further by two means, one of which is simply to use a much larger reservoir capacitor, but this carries a particular danger.

When the power supply is first switched on the reservoir capacitor is fully discharged. As already stated, the first half-cycle of voltage out of the rectifier will attempt to charge it up to the peak value. This charging current that flows into the reservoir capacitor may have a very high value because a high value capacitor (which the reservoir capacitor is) requires a large quantity of charge in order to reach its full potential; also because the only resistance in the circuit to limit the value of the current is the combined resistance of transformer secondary winding and rectifier diode/s. This is usually quite low in value. If a reservoir capacitor is replaced by one of larger value the result will be a larger initial charging current at switch-on. It is possible for this current to exceed the peak current rating of the diodes; if this happens either the original value of capacitor will have to be reverted to or a rectifier of a higher peak current rating will have to be used.

The second means of reducing the ripple voltage is the use of a low-pass filter, either an LC or an RC type. Both are shown in Figure 4. The former is more efficient but is much more expensive and incorporates a bulky hum-radiating component (the choke) while the RC type is very cheap but has poor regulation because the resistor R has a d.c. resistance that is much greater than that of the choke and is in series with the load current, so contributing to the internal volt drop that was discussed earlier. It is sometimes used where the current drawn from the supply is small and more or less constant. This type of 'smoothed' d.c. supply may be found in some TV sets where a particular supply rail draws a fairly constant load current.

In either case the reactance of the choke L or the resistance of the resistor R must be substantially greater than the reactance of the smoothing capacitor C at the ripple frequency. The real problem is that, unless the load current is quite small, the choke has to be very large physically or the resistor has to have a high value so dissipating a substantial amount of power, and hence heat.

Because the present tendency is for electronic circuits to require low voltage and high (relatively speaking) current, the above types of rectifier circuit are less common than they once were. The easiest way of getting rid of the ripple voltage, using current technology, is to follow the rectifier with a stabiliser since, by definition, the constant output of a voltage stabiliser cannot contain any significant amount of ripple. Because IC stabilisers are so cheap the solution is an ideal one and the one that will invariably be used. However, before moving on to a discussion of full-blown IC regulators, it is worth looking at a very simple way of stabilising a voltage using just two extra components; one of these is the zener diode.

The Zener Diode

The circuit shown in Figure 5(a) is known as a 'shunt' stabiliser because the stabilising element, the zener diode, is in shunt or parallel with the stabilised output voltage. Figure 5(b) shows the 'third quadrant' characteristic (reverse current against reverse voltage) for a zener diode, which is the best way of understanding how it works. This type of diode is operated in the reverse region and under breakdown conditions. It is, in effect, merely a silicon diode which, by special fabrication, breaks down at low values of reverse voltage, in the approximate range of 3-24V. To be academic about it, diodes that break down below about 5.6V are true zener diodes; those that break down above this figure are actually 'avalanche' diodes. The physical mechanism is different for each type, though the end result is more or less the same.

breakdown is controlled so that the dissipation of the diode is held within safe limits. By contrast, when a rectifier diode breaks down in use, it is accompanied by a combination of high voltage and high current, without the benefit of any significant series limiting resistance; the result is instant destruction. The breakdown of a zener diode is a reversible phenomenon in that, once the reverse voltage is reduced below the breakdown value, the diode recovers completely.

Figure 5(b) shows that there is a minimum value of diode current if the voltage across the diode is to remain in the constant region; this current is shown as $I_{Z(MIN)}$ and if the current is allowed to fall below this value stabilisation ceases to be effective. There are two important relations to be found by inspection in Figure 5(a) that are used in the design of a stabiliser of this sort. They are:

(i) $I_S = I_Z + I_L$
(ii) $V_{IN} = V_S + V_Z$

Equation (i) states the obvious, that the total supply current is equal to the sum of the current through the zener diode and that through the load. At any instant this supply current is constant so that, if the load current increases the diode current reduces, and vice-versa. Since the diode current must never fall below the value of $I_{Z(MIN)}$, this sets an upper limit on the load current, I_L, such that $I_{L(MAX)} = I_S - I_{Z(MIN)}$.

Numbers should make this easier.

Suppose that the supply current is calculated as being 50mA and $I_{Z(MIN)}$ for a particular diode is 5mA, then the maximum value of $I_L = 50 - 5, = 45$mA.

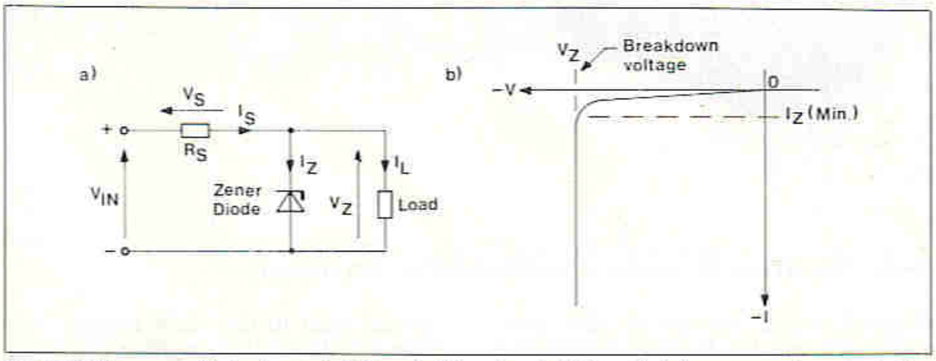


Figure 5. The zener diode shunt stabiliser, (a) the circuit, (b) the diode's reverse characteristic. The design of this circuit is discussed in the text.

The breakdown action is shown by the way in which the reverse current is initially very small, virtually negligible up to the breakdown voltage, and then rises rapidly to a high value, limited only by the series resistance. This method of limiting the current once breakdown has occurred is essential to the design of this type of stabiliser and the only real calculations needed involve determining a suitable value of series resistor (the resistor R_S in Figure 5(a)), apart from ensuring that the rating of the diode is itself adequate for the particular application. Any semiconductor diode, zener or otherwise, will break down if the reverse voltage is made high enough. The difference is, that in the case of the zener or avalanche diode, the

Also obvious from equation (i) is the fact that, if the load is disconnected, then $I_L = 0$ and $I_Z = I_S$. Under these conditions the diode must be able to pass this current without over-dissipation. This maximum value of $I_{Z(MAX)}$ is calculated from the relation:

$I_{Z(MAX)}$ = (Power rating of zener diode)/(zener voltage)

For example, a 10V 500mW zener diode has a maximum current rating of 500mW/10V = 50mA.

Equation (ii) states that the difference between the supply voltage and the zener voltage will be dropped across the series resistor R_S. This fact is used to calculate the value of R_S and its power rating. To take an example:

Suppose that the supply voltage is 15V d.c. (this is the unregulated output from the transformer/rectifier developed across the reservoir capacitor), the regulated output is to be 10V and the load current can have a maximum value of 60mA. Assume that $I_{Z(MIN)}$ is 5mA. This leaves just three unknowns before the design is complete. They are:

(a) The value of the series resistor R_S.
(b) The power rating of R_S.
(c) The power rating of the diode.

Taking (a) first, the value of R_S is chosen so that, with the load current equal to zero, the diode current is safely limited to the sum of $I_{Z(MIN)}$ and $I_{L(MAX)}$, i.e. 5mA + 60mA = 65mA. This is the normal current through R_S.

The voltage across $R_S = V_S - V_Z, = 15 - 10 = 5$ volts.
The value of R_S is therefore equal to 5volts/65mA = 5/0.065 = 76.92 ohms

A preferred value of either 75 ohms or 82 ohms would be chosen in practice.

Now consider (b) The maximum power dissipation in R_S = 5 volts x 65mA = 5 x 0.065 = 0.325 watts.

In this case the dissipation of the series resistor is negligible and a standard half-watt resistor is suitable. However, in some designs the dissipation works out to be several watts and wirewound resistors have to be used.

Finally, the power rating of the zener diode is determined by multiplying the zener voltage (10V) by the maximum possible diode current (65mA), giving a value of 650mW, too great to allow the use of a 500mW type but well within the rating of a 1.3W diode.

If the above seems at first somewhat academic, a little more thought ought to show that it is nothing more than an organised approach to the safe design of a useful little circuit. It is simplified in one respect, it does not take into account increases in V_S (which cause an increase in diode current) or decreases in V_S (which may cause the diode current to fall below $I_{Z(MIN)}$ under extreme conditions). It is possible to calculate for these input changes but that would be piling on the agony! Good design will always automatically incorporate a safety margin anyway, without the need for further calculations.

Where does the experimental aspect come into this? If the idea of designing a simple stabiliser of this type appeals, then an obvious way of proving the validity of the above discussion is to find a zener diode in the spares box, calculate its maximum permissible current and work out a suitable value of series resistor, making a guess that $I_{Z(MIN)}$ might reasonably be 5mA. It will be necessary to assume also a supply voltage rather higher in value than the zener voltage. It isn't necessary to make up a transformer/rectifier for this test; a laboratory power supply or even a battery will do as well. Using the set-up of Figure 6 various

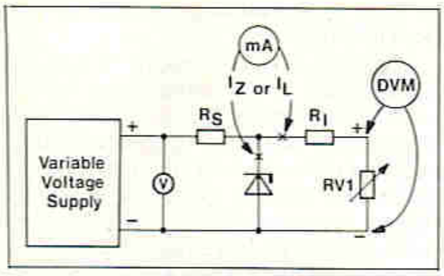


Figure 6. Experimental set-up to study operation of zener diode stabiliser. Voltmeter V reads input to stabiliser; DVM reads stabilised output voltage; mA reads I_z or I_L – circuit must be broken at either point marked to insert meter 'in series' with current.

parameters can be varied and the effects noted. For example:

(a) If a digital voltmeter is available, the variation in the output voltage as the load current is varied from zero up to the point where the current through the zener diode is too small (less than $I_{Z(MIN)}$). This point will be obvious when the output voltage starts to dip rapidly. Including a milliammeter in series with the diode as well as with the load will allow the actual value of $I_{Z(MIN)}$ to be determined.

(b) The lowest value of input voltage that the circuit will accept before the output voltage begins to fall. This will depend upon the value of the load current, being worst when the load current has its full value.

It is not advised to try increasingly high values of the input voltage as this will do nothing more than cause over-dissipation of the zener diode and/or the series resistor.

Although the zener diode shunt stabiliser has limitations as anything other than a fairly low current, fixed voltage supply, it is nonetheless often useful, both in its own right and as the reference section of a more sophisticated stabilised voltage supply – which is what is next on the agenda.

A Stabilised Power Supply

The block diagram of a stabilised power supply is shown in Figure 7. As previously stated, the input voltage to the stabiliser is derived from a mains transformer/rectifier unit, the unregulated voltage being developed across a reservoir capacitor, also as previously described. The stabiliser itself has two principal sections, one of which is known as the series element, the other being the shunt element.

The series element can be considered as a device whose conductivity is controlled by the output (shown as the 'error voltage') of the shunt section. This variation in conductivity determines just how much voltage is dropped across the series element. The latter is quite simple and usually just consists of a Darlington arrangement of transistors whose input is provided by the error voltage mentioned earlier. The key to the whole action is provided by this control of conductivity, since the output voltage will at all times depend upon the difference between the unregulated input voltage and the voltage dropped across the series element. By making this conductivity dependent upon variations in either supply voltage or load current, the output voltage can be forced to be constant.

For example, if the unregulated supply has a value of 18V and the required output voltage is 12V, then clearly 6V will be dropped across the series element. If now the unregulated supply increases by 1V to 19V, then the conductivity of the series element will have to be reduced slightly so that it now drops 7V, thus keeping the output voltage at the required value of 12V (19V – 7V = 12V).

The opposite action occurs if the unregulated input voltage falls; the conductivity now has to increase somewhat in order to drop less voltage if the output is to remain constant.

Similar compensation occurs for varying load currents, the series element automatically changing its conductivity in order to maintain a constant output.

The big question is, of course, how is the automatic action obtained?

The answer lies in the shunt section which, it will be noted has two inputs. The one to the left is a reference voltage, V_{REF}, derived incidentally from a simple zener diode stabiliser of the type just discussed. This is a constant voltage source in its own right. However, its sole function is to act as a reference to allow comparison with what is happening at the output of the power supply.

Here are found two resistors, R1 and R2, these acting as a potential divider to provide a voltage that is proportional to the output of the supply. This is the second input to the shunt section. The latter is a differential amplifier that looks at the output-derived voltage, compares it with the zener-derived voltage and decides if the former voltage is either above the reference, equal to the reference, or below the reference. Depending upon the answer to these questions, it will generate the 'error voltage' that controls the conductivity of the series element. Simple isn't it?

There is one particular elaboration that must always be built into power supplies of this type – short circuit protection. When a short is applied to the output terminals the output voltage reduces to zero and the whole of the input voltage gets dropped across the series element. If this isn't switched off immediately it will be destroyed. This provision is included in IC regulators as a matter of course.

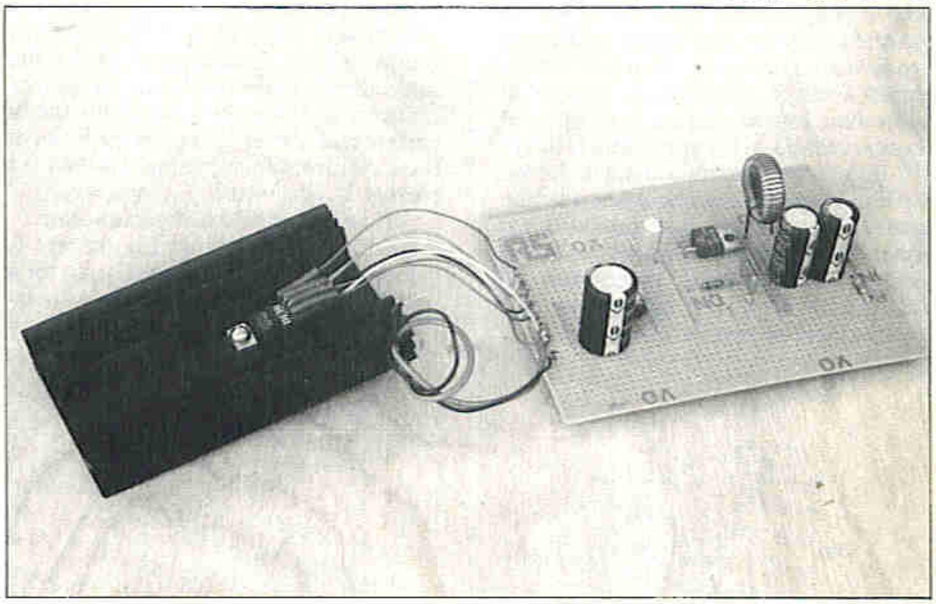


Photo 1. The author's 18V version of the Switched Mode Power Supply.

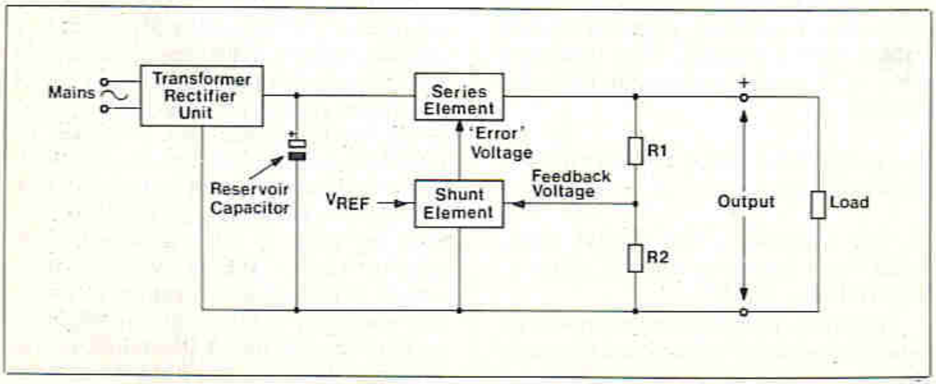
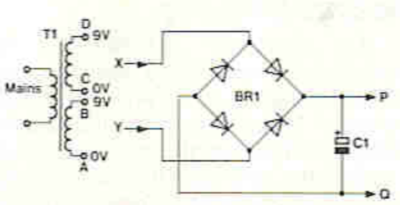


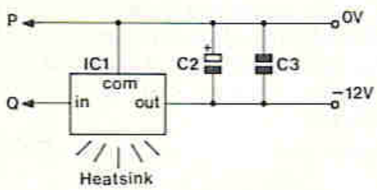
Figure 7. Block diagram of stabilised power supply.

a)



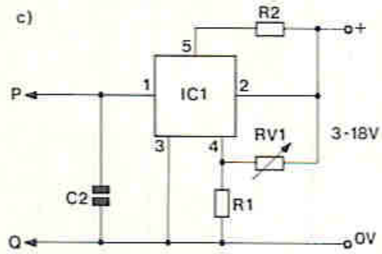
T1 = Min Tr 9V (WB11M)
BR1 = W01 (QL38R)
C1 = 680μF 40V (FB79L)

b)



IC1 = 79M12 (WQ89W)
C2 = 10μF (FB23A)
C3 = 100nF Disc (BX03D)

c)



IC1 = L200 (YY74R)
MOUNT ON HEATSINK (FL41U)
R1 = 820R (M820R)
R2 = 1R (MIR)
RV1 = 4k7 Preset (WR83E)
C2 = 220nF Polyester (BX78K)

TRANSFORMER CONNECTIONS

CIRCUIT (b)	CIRCUIT (c)
PARALLEL CONNECTION	SERIES CONNECTION
A-C	B-C
B-D	D-X
D-X	A-Y
A-Y	

Figure 8. Use of IC regulators to obtain a negative or variable positive voltage supply, (a) transformer/rectifier unit suitable for use with either (b) −12V 0.5A supply or (c) 3–18V positive variable supply.

Once upon a time such circuits would have been built up from a host of discrete components. Now, thanks to integration, the whole lot apart from such obvious components as the transformer/rectifier unit, reservoir capacitor and a few external components to set the parameters, etc, are available in a small and inexpensive silicon chip. Figure 8 (a) shows the design for a suitable unregulated supply that will drive either of the IC regulator circuits shown in Figures 8 (b) and (c). Designs for a +5V regulated supply and a ±15V regulated supply have already been presented in Parts One and Six of this series, respectively. These additional two circuits help to complete the picture by showing how a fixed negative supply or a variable positive one can be obtained.

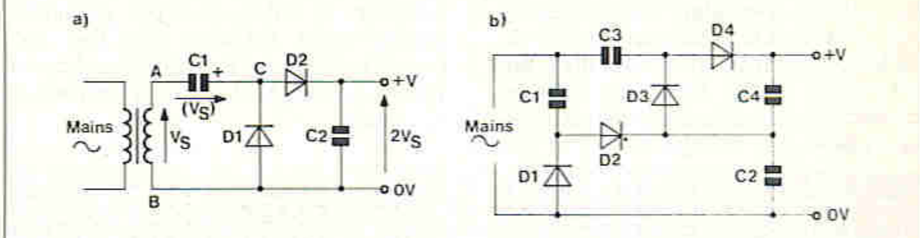


Figure 9. Voltage multipliers, (a) the doubler circuit, (b) the quadrupler circuit.

The Voltage Multiplier

There are occasional exceptions to the usual need for low voltage, high current supplies. Sometimes there is a requirement for a high, or even very high, voltage at a comparatively low current. The provision of the E.H.T. supply for a cathode ray tube is an example. One way of achieving such a high voltage is to use a mains step-up transformer, but this is expensive and carries other problems. An alternative is to use a voltage 'multiplier' circuit; the simplest example of this is the voltage doubler, but the idea can be extended to any number of stages in order to develop as high a voltage as one needs. Two of these multiplier circuits are shown in Figure 9, a doubler and a quadrupler.

Examination of the operation of the doubler circuit of Figure 9 (a) will give an understanding of how these circuits work in general.

As a starting point, it is convenient to assume that the alternating supply is on the half-cycle where the Point A is negative with respect to Point B. Diode D1 will be forward biased and will conduct, a charging current then flowing into C1 so that its potential quickly reaches the peak value of the secondary voltage V_S with the polarity shown. On the next half-cycle the Point A will be positive with respect to B and the total voltage between C and the 0V line will be the sum of the secondary voltage V_S and the capacitor voltage (peak value of V_S), that is twice V_S (peak) at the peak of the supply cycle. Diode D2 is now forward biased, allowing a charging current to flow into C2 so that it charges up to twice V_S (peak). Hence the output of the circuit is double the peak input voltage from the secondary winding.

The voltage quadrupler and higher order circuits merely extend this basic idea, and it is obvious that, from the moment that power is first applied to the circuit, a succession of charging cycles occurs as the successive capacitors in the chain charge up. However, even at mains frequency the time taken for the full output to appear is no more than the blink of an eye!

Any experiments with this circuit should be restricted to a low voltage input (e.g. from a 12V secondary winding) and a small number of stages only made up. It should be obvious that, even with modest amounts of multiplication, quite large voltages are quickly developed. For example, a 20V RMS secondary and an 8-stage multiplier will give an output of around 200V! Available current from the supply depends upon the stored charge in the capacitors. Quite low values, no more than a few microfarads, will suffice for testing the circuit.

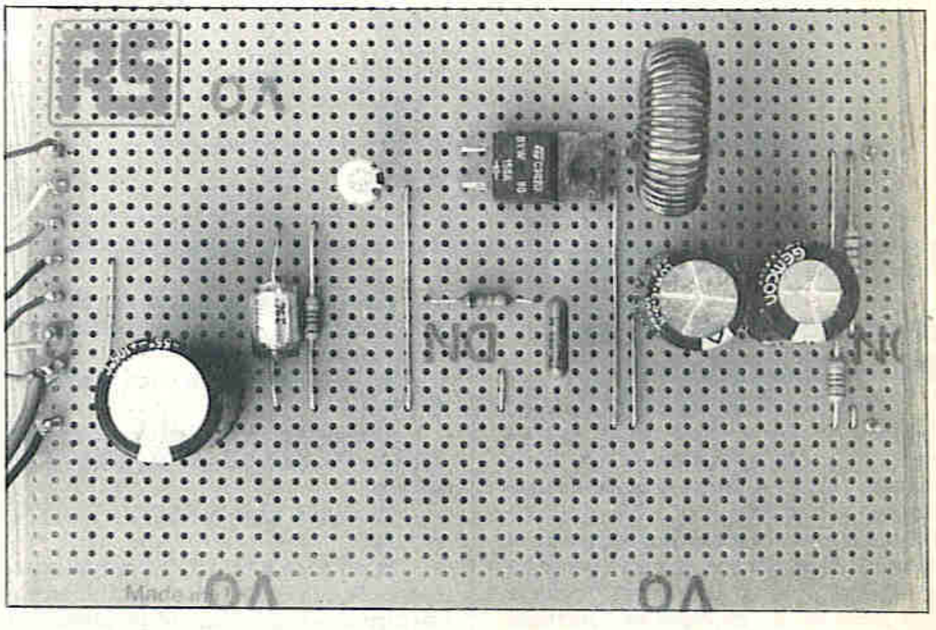


Photo 2. Top side view of the stripboard layout of the SMPS.

The first tests should be made with no load connected across the output, the RMS value of the secondary voltage being read, with an a.c. voltmeter, first of all. Multiplying this reading by 1.414 gives the PEAK value of the secondary voltage. Transferring the multimeter, now set to the appropriate d.c. voltage range, to the output terminals will prove whether the circuit is doing its job, that is whether the output voltage really is 2x, 4x, 8x, etc, the peak secondary voltage, depending upon the factor required. If now a load resistor is connected across the output terminals and gradually reduced so as to draw a progressively larger load current, the output voltage will be found to fall quite substantially, indicating the limited current capability of this type of circuit.

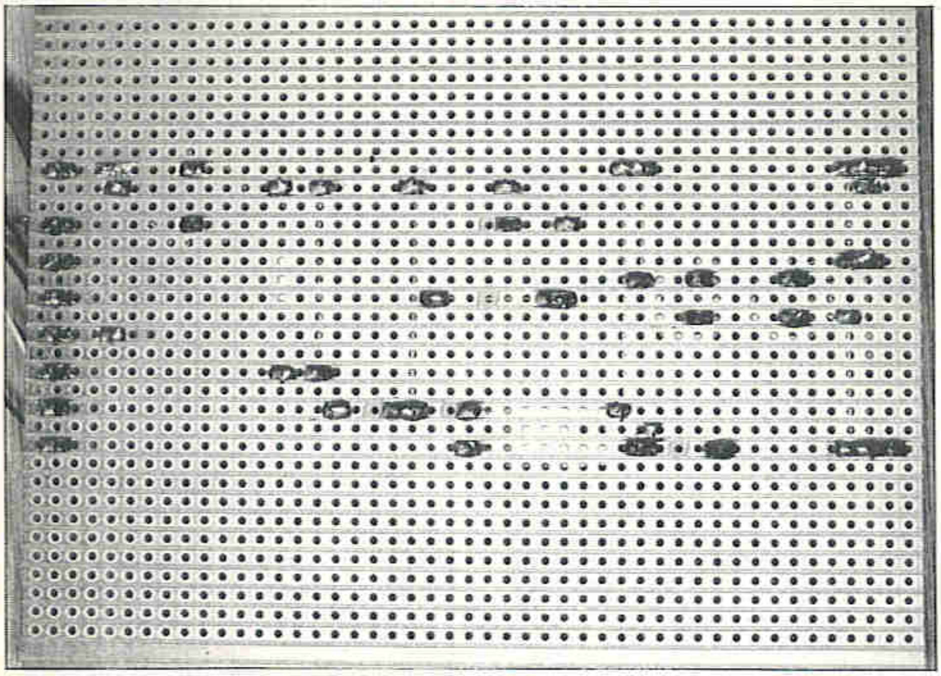


Photo 3. Copper side view of the SMPS board. Note that only five track breaks are required.

An Adjustable Zener Diode Regulator

The zener diode regulator discussed earlier provides a fixed output voltage equal to the zener voltage of the diode chosen. This is, of course, a nominal value subject to a tolerance of ±5% typically. Further, zener voltages are available in discrete steps and sometimes it might be an advantage to be able to set a voltage that perhaps lay between two of these values. For example, a zener voltage of 6.5V might be desired; the nearest values are 6.2V and 6.8V. Sorting through a selection of either of these particular diodes might discover one that just happened to have the right breakdown voltage, namely 6.5V. Not very convenient obviously.

The TL430C 'adjustable zener regulator', shown in Figure 10, has the properties of a zener diode but, by the use of two external resistors (in addition to the usual series resistor R3 in this figure), can be set to give a stable voltage anywhere in the range 3-30V. This voltage is calculated from the formula $V_{OUT} = 2.75[1 + (R1/R2)]$. By making one resistor, say R1, variable it is possible to 'trim' the circuit to have the precise voltage required.

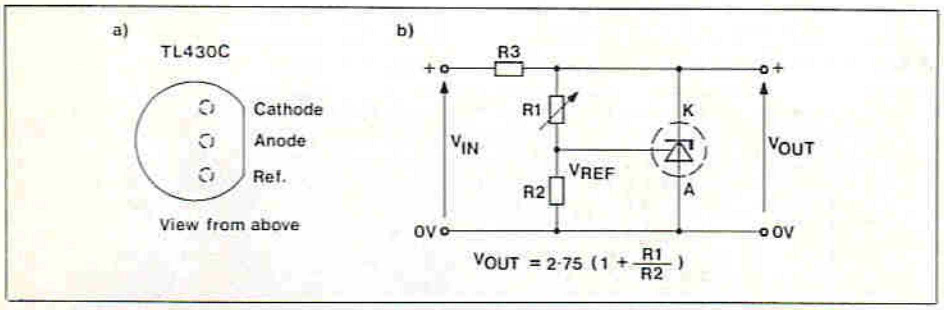


Figure 10. The TL430C Adjustable Zener Diode, (a) the connections (b) application circuit with formula to calculate for required voltage.

For example, to obtain the value of 6.5V mentioned earlier, the calculations could be as follows.

To start with, we have: $6.5 = 2.75[1 + (R1/R2)]$

Assign an arbitrary but sensible value to R2, say 1k, then: $6.5 = 2.75[1 + R1/1)]$ (R1 is in k)

Therefore $R1 = (6.5/2.75) - 1$
$= 1.36k$

In practice it would be convenient to use a 2.5k preset for R1 so that the correct resistance value occurred at about the mid-point of the wiper travel.

A Switched Mode Power Supply

An alternative approach to the provision of a stabilised power supply is offered by the use of the 'power switching regulator'. In this design, the unregulated voltage from the transformer/rectifier unit is used as the input to an IC in which one of the main sections is a high frequency square-wave oscillator. The output from this oscillator can be converted to d.c. by clamping its negative peaks (in the case of a positive supply) and filtering out the high frequency component. Because of the high frequency used the filter components can have quite low values; in fact LC filtering is quite feasible since the coil is small and inexpensive whereas at mains frequency such a coil is large and expensive.

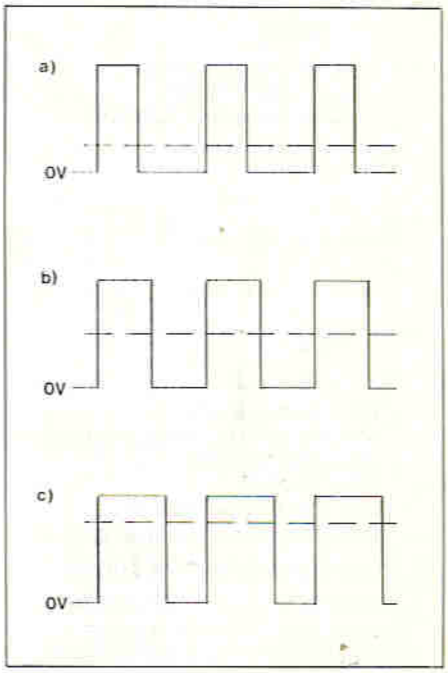


Figure 11. The effect of mark/space ratio on average value (chain line).

The effective d.c. output is the mean value of the square wave, which will depend upon the mark/space ratio of the waveform (hence strictly speaking the wave is rectangular rather than truly square). This gives a clue to the way in which the output level can be controlled – by control of this mark/space ratio, a process known as 'pulse width modulation'. See Figure 11.

OUTPUT VOLTAGE (d.c.)	TRANSFORMER SECONDARY VOLTAGE (RMS)	VALUE OF R4
9V	9V	3k6
12V	12V	6k2
15V	13.5V	9k1
18V	15V	12k
24V	20V	18k
30V	24V	23k

Table 1. Values of secondary voltage and resistor R4 for a range of output voltages for the SMPS circuits of Figure 12.

In the case of the stabilised power supply shown in Figure 7, a feedback voltage, taken from the junction of a potential divider across the output, was used to develop an error voltage which then controlled the series element. In the switching regulator design of Figure 12, a feedback voltage is produced in exactly the same fashion, from the potential divider R3/R4. This is fed back to pin 2 of the L4960 IC in order to control pulse width and, hence, output voltage level. Once again a loop of dependence is formed that maintains a constant output.

This is a simple and useful power supply to build. Evidence that the oscillator is working is given by the presence of a sawtooth waveform, of periodic time 10μs, at pin 5 (where the RC combination R2C2 controls the oscillator frequency). As a guide, this should have an amplitude of about 2.4V. It would be reasonable to expect the square-wave to appear at pin 7. However, the presence of the LC filter L1C5/C6 means that what one sees in practice is a train of damped oscillations (ringing) at this point at the oscillator frequency of 100kHz. The stabilising action can be seen working by varying the input voltage which then shows amplitude variations in the ringing, while the output remains constant over a wide range of input voltage.

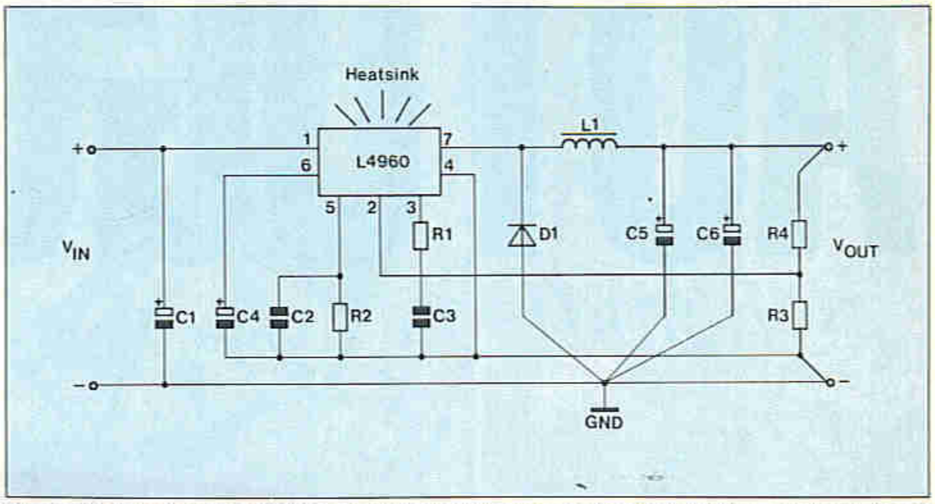


Figure 12. Circuits and parts list for a Switched Mode Power Supply (SMPS) using the L4960 IC. The 0V (GND) arrangements shown should be adhered to. Photographs of an 18V version of this circuit also accompany this feature.

Photographs are included of the author's own design for such a power supply using the L4960 regulator IC. The latter is capable of delivering a wide range of voltages at currents up to a maximum of 2.5A. The IC has to be mounted on an adequate heatsink and the input voltage to pin 1 should be limited to about 4V in excess of the required output. For this reason this particular design is more suitable for a fixed rather than a variable voltage output. Thus, for an output voltage of 24V, the d.c. input to pin 1 should be about 28V. Using a conventional transformer/rectifier the secondary voltage would need to be 20V RMS [since 20 x 1.414 = 28V (approx.)]. A table of secondary voltages and R4 values for a range of discrete output voltages is given in Table 1. A full components list for a design to give +18V at 2.5A appears in Figure 12.

PARTS LIST

IC1	L4960	(UK64U)	C2	Polystyrene 2200pF	(BX37S)
R1	15k	(M15K)	C3	Polyester 33nF	(BX73Q)
R2	4.3k	(M4K3)	C4	Electrolytic 2.2μF 100V	(FF02C)
R3	4.7k	(M4K7)	C5,6	SMPS Cap 220μF 50V	(JL51F)
R4	See Table 1		D1	BYW80-150	(UK63T)
C1	SMPS Cap 100μF 100V	(JL50E)	L1	Toroid 150μH 5A	(JL72P)
				Heatsink	(FL41U)

CLASSIFIED

If you would like to place an advertisement in this section, here's your chance to tell Maplin's 200,000 customers what you want to buy or sell, or tell them about your club's activities – absolutely free of charge. We will publish as many advertisements as we have space for. To give a fair share of the limited space, we will print 30 words free of charge. Thereafter the charge is 10p per word. Please note that only private individuals will be permitted to advertise. Commercial or trade advertising is strictly prohibited in the Maplin Magazine.

Please print all advertisements in bold capital letters. Box numbers are available at £1.50 each. Please send replies to Box Numbers to the address below. Please send your advertisement with any payment necessary to: Classifieds, Maplin Mag., P.O. Box 3, Rayleigh, Essex SS6 8LR.

For the next issue your advertisement must be in our hands by 1st December 1989.

VARIOUS FOR SALE

AUDIO, VIDEO and computer leads and adaptors made to order. Accessories, amplifiers, effects units, mixer etc. Kits and built units. Over 12,000 leads available. Call for details; Paul (0736) 798765.

TELEQUIPMENT D43 oscilloscope, dual trace, in excellent condition, complete with manual £120. Reply Box No 11, Classified, Maplin Magazine, P.O. Box 3, Rayleigh, Essex, SS6 8LR.

ELECTRONICS MAGAZINES June 1987 to September 1989 £6. Television servicing books, first issue to 1975, offers. Tel: 01-568 6014.

MAPLIN AUTOMATIC blood pressure tester (cat. no. XG68T). Excellent condition. Tel: 0209 820066.

EMPROMS – used and erased: 2764 – 75p; 27128 – 135p; 27256 – 185p; 27512 – 325p. Postage £1 (any quantity), state 12½V or 21V. Miss K. Williams, POB4, Tonypandy, Mid-Glamorgan, CF40 1YA.

TANTEL PRESTEL ADAPTOR, with instruction booklet £19. Post office box, taper plug type, polished wood case £22. Green, 7 The Downsway, Sutton, Surrey SM2 5RL.

RADIO CONTROLLED CAR Tamiya 'Avante' c/w radio, speedmaster electronic speed controller, fully ballraced, powerful motor, ni-cad + charger, superb car. Worth £350, bargain £250 o.n.o. Contact (0703) 860622 after 5pm.

MARCONI OSCILLOSCOPE. Twin 'Y' inputs. Ex A.M. brilliant trace. Alos 19" rack 'Telequipment' 'scope. Both working order. £25 each. Will co-operate handover with buyer. Disley, East Cheshire (0663) 63602.

WALKMAN, Saisho "Citybeat", graphic equaliser, in-ear headphones, sounds great. Good condition, boxed. Unwanted gift. £7 including postage. Also Hitachi two band car radio £3 inc. postage. Tel: 0392 218669.

CLUBS

MACCLESFIELD COMPUTER CLUB meets weekly on Tuesdays at the Bulls Head, Market Place. AMIGA, ATARI, IBM interests. Contact P. Solomon on (0625) 20782.

COMPUTERS

DISK DRIVE FOR SALE, 5¼ inch, full height, no case, no power supply. Suit BBC or IBM. £25. Tel: (0204) 852409 (Bolton) after 7pm.

COMMODORE 16 comprising keyboard, monitor, cassette drive. Many extras, £73 o.n.o. Tel: 01-462 3136 (eves and weekends).

ATARI 800 XL 64K, 1050 Disk Drive, 1029 Printer, software inc. mini office II and first word plus. Sell for £130 ono, the lot! Tel: 01 708 1945.

MUSICAL

ELKA X109 ELECTRIC ORGAN, excellent condition, £550 o.n.o. Tel: (0424) 425823.

MAPLIN MES 53 ORGAN. In sections P.C.Boards all made up. 2x61 Keyboards. 2 Oscillators. Offers Tel: (091) 5263937 (Wearside).

YAMAHA CX5-M MUSIC COMPUTER (MSX-COMPATIBLE). With full size keyboard, FM voicing program and cassette recorder. Complete with leads and instruction/technical manuals. Boxed. Only £190 o.n.o. Tel: Jon (0625 526517.

KEYBOARD, 49-Note C-C, with PE string ensemble keying circuits fitted, fully working, documentation. £35 o.n.o. Fred Wright, 29 St Andrews, Houghton-Le-Spring, Tyne & Wear DH4 5NT.

WANTED!

WANTED: Interface unit for Centronics Printer for SHARP MZ700. Contact Harry on 0772 633 333 X 2082 (DAY) or 0253 735175 (Evening).

WANTED: A mains transformer for a telequipment oscilloscope type D52. 9, Newton Road, Cadbury Heath, Bristol, BS15 5EZ.

WANTED BOOK TO BUY: How To Make Walkie Talkies. Send details to Robert Frenech, Block 'M', Flat 5, N'Hood 2, Sta. Lucia, Malta. Thank-You.

WANTED: Artist/Electronics expert on Analogue/Digital. Help needed on my outlines drawings. Must be willing to sign a lawers contract to protect my ideas. Joint patents welcome. Contact: Mr D. Maxted, 22 Birch Gardens, Sandbach, Cheshire, CW11 0HB.

WANTED: MC3340P IC. No longer stocked by Maplin. Also, second hand guitar effects, e.g. Flanger, Phaser, Chorus, Metal, etc. Either broken or in working order. Contact Max on (037387) 677.

WANTED: DOS, on 40 trk disc, for resurrected CORTEX computer. Tel: Neil on (01) 597 9741.

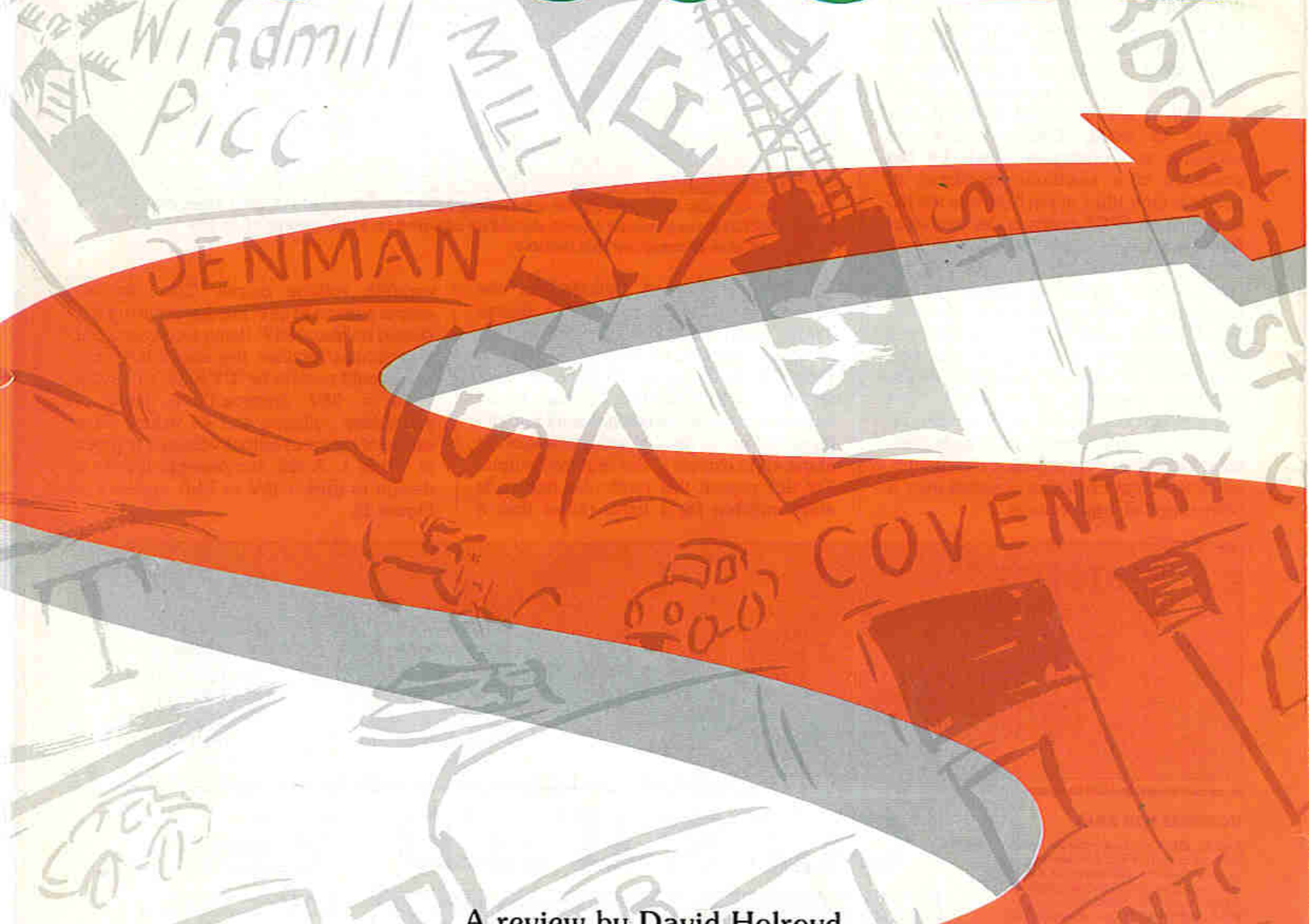
WANTED: PYE RADIO with valves or without but circuit must be complete. Please state price. Models PE60, PE80, 39JH or A39JH. Tel: Mr Murray (01) 747 1271.

WANTED: KEYBOARD FOR ZX81 COMPUTER - new membrane or external - advise condition and price. Vic Ludlow, 6 Raleigh Crescent, Stevenage, Herts, SG2 0EQ. Tel: (0438) 314018.

WANTED: "AVO" VALVE DATA MANUAL, or photocopy. To borrow or buy. M. Tollett, 81 Godstow Road, Wolvercote, Oxford OX2 8PE.

WANTED: CIRCUIT, MANUAL FOR FERROGRAPH Reel to Reel valve tape type 4 CEN. Please contact C Astbury, 16 Eaton Avenue, Handbridge, Chester CH4 7HB.

AUTOGUIDE



A review by David Holroyd

Traffic congestion is a major problem nowadays, and many people are employed in seeking solutions. Electronics plays a major part in traffic control and now a new traffic direction system offers an electronic solution to that tyranny of the motoring classes – the traffic jam.

Autoguide is still some way from being the jam avoidance device it wants to be. However, a special test run, organised for Maplin, showed it to have vast potential.

Autoguide is a complete system which gives drivers recommended routes to their destinations. This information is transmitted to a display device fitted to the vehicle. Information about the route and conditions on the roads is relayed from roadside beacons to a signal controller and on-line control centre, see Figure 1.

Autoguide works using infra-red communication between vehicle and roadside. The system has as its main components the display unit, the roadside beacons, the signal controllers and the central controller.

In use the starting point for Autoguide begins with the driver identifying where he is and where he wants to go. This information is sent from the on-board control unit to the car transceiver. The Autoguide beacons also act as transceivers, and they receive and transmit back the status of the vehicle and its route requirements. Once 'set up' the display unit will indicate where to proceed. Figure 2 shows various examples of the data from the display unit.

The journey is now ready to commence. The display unit will now give a continuous update of the distance to the destination. When any change from 'straight on' is required an audible advice will be given. (Happily, the audible warning is in standard English and seems not to be even a distant cousin of the dreaded Telecom voice, so well know to electronic telephone exchange users.) This audible warning occurs at a preset distance from the traffic light, roundabout or turning. When the destination is reached, Autoguide will confirm this visually and audibly and can be either reset for a further destination or stood down.

Autoguide technical standards have been set to reflect those already agreed across Europe. The demonstration unit has already been tested in Berlin, where a full system operates and was found to be fully effective. Infra-red communication standards are based on the transmission of pulses generated by infra-red emitting diodes at a rate of 125,000 per second. Information is to be conveyed using a bi-directional monologue technique. Data

The display on the dash and the hand held controller.

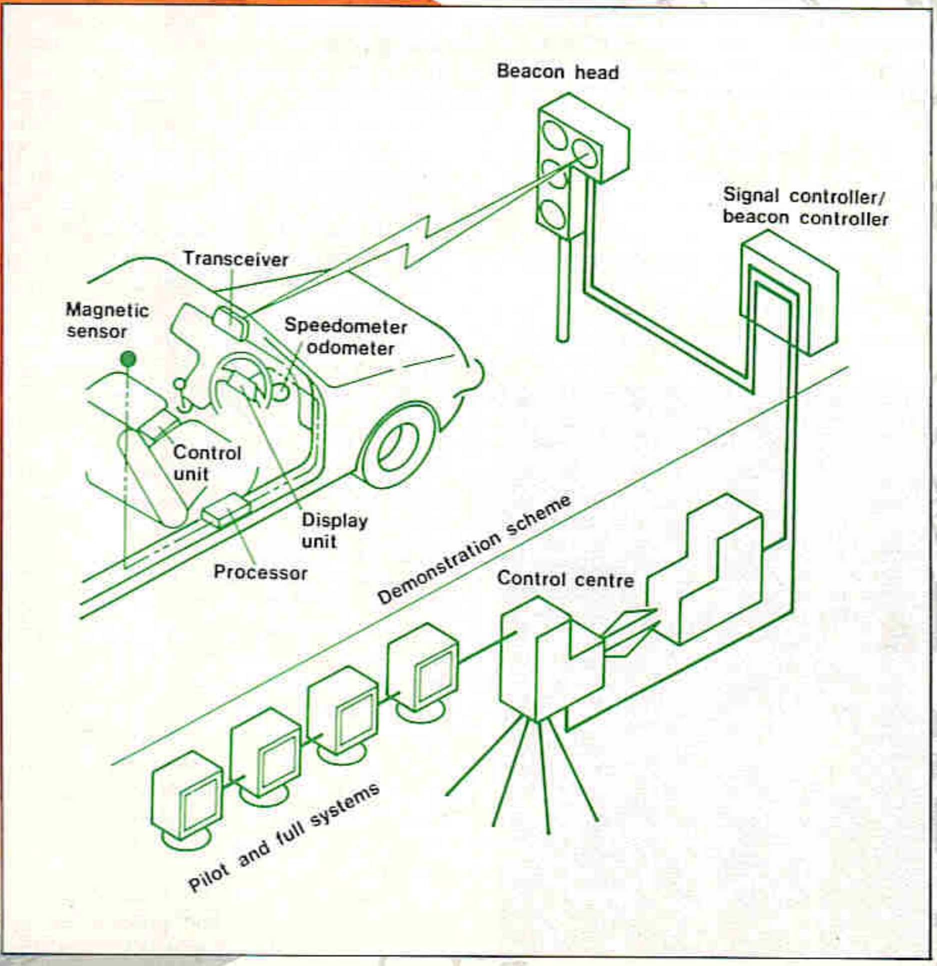


Figure 1. The system.

transmission from the beacons will not depend upon receipt of data from any vehicle. Great emphasis has been placed on this aspect, to avoid any allegations of 'Big Brother' or covert vehicle tracking. The reassurances are fair given that the system design specifications require a form of 'logging on' by way of seeking data from the system.

Data transmitted by beacons will be of three types. These are maps, routes and zones. The map type is information on the defined area around the beacon. It will be a matter for individual schemes to designate their map area.

The routing information will fall into two types. These together represent a route tree or number of trees which start from the beacon and radiate to all possible destinations. Data will cover both the immediate vicinity or beacon region and also destination areas in other parts of the country. In essence this means that the beacon will transmit local data which will provide information about the area around the beacon, and link data to enable route information to be given as the vehicle passes into the beacon region.

The zoning information is the material which will form the dynamic element of the system. This is the data which will identify the entry and departure point and will start to alert the central control to 'longer than programmed' times of passage through the beacon zones. It is from here that eventually the picture of slow progress will be built up and new data transmitted to adjacent beacons advising routes to avoid the zone delay.

As Figure 1 shows, beacons comprise the beacon heads and a controller for a series of beacon heads. Beacon heads are mounted on the roadside typically at traffic lights, crossings, lamp posts, etc. Their ability to integrate with street and road furniture will be crucial if the installation costs are not to be prohibitive.

It is proposed that private sector operators fund the system through a combination of unit sales and subscriptions. The talk is of an in-vehicle unit cost of £250 to £300, with an annual subscription of £100 to £150 per annum. These costs are based on a target of 500,000 units and the in-car units fitted as standard or optional extra equipment. The final figures must await the pilot trial evaluation. If cellular telephones are a guide, it is likely that the hardware will become even cheaper with subscriptions rising and a variety of additional features being provided at extra cost.

Currently there is only a demonstration Autoguide system operating in a small part of central London. This unit is the taster for a full scale pilot test. The successful tender for the pilot scheme has now been announced. The Transport Secretary has now confirmed that a licence to install and operate Autoguide will be discussed with G.E.C. This will operate in "a specified part of the London/M25 area". The scheme has to be capable of being upgraded to the full scale system described here. G.E.C. and their partners, the R.A.C., won a rather quiet battle with a rival A.A./Plessey group, known as AGuide Services. Little details of the difference between the proposals is available. It may well be that the offer to undertake a scheme in another part of the country was a decisive factor. This may be where a possible consolation prize can be picked up. The Transport Department will "be willing to discuss proposals" for a further scheme; states the announcement.

A pilot scheme involving establishing roadside beacons and signal and beacon control units for a designated area was sought. An example area stretching from Westminster to Heathrow Airport and up as far as Ealing was given. In essence the A4/M4 corridor from Westminster Embankment through to Heathrow. The final proposal can be for any area.

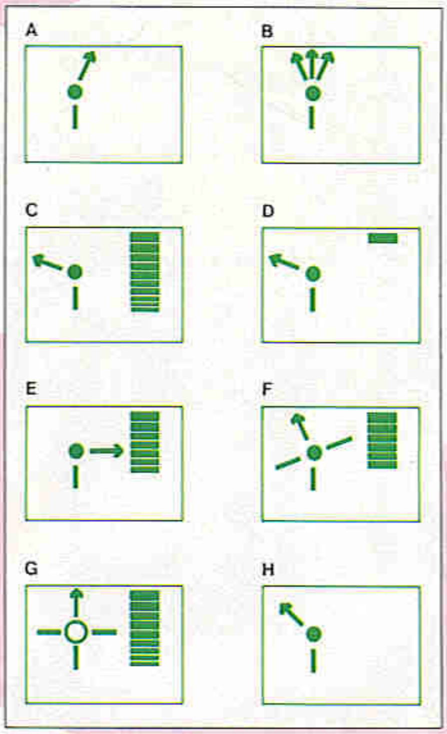


Figure 2. Display examples: (a) Compass direction and crow-fly distance to destination. (b) Follow road ahead even if it twists and turns. (c) Initial indication of a turn; distance shown on bargraph. (d) Turn left; distance remaining. (e) Lane selection; use either of 2 left lanes. (f) Complex junction, indicates exit. (g) Roundabout; with exit indicated. (h) In destination zone.

Beacons will be sited every fifty yards on the main routes. Beacon control units will be sited underground where possible. The pilot trial will hope to involve 1000 vehicles and 300 roadside beacons within the designated area.

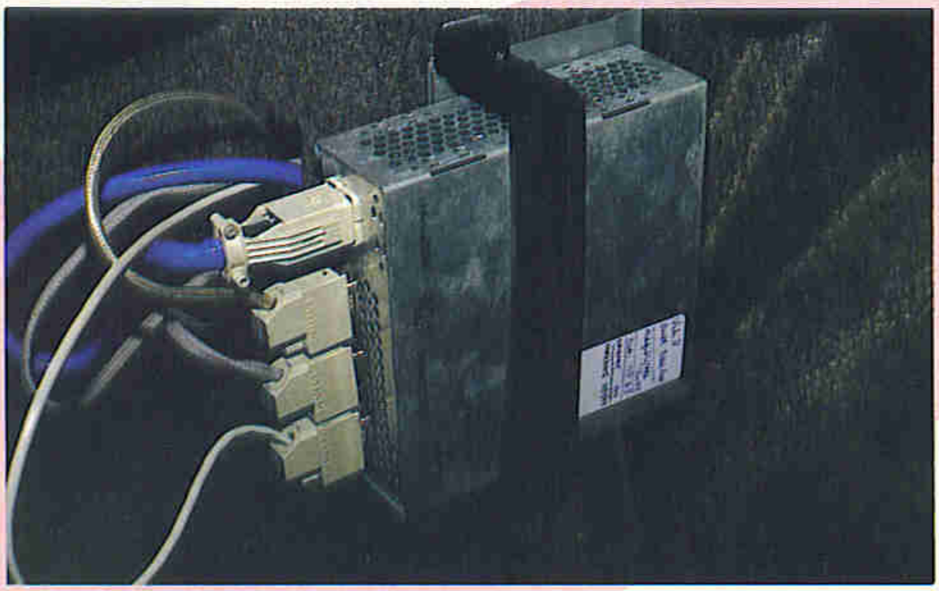
How far the pilot system will be dynamic remains to be seen. The invitations have stressed the need for the central control to be able to re-route according to traffic conditions. The final details show how far these objectives can relate to local traffic management arrangements.

In use Autoguide is novel. The technology is simple. The operator keypad bears a distinct resemblance to an extended television remote control unit. It has a full alpha-numeric keyboard and fits neatly into the glove box. The information is rapidly processed, thus ensuring the journey logging-in is soon achieved. The in-car display unit was very neatly built into the Rover 800 Demonstrator. It is the size of a clock and displays a note of direction to be travelled and destination. The beacons have to be pointed out and are the size of a small C.C.T.V. camera. The feeling is initially surreal as the voice display whispers the various instructions. The offering of verbal display at preset road points takes little account of speed. Thus, if you are approaching a junction a little fast, it could be necessary to wait until the instruction has been given. The initial view was that the system would inhibit concentration. That is not the case and it takes far less getting used to than, say, the on-board computer on the new BMW and offers more useful information. All in all, Autoguide in this static state beats shouting at your travelling companion for instructions and is certainly more reliable. The real development must come with the dynamic state. This will be when the beacons and the central control start to interact. Then information from both the beacons and other sources will be available to the user. Thus, if the police notify a control of an accident in a certain sector, that will be relayed to the relevant beacons, and onward to vectors and navigation trees. The system will then advise both users within the beacon zone, and those for whom it forms part of their navigation tree, of the variation. A new route will be computed and immediately relayed to the beacons. Thus at the next beacon the user will be advised to make variations to deal with the route interruption.

This is where the system starts to replace current, and rather variable in quality, means of help, including the radio traffic reports. It is also the point at which many back street short cuts may well become far better known. The advantages for motorists will soon be felt. Residents of hitherto quiet streets may not be so delighted.

The road system now plays an essential part in everyone's life. The summer rail disruption and every Bank Holiday show how overcrowded our major and not so major routes are. Anything which starts to make an impact on that misery is to be welcomed. If Autoguide can deliver at the envisaged prices, it is not likely to be a rich man's toy for very long. A proven trial and mass production could make it standard equipment in the car of the 1990's.

In the meantime, the electronics and computing world can take pride in having again shown how technology so regularly responds to the needs of modern society.



Under the bonnet.

ORDER COUPON

Maplin ELECTRONICS

P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone, Credit Card Sales (0702) 554161; Enquiries (0702) 552911.
A different postal code is correctly shown on the reply paid envelopes.

In any correspondence please quote your customer number. *Date* ....

Customer No ....
Name ....
Address ....
....
.... *Post Code* ....

IT IS MOST IMPORTANT THAT YOU INCLUDE YOUR POSTCODE

Block capital letters please. ***Keep a copy of your order.***

*Please enter catalogue page no. where item appears. If not in catalogue, write Mag for Magazine or SO for Special Offers etc. If not using 1990 catalogue, enter date of catalogue here: 19..........

Description (for your information only)	**Page***	**Order Code**					**Quantity**	**Price Each**	**£ Total**	**p**
Current Price List (Please write 1 in quantity, if required)		X	F	0	8	J		FREE	0	00
Price Change Leaflet (Please write 1 in quantity, if required)		C	A	9	9	H		FREE	0	00

Total this sheet £		
Total other sheet(s) £		
Total for goods £		
Handling charge. If total for goods between £9.25 and £10, make total £10. If total less than £9.25, add 75p.		
Deduct value of Credit Note No .... Enclose the numbered Credit Note with this order.		
Deduct value of Gift Token No. .... (Enclose Gift Token with order.)		
Please add 75p Carriage and Packing. This amount must be added to each order placed.	0	75
Total £		

Phone before 5pm for same day despatch.

Overseas customers including Channel Isles and Eire, please deduct VAT where applicable and tick this box.

Export Order ☐

Office Use Only			
DOR	CQ	CA	PO
CNC	Total		
CNM			

I authorise you to debit my credit card account for the cost of goods despatched.

Credit Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Access/American Express/Mapcard/Visa/.............................. Delete as required.

Note. Goods will be despatched only if the address above is the cardholder's address.
If ordering by Credit Card please sign:

....

Expiry date of Credit Card ....

DID YOU MISS THESE ISSUES?

Best of Maplin Projects Book One. A complete **Burglar Alarm System** including main control box, break contact module and an external alarm horn (with programmable timer). Add-ons to the main system include an ultrasonic intruder detector, a radar doppler effect intruder detector and a 'panic' button project. A **digital multi-train controller** and receivers to fit into most loco's. Other model train circuits include a head/tail lamps controller, an automatic loop control and train position locator. A superb **8 digit frequency counter** with a range from 10Hz to 600MHz.
Order As XC01B (Best of Projects 1) £1.75*NV*.

Best of Maplin Projects Book Two. A powerful **bridging module** for use with 2 of our 150W Mosfet Amplifiers to give an amazing 400W output. A tunable **scratch filter**, a **D'xers audio processor**, a **sweep oscillator**, a **CMOS crystal calibrator** and a **logic probe**. Also there is a **moisture meter**, a musical '**synchime**' project and an **RS232 interface** board for the Commodore Vic 20. A unique '**telephone exchange**' project is included with facilities for upto 32 lines, and a **240V inverter** so you can run domestic appliances from a standard 12V car battery.
Order As XC02C (Best of Projects 2) £1.75*NV*.

Project Book 3 Radar Intruder detector. 20 metres range, may be used with our security system. **Remote Control for Train Controller.** Remote control by infra-red, radio or wire.
Order As XA03D (Maplin Project Book No. 3) Price £1.00 *NV*.

Project Book 7 CMOS Crystal Calibrator. For amateur radio receiver calibration. **DX'er's Audio Processor.** Improved sound from Communications Receivers. **Sweep Oscillator.** Displays AF frequency response on an oscilloscope screen. **VIC20 and ZX81 Interfaces.** RS232 compatable.
Order As XA07H (Maplin Project Book No. 7) Price £1.00 *NV*.

Project Book 8 Synchime. Simulates bells, gongs and other chiming sounds. **Dragon 32 RS232/Modem Interface.** Plugs into ROM expansion port. **Codelock.** Programmable electronic lock. **CMOS Logic Probe.** Digital display shows logic states. **Minilab Power Supply.** Versatile unit for the test bench. **Dragon 32 I/O Ports.** Two 8-bit ports. **Doorbell for The Deaf.** Flashing lamp attracts attention.
Order As XA08J (Maplin Project Book No. 8) Price £1.00 *NV*.

Project Book 9 Oric Talkback. Speech synthesiser for the Oric 1. **TDA7000 FM Radio.** Complete FM receiver on a chip. **Nine Projects!** Personal Stereo Dynamic Noise Limiter; Logic Pulser; TTL/RS232 Converter; Pseudo Stereo AM Radio; and more.
Order As XA09K (Maplin Project Book No. 9) Price £1.00 *NV*.

Project Book 10 Spectrum Easyload. Helps cassette loading with the Spectrum. **80m Receiver.** Simple SSB direct conversion receiver. **Fluorescent Tube Driver.** 8W 12V for camping and caravanning. **Auto-Waa.** Automatic waa-waa effects unit. **Digi-Tel Expansion.** Expands Maplin Telephone Exchange to 32 extensions. **Dragon 32 Extendiport.** Makes the Dragon's cartridge socket more accessible.
Order As XA10L (Maplin Project Book No. 10) Price £1.00 *NV*.

Project Book 11 Mapmix. Six channel audio mixer. **Xenon Tube Driver.** Xenon flash tube module with strobe. **Enlarger Exposure Meter.** Simple inexpensive tool for the darkroom. **8 Channel Fluid Detector.** Check/control fluid level in up to 8 containers. **Servo & Driver Module.** Servo mechanism with driver module kit. **Mk II Noise Reduction Unit.** Improves signal/noise ratio of tape recordings. **Motherboard for The BBC Micro.** Gives easy access to ports.
Order As XA11M (Maplin Project Book No. 11) Price £1.00 *NV*.

Project Book 12 RTTY Unit. The TU1000 receives/transmits Radio Teletype; connects to computer via RS232. **Computadrum.** Use your computer as a drum synthesiser. **Light Pen.** Draw onto the TV screen or select menu options. **PWM Motor Drive.** Reversible model motor driver for 6V and 12V.
Order As XA12N (Maplin Project Book No. 12) Price £1.00 *NV*.

Project Book 13 Explosive Gas Alarm. Flammable gas detector. **Musical Announcer.** A doorbell with a difference. **Mains Controller.** An add-on for the 8-Channel Fluid detector.
Order As XA13P (Maplin Project Book No. 13) Price £1.00 *NV*.

Project Book 14 Live Wire Detector. Invaluable aid for the handyman. **Trundle.** The line follower robot as featured on Channel 4. **4-Channel PWM Controller.** Digital control of motors and servos. **Display Driver Module.** How to use our LED bargraph display ICs. **Control-A-Train.** Full inertia control of model trains.
Order As XA14Q (Maplin Project Book No. 14) Price £1.00 *NV*.

Project Book 15 Z80 CPU Module. Expandable CPU based controller. **Ultrasonic Car Alarm.** Stop car thieves. **Active Crossover.** Includes matched output power amplifiers. **Guitar Equaliser.** Specifically for six string electric guitars. **Fabulous Five.** A selection of interesting circuits.
Order As XA15R (Maplin Project Book No. 15) Price £1.00 *NV*.

Project Book 16 Floodlight Controller. Both power supply and mains switching unit for the Infra-red Intruder Detector Kit. **Mains Tx/Rx Data Communications System.** Sends or receives data via the mains wiring. **16-Channel Logic IC Tester.** Simultaneously displays logic states for any logic IC of up to 16 pin-outs on your oscilloscope.
Order As XA16S (Maplin Project Book No. 16) Price £1.00 *NV*.

Project Book 17 Video Digitiser. Interface a TV camera to your computer. **Mixing It.** A comprehensive range of audio amplifier modules. **Hobbyist's Temperature Controller.** General purpose electronic mains power thermostat. **Play Along Mixer.** Play along to your favourite records and tapes on your own instrument.
Order As XA17T (Maplin Project Book 17) Price £1.00 *NV*.

Project Book 18 Weather Satellite Receiver. Display regional weather systems on your TV or monitor. **Mixing It Part 2.** Mono/stereo Hi-Z mic input, mixer and line amplifiers; VU/headphone driver. **Stepper Motor Driver.** How to build and start using the Stepper Motor Kit featured in the Catalogue. **Amstrad Expansion System.** The Maplin Amstrad External ROM Card System for the CPC 464, CPC 664 and 6128. **Sealed Lead Acid Battery Charger.** Special high stability output with automatic trickle charge mode for sealed lead acid batteries. **Fantastic Five.** Veroboard projects comprising HF tremelo unit, crystal checker, clap switch, low-Z ohmmeter, snooze timer.
Order As XA18U (Maplin Project Book 18) Price £1.00 *NV*.

Project Book 19 Active Aerial and Aerial Tuning Unit. Get more from SW. **Amstrad Expansion System.** 6 x 8-bit parallel I/O card and PSU. **ADA Digital Echo.** RAM based low cost echo machine. **Mixing It.** Mixer Modules' PSU.
Order As XA19V (Maplin Project Book No. 19) Price £1.00 *NV*.

Project Book 20 Weather Satellite Decoder. Displays output from Satellite Receiver on TV or monitor. **Infra Red Proximity Detector.** Short range heat or movement detector. **Fibre-Optic Link.** Sends AF signals over up to 20m of fibre-optic cable. **Low-Z Microphone Pre-amp.** For 200-600Ω mics plus gain adjustment.
Order As XA20W (Maplin Project Book 20) Price £1.00 *NV*.

Electronics Issue 21 6 Channel Burglar Alarm. Develop a complete security system. **Six Circuits.** Bass Fuzz, Voice-Over Unit, Noise Gate, Envelope Tremolo, RTTY Decoder and Scratch & Rumble Filter on veroboard. **Notch Filter.** AF processor for communications receivers. **12V Public Address System.** 10W per channel from car battery. **Tungsten Lamp Controller.** AC phase control for mains lamps.
Order As XA21X (Maplin Magazine Volume 6 Issue 21) Price 85p *NV*.

Electronics Issue 22 MIDI Interfacing Techniques. Connect MIDI instruments to the VIC20 or CBM64. **Hi-Fi Speakers & Enclosures.** Two high quality loudspeaker cabinet designs. **Keypad for Z80 CPU.** At last a keypad I/F & ROM for the Z80 CPU kit. **4½ Digit Counter.** Versatile basic counter module to 4½ digits. **Weather Satellite Down Converter Part 1.** Aerial & freq. converter for MAPSAT Receiver to tune into the Meteosat satellite. **Mini Circuits.** Veroboard Audio Level Tester, Sound Triggered Flash, In-Circuit Resistance Meter, I/R Audio Isolator.
Order As XA22Y (Maplin Magazine Volume 6 Issue 22) Price 85p *NV*.

Electronics Issue 23 MAPSAT Frame Store #1. Z80B CPU controller. **Servo Tester.** Proportional servo tester. **Weather Satellite Down Converter Part 2.** Channel Switching Unit. **Capacitance Tester.** 5 ranges, 3 digit display. **More Mini Circuits.** Movement alarm, Stepper Motor Driver, Pink Noise Generator, Optical Port Data Link, 'Metal Pedal'.
Order As XA23A (Maplin Magazine Volume 6 Issue 23) Price 85p *NV*.

Electronics Issue 24 Nuclear Radiation Monitor. Alpha, Beta, Gamma & X-ray gieger counter. **VHF Pre-Amp Module.** MAPSAT VHF pre-amp. **External Horn Programmable Timer Update.** Modifying the module for use with other than the Maplin Home Security System. **MAPSAT Frame Store #2.** The Video Graphics Card. **VHS Video Alarm.** Battery powered portable movement alarm built into a VHS Video Cassette.
Order As XA24B (Maplin Magazine Volume 6 Issue 24) Price 85p *NV*.

Electronics Issue 25 Track side Rapid Charger. Model radio control car ni-cad battery pack charger using 12V car battery as power source. **Slow Charger.** Mains powered trickle charger for model cars. **Temperature Module Expansion.** Relay switch board and serial to parallel converter add-ons. **Disco Partylite.** High quality, 3 channel party lights. **Mini Metal Detector.** Detects ferrous and some non-ferrous metals such as iron wall board nails or brass screws. **Tester for Electrical Domestic Appliances.** Check the safety of any new appliance before you plug it into the mains. **Bob's Mini Circuits.** A pulsed speed controller, a train controller & an electronic lock.
Order As XA25C (Maplin Magazine Volume 7 Issue 25) Price 85p *NV*.

Electronics Issue 26 1kW High Power Mosfet Amplifier. Superb amp primarily aimed at use in halls, auditoriums, etc. **Simple Melody Generator.** Versatile musical project with four tunes available. **Multi-Tune Generator.** Built around the UM3411A giving 16 tunes etc. **Siren Sound Generator.** Gives 4 different types of siren noises. **Programmable Metronome.** Useful musicians aid.
Order As XA26D (Maplin Magazine Volume 7 Issue 26) Price 85p *NV*.

Electronics Issue 27 TDA 7000 FM Radio MkII. Complete radio kit including case. **3-Way Loudspeaker System.** 20 litre passive radiator cabinet design. **Watt Watcher.** Check to see if you are overdriving your speakers. **Morse Code Practice Oscillator.** Learn Morse Code the practical way with this excellent project. **Noise Generator.** Make as much noise as you want with this useful piece of test gear. **Bob's Mini Circuits.** Stereo Bargraph, Stereo VU Meter, Simple Fibre-optic link, Serial-Parallel converter and a Games Timer.
Order As XA27E (Maplin Magazine Volume 7 Issue 27) Price 85p *NV*.

Electronics Issue 28 Direct Conversion Receiver. Listen to speech or morse code from 10 metres to 160 metres. **2 Way 16 litre Loudspeaker System.** Another in our series of popular loudspeaker cabinet designs. **Bob's Mini Circuits.** A MIDI thru box, a capacitance meter adaptor, a crystal calibrator and a transistor tester.
Order As XA28F (Maplin Magazine Volume 7 Issue 28) Price 85p *NV*.

Electronics Issue 29 1kW High Power Mosfet Amplifier Hardware. Round off this super project from Issue 26 by 'boxing up' the unit. **Electronic Roulette Wheel.** Super fun project for the whole family. **Laser and Controller.** Marvellous 2mW laser with PSU and a motorised mirror add-on unit with controller. **TEA2000 PAL Colour Encoder.** Building block project based on the TEA2000 chip. **Data File: LM386.** In depth look at this useful low voltage power amplifier.
Order As XA29G (Maplin Magazine Volume 8 Issue 29) Price £1.00 *NV*.

Electronics Issue 30 Digital Record & Playback Module. Records speech digitally and allows playback at the touch of a button. **Video Dubber & Switching Unit.** Links up several VCR's. **4 Way Speaker Switch Box.** Allows connection of up to 4 pairs of speakers to your Hi-Fi. **Audio & Video Modulator.** Allows connection of video equipment to a normal TV when direct connection is not possible. **Bob's Mini Circuits.** Accented Metronome, Reaction Tester, Basic Noise Gate, Electronic Die. **Data File.** In depth look at the LM1875 audio power amplifier.
Order As XA30H (Maplin Magazine Volume 8 Issue 30) Price £1.00 *NV*.

Electronics Issue 31. Wind Speed & Direction Indicators. Monitoring system for measuring wind speed and direction (external electronics and mechanics). **Bob's Mini Circuits.** Guitar Headphone Amplifier, Morse Regenerator, TTL Logic Tester, TTL Logic Pulser, AF Signal Source. **Data File.** Versatile circuits based on LM13700 transconductance operational amplifier. **RS232/TTL Level Shifter.** Provides level translation on Tx and Rx data and handshaking lines, selection of data polarity and on board voltage conversion. **Digital Panel Meter.** Multi-purpose digital display module, can be set to read current or voltage. **Playback Module & EPROM Programmer.** Expansion modules for the Digital Record & Playback Module.
Order As XA31J (Maplin Magazine Volume 8 Issue 31) Price £1.00 *NV*.

Electronics Issue 32. RTTY FSK Demodulator. Allows reception and decoding of Radio Teletype transmissions. **Hi-Low Switch.** Versatile electronic switch for a variety of applications. **Logic IC Tester.** Enables an IBM PC or clone to be used to test digital integrated circuits. **Data File.** More versatile circuits based on the LM13700 transconductance operational amplifier.
Order As XA32K (Maplin Magazine Volume 8 Issue 32) Price £1.00 *NV*.

Electronics Issue 33. Weather Station Main Unit, part two of the meteorological monitoring project, decodes and displays information from wind speed and direction indicator project. **Sharp Audio Filter**, a special audio filter for use with RTTY demodulation; filters out unwanted signals that would otherwise prevent a signal from being decoded. **Data File**, application circuit for the LM1035 DC controlled volume, balance, tone control IC. **High Power Speaker Cabinet.** A verstile design for a top flight, high power speaker system. **Stereo Pre-Amplifier**, a general purpose pre-amplifier for low level audio signals. **Infra-Red Remote Control Switch.** Allows switching of a relay by remote control using pulsed infra-red light.
Order As XA33L (Maplin Magazine Volume 8 Issue 33) Price £1.00 *NV*.

Electronics Issue 34. TDA2822 Stereo Audio Amplifier, a compact stereo amplifier which delivers up to 1W into 8Ω from a 9V supply. **NICAM-728**, part one in a series about constructing a NICAM-728 Digital Stereo TV Sound Decoder. **Electronic Digidice**, an electronic version of the familiar six-sided cube! **Data File**, application circuit for the LM1037 stereo signal source selector. **MIDI 8-Way Thru' Box**, provides eight independently buffered MIDI outputs from one opto isolated MIDI input. **Remote Power Switch**, a 16A relay switching unit for use in cars and other applications.
Order As XA34M (Maplin Magazine Volume 8 Issue 34) Price £1.00 *NV*.

NEWS REPORT

High Tech Travel

High-tech travel must have the pride of place in this issue. For a start, Rank Xerox is providing office facilities at London's Heathrow airport for travellers on British Airways new Super Shuttle Executive Service. Terminal One Centre is a fully fledged office automation facility containing such hi-tech delights as facsimile, photocopying, overhead transparency production, telephones and desks.

This would seem to be just the venue to flaunt your new Hitachi portable computer, the HL400C. This, the first Hitachi portable, has an active drive 8-colour LCD screen which makes use of thin film transistor (TFT) technology. Details: 0628-890833.

The Hitachi might find itself performing alongside the new ultra slim, STL64/EGA portable computer from Sygnos Technologies. This features a high quality monitor which is only 34cm wide, 27cm high and 6.5cm deep with a display size of 11 inches. The IBM compatible monitor costs about £595. Details: 01-352-1478.

No Escape

There is not much chance of the high flyer escaping from technology by going underground. Racal Electronics are putting in a voice and data communications network system in the Channel Tunnel to keep both French and British construction teams in touch. No doubt the fibre optic network will serve passengers in three years time as they hurtle through the tunnel.

Clocking In

Just the job for the executive traveller to show-off to his fellow passengers in the Rank Xerox Centre is the Bioclok pocket-sized computer. Designed for the time zone crossing jet setter, the unit keeps tabs on how the traveller should organise his day. Whether to go out into the sunlight or stay indoors, thereby letting the body adjust to local light and time conditions.

With David Lawrence of international communications consultancy Lawtelco suggesting that up to 80% of businessmen suffer from some form of jet lag for up to five days or more, there could be a healthy demand for the £100 product.

Flighty Information

Just in case the traveller didn't have time to visit the Rank Xerox Centre, Swiss Air has installed cellular telephones in its aircraft. But usage is limited to the time when the plane is on the tarmac. Apparently as Computergram International points out, the phones can't be used in flight as they could affect the plane's electronics.

But fortunately for the pace setters, not all airlines have such high tech reservations as Swiss Air. It seems that Plessey is discussing with six international airlines, the possibility of incorporating on-board telephone entertainment centres. The idea is that between phoning his girl friend in New York or Geneva, he can fax messages to his company, order goods by electronic mail order, or play electronic Batman.

PC Growth and More Growth

The latest industry survey reveals that the UK and European Personal Computer market grew by a factor of 50% in the first six months of the year. In sector terms, sales of laptop computers were 100% up. IBM and Compaq continue to lead the sales field, but Amstrad's share of the market has been affected by recent market attitudes.

Designer Fax

The yuppie world must be delighted. The coverted business phone award sponsored by BT and The Sunday Times has been won by a London sandwich shop. Apparently the company send out its menus designed to fit into your Filofax. The customer faxes in his order which is dispatched without delay, probably in a Porsche.

Getting the Right Number

Thanks to the growth and growth of telephone ownership, much thought is being given to a revised numbering system. Management consultancy Sterlings of North London point out that demand for numbers recorded by government watch-dog OFTEL, will rise from under 30 million now to 400 million by the middle of the next century. The solution says Sterlings could be to add an extra digit to the present numbers, or to ignore geographic locations in future numbering plans. One option could be to issue personalised numbers (rather like cherished car number plates) which will serve the subscriber for life.

With all these extended numbers in prospect, BT are already taking steps to streamline their directory enquiries service.

Automation is moving in and digitally recorded number messages will be automatically inserted following the initial enquiry procedure – allowing operators to handle the next call. This says BT will reduce operator time taken to handle the average call by more than a third.

BT have hired an actress to record numbers with an inflection determined by the position of that number in the total string. Lets hope that the actress will refrain from adding "love or darling" to her responses. It is now expected that BT will introduce charges for directory enquiries next year. There will however be dispensations for users of payphones and the visually handicapped.

Computers – A Growing Influence

The use of the personal computer will have a growing influence in the garden following the development of a new greenfingers computer program. For the first time, a database of some 8,000 plants has been drawn up which will enable gardeners to find the most suitable plants for their needs. The new "Plantfinder" program is being run on an Opus Technology PC V 386 personal computer. It allows up to 40 different requirements to be defined, including the type of plant, its size, colour, flower attributes, size and hardiness and, where appropriate, bark and stem effects.

More Video Moves

In the previous issue of 'News Report' we featured the videophone marketplace. Now PictureTel is ready to launch their new generation videophone in the UK – once BT have introduced IDA dial-up line facilities, probably next year. As Computergram International comment, PictureTel codex looks like giving rivals BT and Maxwell Communications, a good run for their money.

Payphones Pay Dividends

British Telecom is also facing competition for its public call box operations from a new payphone service, International Payphones. The company aims to install some 70,000 phones over the next year or so, all of which will have a Mercury option button. But watch out. Private payphone operators can set their own tariffs and your call could cost more than using a BT phone box.

Incidentally have you noticed that both BT and Mercury are stumbling over themselves to install their new pay phones. BT alone have installed a further 5,000 units this year, making a total of 86,000 across the UK.

Getting the Messages

British Telecom can't be very happy at the news that alternative carrier Mercury now handles over 30% of the UK's outgoing international telex traffic. Now UK data communications equipment manufacturer Data and Control Equipment is doing its best to ensure Mercury has even more users. The company has introduced the TeleBox 3 computer telex interface which allows customers to automatically prefix the Mercury access code.

Fax is now following the payphone out of the office and into the high street. The aptly named company Faxit UK intends installing fax machines in public places, operated by credit card. Whether the new Amstrad fax machine will similarly find its way on to the street, remains to be seen. The Amstrad which has several built-in features including a Mercury button and a computer link, has a sub £600 price tag.

Meanwhile fax supplier Pitney Bowes has introduced an option which is designed to lock-out unwanted (or junk mail) faxes. Software allows a fax to be received only if the senders telephone number is on a list of preferred user designated numbers. The problem of junk faxes is one which is becoming a problem for many users reports John Sommerwill of systems house Saffronrose. Unlike junk letters, the fax variety cost the recipient money in terms of expensive facsimile paper used to record the unwanted messages.

Wristwatch Paging

Some of the major industry names such as Plessey and Seiko have pooled their resources to produce the Receptor wristwatch terminal. This, says the essential industry daily publication, Computergram International, receives, stores and displays a variety of messages – such as call home or the office. It has the ability to scan FM radio frequencies world-wide for messages and has a battery life of a year. And yes, it does work as a watch.

Training by Computer

In what is probably the largest computer-based training scheme ever undertaken in the UK, Andersen Consulting have developed a computerised training system for the 50,000 Department of Social Security staff. Personnel will undergo the training – which covers new computing routines and procedures in a period of just ten days – a much shorter period of time than would have been needed without the new training method. With computers taking over from manual systems, the new Andersen innovative training will ensure the standard of training is consistent over all the courses.

Satellite Wars

According to a Frost and Sullivan report, the number of households in Western Europe equipped to receive satellite TV will have reached 700,000 by the end of the year. Meanwhile British Satellite Broadcasting came a massive step closer to transmission early next year, following the successful launch of its new high definition satellite Marcopolo I. But it is back to the drawing board for the BSB Squarial. Apparently a number of new designs are now under urgent review.

But Sky Television are now offering a total satellite £4.49 per week subscription pack which includes the installation and maintenance of all receiving equipment. To make sure we get the message, Sky are committing £10m on advertising the new package in the months up to Christmas.

PC Sales Gather Pace

It's a bad year for PC sales in Europe. The market has only increased by a factor of 50% reports Ambit Research. The fastest growing area is that of portable computers which have grown by over 200% in the past six months. The news must be pleasing to Amstrad who, as News Report forecast in the last issue, have now relaunched several of their computer systems at a lower price. The popular PCW9512 word processing model now comes bundled with a free £100 automatic sheet folder for the printer.

On the Line

No issue of 'News Report' would be complete without a quota of items on telephony. This is not really surprising given that according to Siemens, there is an average of 8.8 numbered lines per hundred people on Earth. This figure allows for the uneven distribution of telephones around the world. North America has one telephone for every two people, while Africa has to get by with just one per hundred. The company says there are currently over 700 million phones in use, but hopefully, not all at the same time.

To make sure you get the phone message, Vanderhoff have introduced a new style answering phone, based on digital technology. A voice processor lets you record a message and have it automatically transmitted to selected parties. Details: 0252-628018.

BT Matters

Having attracted much criticism by painting their standard issue phone boxes yellow, or even exchanging them for futuristic looking units which are guaranteed to annoy Prince Charles, BT are doing their best to become industry good guys. The Corporation have now developed a system of moving cartoon pictures on miniature TV screens which allow deaf people to communicate over the ordinary telephone network using sign language.

Basically the system makes use of a 2.5 inch TV screen which unlike a normal videophone which uses digital signals, can transmit image codex algorithm pictures over BT's analogue network at 14,400 bits a second. The resulting picture is a moving black and white outline or cartoon, depicting the main facial characteristics sufficiently for the individual to be clearly recognised, or hand movement of sign language to be reliably identified. However, a commercial version is still several years away.

Getting the Image Right

Fujitsu, Japan's largest computer manufacturer and a world leader in electronics, are following the British Petroleum path by adopting a new corporate logo. Our new signature says Fujitsu President Takuma Yamamoto, conveys the message that we are an international company in both outlook and scope which will serve us well into the 21st century.

In case you fail to grasp the significance, the chief characteristic of the new design is that the name Fujitsu will be universally written in Roman letters. The new design also features an infinity sign over the 'j' and 'i' of Fujitsu, symbolising the company's limitless possibilities. Red and grey incidentally are the new corporate colours, representing warmth and vitality as well as innovation. The new logo is part of an extensive UK awareness campaign which involves Fujitsu announcing new products at the rate of one a week over the next three months.

High Tech Developments

The boys in the labs have been extra busy since our last issue. IBM scientists have demonstrated two experimental computer chips for transmitting and receiving data over fibre optic lines at speeds of a billion bits per second. They believe the receiver chip is the densest optoelectronic chip ever reported. To make the point, one quarter-inch fingernail-size 'receiver' holds 50 times more optical and electronic components than ever previously assembled on a chip for the optoelectronic receiving and processing of data. The receiver chip contains over 8,000 transistors with characteristic features as small as 40 millionths of an inch or one micron.

Optoelectronic technology permits electronic devices such as computers to communicate using pulses of laser light as the carrier of the information. IBM believes the ability to provide the transmitting and receiving functions on a two-chip 'set' creates the potential for more reliable, faster and less expensive data communications

Meanwhile, the boys at Texas Instruments have announced the world's lowest noise CMOS OP-AMP the TLC2201. This is a precision ultra low noise op-amp, which is specifically designed for interfacing to high impedance sources such as sensors and piezo-electric transducers. Previous op-amp designs have not been able to achieve low offset, low current and low voltage noise from a single device. But the boys in the lab can not afford to relax. According to a US report, future chips will be about one-tenth of a micron in size. "Scientists of the future will say today's chips are great chunking things".

Picture Caption Challenge

No prizes but just what is going on?

The picture caption itself is "A TESTING TIME".

- ★ Is it the governments latest electronic tagging system?
- ★ A high tech group of Boy Scouts brewing up in Hyde Park?
- ★ BSB's answer to Sky TV? or
- ★ System "X" switching exchange.

Massive Maplin Expansion

Maplin Electronics, the UKs largest retailer of electronic components, have opened a purpose built distribution centre near Barnsley. The new building has over 100,000 square feet of storage space and is centrally located in the country. With Maplin's reputation for excellent stock levels and speedy service, things look set to be better than ever. The transfer of distribution from Rayleigh to Barnsley was a masterpiece of coordination, ensuring only a minimum of disruption to order collection and despatch. All orders are received and processed at the familiar P.O. Box 3, Rayleigh address. Then, using the latest computer technology, orders are electronically zapped at lightning speed to the new distribution centre, where they are collected, packed and despatched! Note also, that the telephone sales number, 0702 554161, is unchanged. For details of the new Maplin 1990 Buyers Guide, see outside back cover.

NEW BOOKS

Lasers: Principles and Applications

J. Wilson and J. F. B. Hawkes

A clearly written introduction to a rapidly developing subject, this book provides the reader with, a grounding in laser physics, an analysis of laser technology and a wide survey of laser applications. Suitable for professional engineers wishing to increase their knowledge of laser applications and for students seeking an up-to-date introductory text which includes worked examples and end-of-chapter problems.

308 pages, 150 x 228mm, Illustrated.

Order As WS67X (Laser Principles) Price £17.95NV

A Concise Introduction to Lotus 1-2-3

N. Kantaris

If you are a PC user and want to get to grips with Lotus 1-2-3, then this book will teach you how to do just that, in the shortest and most effective way. The book explains:- How Lotus 1-2-3 can be used to build up simple spreadsheet examples, edit, save and retrieve them. How to format labels, enter and format numbers, change the default width of cells, enter formulae and Lotus 1-2-3's in-built functions, and print a worksheet. How to freeze titles on screen, use a non-continuous address range, inset, erase and move blocks of information, add graphs to a worksheet, add legends and titles to graphs, view and print graphs. How to set up a database management system, sort and search a database, use the find and extract commands to query infromation held in a database. How to create a simple macro. The book lists all Lotus 1-2-3 indicators, functions and macro commands so that it is self contained and can be used as a reference book long after the reader becomes an expert in the use of the program.

74 pages, 198 x 128mm, illustrated.

Order As WS64U (Cncse Lotus 1-2-3) Price £2.95NV

How to Use Oscilloscopes and Other Test Equipment

R. A. Penfold

Advances in electronics over recent years have brought some quite advanced pieces of test equipment within the scope of many electronics hobbyists. Whether building your own or buying ready made equipment, you no longer need to be a millionaire in order to afford signal generators, digital measuring equipment, or an oscilloscope having a fair specification! But how do you set about using such equipment? Some items of test equipment are very simple to use, such as an auto-ranging digital capacitance meter. You just connect the capacitor and its value is displayed. Not all test equipment is this simple though, and oscilloscopes in particular tend to have vast numbers of knobs and switches. These can be a bit daunting for the uninitiated, but mastering a workshop oscilloscope is not really too difficult. This book explains the basic function of an oscilloscope, gives detailed explanations of all the standard controls, and provides advice on buying an oscilloscope. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits. Plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.

110 x 179mm, Illustrated.

Order As WS65V (How to Use Scopes) Price £3.50NV

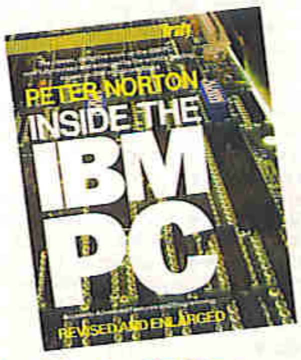
More Advanced Uses of the Multimeter

R. A. Penfold

This book is primarily intended as a follow-up to 'Getting The Most From Your Multimeter' and also should be of value to anyone who already understands the basics of voltage testing and simple component testing. Thoroughly testing some components requires specialised and expensive equipment. In some cases there would not seem to be equipment of the right type available at any price. By using the techniques described, you can test and analyse the performance of a range of components. Designs for simple add-ons are given to make the multimeter even more useful: An active RF probe, a high resistance probe, an AC sensitivity booster and a current tracer.

83 pages, 178 x 112mm, illustrated.

Order As WS63T (Adv Use of M/meter) Price £2.95NV



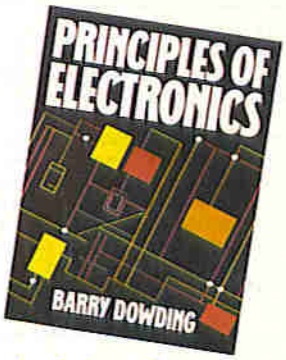
Inside the IBM PC

P. Norton

This best-seller has been thoroughly updated to include every model of the IBM microcomputer family! Detailed in content yet brisk in style. The book reviews fundamentals and then moves on to discover new ways to master the important facets of using your microcomputer to its fullest potential. Definitive in all respects. Inside the IBM PC, includes: A detailed look at all of the special features of the IBM PC family – its clones and their compatibility. The fundamentals of the 8088 and 80286 microprocessors, plus the DOS operating system and BIOS. Programming examples to show how each feature works, in BASIC, Pascal, and Assembly Language. A discussion of how the assembler can be integrated into Pascal and BASIC for more power. A look at how the ROM is allocated. A detailed view of disk data storage. A complete, easy-to-use glossary in narrative form.

387 pages, 188 x 233mm, Illustrated.
American Book.

Order WS68Y (Inside the IBM PC) Price £19.10NV



Principles of Electronics

B. Dowding

This book develops, from first principles, an understanding of the properties, performance and operating capabilities of an extensive range of modern digital and analogue devices, circuits and sub-systems. It is ideal introductory electronics text for undergraduate students at colleges and universities. The book includes: A balanced coverage of both digital and analogue electronics. Six graduated chapters on digital electronics which take the reader from a descriptive introduction through to combinational and sequential logic design using NAND/NOR logic and complex integrated circuits. An outline of semi-custom array technology is also given. A comprehensive treatment of Op-Amps (including noise) supported by separate chapters on amplification and feedback. Chapters on specialist areas such as power supplies (linear and switching) and power devices and circuits (including DMOS). Three introductory chapters covering semiconductor theory, the BJT and FETs. Numerous worked examples throughout the text and many end-of-chapter problems.

509 pages, 175 x 235mm, Illustrated.

Order WS69A (Prncpls of Elctrncs) Price £16.95NV

NOW OPEN

WE GUARANTEE A FRIENDLY WELCOME AND THE BEST OF SERVICE AT OUR

NEW SHOP IN EDGWARE

Don't forget to visit our newly opened Leeds and Nottingham shops ***TODAY!***

Maplin HELP SERVE YOU BETTER!

BIRMINGHAM:
Sutton New Road, Erdington.
Tel: 01-384 8411

BRISTOL:
302 Gloucester Road.
Tel: 0272 232014

LEEDS:
Carpet World Bldg, Regent St.
Tel: 0532 449200

LONDON:
159-161 King Street,
Hammersmith.
Tel: 01-748 0926

146-148 Burnt Oak Broadway,
Edgware.
Tel: 01-951 0969

MANCHESTER:
8 Oxford Road.
Tel: 061 236 0281

NOTTINGHAM:
86-88 Lower Parliament St.
Tel: 0602 410242

SOUTHAMPTON:
46-48 Bevois Valley Road.
Tel: 0703 225831

SOUTHEND:
282-284 London Road,
Westcliff-on-Sea.
Tel: 0702 554000

There's a friendly welcome in store for you at any Maplin shop. Our helpful staff will often be able to help you with a technical problem or a constructional difficulty.

For mail order enquiries, please DO NOT call our shops as they will be unable to help you.

- ★ **Expert Help & Advice**
- ★ **Credit Facility Available** (written details on request)
- ★ **Self-Service – browse at leisure**
- ★ **Open SIX days every week**
- ★ **Shop with confidence with the Maplin Guarantee**

Before you send your next order to us by post, take a look and see if there's a Maplin shop near you. In our shops you'll find that personal service that even the best mail order operations cannot match. And you can check out the goods BEFORE you buy. If you're coming for a particular item, a quick phone call will enable you to be certain the shop has everything you want in stock.

Our shops are pleased to accept Access, Barclaycard, Connect, American Express, Mapcard and cheques up to £50 with a cheque guarantee card. We'll even accept ordinary money as well!

All our shops are close to excellent parking facilities, meters in London and Manchester, and free elsewhere.

NEWCASTLE OR READING? WATCH THIS SPACE!

POP IN TO A Maplin SHOP TODAY AND DISCOVER A UNIQUE SHOPPING EXPERIENCE!


MAPLIN