ELECTRONICS

The Maplin Magazine

IR £1.54

JUN-JUL '89 £1.00

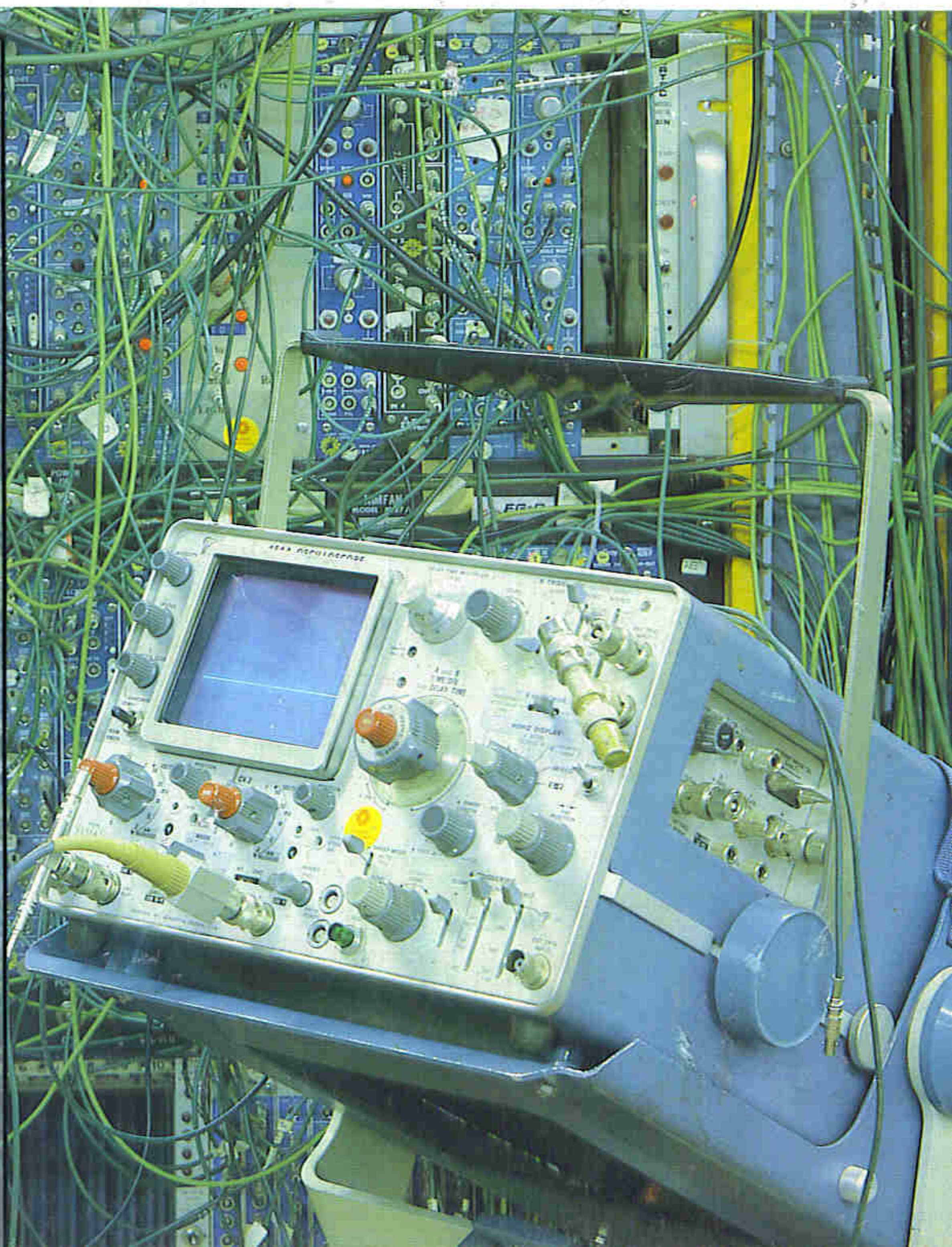
Two new oscilloscopes from Topward. Are they value for money?

Construct an IC Tester which fits into your PC!

FSK Tone Demodulator based on the XR2211 IC, for you to build.

Security Keypad with master and user codes, zone/duress codes and panic alarm!

Features on telephones, telecommuting, & new products.



CONTENTS

JUNE TO JULY 1989 VOL.8 No.32

EDITORIAL

We have some fascinating projects and features for you this issue! The FSK tone demodulator is the first in a series of projects which will enable you to receive radio teletype (RTTY) transmissions from around the globe. The 'hi-low' switch board has many applications including letting you know if your plants need a drink! If you have an IBM PC or clone, the logic IC tester will be of interest. It simply plugs into your machine, you boot-up the software, and you have the capability of checking out your CMOS and TTL chips. The lids have been taken off of two new oscilloscopes and Robert Ball investigates if what's under the bonnet is value for money! Dave Goodman has got his hands on a super security keypad, packed full of features, and explains what it can do for you. Plus, of course, your regular dose of radio construction, the history of loudspeakers, the development of telephones, experimenting with electronics and those fiddly equations in the 'Calcs' series! Until next time, read on and enjoy!

R. T. Smith

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PROJECTS

FEATURES

REGULARS

20MHz version.

Reviewed by Robert Ball A.M.I.P.R.E.

20MHz and 40MHz Bandwidth Versions Available

- ★ 20MHz and 40MHz
- ★ Triple Trace Facility
- ★ Excellent Value for Money
- ★ Robustly Built
- ★ Dual Timebase (40MHz Version)
- ★ Professional Quality

Introduction

One of the most useful pieces of test equipment that any serious engineer or hobbyist should have, is the Cathode Ray Oscilloscope (often abbreviated to CRO, 'scope or oscilloscope). The oscilloscope produces a graphical display of voltage against time and can be used for numerous test measurements and fault finding procedures. From the display produced, voltage levels, amplitudes, period, frequency and phase of waveforms can be determined. The oscilloscope is clearly a versatile addition to the electronics workshop.

An oscilloscope, even with fairly basic facilities, can be quite expensive and until recently, the hobbyist found it difficult to obtain a good specification, versatile oscilloscope at a reasonable price. Clearly any investment in such a piece of test equipment must be the product of careful scrutiny of the facilities offered, price and what is required of the equipment.

Once again, Maplin Electronics have been able to ease the choice for the engineer and hobbyist. Two new oscilloscopes have been introduced into their comprehensive range of test gear, two versions are available, with 20MHz bandwidth and 40MHz bandwidth, each one offering a host of facilities often only found on oscilloscopes costing many times the price.

Features

3 Channels, 3 Traces.
Sensitive vertical amplifiers, 1mV per division allowing very low level signals to be easily measured.
150mm rectangular CRT, with internal graticule (and percentage markers) to eliminate parallax error and ensure high accuracy.
X-Y mode allows Lissajous figures to be displayed (frequency and phase measurements).
Internal TV synchronisation separator enables easier measurement of video signals.
20ns per division sweep rate makes high speed/fast rise-time signals observable.
Algebraic operation in add mode can display the sum or difference of Channel 1 and Channel 2 signals.
Vertical mode triggering enables stable triggering and simultaneous observation of Channel 1 and Channel 2 with signals of different frequency.
Channel 1 pre-amp output provides 50mV per division to drive external instument, e.g. frequency counter.
Variable hold-off function allows triggering of complex signals and aperiodic waveforms.
Single sweep facility for 'one-shot' operation of the timebase.
Delayed sweep time-base provides magnified waveform operation and accurate time interval measurement (40MHz version).

Value for Money

With my background being firmly planted in commercial and industrial electronics, I have always been spoilt for choice in terms of oscilloscopes, being used to 'all-singing all-dancing' top of the range models that cost the earth. For this reason I could look critically at the new range of oscilloscopes from Maplin. In my opinion, electronic equipment should

40 & 20 MHz MHz Oscilloscopes

40MHz version.

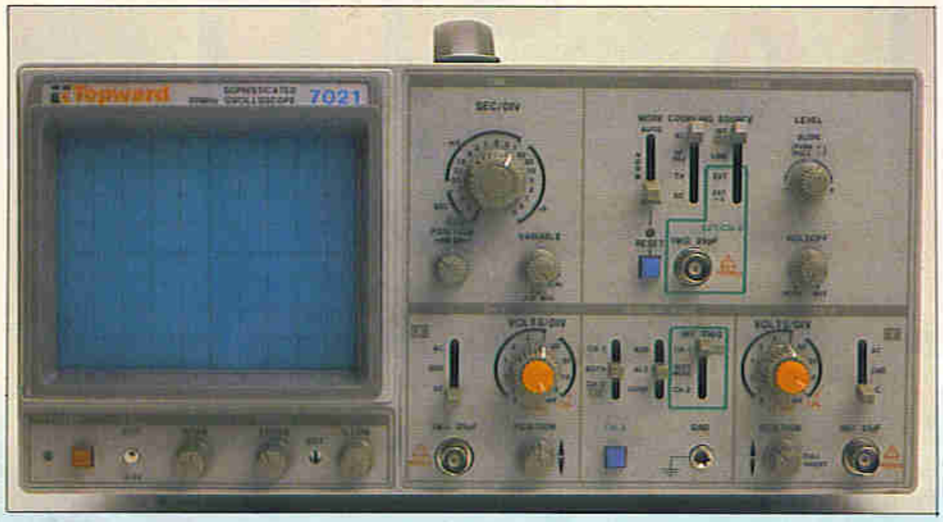


Photo 1. 20MHz Oscilloscope – Front Panel.

have as much thought, if not more, put into the internal construction and layout, as is often given to the outward appearance. So the first thing I did, after unpacking the oscilloscopes from their substantial packaging, was to take them apart! For SAFETY REASONS please DO NOT dismatle your own scope as this will expose high voltages (thousands of volts), which will remain present after switching off, due to charge storage. Removing the covers will also invalidate the guarantee.

I was pleaseantly surprised by the quality of construction. Essentially, the 20MHz and 40MHz oscilloscopes are similar, the oscilloscopes are constructed on a steel chassis with all parts fimly supported. There are two main circuit boards, both of which are high quality, double sided, through-hole-plated fibre glass PCBs. These boards contain the circuitry for the attenuators, amplifiers, time base, triggering circuitry and high voltage power supply. The 40MHz version contains additional circuitry for the delayed time base, 12kV power supply, and the 120ns delay line. Good quality components are used throughout and interwiring is routed via 'minicon' type connectors as an aid to serviceability and to this end, everything is easily accessible. Other controls and switches are mounted on sub-PCBs.

The CRT is very securely mounted front and rear, which is a welcome feature, as the CRT is one of the single most expensive parts in an oscilloscope. The CRT features an internal graticule which eliminates parallax errors when making measurements, and also graticule illumination for improved contrast against the display. A Mumetal shield is provided around the CRT, which prevents stray magnetic fields from causing distortion of the electron beam path. Mumetal, incidentally is a high permeability alloy of iron and nickel, utilised because of its excellent shielding properties.

The outward appearance is smart, with the case being finished in a semi-matt cream paint finish. The front panel controls are grouped systematically, with all related functions encompassed by a line border and headed by a description block, it is therefore easy to find the appropriate control knob or switch.

Photographs 3 and 4, show the inside of the oscilloscopes.

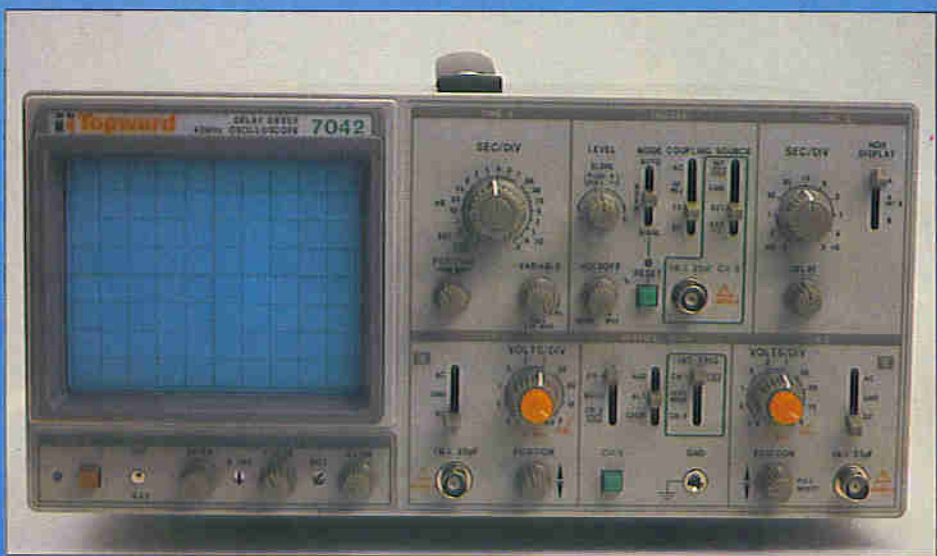


Photo 2. 40MHz Oscilloscope – Front Panel.

Controls and Use

A concise manual is supplied with the oscilloscope, illustrating the controls and their usage in making measurements. For further information on servicing and calibration procedures, a separate manual is available from Maplin Electronics (Order code XH58G price £10.00 NV)

Photographs 1 and 2 show the front panels of the oscilloscopes.

Beneath the CRT, on the front panel, is the mains on/off switch, beam intensity, beam focus and graticule illumination controls. Additionally a preset control for trace rotation, and on the 40MHz version only, a preset control for 'B' intensity. The presets are accessible with a small flat bladed screw driver. The 'B' intensity preset allows adjustment of the 'bright line' portion of the display when in the 'A int B' mode.

On the lower right-hand part of the front panel are BNC channel input connectors, controls for channels 1 and 2; sensitivity, vertical position and coupling mode (AC, DC or grounded), also switches for selecting the vertical mode, internal triggering source and Channel 3.

The channel inputs present an input characteristic of 1MΩ/25pF, for Channels 1 and 2 the sensitivity is variable, whilst on Channel 3 it is fixed at either 0.1V/div or 0.5V/div. As with most types of test equipment, when measuring an unknown signal, it is advisable to set the sensitivity to minimum (maximum volts per division) and then increase the sensitivity until the range accomodates the signal adequately. The channel sensitivity controls are calibrated in defined steps, however the controls may be un-calibrated by rotating the central 'variable' control. Pulling the 'variable' control will expand the trace vertically by a factor of 5 times.

The vertical position control can be adjusted to move the trace so that it is conveniently positioned on the graticule. The selectable coupling mode allows the DC component from a signal to be removed, this is achieved by setting the coupling switch to AC. This facility is useful when measuring the amount of ripple present on a DC supply rail. If AC coupling is not required then set the switch to DC. The grounded (GND) mode allows the input to the attenuator to be connected to ground, without the necessity of disconnecting the input lead. This is often used when establishing a reference point on the oscilloscope graticule.

The vertical mode selection switches select which traces are displayed; Channel 1, Channel 2 or both. When displaying both channels three modes can be selected; Add, Alt or Chop. The Add mode performs an algebraic addition of the the signals present on Channels 1 and 2, displaying the resulting summed waveform. Subtraction may be performed by inverting Channel 2. The Alternate (Alt) and Chop modes select how the oscilloscope displays two (or three) waveforms on the screen simultaneously. In Alternate mode, only one trace is displayed per sweep, this is best used for high frequency signals viewed at high sweep speeds, persistance of vision gives the appearance of all traces being present at once. The Chop mode switches quickly between the traces and is best suited for use with low frequency signals viewed at slow sweep speeds. If in doubt as to which mode to use (Alt or Chop) switch between the two and choose which mode gives the best display. The internal triggering mode switch, selects the trigger source; either Channel 1, Channel 2 or composite triggering from Channel 1 and 2 (Vert mode). Vert mode is used when the signals on Channels 1 and 2 are not frequency related, otherwise the display is unlikely to trigger properly.

The Seconds per Division (Sec/Div) control, allows selection of the horizontal sweep speed and is adjusted to resolve the required time scale. Generally, a high frequency signal will require a fast sweep speed to display the signal, and vice-versa. When the Sec/Div control is rotated fully anti-clockwise (X-Y) and the vertical mode channel select switch is set to the X-Y position, the X-Y mode is selected; in this mode, Channel 1 provides deflection along the X axis and Channel 2 provides deflection on the Y axis. This allows two signals to be compared in terms of phase and frequency.

The horizontal position of the trace may be shifted by adjusting the position control adjacent to the Sec/Div control. The Sec/Div control is calibrated in defined steps, however as with the vertical sensitivity selectors, the 'variable' control may be used to un-calibrate the setting. Pulling the 'variable' control will expand the horizontal axis by a factor of 10 times.

The 40MHz version also has a delayed time-base (Time B), which allows a specified portion of the trace to be expanded out, this can greatly ease measurements on complex waveforms, such as video signals; where it may be necessary to examine the content of individual TV lines. Without a delayed-time base it is difficult to achieve this, unless an extra triggering unit is connected to the oscilloscope. The desired 'B' (delayed) sweep speed is selected and the mode switch is set to 'A int B'. In this mode the part of the waveform that will be displayed in the 'B' mode will be highlighted on the display as a bright portion, the 'delay' control can be adjusted to select the required part of the waveform. When controls have been adjusted, the mode switch can be set to B and the display will now show the required part of the waveform expanded out. The delay control can be adjusted to view other parts of the waveform, whilst in 'B' mode.

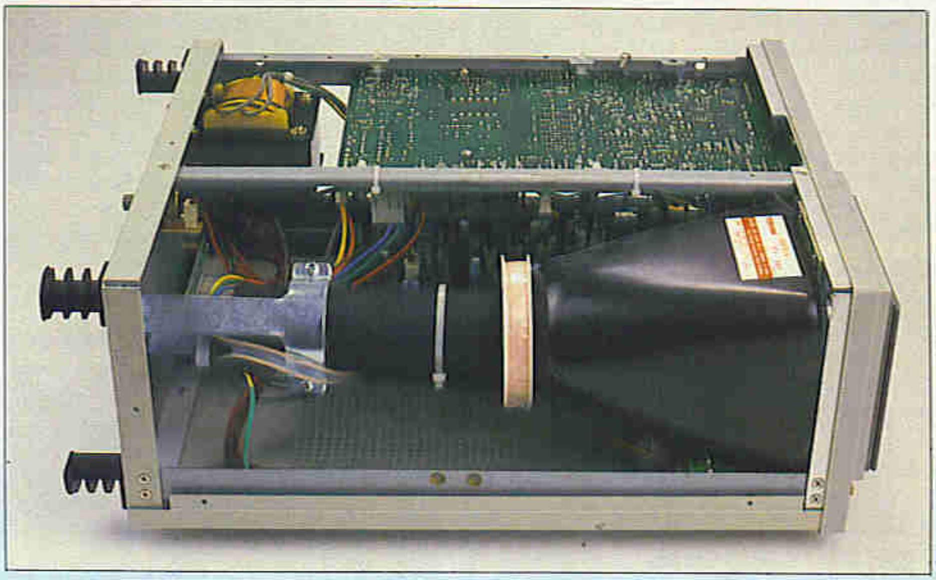


Photo 3. 20MHz Oscilloscope – Internal View.

The triggering circuitry has several modes of operation; Auto, Normal and Single. In the Auto mode, when the signal is not triggered the display will 'free-run', if this is not required the Normal mode can be selected, which will blank the display when trigger is lost. The Single mode provides a one- shot sweep of the display. The reset button 'arms' the single sweep, which is then triggered by the next valid trigger pulse.

As with the input channels, the trigger circuitry can be coupled in different ways; AC, HF Reject, TV, DC. AC coupling removes the DC component from the trigger signal. HF Reject mode filters out high frequency signals above 50kHz. TV mode routes the trigger signal via a synchronisation separator, which enables easier triggering on video waveforms. DC mode couples the trigger signal straight through.

The source of the trigger signal can be from either; the input signals from Channels 1 and/or 2 (Int), a mains (Line) frequency source obtained from the secondary side of the mains transformer, External (Ext) signal applied to the Ext/Ch 3 input or External signal, internally attenuated by a factor of 5 (Ext/5), applied to Ext/Ch 3 input.

The level at which the oscilloscope triggers is determined by the setting of the Level control, which is adjusted until the waveform displayed locks correctly, the slope on which triggering occurs can be changed by pulling the Level control (in = positive edge, out = negative edge).

A trigger Hold-off control is also provided (something that is not often found on low priced scopes), and is a very worthwhile addition. The Hold-off control allows improved triggering on aperiodic waveforms, which would otherwise not lock properly.

On the rear panel of the oscilloscope, there is a vertical position control for Channel 3, a Channel 1 output;

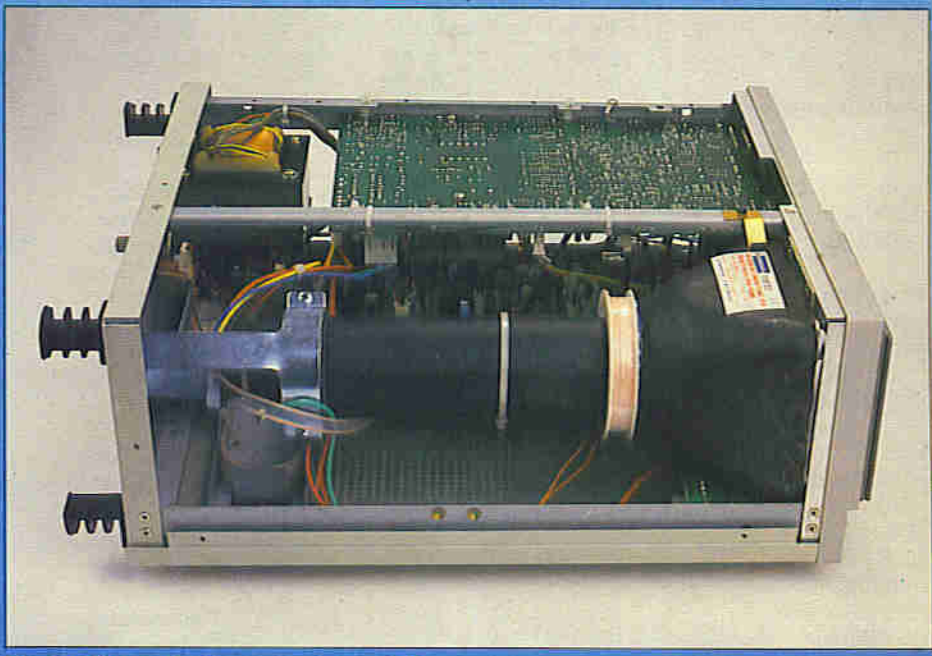


Photo 4. 40MHz Oscilloscope – Internal View.

which provides a voltage proportional to the magnitude of the Channel 1 input signal (50mV/div). There is also a 'Z' axis input which allows the intensity of the beam to be modulated and the all important socket for the Euro-connector mains lead. Note, a mains lead is supplied, but without a mains plug.

Suggested Accessories

Since a mains lead is supplied without a mains plug, a 13 Amp mains plug, with a 2 Amp fuse, should be fitted.
Order code RW67X (13A Nylon Plug) 69p.
or
Order code HL58N (13A Rubber Plug) £1.20.
Order code HQ31J (Plug Fuse 2A) 12p.

To facilitate connection of the oscilloscope to the circuit or equipment under test, oscilloscope probes are required (suggested, two off). Two types of oscilloscope probe are available; a low cost probe consisting of a 50Ω co-axial lead, terminated in a 50Ω BNC plug at one end, with a spring loaded hook probe and black crocodile clip at the other. A high quality probe with selectable 10:1 and 1:1 attenuator, terminated in a BNC plug, including probe accessories. Both probes may be found on page 499 of the current Maplin catalogue.
Order Code YR95D (Lo-Cost Scope Probe) £3.95.
Order Code BW05F (Scope Probe BNC) £17.95.

A service manual covering both of the oscilloscopes is available. Order code XH85G (Scope Service Manual) £10.00NV

Conclusions

The 20MHz and 40MHz oscilloscopes available from Maplin Electronics represent excellent value for money, they are well made, attractive in appearance, offer good facilities and work very well. These oscilloscopes would be a very welcome addition to the workshop of any engineer or hobbyist.
20MHz Triple Trace Oscilloscope Order code XJ61R (20MHz Triple Scope) £287.49
40MHz Triple Trace Oscilloscope Order Code XJ60Q (40MHz Triple Scope) £499.95

Specifications

Vertical Deflection

Sensitivity Ch1, Ch2:	5mV/div to 5V/div ±3% in 10 calibrated steps (1, 2, 5 sequence)
Bandwidth (-3dB), (20MHz):	DC to 20MHz; DC to 15MHz with x5 mag; from 10Hz when AC coupled
(40MHz):	DC to 40MHz; DC to 20MHz with x5 mag; from 10Hz when AC coupled
Sensitivity Ch3:	0.1V/div and 0.5V/div ±3%
Display Modes:	Ch1, Ch2, Ch2 inv, Ch3, Add, Alt, Chop
Rise-time, (20MHz):	17.5ns (23ns x5 mag)
(40MHz):	8.8ns (17.5ns x5 mag)
Input Impedance:	1MΩ/25pF
Input Coupling Ch1, Ch2:	AC, DC, GND
Input Coupling Ch3:	DC, DC/5
Max Input Voltage Ch1, Ch2:	400V DC, 400V AC Peak to Peak
Max Input Voltage Ch3:	100V DC, 100V AC Peak to Peak
Ch1 Output Signal:	50mV/div at 50Ω approx.

Horizontal Deflection

Sweep Time:	0.2μs/div to 0.5s/div ±3% in 20 calibrated steps (1, 2, 5 sequence); 20ns/div to 50ms/div x10 mag
Delayed, (40MHz only):	0.2μs/div to 0.5ms/div 11 calibrated steps (1, 2, 5 sequence)
Display Modes, (20MHz):	A
(40MHz):	A, A int B, B

Triggering

Mode:	Auto, Normal, One-shot
Source:	Ch1, Ch2, Vertical mode, Line, Ext, Ext/5
Coupling:	AC, HF Reject (50kHz), TV, DC
Polarity:	+ or −
Sensitivity, Int (Ext), (20MHz) DC to 10MHz:	0.5 div (0.1V)
to 20MHz:	1.5 div (0.2V)
(40MHz) DC to 10MHz:	0.5 div (0.1V)
to 40MHz:	1.5 div (0.2V)
Hold off:	Variable to x4 (time base < 5ms/div)

X-Y operation

Ch1:	X axis
Ch2:	Y axis
Sensitivity:	5mV/div to 5V/div
Bandwidth (-3dB), (20MHz):	DC to 1MHz
(40MHz):	DC to 2MHz
Phase Difference, (20MHz):	<3° DC to 50kHz
(40MHz):	<3° DC to 100kHz

Z Axis Input (Intensity Modulation)

Sensitivity:	3V p-p TTL compatible, positive going input decreases beam intensity
Bandwidth (-3dB):	DC to 5MHz
Impedance:	5kΩ

CRT

Screen:	6 inch rectangular, internal graticule with percentage markers, Suitable for photography
Effective Area:	8 x 10 div (1 div = 1cm)
Intensity, (20MHz):	A
(40MHz):	A,B
Acceleration Voltage, (20MHz):	2kV
(40MHz):	12kV
Illumination:	Adjusts CRT background brightness for good contrast to graticule
Phosphor:	P31

Calibrator

Waveform:	Square wave
Frequency:	1kHz approx.
Output Voltage:	0.5V ±5%
Duty Cycle:	40% to 60%

General

Voltage:	100V, 110V, 215V, 230V ±10%
Power:	40W
Frequency:	50 or 60Hz
Operating Conditions:	0°C to 40°C at 35% to 85% humidity
Dimensions:	314mm x 165mm x 425mm (w,h,d)
Weight:	9kg approx.

Accessories
Mains Lead (plug not supplied)
Instruction Manual

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.

Whether Station?

Dear Sir,
In writing, may I bring to your attention a 'glaring' error by your author Mr. Dave Goodman, in his constructional article of the 'Wind Direction Indicator', which appears in the current issue of 'Electronics'. His ability as a circuit designer is unquestioned, but his appreciation of the principle of the simple weather vane leaves something to be desired! In paragraph 4 of his introduction, he states, quote; 'The arrow tip... points to where the wind is going to...'
Rubbish! – The pointer of the vane points towards the direction from whence the wind is blowing. – Fundamental! Since this can hardly be a printing error, may I suggest that Mr. Goodman's misconception be brought to his attention. – Otherwise when he comes to describe the actual indicating instrument we shall be reading the reciprocal of the actual wind direction, total confusion thereby.
A. G. Higby. Penryn, Cornwall.

Thank you Mr. Higby for bringing this 'glaring' error to my attention. I stand corrected by a higher authority! Actually we were aware of the error whilst the magazine was being printed and prepared a corrigenda at that time. Of course, once printed, it's too late – "Be prepared for the onslaught from millions of distraught readers and standby to repel boarders cap'n!"
Dave Goodman.

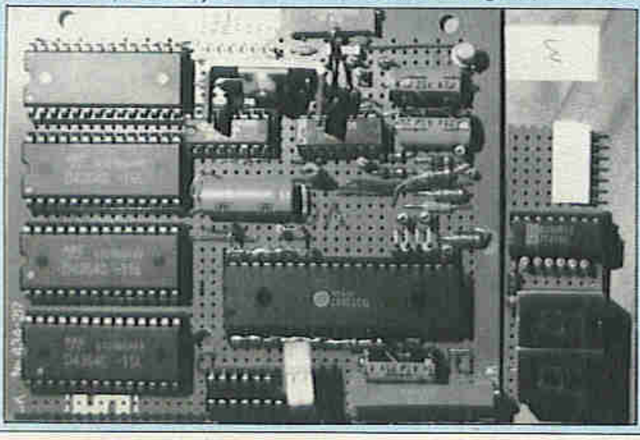
Colour Circuits

Dear Editor,
Although I belong to the era of 'zigzag' resistors, when they were often made more like a fuse with metal ends fitted in a similar type of holder, I still enjoy reading your magazine and using the convenient facilities of the Maplin Catalogue to order components for projects. Yes I do use modern test equipment such as digital meters, oscilloscopes etc, although I have disposed of my replacement crystals for the cats whisker detectors and wax cylinders for my phonograph.
However I have one slight criticism of your otherwise excellent magazine and that is the practice of using certain colours for your circuit diagrams. In the Feb/Mar issue you have them using blue printing on a pink background – ugh! Maybe it is only my tired old eyes, but I find them difficult to read, black on any colour stands out, but not these two, so would it be possible to keep such a vivid combination for the headline displays etc.
N. L. Smith. Stoke-on-Trent, Staffs.
P.S. I agree that the 'boxed' resistors are not a problem, it's just a question on what you cut your teeth on. I still mentally convert decimal currency to £.s.d, though it is a futile exercise.

Your comments on coloured backgrounds to circuits have been noted, we have had quite a lot of feedback on this matter (from the Lab engineers as well) and you can rest assured that all circuits and drawings will be in 'good old fashioned' black on white (or a light colour).

Digital Call Signs

Dear Sir,
Prompted by your inclusion of the digital record/playback module in the Feb/Mar '89 issue of 'Electronics'. I thought you might be interested in my version of the unit, built when the UM5100 first appeared in the catalogue.
I decided to build the unit for use with my amateur radio station – make one CQ call and the box does it for any subsequent calls.
I needed to use the maximum 256K RAM and this was implemented using 4 x 64k and a 74LS138, as these were readily available.
Wiring all this up on veroboard was a daunting task, but as can be seen from the photograph, I reckon I did OK.
There are two main differences between my circuit and yours: instead of using a large AND gate, I used a diode on each address line as per D3-5 in your magazine. These can be seen mounted vertically adjacent to the UM5100. The reason for this is that the diodes, like the RAMs were available at the time.
The other difference is, of course, the display. This decodes using a 32 x 8 bit PROM, the four highest order address lines and displays them in a 2 digit decimal count from 0 to 15. This is a useful tip for anyone requiring a particular type of display driver. The PROM is capable of sinking or sourcing enough current for a 7 segment LED display. 7 of the data outputs control the LSD whilst the 8th drives both segments of the 10s.
I set the oscillator to run for 15 seconds, so the display shows elapsed time, very useful when making the initial recording. This display can be interfaced to your design via the EPROM PCB connector.
I hope this has given a few ideas to other constructors.
C. J. Pollard. Livingston, West Lothian.



North or South?

Dear Sir,
In the Feb-Mar '89 issue, J. H. Preston berates us for a supposed lack of geographical knowledge but really he is no more living in the North than a reader in Brighton! As any car driver can see the signs on the M23 point to 'The North' as they do on the M25. This continues on the A1 and the M1 and is still the case at York. When my wife and I were on holiday last year, half the signs at Durham pointed to the North (the rest pointed to the South). At that point I recall the folk in Edinburgh, Stirling and Oban all speaking of the North and could only conclude that somewhere near John o' Groats or Dunnet Head there must be a road sign proudly proclaiming 'The North!'. Perhaps a Scottish correspondent could enlighten us?
R. H. Thornton. Barking, Essex.
P.S. I haven't yet found the 'South' sign on the coast that runs from Cornwall to Kent.

Intergalactic Boob

Honoured Sir,
Extremely urgent that you contact University Library, Trantor. If in their translations into Galacta, they confuse 'i' with 'e', (vide 'itenerary') they are likely to blow a few intergalactic fuses at the very least!
3061061 Smith, ex 'Joe Blake's Seven', 2BS & RU, Paya Lebar.
Actually, University Library Trantor did not confuse 'i' with 'e', it was OUR error (again)! Fortunately, we do not makkee vely many typpineg mislakes. In our constant quest for improved efficiency we are thinking of replacing our type-setters with a ZX81 (16K) and a thermal printer.

Circuit Difficulty

Dear Sir,
Having been a reader of your magazine for a number of years I cannot understand a hell of a lot of the drawings that you print. I think it would be a good idea if you described on the heading whether it was a beginners, intermediate or an advanced project, this would make life a lot easier. I would also like to see a lot more of a beginners section, has it occurred to you that a lot of young people, including myself (61 yrs) would like to get off the ground floor.
D. W. M. Stark. Castle Donington, Derby.
We have always tried to include a wide range of projects and articles covering all areas of ability, from beginner to expert. The text accompanying projects is written so that it is as clear as possible, avoiding jargonese, and including drawings, diagrams and photographs to illustrate every aspect of construction. Projects wise, it is not possible to get much simpler than the live wire detector and mini metal detector. We are currently running a series on 'Electronics by Experiment' (back issues are available, see page 70) and our constructors guide has many useful tips. For teaching from absolute basics the Books section of the catalogue has a good selection of suitable titles. Projects in the Maplin catalogue ARE graded 1 to 5 in terms of difficulty and expertise required. Level 1 is suitable for absolute beginners. Surely the level of project difficulty in the magazine can be determined by reading the article and looking at the circuits and drawings!

Electronics In Cars

Dear Editor,
I like the new style magazine very much. Here is an idea for a future series of articles. Many of us who are interested in electronics are also interested in car mechanics, especially these days when our cars are becoming increasingly electronic, with engine control systems and so on. the result of this electronic revolution in the auto industry is that many of us who have previously serviced the ignition systems of our cars with relatively simple equipment are baffled by the complexity and sophistication of the black boxes. I would willingly buy, for example, one of Maplin's triple-trace oscilloscopes, which seem excellent value for money, if I were convinced that I could use it to monitor and tune the engine of my new electronic car! No one seems to be focussing on this subject which is falling between the two stools of electronics and DIY auto servicing. But most of us who are interested in electronics will either already have cars with electronic engine control systems or will be buying cars with them in within a year or so. A good series of articles on this subject would, I suggest, boost the sales of your magazine and of Maplin equipment. How about it?
N. B. W. Tompson. Kenton, Harrow.

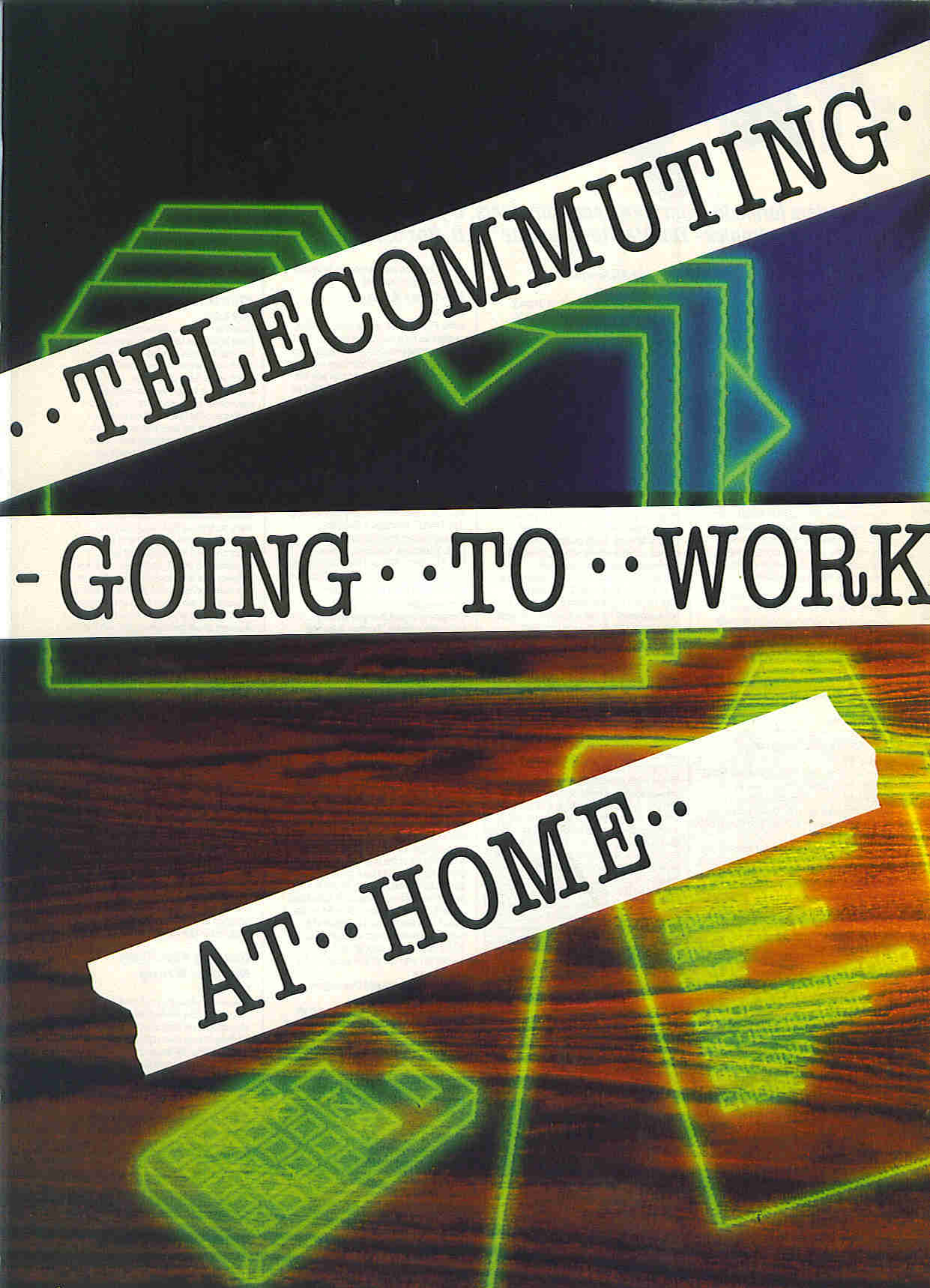
Certainly the area of car electronics is very interesting and topical, and is a good idea for a future series of articles, we feel for a number of reasons that adjustments or servicing of engine management systems should be left to the experts: Car manufactures are generally very reluctant to release information of this nature because of industrial secrecy, these systems require millions of pounds of development. Invariably special dedicated diagnostics equipment is required. Any adjustments made would invariably invalidate the warranty and there is the danger of causing costly damage. Also a car may be considered as a lethal weapon, it is possible that an incorrectly adjusted engine management system could endanger life.

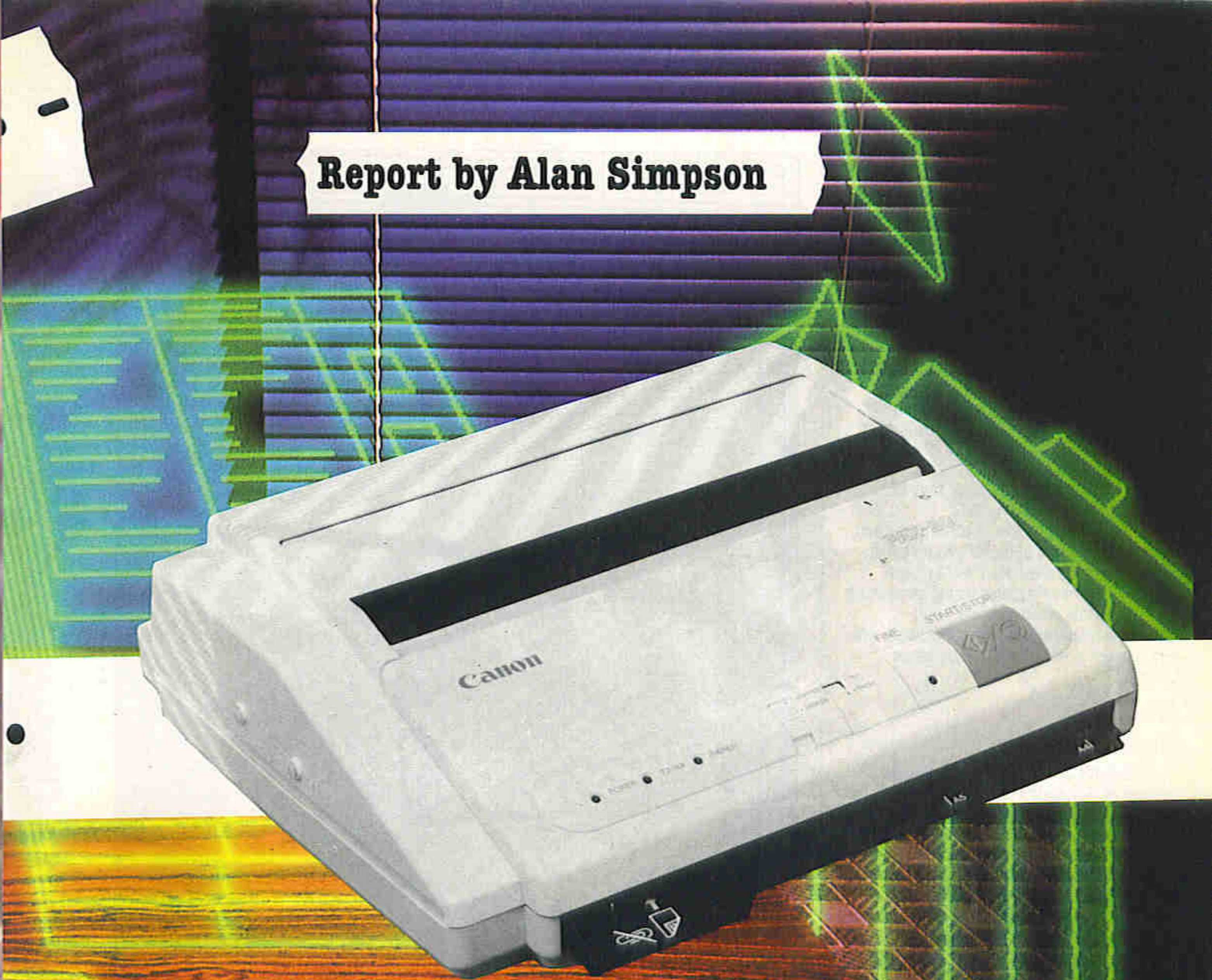
Getting The Right Number Wrong

Dear Sir,
I have today bought your magazine for the first time. Allow me to congratulate you on its quality. One item caught my eye – 'Getting the number right' on page 47 of the April-May '89 issue. First it is implied that an extra digit is to be applied to London telephone numbers, thus producing eight figure numbers. But this one digit the writer says will be either 070 or 081 – three digits each. Is the plan in fact to divide London into two dialling code areas, 01 and, perhaps 081? Surely, 070 is an error, as 071 and 081 are the only 0x1 prefixes free.
J. Fox. Redhill, Surrey.

As you suggest, it is intended to split London into two zones, central and outer. The numbers 071 and 081 replacing 01, i.e. producing eight figure numbers thus 071-NNN-NNN or 081-NNN-NNN. For more information turn to 'News Report' on page 78.

TELECOMMUTING — GOING TO WORK AT HOME





Report by Alan Simpson

For once, all industry authorities are agreed. The age of Telecommuting – working from home making use of telecommunications to keep in touch with your company or business – is set to take off. British Telecom calls the movement the second industrial revolution. "We are about to see the birth of a new breed of worker, the teleworker, who travels to work not down the Piccadilly line but the telephone line".

According to BT, within four years or so, one in five of us will be working from home. The CBI translate this figure as representing some four million individuals. Looking even further ahead, BT sees thirteen million telecommuters by the beginning of the next century, a figure incidentally which will represent some 50% of the UK workforce.

This year for the first time, The Daily Mail Ideal Home Exhibition featured a computer-based home office. British Olivetti had assembled a range of equipment – all of which can be fitted into drawers, presumably to be slotted away when the office has to be converted back into the lounge.

The government is also joining the telecommuting movement by supporting an initiative to move computing jobs out of London to certain areas of high unemployment in the North. Companies such as BT, British Rail, British Petroleum, Shell and a leading clearing bank are supporting the venture which is designed to elliminate commuting for some 800 employees. A major incentive point for the workers involved is that they will be paid salaries equivalent to their London-based colleagues. Meanwhile the European Development Organisation (NEDO) are working on project 'Frontline'. Here the aim is to create 500+ new jobs by setting up a number of linked teleworking centres in the UK. With the mobile office already a factor of business life – though judging by the number of drivers using their cellular 'phones while stuck in traffic jams on the M25, Park Lane or Hampstead High Street, perhaps a better term would be the immobile office – the communication industry is now turning its weighty attention to developing the office at home.

Factors For Change

But this is one revolution which will involve us all, not just the fortunate travelling executive. Dr. Gordon Ross of PA Consultancy, who is the recognised authority on all matters telecommuting, believes that the elimination of the daily wear, tear and expense associated with commuting, will enhance the quality of life for a growing body of workers.

Gordon Ross points out that the cost of inner city housing is forcing people to live ever further away from their place of business. Given that the average commuter spends over two hours a day travelling to and from work (the costs associated with communting is put at over four billion pounds) there should be no shortage of volunteers to join the telecommuting club.

Costs are also a major factor influencing companies to consider telecommuting policies. Thanks to office rent escalation, we have all heard about the high price of accommodating that waste paper basket in

Lombard Street or High Holborn. Also as Gordon Ross points out, the growing shortage of workers, thanks to declining birth rates, is also stimulating employers to introduce telecommuting as a means of attracting, or retaining not just key personnel, but mothers with young children, the infirm and the not so young.

If the skill shortage is acting as a key telecommuting pressure point, the economics of the office automation market-place is also a major influence. Thanks to falling costs of equipment, it is now possible to fix up a person with suitable IT equipment to work at home from as little as £2,000, believes Gordon.

Other contributing factors, says Dr. Peter Scott who heads the NCC communications division, is the introduction into the UK network of digital transmission technologies. By the early 1990's reports Peter, BT will have installed its digital network covering the UK while Mercury Communications existing digital network will be extended to reach most UK business centres.

Being in When You Are Out

Certainly John Sommerwill of leading London BOS Systems House Saffronrose, believes that the advent of digital technology will open the working at home horizons for the telecommuter. At that stage, it will be as easy to use the phone to transmit data or image as it is now to transmit voice traffic. "You will be able to program your 'phone for calls to automatically follow you around. Ideal if you are paying a visit to your company, supplier or visiting the local bank manager".

But Bill Loose, of PA Applied Systems Centre warns "don't hold your breath for digital facilities. In most cases the digital network will stop short of your local, or even not so local exchange, not at your front door. In the meantime, Bill sees CT2, the new generation of cordless 'phones as being essential telecommuting equipment. "They will operate as a normal cordless phone in the home (allowing you to pop next door for elevenses with Mary or Tracy) and as a mobile phone outside".

A further benefit of digital technology – one which does not require any new cable to enter your home – will be itemised telephone billing. By 1995, a period incidentally which Bill Loose believes is far too leisurely, all BTs twenty three million customers will be able to receive fully itemised telephone billing. This will be an important factor for all homeworkers needing to keep close tabs on their business and domestic calls.

The Intelligent Home

If the central feature of the intelligent home is the telephone, then a computer must be next in the importance league. The Federation of Microsystems Centres sees a telecommuting package including a hard disk Personal Computer, one which will double as a terminal; a modem which connects the P.C. to the public switched telephone network; a printer, laser for choice but a good quality daisy wheel machine will do, together with

The Cannon Fax-80 fax machine is capable of transmitting a document in 18 seconds.

application software to cover work processing, general accounting plus possibly a spreadsheet program.

Communication links could include a small desktop facsimile machine, – the latest Canon FAX-80 measures just 28 × 25 centimetres and costs £650 (probably even less from your local dealer). As a method of zapping messages, drawings and working documents to your office, fax is much cheaper than electronic mail, especially if you use it off peak, and certainly speedier and more reliable than Royal Mail.

Telex says the Federation, is becoming a less important business tool, apart from the relatively high cost of equipment, rental of a special teleprinter network line is over £100 a quarter and you can't send graphics. Definately only useful if your company is picking up the cost tabs.

You can also ignore teletex, a form of computerised telex. It is being superseded by the X.400 electronic messaging system. But don't forget teletext, the information services available free of charge on your modified tv set. This will enable you to keep in touch with world stock markets and other information matters such as the latest test match or Wimbledon scores.

For the home worker who may not have a large-scale budget, or too much space, it must be worth considering the new 'four in one' telephone units. These combine a telephone, fax, answering machine and copier facility, making use of just one single phone line. Meanwhile, BT's chairman is forecasting the time when the focus of the telecommuting work centre will be a small portable computer which can be plugged directly into the 'phone socket There will be no need for a modem, when using a fully digitised network.

Less High Tech – More A Sociological Problem

According to Bernard Beaver of BMS Beaver Ltd., who market the top selling computerised time management tool, The System, it is not the technology associated with telecommuting but the problem of sociology. Not all individuals have the necessary fund of self motivation, self discipline and ability to manage time, in order to make a success of home working. In many cases, we need other people to work with, being part of a team is an all important factor.

There is also, as Bernard Beaver reminds us, the not so small factor of the home environment. "Ideally, the telecommuter needs his own office, one which can be shut off from the rest of the

Continued on page 36.

ELECTRONICS BY EXPERIMENT

Part 8 by Graham Dixey C.Eng., M.I.E.R.E

Introduction

Although known as a unijunction 'transistor' the construction of the UJT is quite different from that of other types of transistor, being very much simpler. It is not, in fact, either an amplifying device or a logical device. It is a switching device that is 'level sensitive' i.e. one that triggers when the voltage applied to it reaches a predetermined value.

The symbol and form of construction are shown in Figure 1. From this it can be seen that it has an emitter and two bases, the latter being suffixed 1 and 2. The construction shows that the UJT is formed from a bar of n-type silicon with a small p-type region 'diffused in' about halfway along. The base connections are mere ohmic (that is non-rectifying) contacts made at each end of the bar; the emitter connection is made to the p-region.

It is fairly obvious that there is a p-n junction between the p-type emitter and the n-type bar, and it is on this fact that the basic action depends, as will be seen later. There is a finite value of resistance between the connections base 1 and base 2, which can be referred to as R_{BB}, the 'inter-base resistance'. To explain the action and to represent the device properly, this resistance is divided into two parts, that between base 2 and the emitter, and that between the emitter and base 1. These are known as r_{B2} and r_{B1} respectively. The p-n junction between emitter and bar can, logically, be represented by a diode. This gives a very easy to understand equivalent circuit, which is shown in Figure 2.

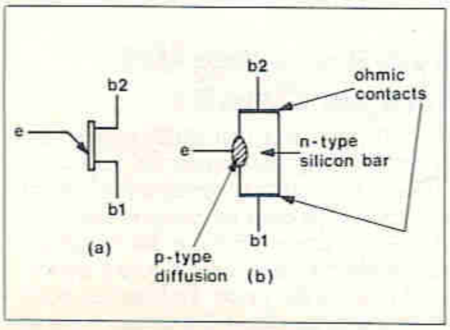


Figure 1. The unijunction transistor (UJT). (a) circuit symbol. (b) construction.

This figure includes some other quantities that need explaining. In use, a direct voltage will be applied between base 2 and base 1, such that base 2 is positive with respect to base 1. This voltage is referred to as V_{BB}. Since the path between base 2 and base 1 consists effectively of two resistors in series, the voltage V_{BB} will be divided into two parts according to the relative values of r_{B2} and r_{B1}. In other words, the division of voltage is according to the usual potential divider rule, such that the voltage across r_{B1} is equal to:

$V_{BB} \times [r_{B1}/(r_{B1} + r_{B2})]$

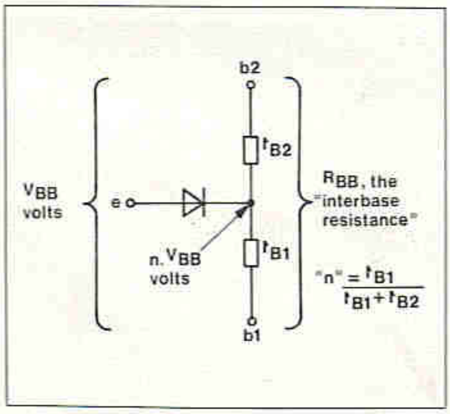


Figure 2. Equivalent circuit of UJT.

The term in the square brackets represents the relative values of the two base resistances. If they were equal its value would be 0.5, corresponding to the emitter being exactly halfway along the bar. This fraction is given the name of 'intrinsic stand-off ratio'. This is denoted by the symbol 'n' in Figure 2, and it usually has a value that lies between 0.51 and 0.82. In this figure it is used to describe the voltage that exists at the junction of r_{B1} and r_{B2}, that is $n.V_{BB}$. This is, of course, also the voltage at the cathode of the diode. The significance of this is that the cathode of the diode is normally held at this particular voltage by the d.c. conditions, and the anode of the diode (which is also the emitter connection of the UJT) must reach a voltage that is approximately 0.5V greater than this voltage in order to conduct. To take an example that illustrates this.

Suppose that V_{BB} = 6V and n = 0.6, then the value of $n.V_{BB}$ is equal to 0.6 x 6 = 3.6V; this is the voltage at the cathode of the diode. For the diode to conduct, the voltage at its anode must reach 3.6 + 0.5V = 4.1V. This idea is important because it is essential to the basic operation of the device.

Now, with the above ideas in mind, it is possible to consider what actually happens when the emitter voltage, starting at 0V, say, is gradually raised until the voltage is reached at which the diode begins to conduct. When it does so, current will flow through the diode, from the source of the emitter voltage, and down through the base resistance of r_{B1} to 0V. This current flow will have the effect of reducing the value of r_{B1}; thus the current flowing in it will increase further. The base resistance then falls even more, the current increases further, a further drop in resistance occurs, followed by more current, and so on. In other words, once the diode starts to conduct, a regenerative action occurs which ends with the value of r_{B1} becoming very small and a large current flowing from the emitter down to 0V through the B1 lead. The action is reinforced by the fact that, as the resistance of the base region falls, the voltage nV_{BB} also falls, giving an increased forward volt drop across the diode; this itself makes the diode current increase.

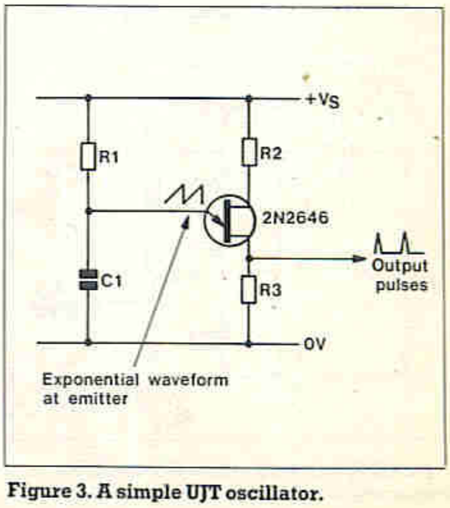


Figure 3. A simple UJT oscillator.

This description of the UJT's basic mechanism shows it to be a voltage operated switch which presents a high impedance to the triggering voltage (when the diode is non-conducting) and a very low impedance path to 0V once it has triggered. The emitter voltage at which triggering occurs is known as the 'peak point voltage' V_P, which we know is equal to $n.V_{BB} + 0.5$ volts.

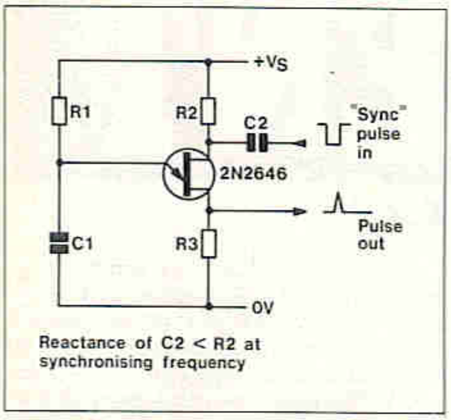


Figure 4. Synchronising the UJT oscillator frequency to that of an external pulse source.

A Simple Relaxation Oscillator

The circuit of Figure 3 shows the use of a UJT as a relaxation oscillator. This circuit, which can be developed using various switching devices, depends upon the regular charge and discharge of a capacitor. In the circuit the capacitor C1 charges through resistor R1 towards the supply voltage V_s. The emitter of the UJT is joined to the junction of these two components and so its potential follows that of the exponentially rising voltage across C1. According to the previously explained theory, when the voltage at this point reaches the peak point voltage V_p, the UJT will start its regenerative cycle that takes it into the conducting state. As a result the capacitor rapidly discharges itself and a short but heavy current pulse flows through the Base 1 resistor R3, generating a short positive output voltage pulse. At the same time the voltage at Base 2 falls and a negative pulse of voltage appears at this point also.

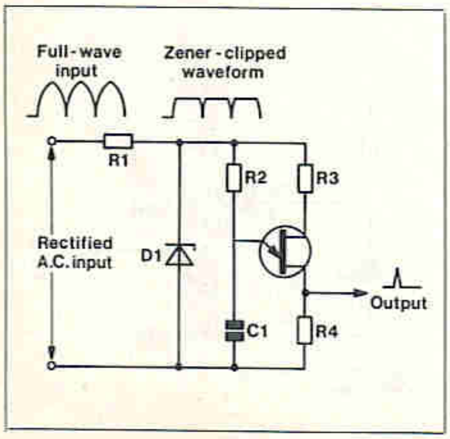


Figure 5. Synchronising the UJT oscillator frequency to a sinusoidal input.

The capacitor now being discharged, the emitter voltage returns to 0V, or very nearly. The cycle is ready to start again. The frequency at which the circuit oscillates is obviously related to the time constant of R1 and C1. There are precise formulae for determining the frequency, but a good starting point is given by using the expression that $f = 1/(R1C1)$. This relation actually assumes that n has a value of 0.63 which, being an average value for this parameter, is a good basis for approximation anyway.

temperature coefficient its increase with temperature rise can be put to good effect. A resistor included in the Base 2 lead will, together with R_{BB} and the load resistor in the Base 1 lead, form a potential divider for the supply V_s. Thus, if R_{BB} increases with temperature, then its proportion of the total voltage V_s will also increase; since this term, V_{BB}, appears in the expression for V_p it will cause the latter to increase and so cancel the original reduction due to the temperature rise. The correct value for R2 can be calculated from the relation $R2 = 10{,}000/n.V_s$.

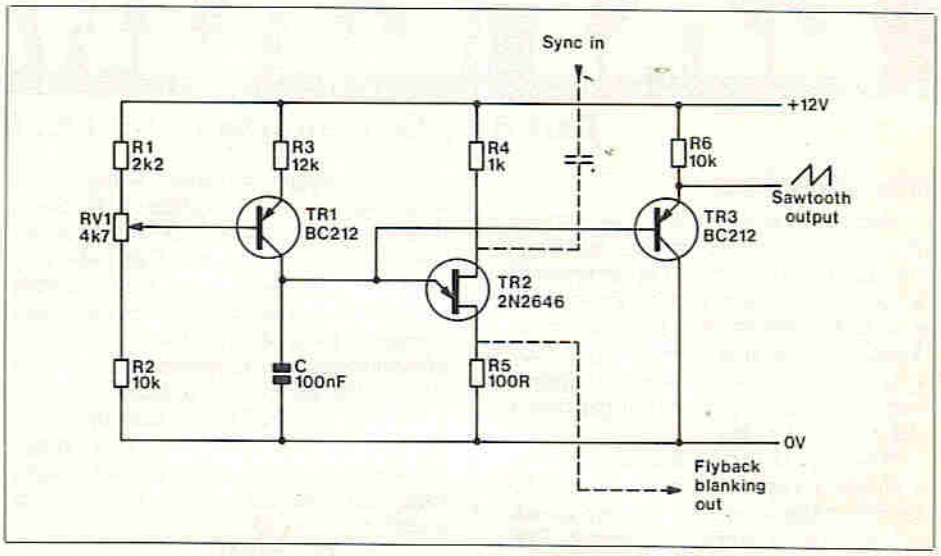


Figure 6. A UJT linear sweep generator (a possible basis for a timebase).

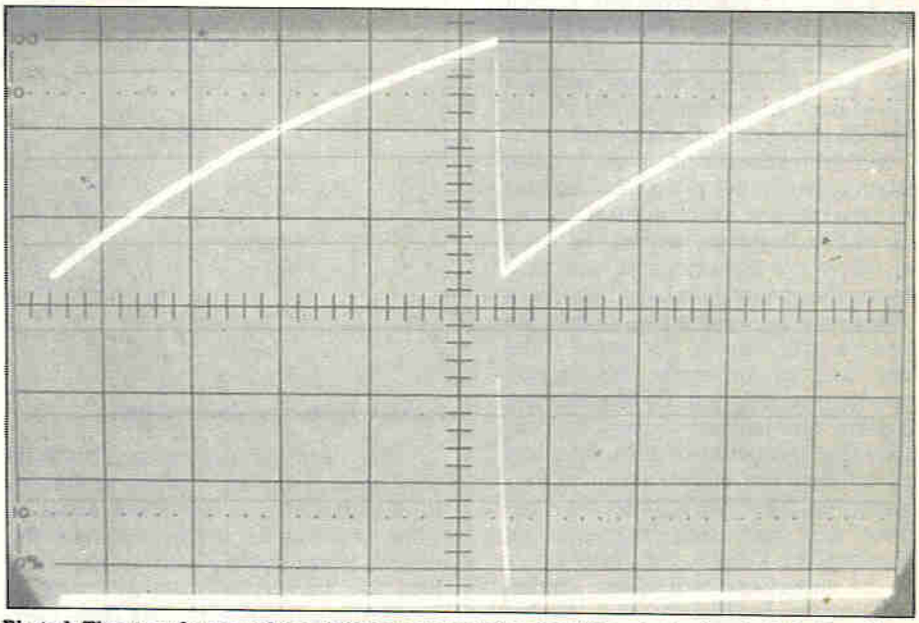


Photo 1. The waveforms at the emitter (upper waveform) and Base 1 of a simple UJT relaxation oscillator. Note how short the Base 1 pulse is.

As well as the resistor R3 in the Base 1 lead, the function of which is obviously to develop the output pulse, there is also a resistor R2 in series with the Base 2 lead. The function of this is less obvious. Its purpose is, in fact, to compensate for the effects of temperature variations which might otherwise cause some variability in the triggering point. This is because the peak point voltage V_p decreases with temperature rise at a rate of 3mV/°C, taking the 2N2646 as an example. However, as the interbase resistance R_{BB} has a positive

Synchronising UJT Trigger Circuits

We have seen that a UJT triggers into the conducting state when the voltage at the emitter reaches the peak point voltage V_p. Since V_p is dependent upon the value of V_{BB}, the firing point can be varied by effectively varying V_{BB} at some convenient point in the cycle. This can be done by coupling into Base 2 a negative-going pulse of sufficient amplitude to force the UJT to trigger immediately. See Figure 4 for the arrangement. Thus, the UJT pulse generator is forced into synchronism with these external pulses. Oscillograms show the time relation between these 'sync' pulses and the output trigger pulses appearing at Base 1. Note the effect when the amplitude of the sync pulses is not quite large enough.

The time constant R2C1 must be longer than the half-cycle time of the input otherwise the circuit is likely to trigger during the steady period of the supply voltage rather than just at the end when it dips to zero. For 50Hz mains this half-cycle time is 10ms which means that R2C1 must be greater than 10ms. There are many values of R2 and C1 that, multiplied together, will give this product but we must choose values that are both practicable and convenient. A good starting point is to take an 'educated guess' at the value of C1 and work out the corresponding value for R2, rounding the latter up or down to the nearest preferred value as necessary. For example, if the value of C1 is initially chosen to be 1μF for a time constant of, say, 15ms, then R2 works out at exactly 15k.

$$R2 = (15 \times 10^{-3})/10^{-6} = 15 \times 10^{3} = 15k$$

If we wish we can modify the values, scaling one up and the other down. For example, we could make R2 = 150k and C1 = 100nF instead since this would give the same time constant. Why should we do this? Because then the capacitor C1 can be the more reliable and closer tolerance polyester type instead of an electrolytic type. The value of the base resistors is arrived at as follows.

Empirical design shows that the Base 1 resistor R4 should always have a value of less than 100 ohms. Let us settle for 47 ohms. The value of the other base resistor R3, can be calculated from the formula given previously, assuming an average value for n of 0.67 and a supply voltage V_S of 12 volts.

Then $R3 = 10{,}000/(n \times V_S) = 10{,}000/(0.67 \times 12) = 1.2k$ approx.

This completes the design for the mains-synchronised UJT trigger circuit. When it is hooked up, a dual-trace CRO should be used to show the time relation between the clipped, rectified a.c. input and the synchronised output trigger pulses.

Even relatively simple UJT circuits of the above types can be usefully employed as trigger devices in SCR power control circuits.

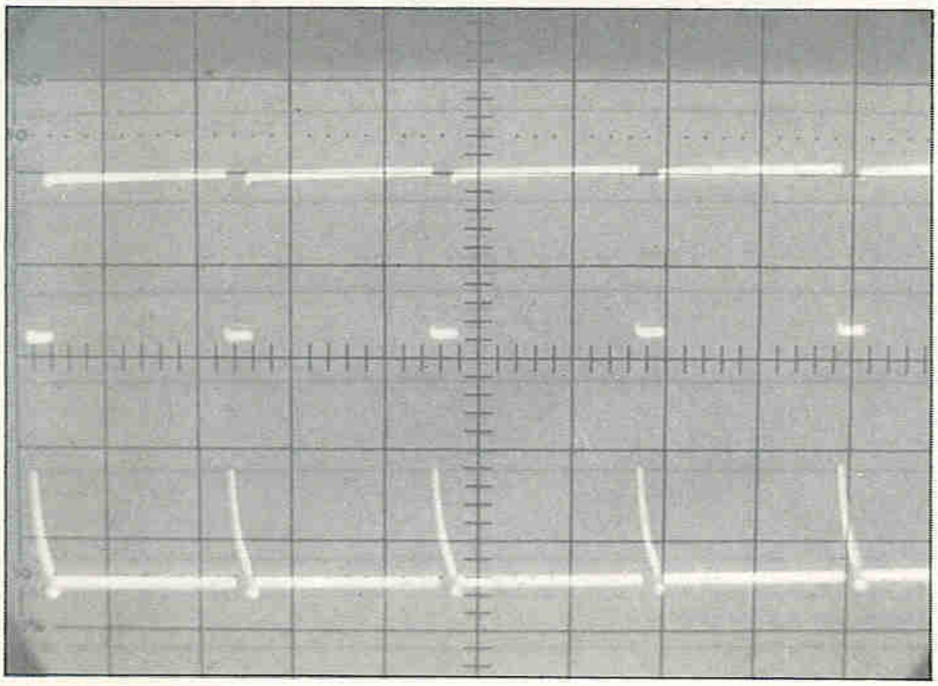


Photo 2. Correct synchronisation of a UJT oscillator.
The upper waveform shows the negative 'sync' pulses applied to Base 2; the Base 1 pulses are seen to be in exact synchronisation.

It is also possible to synchronise a UJT generator to run at either power line frequency or twice this frequency by supplying it from the output of either a half-wave or full-wave rectifier, as shown in Figure 5. The rectifier output has to be clipped to a convenient level by a zener diode limiter (R1 and D1 in Figure 5). If the peak value of the a.c. before clipping is much greater than its value after clipping, then it will spend most of the time at this limited value, dipping only briefly to 0V between half-cycles. It is at the instant that this supply falls to zero that the UJT is forced to trigger. Why? Because at these instants the value of V_{BB} becomes zero, as a result of which the value of V_p will be very small (much less than the capacitor voltage) and the device will trigger immediately.

As a starting point for investigating this action experimentally the rectified a.c. can be derived from the secondary of any convenient, small mains transformer via a bridge rectifier. For example, a 15V RMS secondary winding will give a peak voltage of about 21V. If a 12V 400mW zener diode is used, it will be necessary to drop 21-12 = 9V across the series resistor R1. The maximum zener current must not exceed 400/12 = 33.3mA, which leads to a 'minimum' value for R1 of 9/33.3 k, or approximately 270 ohms. This value can be safely doubled to give a working value of 560 ohms, allowing the diode to operate well within its rating.

A UJT Linear Sweep Generator

The exponential waveform that occurs at the emitter of the UJT can be 'linearised' if the timing capacitor is charged with constant current. The quantities of voltage V, charge Q and capacitance C are related by the well

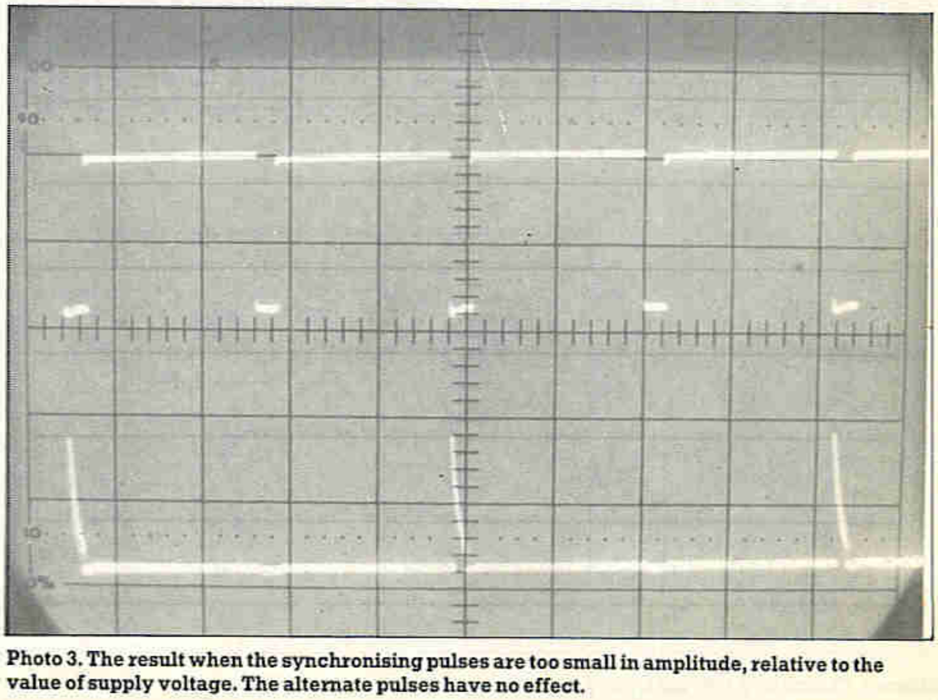


Photo 3. The result when the synchronising pulses are too small in amplitude, relative to the value of supply voltage. The alternate pulses have no effect.

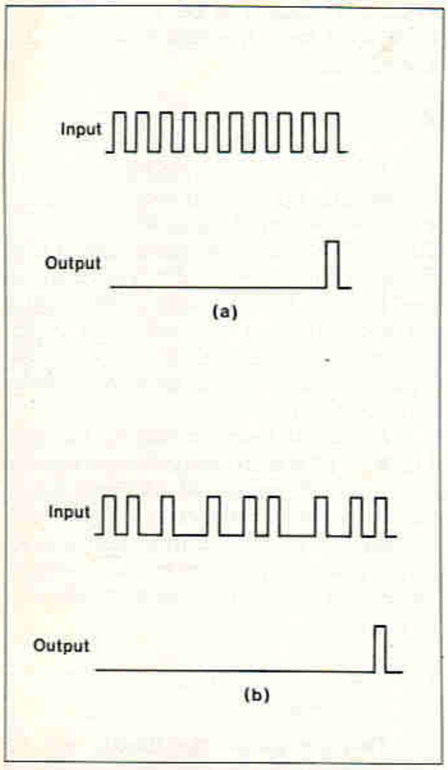


Figure 8. Input and output waveforms (Base 1) for UJT staircase circuit. (a) shows frequency division of 10:1 for regularly recurring pulses. (b) every occurence of ten random pulses generates a single output pulse.

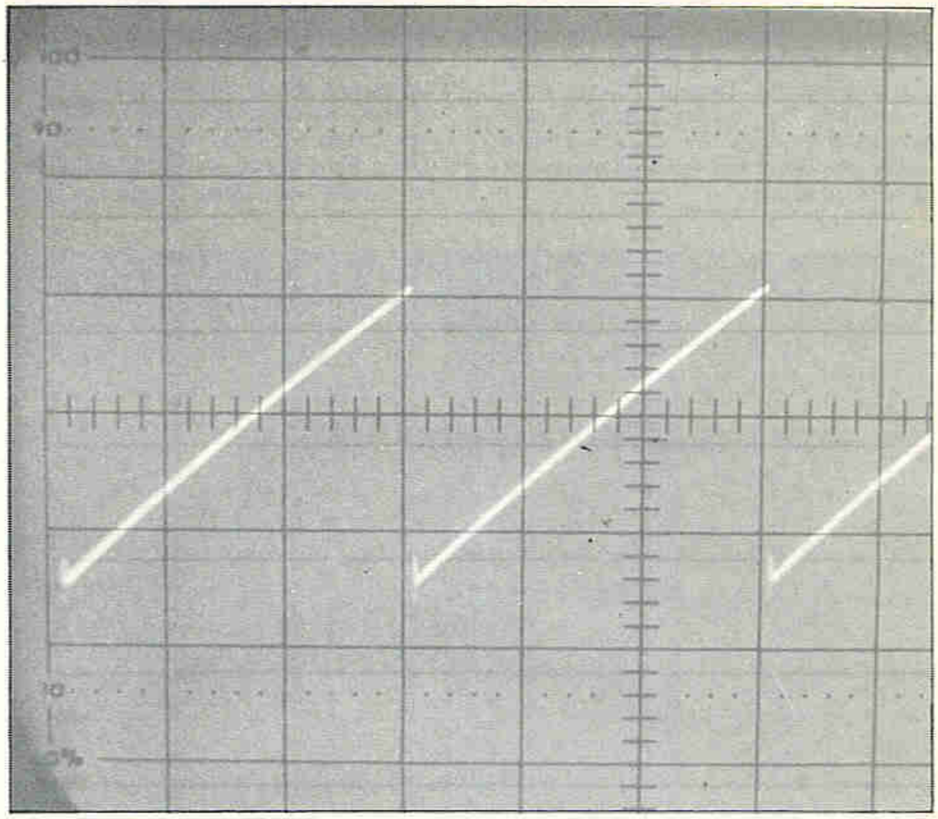


Photo 4. The much improved output of the Linear UJT Generator of Figure 6. Compare with the emitter waveform of Photo 1.

known relation Q = CV. The charge Q is also equal to the product of current and time, that is Q = I x t. From this we deduce that V is proportional to Q and hence, in turn, to the product of current and TIME. So, if I is constant the voltage is then directly related to time and must rise linearly with it.

A bipolar junction transistor (BJT) has constant-current characteristics, which simply means that, for a given set of bias conditions, the collector current is constant for a wide range of collector-emitter voltage. This makes it possible to use the collector current of a BJT as the charging current for the UJT's timing capacitor. The circuit for generating a linear sweep in this way is shown in Figure 6.

TR1 and its associated components comprises the constant current charging circuit. The potentiometer RV1 directly controls the size of the charging current and hence determines the frequency. With the component values given, the frequency range should be between about 500Hz and 1500Hz. The linear sawtooth at the emitter of the 2N2646 UJT is at high impedance and needs buffering. TR3 and R6 comprise an emitter follower to effect this.

It is quite possible to develop the circuit further and use it as a timebase (with some subsequent amplification). The linear sawtooth output will provide the required 'sweep' waveform while the pulse generated across R5 at the end of the sweep period can be used for 'flyback blanking'. Synchronisation, essential to any timebase, can be obtained by feeding negative sync pulses to Base 2, as previously described, through a suitable capacitor (a value of 10μF is suggested as a starting point).

A Staircase Frequency Divider

An interesting circuit for the experimenter is shown in Figure 7. It is arranged that transistor TR1 is normally OFF; as a result TR2, a PNP transistor that supplies the constant charging current to C2, is also OFF. There is, therefore, no charging current. A short positive pulse (short that is compared with the UJT's cycle time) will turn both TR1 and TR2 on for just the duration of the pulse. Charging current will flow into C2 during this time, causing its terminal voltage to rise by a small, but specific, increment. After which both TR1 and TR2 turn off again. Further pulses will have the same effect, the capacitor voltage rising in a 'staircase' waveform until the UJT eventually fires and generates a single output pulse.

The capacitor C2 has now discharged and the cycle recommences. The choice of C2 is important. Together with its charging resistance (R5 and R6 in series) it must have a time constant that is substantially longer than the duration of the input pulse; it is assumed that the input pulses are of constant width. For example, for a 'ten-step staircase', there should be a 10:1 relation between these two time periods.

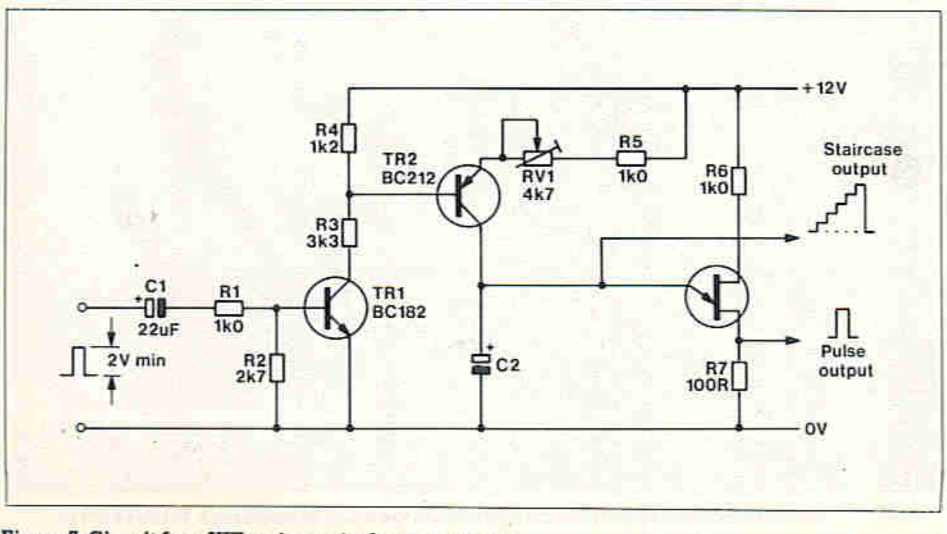


Figure 7. Circuit for a UJT staircase/pulse generator.

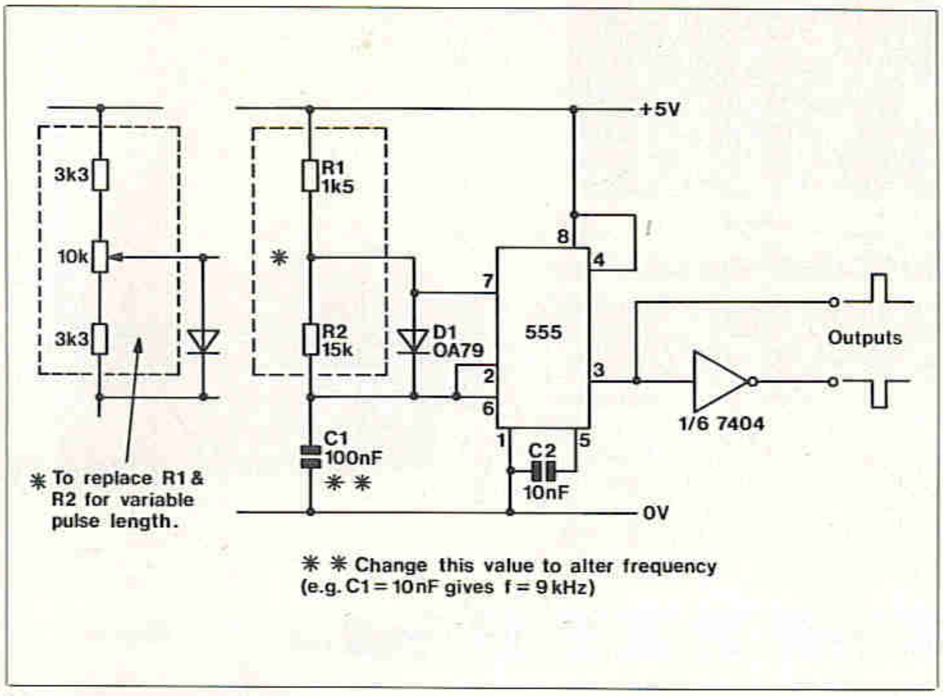


Figure 9. Test pulse generator (900Hz).

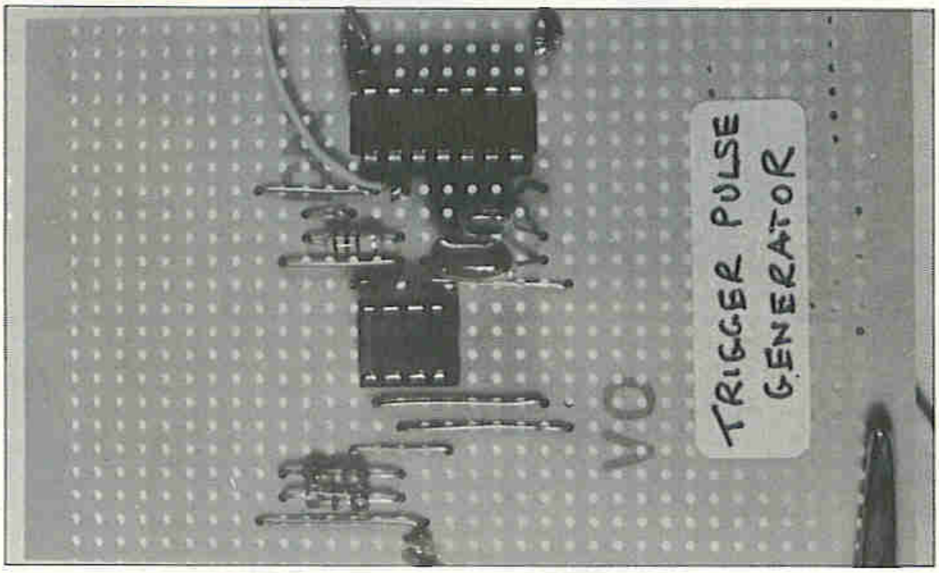


Photo 5. Component side view of the Test Pulse Generator of Figure 9.

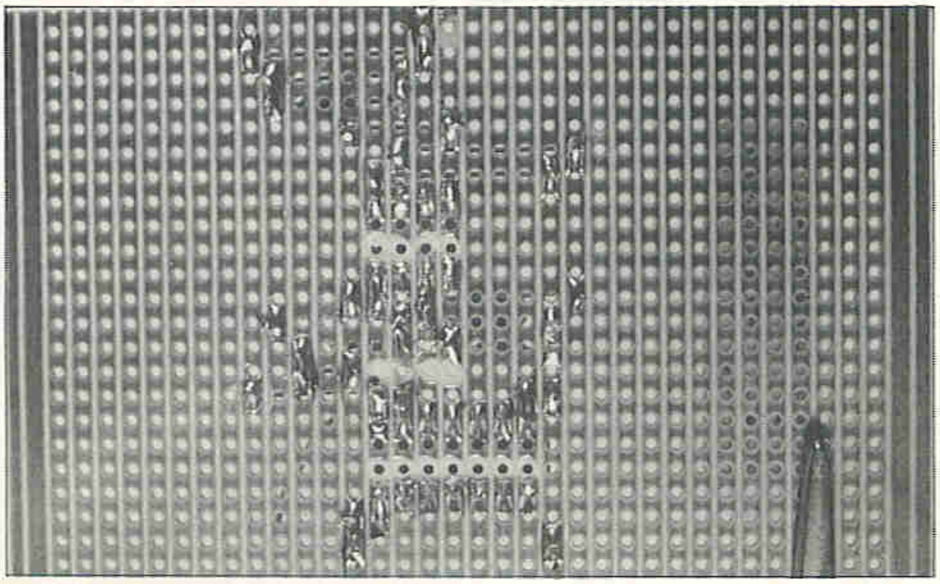


Photo 6. Copper side view of the Test Pulse Generator.

As for the function of the circuit, it can be considered in two ways. Either the pulses occur at a regular rate (constant repetition frequency) or they occur randomly. It is assumed that, in both cases, the pulse width is constant. This being so, the circuit acts as a 'frequency-divider' for the constant frequency input (e.g. 1kHz IN produces 100Hz OUT), or the circuit acts as a 'frequency-counter' for randomly occuring pulses (e.g. a single pulse is generated at the output when 'n' pulses have been received at the input). Figure 8 should make this clear. The input pulses must have sufficient amplitude, at least 2V, in order to drive TR1 and TR2 into saturation.

The circuit works extremely well but to observe the staircase waveform clearly it is necessary to choose a pulse repetition frequency (for the input pulses) and a time constant for the UJT that will allow the output to be displayed on a CRO. Using a 3μF timing capacitor and a pulse frequency of about 60Hz (the pulses being just over 100μs in length), a steady display was just possible, but a better display will be obtained if shorter pulses at a higher frequency, together with a much shorter UJT time constant, are used instead. This is because one can then use the higher sweep speeds of the CRO.

The Programmable Unijunction Transistor (PUT)

This is an opportune moment to mention another type of UJT that finds application in relaxation oscillator circuits, trigger and timing circuits, and in lamp driver and ring counter circuits. Since this puts it firmly in the field of 'power electronics', it will be dealt with in a later article, in connection with various other members of the 'thyristor family'.

For now it can be said that the term programmable is perhaps a trifle misleading. It merely refers to the fact that some of the parameters of the device can be predetermined. Enough of that for now.

A Useful Test Pulse Generator

Figure 9 shows a circuit that can be made up quite quickly and cheaply and will be found useful for providing a ready source of short positive and negative TTL compatible pulses. As shown it has a pulse repetition frequency of about 900Hz, the pulse duration being about 120μs. The pulse amplitude is about 4V for both positive and negative outputs. Both frequency and pulse length can be varied by modifying the values of the components indicated in the figure. Several spot frequencies could be provided by switching different values of the timing capacitor C1. If the series resistors R1 and R2 are replaced in part by a potentiometer, the pulse length can be varied without affecting the frequency. Photographs show the layout of the stripboard used.

FSK Demodulator

by Chris Barlow G8LVK

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- ★ Expandable
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Specification of Prototype	
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Data output:	Normal or Inverse TTL
LED indicators:	Carrier-detect (LOCK)
	Data output state (RX DATA)
Tone system:	1kHz or 2kHz
Tone shift:	170Hz, 425Hz, or 850Hz
Data filter:	45 Baud to 300 Baud (60 to 400 WPM)
AF Input Specifications	
Input impedance:	15kΩ
Input signal:	Min 2mV RMS
	Max 5V RMS
Internal Oscillator	
Frequency accuracy:	±1%
Frequency stability:	±20 ppm/°C
DC Specifications	
Power input:	Min +8V
	Max +15V
Power output:	+5V (maximum current 60mA)
Current drain at 12V:	8mA no signal
	18mA with signal
Printed Circuit Board	
Type:	Single-sided fibre glass
Dimensions:	115mm x 51mm

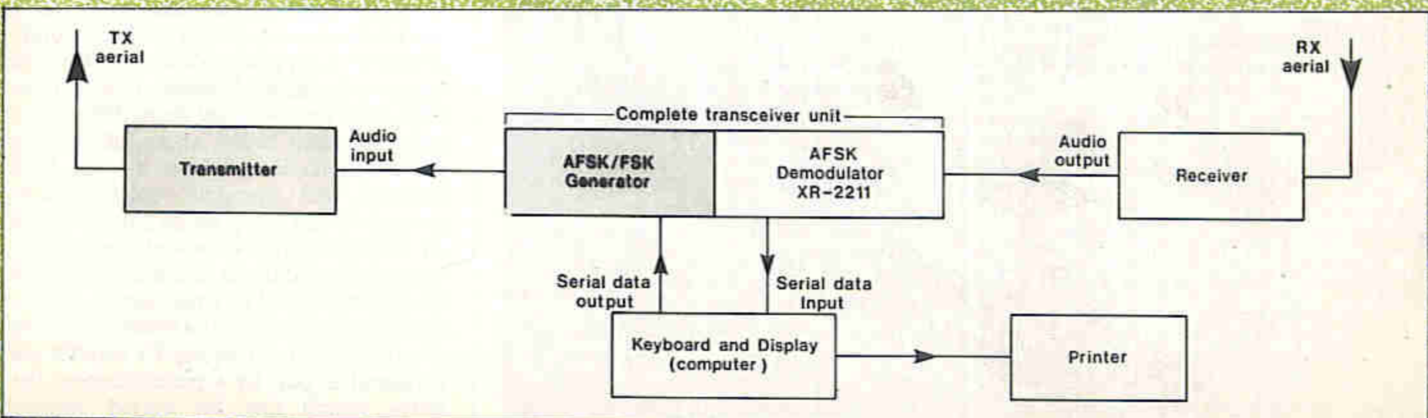


Figure 1. RTTY receive and transmit system.

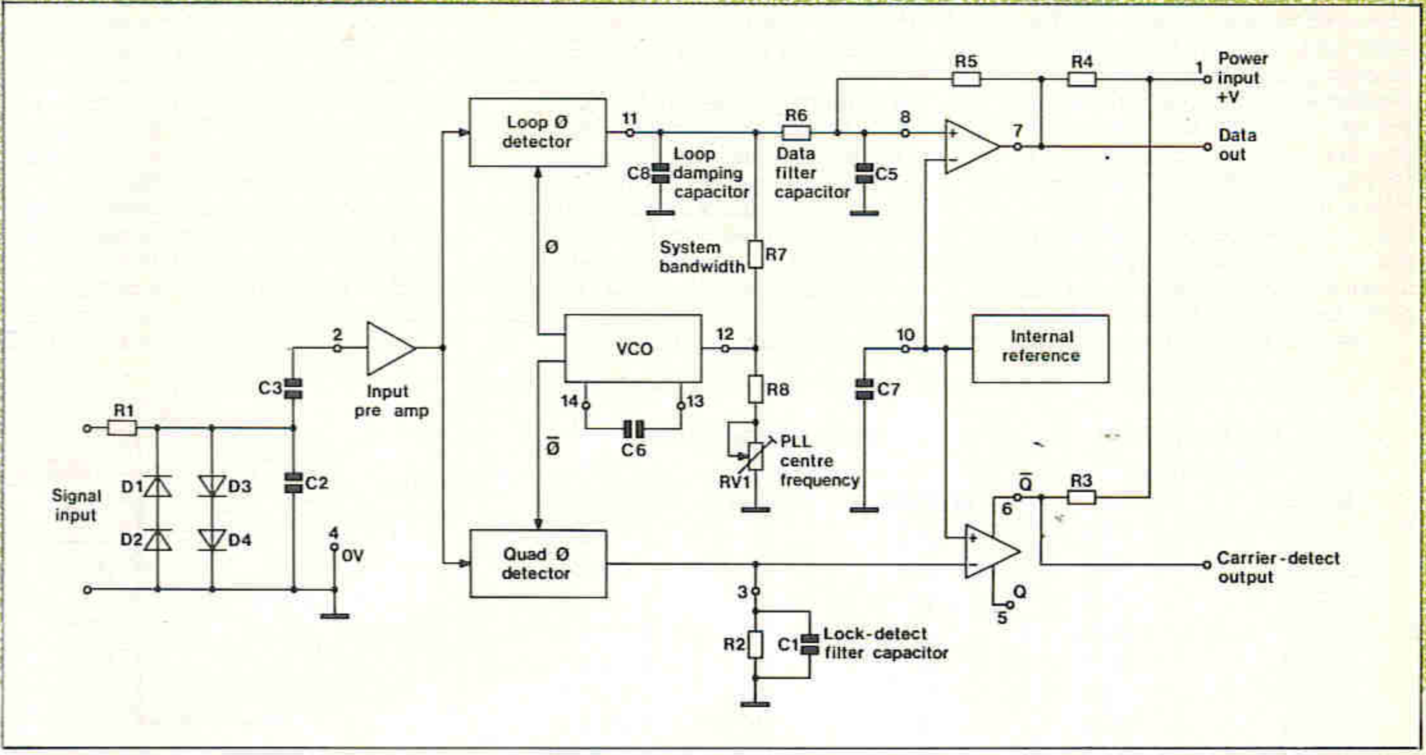


Figure 2. Circuit connection for the XR-2211.

Introduction

The reception and transmission of Radioteletype (RTTY) on the short wave and VHF radio spectrum is as popular now as it was when Maplin first launched the TU1000, published in the September 1984 issue of 'Electronics'. The TU1000 offers a complete self-contained terminal unit with receive tone demodulator and transmit tone generator, see Figure 1. In addition, it has an internal mains power supply, tuning aid and RS232 output driver. Unfortunately all this electronics makes the TU1000 a top of the range unit and out of the financial reach of some constructors. It is for this reason a second RTTY unit has been developed using smaller PCB building blocks. The first of which is the frequency shift keying (FSK) tone demodulator, based upon the XR-2211 decoder IC, see Figure 2. This circuit is all you require to decode RTTY if your computer has a TTL, 45/50 Baud, 5 bit serial data input. However, this format is not to be found on all computers, so in addition you may need to use a serial data translator with a TTL to RS232 converter, see Figure 8.

The two tone system and shift for the carrier-detect circuit is set by the values of certain components, see Table 2. Once you have set them, the unit can receive other shifts but the carrier-detect will not lock under these conditions, see Figure 9 and 'Using the demodulator'.

Another useful addition to the system is an audio bandpass filter. This is used to reject interfering signals just outside the tone range, which could overload or swamp the demodulator. The filter, translator, converter and AFSK tone generator modules are currently under development and will be published in future issues of the Maplin magazine.

The Baudot Code

The code has five data bits, or elements, so there are only thirty two possible characters to be interpreted. The alphabet takes twenty six of the code values, which leaves six for control functions, null or no data, return, line-feed, space, letters and figures. The last two speak for themselves. 'Letters' puts the printer, or VDU into upper case A to Z and 'Figures' gives numbers 0 to 9, fifteen punctuation marks, and the 'Bell' command.

If the 'Bell' code were sent, a bell would sound on the receiving teleprinter to alert the operator to an incoming message. As you can see, the system does not support lower case, unlike the majority of home computer displays.

A complete list of the Baudot Code, showing letters and figures, plus their decimal, hexadecimal and ASCII values, is shown in Table 1. Apart from the five data bits, the system uses 1 start bit and 1½ stop bits, although, in practice, you can set your computers serial I/O port to 1 or 2 stop bits, if 1½ is not available.

As stated in the introduction, RTTY uses two audio tones to represent the logic conditions high or low, commonly referred to as mark and space tones. The frequency difference (shift) of the tones can vary considerably, but, in practice three are used; 170Hz, 425Hz and 850Hz. The demodulator has the ability to be set to any of these shifts by using the information given in Table 2. As can be seen the shifts are in two groups, the 'old' 2kHz system and the 'new' 1kHz system. Most modern RTTY demodulators are tuned to the 1kHz system. However, on some short wave receivers equipped with an RTTY band pass filter the 2kHz system is favoured by certain manufactures (ICOM).

The rate of change between the tones, or Baud rate, has to be configured on your computers serial I/O port to resolve the incoming data correctly. In general, radio amateurs use Baud rates of 45.45 or 50 Baud (170/425Hz shift), with commercial stations tending to use 50 or 75 Baud (425/850Hz shift).

Phase Locked Loop (PLL) Tone Decoder

The circuit used for the frequency shift keying (FSK) demodulation is centred around the XR-2211 integrated circuit (IC). This IC is a monolithic PLL system, especially designed for data communications and is particularly suited for RTTY modem applications. Inside the IC package is a chip consisting of a basic PLL, for tracking an input signal within the pass band, a quadrature phase detector which provides carrier detection, and an FSK voltage comparator which provides FSK demodulation, see Figure 3. Only a few external components are required to set the centre frequency, bandwidth, and output delay, see Figure 2.

The audio signal is fed to pin 2 of the XR-2211 (IC1) via an input clamping circuit consisting of R1, D1 to D4 and C2. This limits the signal to approximately 2.5V peak to peak, well within the range recommended by the manufacturer's data sheet. The signal is then AC coupled via C3 to pin 2 of IC1, which has an internal impedance of approximately 20kΩ. The output from the pre-amp is fed into the loop and quadrature phase detectors which also receive a signal from the voltage controlled oscillator

(VCO). The incoming frequencies are compared to the VCO frequency. The error signal produced by the loop detector is used to control the VCO until the frequency difference between the signals are zeroed. This control signal must first have its response damped by C8, before being fed via R7 to the control input of the VCO. The value of this resistor sets the loop tracking bandwidth, while the combined value of R8 and RV1 is used in conjunction with C6 to set the centre frequency of the VCO.

Resistor R6 and capacitor C5 form a one-pole post-detection filter for the FSK data output. Positive feedback is introduced by placing a resistor, R5 across the FSK comparator, to provide a rapid transition between output logic states. The output is an open collector stage which requires a pull-up resistor, R4. When decoding an FSK signal the data output is 'high' or off state for the lower input frequency and 'low' or on state for the higher frequency. The threshold voltage of the comparator is set by the internal reference voltage, this DC level is internally biased to half the supply (+2.5V) less 650 mV, giving +1.85V, decoupled by C7 on pin 10.

The output from the quadrature phase detector on pin 3 is internally connected to the input of the lock-detect voltage comparator. Pin 3 is connected to ground through the parallel combination of C1 and R2, so as to eliminate any chatter at the lock-detect outputs (pin 5 and 6). The output at pin 5 is 'high' when the PLL is out of lock and the inverse logic condition appears on pin 6. Both outputs are of the open collector type, so a pull-up resistor, R3, is required on pin 6 which results in a +5V when in lock and a zero volt condition when out of lock. The threshold voltage of this comparator is set by the same internal reference as previously mentioned. Pin 6 is referred to as the carrier-detect output because until the received tones are tuned to the correct frequency a lock condition will not exist.

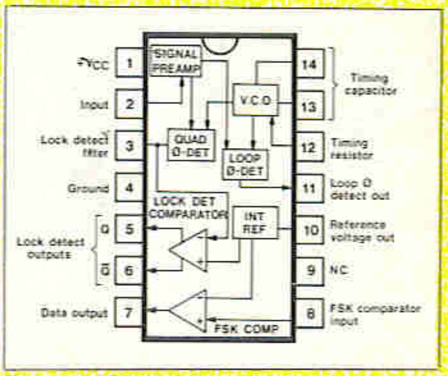


Figure 3. XR-2211 pin configuration.

The complete circuit diagram for the RTTY unit is shown in Figure 4. As can be seen from the values of C5, C6, C8 and R7 it is set up for the 1kHz tone system with 170Hz shift and a maximum data rate of 110 Baud.

The 555 timer, IC2 and half of IC3 are used as the data lock circuit which inhibits the data output until a stable lock condition occurs. However, this function can be overridden by S1, the data lock on/off switch. Irrespective of the setting of S1, the light emitting diode (LED) LD1 will display the lock condition of the demodulator. The other half of IC3 is used as a logic inverter for the data output and as a driver for RX data LED, LD2. The normal and inverse signals are fed to S2 where the final data ouput appears on its centre terminal.

CHARACTERS [ASCII VALUE]		BAUDOT CODE VALUE		
LETTERS	FIGURES	DECIMAL	HEXA-DECIMAL	BIT 1 2 3 4 5
A[65]	-[45]	3	03	1 1 0 0 0
B[66]	?[63]	25	19	1 0 0 1 1
C[67]	:[58]	14	0E	0 1 1 1 0
D[68]	$[36]	9	09	1 0 0 1 0
E[69]	3[51]	1	01	1 0 0 0 0
F[70]	![33]	13	0D	1 0 1 1 0
G[71]	&[38]	26	1A	0 1 0 1 1
H[72]	#[35]	20	14	0 0 1 0 1
I[73]	8[56]	6	06	0 1 1 0 0
J[74]	BELL	11	0B	1 1 0 1 0
K[75]	([40]	15	0F	1 1 1 1 0
L[76]	)[41]	18	12	0 1 0 0 1
M[77]	.[46]	28	1C	0 0 1 1 1
N[78]	,[44]	12	0C	0 0 1 1 0
O[79]	9[57]	24	18	0 0 0 1 1
P[80]	0[48]	22	16	0 1 1 0 1
Q[81]	1[49]	23	17	1 1 1 0 1
R[82]	4[52]	10	0A	0 1 0 1 0
S[83]	'[39]	5	05	1 0 1 0 0
T[84]	5[53]	16	10	0 0 0 0 1
U[85]	7[55]	7	07	1 1 1 0 0
V[86]	=[61]	30	1E	0 1 1 1 1
W[87]	2[50]	19	13	1 1 0 0 1
X[88]	/[47]	29	1D	1 0 1 1 1
Y[89]	6[54]	21	15	1 0 1 0 1
Z[90]	+[43]	17	11	1 0 0 0 1
return[13]	return[13]	8	08	0 0 0 1 0
line feed[10]	line feed[10]	2	02	0 1 0 0 0
space[32]	space[32]	4	04	0 0 1 0 0
letters	letters	31	1F	1 1 1 1 1
figures	figures	27	1B	1 1 0 1 1
not used	not used	0	00	0 0 0 0 0

Table 1: The Baudot Code.

TONE SYSTEM	SHIFT	STANDARD FREQUENCIES MARK	STANDARD FREQUENCIES SPACE	CENTRE FREQUENCY RV1	C6	R7	C8
1kHz	170Hz	1275Hz	1445Hz	1360Hz	33nF	180kΩ	8n2F
	425Hz	1275Hz	1700Hz	1487Hz	33nF	82kΩ	8n2F
	850Hz	1275Hz	2125Hz	1700Hz	27nF	47kΩ	6n8F
2kHz	170Hz	2125Hz	2295Hz	2210Hz	22nF	270kΩ	6n8F
	425Hz	2125Hz	2550Hz	2337Hz	22nF	120kΩ	6n8F
	850Hz	2125Hz	2975Hz	2550Hz	22nF	68kΩ	6n8F

DATA FILTER CAPACITOR, C5.		
BAUD RATE	WORDS-PER-MINUTE (WPM)	VALUE
45	60	68nF
50	66	47nF
75	100	39nF
100	133	33nF
110	146	27nF
300	400	10nF

Table 2: Tone System and Data Filter.

```
10 'RTTY RECEIVE PROGRAM
20 'BY CHRIS BARLOW G8LVK
30 'WRITTEN IN MICROSOFT BASIC
40 '-HARDWARE-
50 '1. SHORT WAVE RECEIVER
60 '2. SHORT WAVE AERIAL
70 '3. RTTY DEMODULATOR
80 '4. SERIAL DATA TRANSLATOR
90 '5. TTL TO RS232 CONVERTER
100 '6. IBM OR 'CLONE' COMPUTER
110 '-RS232 CONNECTIONS-
120 'LINK PINS 4,5,6 AND 8
130 'RECEIVED DATA PIN 3
140 'SIGNAL GROUND PIN 7
150 '---- THE PROGRAM ----
160 KEY OFF:CLS:S%=1
170 'BAUDOT TO ASCII SET-UP
180 DIM RTTY(31,2)
190 RESTORE 560
200 'LETTERS
210 FOR R%=1 TO 31:READ DAT%
220 RTTY(R%,1)=DAT%:NEXT R%
230 'FIGURES
240 FOR R%=1 TO 31:READ DAT%
250 RTTY(R%,2)=DAT%:NEXT R%
260 ON COM(1) GOSUB 420
270 COM(1) ON
280 'OPEN AND SET SERIAL PORT
290 OPEN "COM1:300,N,8,1" AS #1
300 'GET KEY
310 I$=INKEY$
320 'SPACE = LETTERS/FIGURES
330 IF I$=CHR$(32) AND S%=2
    THEN S%=1:I$=""
340 IF I$=CHR$(32) AND S%=1
    THEN S%=2:I$=""
350 '# TO CLEAR SCREEN
360 IF I$=CHR$(35) THEN CLS:
    I$=""
370 IF I$=CHR$(13) THEN PRINT
380 IF I$ < CHR$(32) OR I$ >
    CHR$(122) GOTO 310
390 PRINT I$;
400 GOTO 310
410 'RECEIVE
420 WHILE LOC(1)<>0
430 A$=INPUT$(LOC(1),#1)
440 A%=ASC(A$)
450 IF A%>32 THEN 530
460 IF A%=0 THEN 530
470 IF A%=31 THEN S%=1
480 IF A%=27 THEN S%=2
490 B%=RTTY(A%,S%)
500 IF B%=0 THEN 530
510 IF B%=-1 THEN BEEP:GOTO 530
520 PRINT CHR$(B%);
530 WEND
540 RETURN
550 'BAUDOT TO ASCII LETTERS
560 DATA 69,10,65,32,83,73,85
570 DATA 13,68,82,74,78,70,67
580 DATA 75,84,90,76,87,72,89
590 DATA 80,81,79,66,71,0,77
600 DATA 88,86,0
610 'BAUDOT TO ASCII FIGURES
620 DATA 51,10,45,32,39,56,55
630 DATA 13,36,52,-1,44,33,58
640 DATA 40,53,43,41,50,35,54
650 DATA 48,49,57,63,38,0,46
660 DATA 47,61,0
```

Program Listing 1. Microsoft Basic/IBM PC.

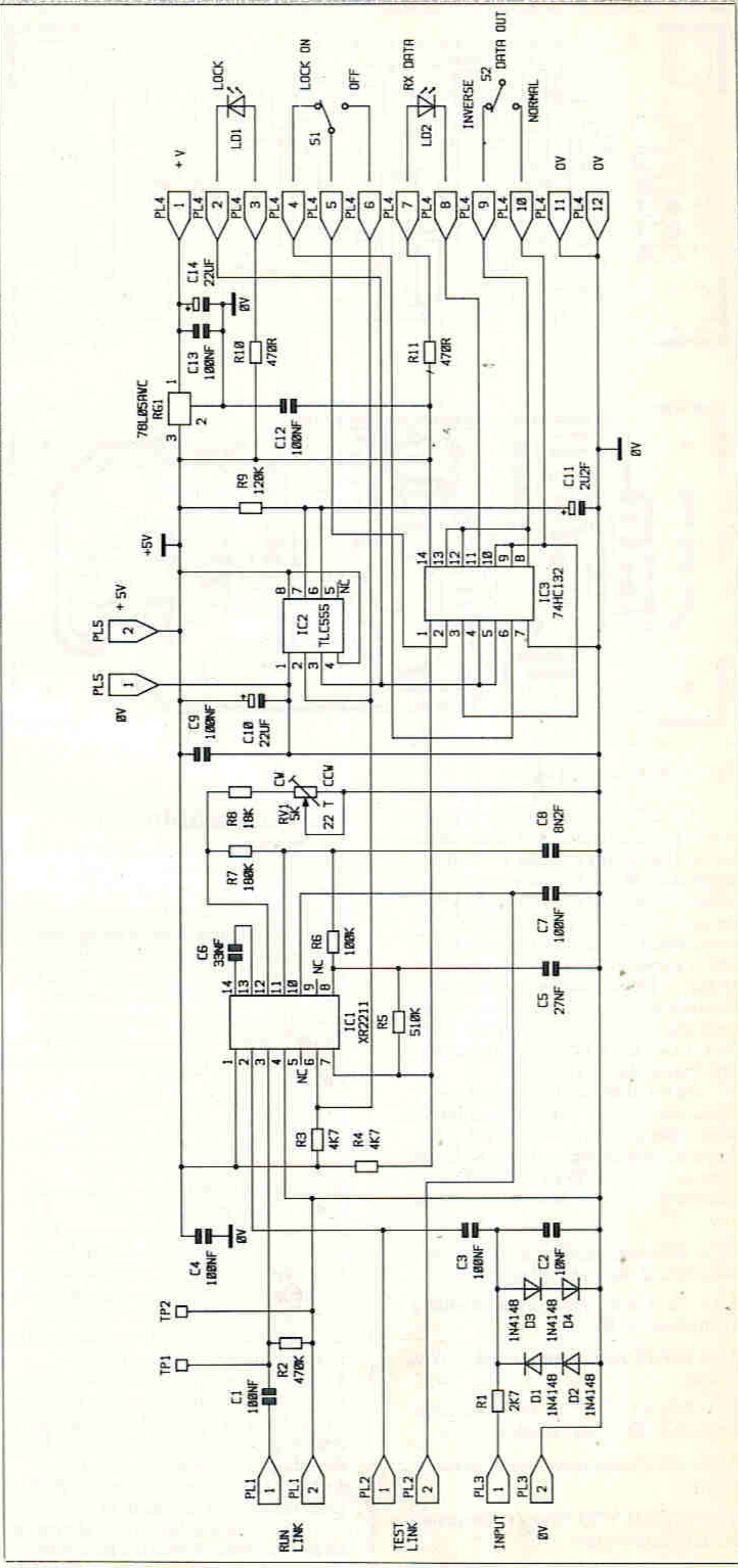


Figure 4. Circuit diagram.

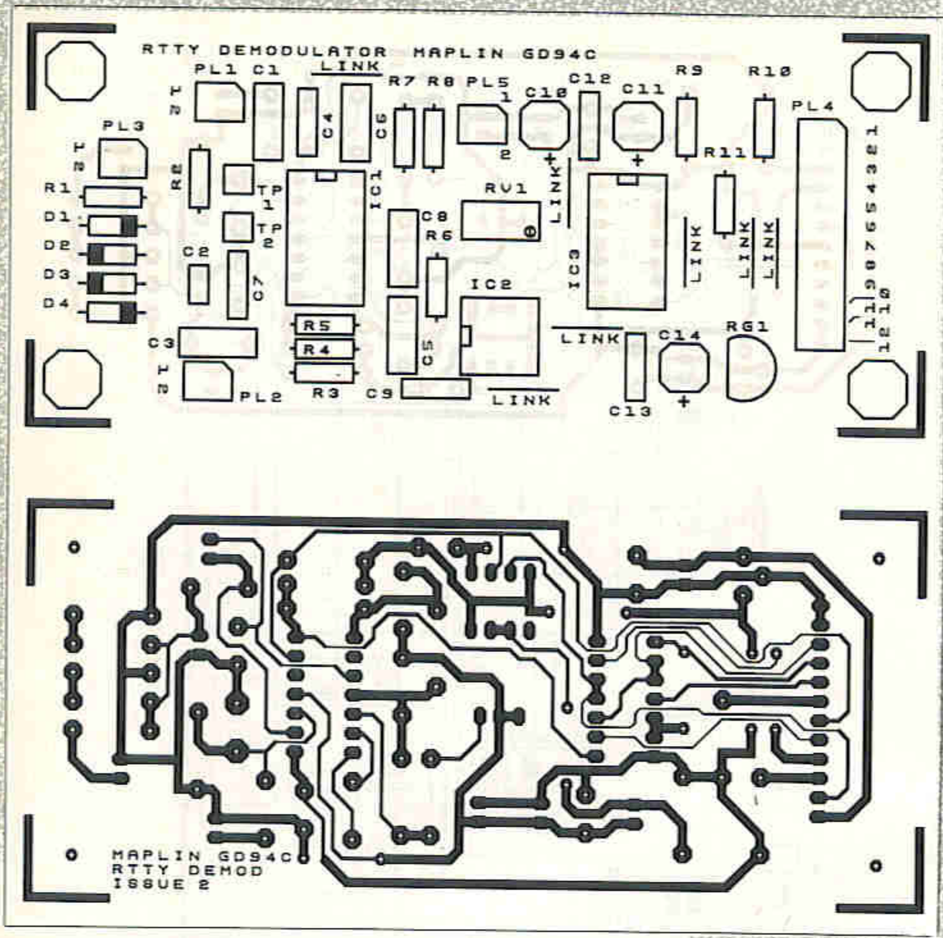


Figure 5. PCB track and legend.

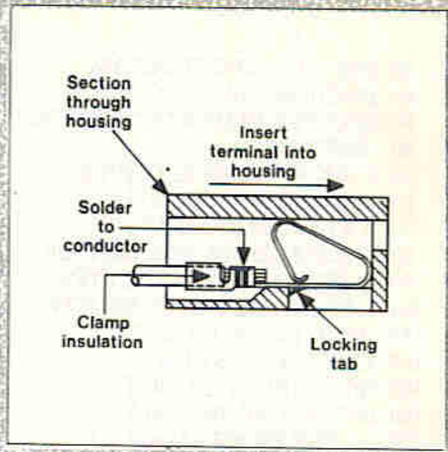


Figure 6. Fitting and inserting the 'Minicon' terminals.

The DC power for the unit is applied to PL4, positive to pin 1 and negative to pin 12. This supply must be within the range of 8V to 15V and have the correct polarity, otherwise damage will occur to the semiconductors and polarised components. All the ICs are powered from a single +5V supply rail provided by RG1, a 100mA voltage regulator IC. Capacitors C10 and C14 provide the main decoupling for the +V supply rail, with C4, C9, C12 and C13 giving additional high frequency decoupling.

All the inputs and outputs of the circuit are taken to 'Minicon' locking plug assemblies, numbered PL1 to PL5. However, two 'Veropins' are used for test point connections, TP1 and TP2. The function of each plug is listed as follows:

PL1 = RUN link. This link must be fitted once the unit has been set up.

PL2 = TEST link. This link must be fitted when adjusting RV1.

PL3 = INPUT. Audio signal input, 2mV to 5V RMS.

PL4 = DATA OUT (TTL), Power in, Lock switch and LED, Data switch and LED.

PL5 = +5V Output (maximum current 60mA).

TP1 = XR-2211 VCO Output to frequency counter/oscilloscope.

TP2 = Ground (0V) to frequency counter/oscilloscope.

PCB Assembly

The PCB is a single-sided fibre glass type, chosen for maximum reliability and 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 5. Some of the components have to be selected for the appropriate tone, shift and data rate, see Table 2.

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, polyester and electrolytic capacitors. The polarity for the electrolytic capacitors is shown by a plus sign (+) matching that on the PCB legend. However, on some 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. The diodes have a band at one end. Be sure to position them according to the legend, where the appropriate markings are shown. Next install the voltage regulator, RG1, matching its case to the outline shown on the legend. When fitting the IC sockets ensure that you match the notch with the block on the board. Install the ICs making certain that all the pins go into the socket and the pin one marker is at the notched end. Next install the preset resistor RV1. This is a 22-turn cermet preset with a slipping clutch, which should make an audible clicking sound at each end of its travel. To set it to the half way position, simply rotate the adjustment screw until the clicking sound is heard, then reverse the direction for 11 turns. When fitting the 'Minicon' connectors ensure that the locking tags are all facing the diode (D1 to D4) end of the PCB. Finally, using component lead off-cuts fit wire links at the positions marked on the PCB.

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 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 kit.

Final Assembly

No specific box has been designated for the project as your finished unit could contain several PCBs. However, the single board prototype fitted nicely in to an instrument case type 3501 (stock code YN32K), see Figure 11 for box drilling details.

The choice of connectors for the audio, power and data lines is entirely up to you. However, it is good practice not to use the same type of connector for two or more different functions, i.e. DATA output and POWER input.

CAUTION, when installing the PCB assembly remember to use some form of spacer between its soldered side and the inside surface of the case, this is vital if you are using a metal chassis or box.

Once you have completed the mechanical assembly of the unit you should check your work very carefully before proceeding to the wiring stage.

Wiring

The wire connections to the PCB are made using 'Minicon' connectors and the

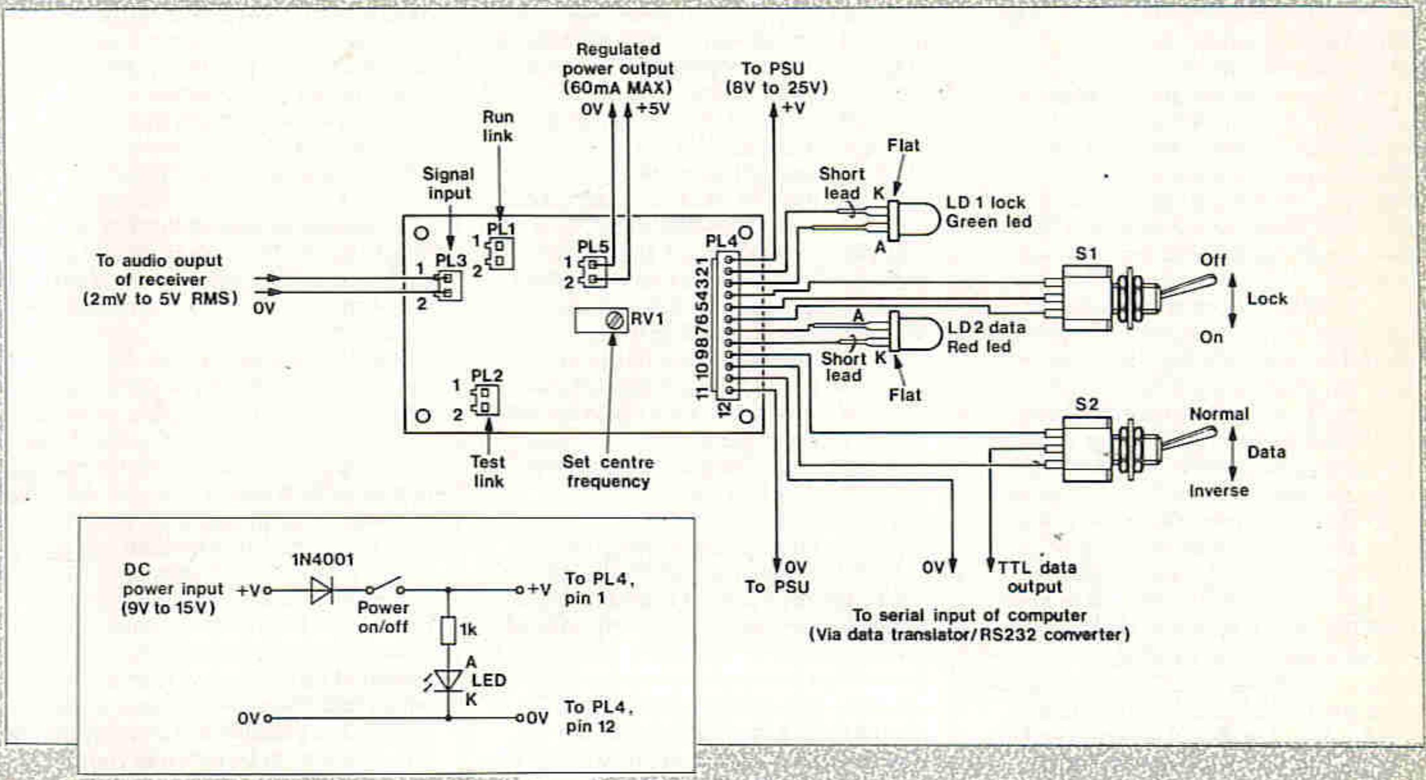


Figure 7. Wiring. (Inset) Optional power switch, indicator and polarity protection circuit.

method of installing them is shown in Figure 6. No specific colour has been designated for each wire connection, however the use of coloured hook-up wire will make it easier to trace separate connections to off-board components, just in case there is a fault in any part of the circuit. A wiring diagram showing all the interconnections is given in Figure 7. Included in this diagram is an optional power switch and indicator, with a 1N4001 diode providing reverse polarity protection. Finally, with a short length of wire between pins 1 and 2, make up two link connectors using the two pin 'Minicons'.

Testing and Alignment

The DC tests can be made with a minimum of equipment. You will need a multimeter and a 12V DC power supply capable of providing at least 100mA. 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.

Initially, remove all the 'Minicon' connectors from the PCB assembly. The first test is to measure the resistance at the power input on PL4. With your multimeter set to read ohms, connect its red positive test lead to pin 1 of PL4 and connect the black negative lead to pin 11, or 12. You should obtain a reading of approximately 10kΩ and when the test leads are reversed, a lower reading of approximately 5kΩ should be measured.

In the following tests it will be assumed that a regulated +12V power supply unit (PSU) is being used. Reconnect the 12 pin 'Minicon', PL4, then select a suitable range on your meter that will accommodate a 100mA DC current reading and place it in the positive power line from the PSU. The DATA and LOCK LEDs should not light and a current reading of approximately 8mA should be observed. 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 a convenient ground point on the unit. Before taking any readings ensure that the LOCK switch, S1 is in the off position and S2 the DATA switch is set to normal. When the demodulator is powered up, without an RTTY input signal, voltages present on the PCB assembly should approximately match the following readings:

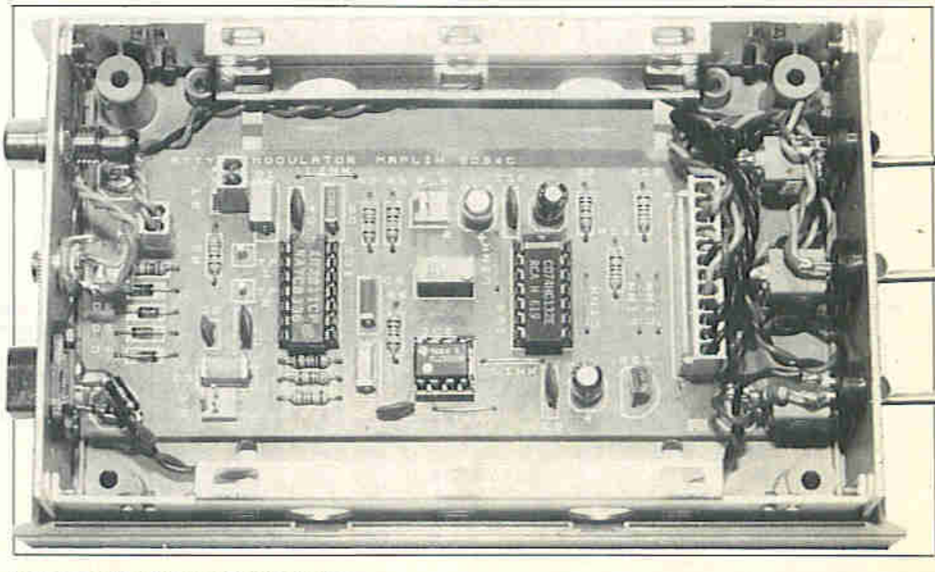
PL1 pin 1 = Square wave TTL clock.
PL1 pin 2 = 0V

PL2 pin 1 = +2.5V DC
PL2 pin 2 = +1.8V DC

PL3 pin 1 = 0V
PL3 pin 2 = 0V

PL4 pin 1 = +12V DC
PL4 pin 2 = + 5V DC
PL4 pin 3 = + 5V DC
PL4 pin 4 = 0V
PL4 pin 5 = 0V
PL4 pin 6 = 0V
PL4 pin 7 = + 5V DC
PL4 pin 8 = + 5V DC
PL4 pin 9 = 0V
PL4 pin 10= + 5V DC
PL4 pin 11= 0V
PL4 pin 12= 0V

PL5 pin 1 = 0V
PL5 pin 2 = + 5V DC



Inside the Single board prototype.

This completes the DC testing of the demodulator, now disconnect the multimeter from the unit.

There is only one preset control in need of alignment, RV1 and this can be set to a high degree of accuracy if a frequency counter is employed. However, if one is not available then off-air RTTY signals of known tone format can be used but will give less accurate results.

When using a counter, its signal input should be connected to TP1, with its ground connected to TP2. Using the two 'Minicon' links, fit one at PL2 and the other at PL3. From the tone system and shift information in Table 2, set RV1 to the centre frequency shown for the shift you have previously chosen. Turn the unit on and off a few times to ensure that it starts up on the same frequency each time. Finally, remove the frequency counter and the 'Minicon' links from PL2 and PL3, transferring one of the links to PL1.

If you are using an off-air RTTY signal, ensure that the INPUT 'Minicon' is connected to PL3 and the RUN link is fitted at PL1. You should now proceed to the 'Using the demodulator' for more information on tuning-in RTTY signals.

RTTY Software

The software necessary to receive and transmit RTTY data can be as complex as you care to write. Due to the large number of microcomputers used in the home, it is not possible to produce a program listing which will run satisfactorily on all machines. This is due to the various BASIC dialects and differing internal hardware.

Not many RTTY or communication programs have been published in the computer magazines, but the program included in this article is for use with an IBM PC or clone computer running Microsoft basic, see Program Listing 1. IMPORTANT, note that in this program the serial port is set to 300 Baud, 8 data bits, 1 stop bit and no parity (see line 290). This is because the slowest baud rate available on the computer was 75 Baud and to receive RTTY at 45/50 Baud a serial translator module is required, with its output set to 300 baud, see Figure 8.

As you can see from Table 1 the value allocated to each Baudot character is not the same as the ASCII values used by the computer. A simple method of converting between code values is to create a 'look-up' table using a two dimensional array, this is set in line 180. The conversion values are held as DATA statements in lines 550 to 660. The incoming Baudot code sets the position in the array to read the ASCII equivalent, for example, if the Baudot value is 3 then the third position in the array has a value of 65 the ASCII for the letter 'A'. When the 'figures shift' code is received, a software flag is set so the conversion data is read from the second part of the array, see lines 470 and 480. However, a manual toggle action is available from the keyboard should a piece of corrupt data be received, see lines 320 to 340.

This program is the minimal requirement for receiving RTTY and should be used as the basis for additional refinements. Such refinements could be a split-screen to enable you if transmitting, to compose your reply while the incoming message is being displayed on the other half of the screen, or it may be useful, if a printer is available, to add a hard copy option to the program. If you do not possess a printer, another method of data storage is to create a file on cassette, or preferably disk. Another option is to be able to select the Baud rate, if your system allows software control of the RS232/TTL serial port parameters from 45 to 300 Baud. A useful feature if you are transmitting, is pre-recorded messages and tests (RYRY) which could be retrieved from cassette or disk. It is possible that you may require other features to be built into your program.

Using the Demodulator

To receive RTTY signals on the short wave bands your radio must have a beat frequency oscillator (BFO), although

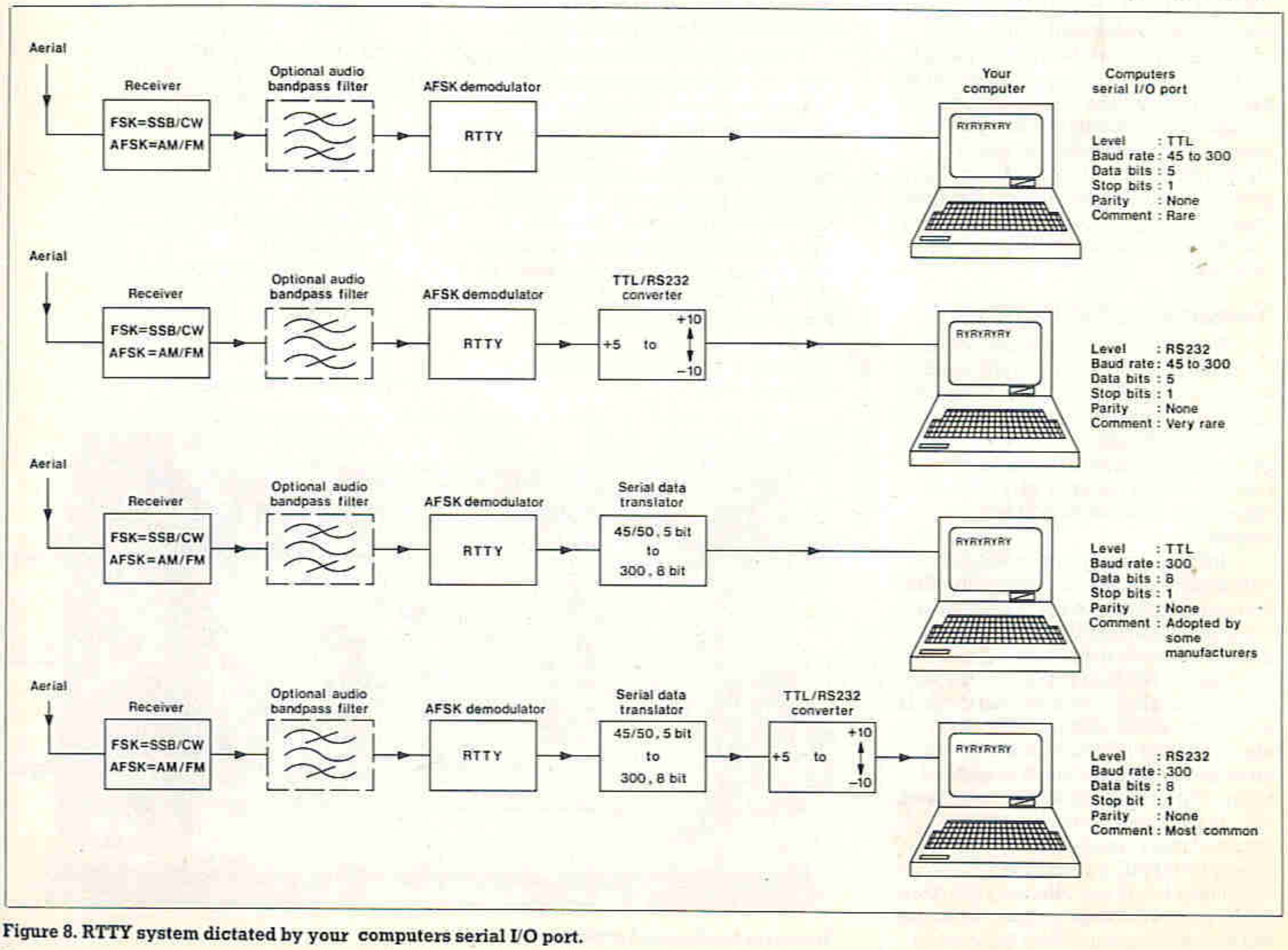


Figure 8. RTTY system dictated by your computers serial I/O port.

most communications receivers have a built-in CW or SSB position. The frequencies covered by a modern receiver are typically between 1 and 30MHz. It is within this range of frequencies that there are literally thousands of RTTY signals. Probably the best antenna to use for simple monitoring is a long wire, as long as possible and as high as possible. If you can orientate it South-West to North-East, so much the better. It is advisable to tune the receiver against a good external ground system, such as a buried bare copper wire, or a ground rod.

The audio connection to your receiver can be made through the tape, headphone or loudspeaker socket. The tape socket is preferable because the level of signal should not change with the setting of the receivers volume control. With this output the initial tuning is achieved by identifying the characteristic sound produced by an RTTY transmission and once this is done the data will be presented on the computers screen avoiding the need to have the volume turned up all the time.

Connect the data output from the demodulator via any of the additional hardware to your computers serial input port. On the Amstrad PC1512, pins 4,5,6 and 8 had to be linked together with data in on pin 3 and signal ground on pin 7.

The RTTY demodulator has been designed to be tolerant to varying supply voltages and differing inter-connecting lead lengths. To power the unit a battery or AC-DC mains adaptor can be used, the Maplin XX09K model set to its 9V output is adequate.

I would recommend that initially you tune into one of the amateur RTTY portions of the short wave band. A good start would be to set your receiver to 14.090MHz. It is around this frequency that RTTY signals should be found all day, except in the winter when they will tend to disappear around sunset or shortly after. RTTY is easy to identify from the other signals most likely to be found in this portion of the band, namely Morse code. RTTY signals have a pronounced warble as one tone is transmitted and then the next.

Amateur RTTY transmissions are usually set at 170Hz shift between mark and space tones with a Baud rate of 45.45 or 50. Using the main tuning control of the receiver, tune across an RTTY transmission and you will notice that the sound of the pitch of the signal will change, the S-meter on the receiver should peak and the LEDs on the demodulator should flash. Assuming that you have set the demodulator for 170Hz shift and the amateur transmission is the same, then with careful fine tuning the lock LED, LD1, should light and LD2 should flash in sympathy with the data, see Figure 9. When receiving AFSK tones in the FM mode on the two metre amateur band (145.300MHz), no fine tuning should be necessary.

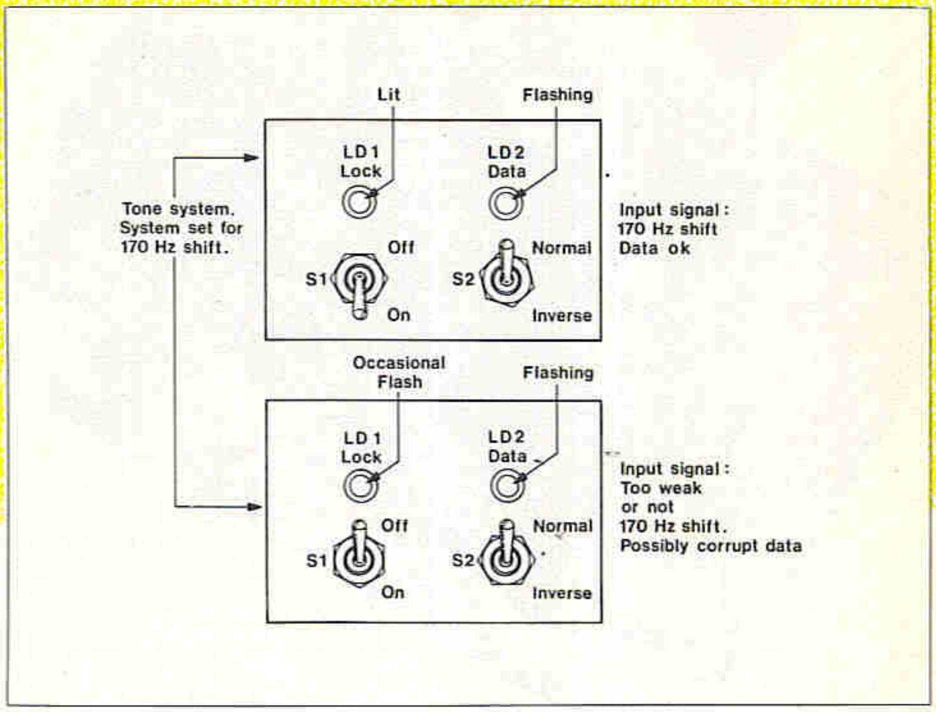


Figure 9. Tuning in an RTTY signal.

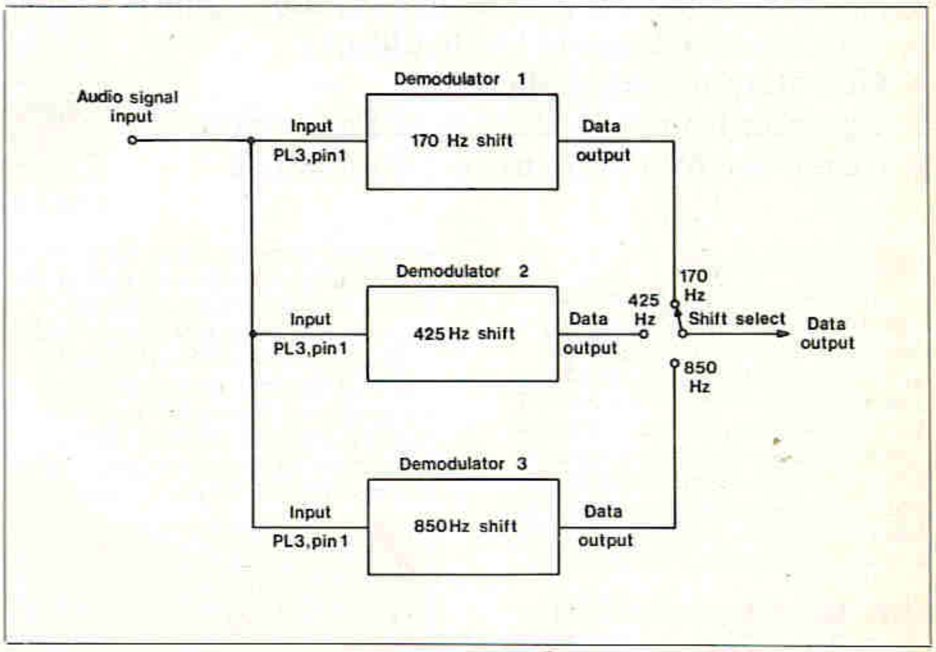
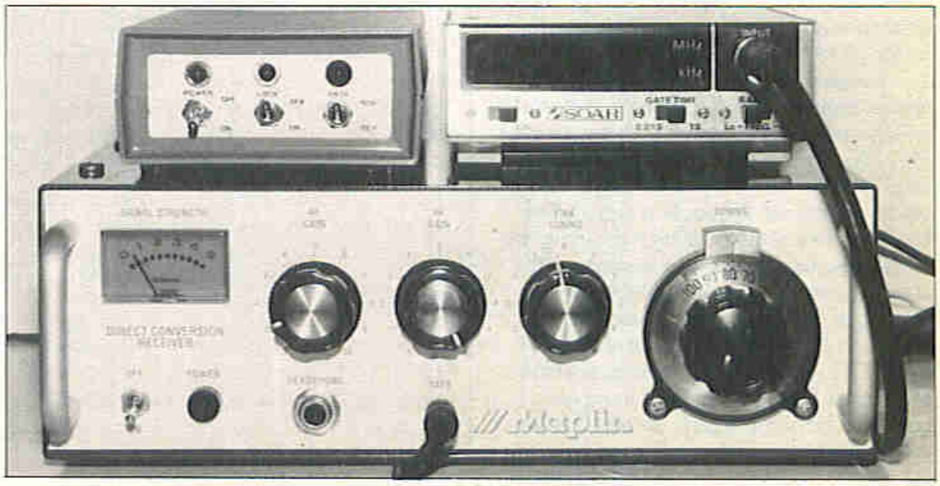


Figure 10. Three board system.



Typical receiver and demodulator set up.

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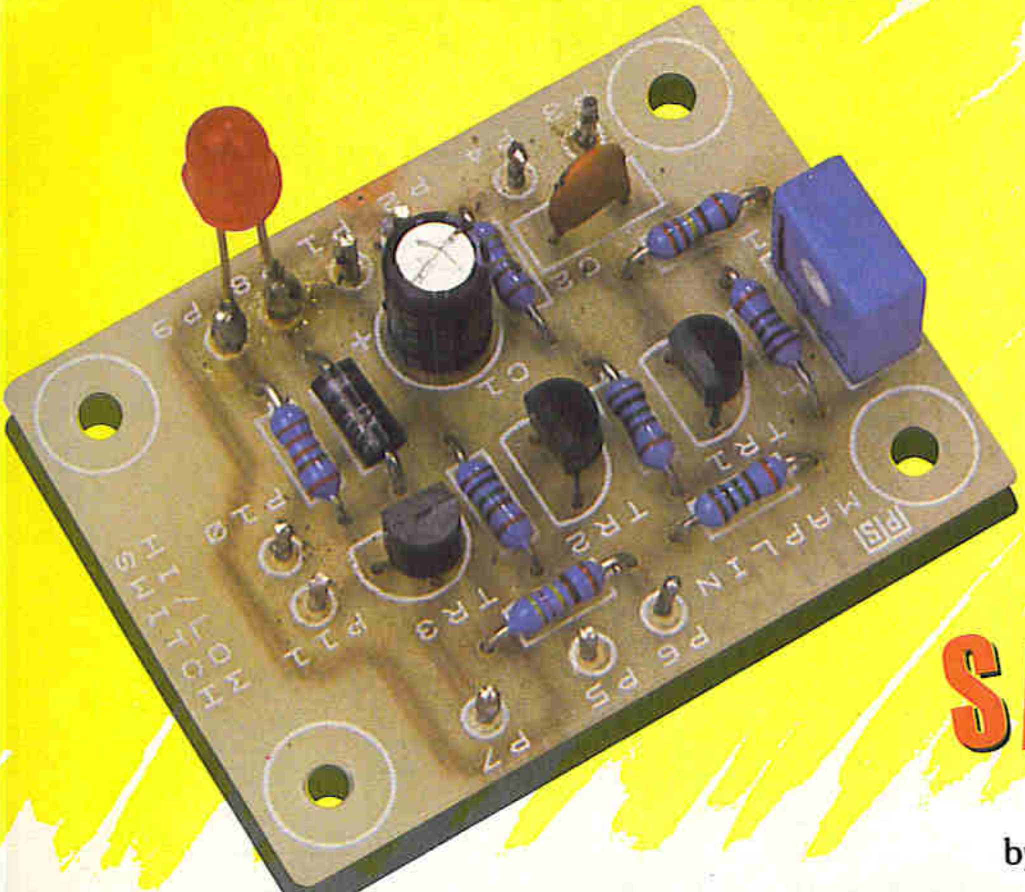


HI LOW SWITCH

by Gavin Cheeseman

- Adjustable Switching Threshold (500k - 10M)
- Low Standby Current Drain (30μA)
- LED Output State Indicator
- Operates from a 9V Battery or Power Supply
- Requires a Minimum of Test Equipment

Power Supply Voltage.	9V-12V
Current Consumption (9V supply):	
Quiescent.	Less than 30μA
LD1 lit, P10 and P11 open circuit.	4mA
Trigger Range (set by RV1).	500k - 10M approximately
Maximum output load current.	50mA

Table 1. Specification of Prototype.

Introduction

This 'Hi-Low Switch' project is a resistance operated transistor switching circuit providing an output capable of driving a small buzzer or relay. Because of the very low current drain of the circuit in the standby mode the Hi-Low Switch will operate for long periods from a standard 9V battery. Switching thresholds may be adjusted between approximately 500k and 10M to suit different requirements. Table 1 shows the specification of the prototype.

Circuit Description

The Hi-Low Switch circuit is based on the operation of three darlington transistors. The darlington has a high input resistance and hence a low base current making it ideal for low power applications.

Referring to Figure 1, the potential divider network, R1, R2 and RV1 sets the switch-on threshold for TR1. Preset resistor RV1 allows the threshold trigger point to be adjusted over a very wide range. The power supply rail decoupling is provided by C1 and input decoupling is provided by C2 helping to prevent false triggering that could occur due to external noise pickup. As long as the resistance between P3 and P4 is high (above the switch on threshold level) TR1 remains off. If P6 is connected to P7, then TR3 also remains in an off condition since there is no current flowing through the base. If the resistance between P3 and P4 falls below the threshold level, enough current flows in the base of TR1 to activate the transistor. When TR1 turns on, the base of TR3 is pulled high through R3 and the transistor conducts, allowing a current to pass through its collector load comprising of the Light Emitting Diode (LED), LD1 and through any additional load connected between P10 and P11. Resistor R8 serves to limit the current through the LED to a few milliamps. If the resistance between P3 and P4 rises above the threshold level, the output returns to the original off state. The action of the circuit can be reversed by connecting P7 to P5 instead of P6; transistor, TR2 then acts as an inverter, switching TR3 off when TR1 is on and turning TR3 on when TR1 is off. Diode D1 is included in the circuit to prevent damage to TR3 from any high voltage spikes that could occur if an inductive load such as a relay is used.

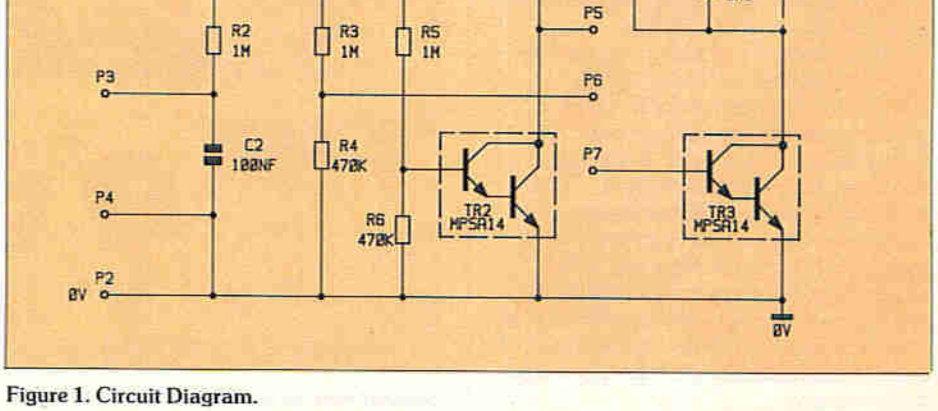


Figure 1. Circuit Diagram.

Modes of Operation

As previously explained the Hi-Low Switch may be operated in two different modes and these are as follows:
1. Trigger on high resistance (P5 and P7 linked).
2. Trigger on low resistance (P6 and P7 linked).

When using the circuit in mode 1, P5 is connected to P7; in this mode the output remains switched off as long as the resistance between the input pins (P3 and P4) remains low. If the resistance between the input pins rises above the preset threshold level set by RV1, then the output is active. As soon as the input resistance drops below the threshold level, the output returns to the original high resistance state.

In order to operate the circuit in mode 2, P6 must be connected to P7 (P5 is not used); in this mode the output is off as long as the resistance between the input pins remains high. When the input resistance drops below the threshold level, the output transistor (TR3) is turned on; this condition will continue until the input resistance rises above the preset threshold.

Construction

Construction of the Hi-Low Switch is relatively straight forward and does not require the use of specialist tools or test equipment. The circuit is constructed on a high quality PCB which has a printed legend to simplify component positioning. Insert and solder the components onto the PCB referring to the track layout diagram (Figure 2) starting with resistors R1 to R8 and preset resistor RV1. Capacitors C1 and C2 should then be fitted. Please ensure that C1 is fitted observing the correct polarity; the negative lead, marked by a minus (-) sign on the capacitor case should be inserted away from the positive (+) sign on the PCB. PCB pins P1 - P11 may then be fitted; these are first inserted through the holes in the PCB from the track side and carefully pressed down onto the pad using a hot soldering iron. Once the pins have been positioned they can then be soldered. Insert and solder transistors TR1, TR2 and TR3 so that the transistor case corresponds with the outline on the PCB legend taking care not to overheat the devices during soldering. When fitting diode D1, once again, the polarity is important; the cathode is indicated by a band at one end of the diode and must be positioned as indicated by the legend. Light Emitting Diode, LD1 can either be soldered directly to P10 and P11 or connected to the pins via a short length of wire. Please make sure that the LED is connected observing the correct polarity; the cathode is the shortest of the two leads and is on the flat side of the LED. The anode of the LED is connected to P8 and the cathode is connected to P9. A PP3 battery clip is included in the kit; the red lead should be connected to P1 (+V) and the black lead should be connected to P2 (0V). For further information on construction techniques, please refer to the constructor's guide included in the kit.

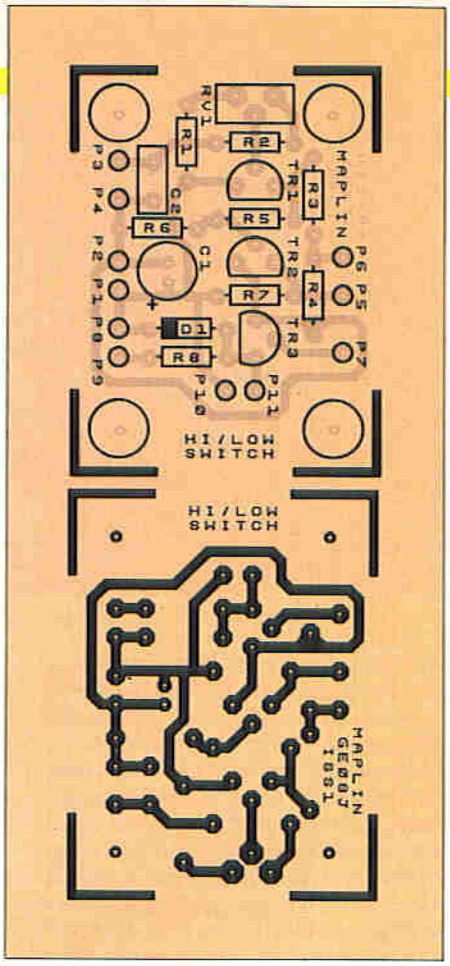


Figure 2. PCB Track Layout Diagram.

Power Supply Requirements

The circuit will operate from a 9V PP3 type battery and exhibits a very low current drain when in the quiescent (standby) mode. An alkaline battery is recommended for optimum performance and length of life. When triggered the current drain of the Hi-Low Switch depends very much on the type of load being driven. If the unit is only driving LD1 (no other load connected) the current consumption of the circuit when triggered is approximately 4mA. The circuit is capable of driving a buzzer (Maplin stock code FK83E) for short periods when operated from a 9V battery.

If the circuit is used to drive a relay it is recommended that a mains operated DC power supply or a battery of larger capacity is used (the supply voltage should be between 9V and 12V). It is important that the power supply is adequately decoupled to prevent the introduction of mains derived noise onto the supply rails. A suitable relay for use with the Hi-Low Switch is Maplin stock code YX96E and the current consumption of the circuit when using this relay is approximately 32mA at 12V.

Testing

Before applying power to the circuit, double check that all the components are fitted correctly and that there are no dry joints or solder short circuits. If a multimeter is available, the resistance between power supply pins P1 and P2 can be measured to make sure that the supply rails are not short circuit. The resistance should start off at a low value and quickly increase to a much higher value as C1 charges.

Connect P5 to P7 and set RV1 to the centre of its travel. When power is applied to the module LD1 should light, indicating a high resistance between the input pins (P3 and P4). If the input pins are then shorted together, LD1 should extinguish indicating the presence of a low resistance. Remove the connection from P5 and connect P6 to P7. With no connection between the input pins, LD1 should remain off; however, if the input pins are shorted together the LED should then light.

More accurate tests to determine switching threshold levels can be made by connecting resistors of known value between the input pins and adjusting RV1 until the circuit triggers. The switching threshold should be adjustable between approximately 500k and 10M, although some variation is inevitable. For most purposes, the setting of RV1 is not that critical and in practice the optimum threshold level is obtained by experimentation.

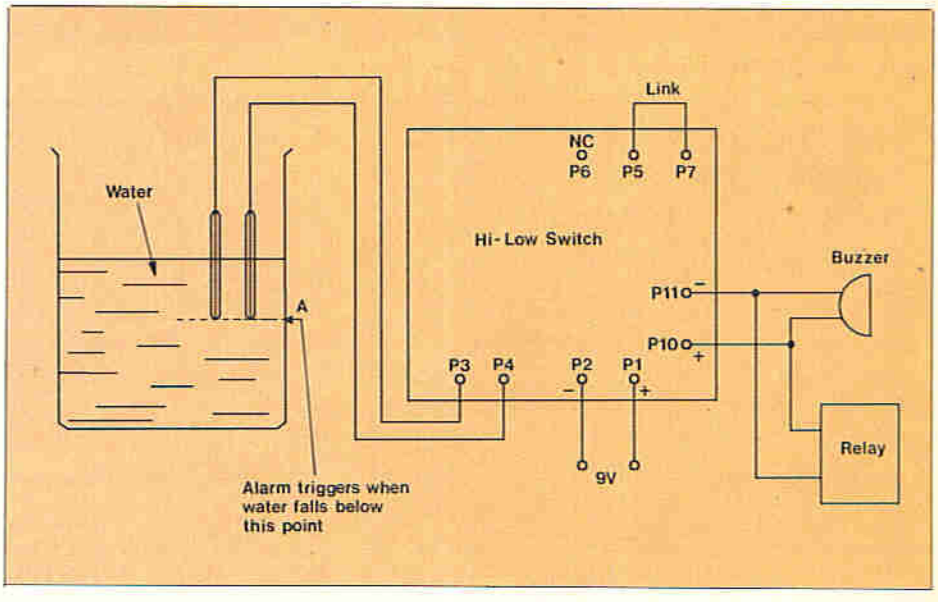


Figure 3. Water Level Detector.

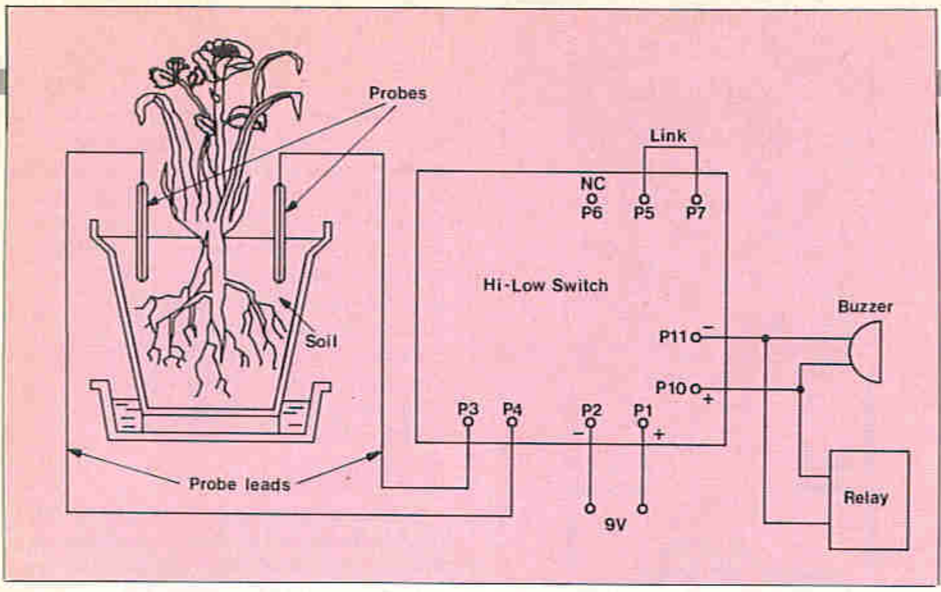


Figure 4. Soil Moisture Detector.

Using the Hi-Low Switch

The Hi-Low Switch is an open ended circuit that could be used in many different applications requiring a resistance operated switch. One of the main applications for a circuit such as this is the detection of moisture (water). Figure 3 shows how the circuit may be used to operate a buzzer when the water in a container falls below a given level; when used for this purpose P5 is linked to P7 and P6 is left open circuit. Under normal conditions the ends of the probes are submerged in water and the resistance between the input pins is therefore relatively low; however, when the water level falls below point 'A' the resistance between the two probes becomes very high triggering the circuit and switching on the buzzer. The output returns to the off state as soon as the water level is restored. A similar arrangement to that of Figure 3 could form the basis of a simple flood alarm and when used for this purpose P6 should be linked to P7 (P5 is not used); the circuit will then remain in the standby mode until the probes become submerged in water.

The type of probe used with the Hi-Low Switch depends on the specific application. For general purpose use copper probes may be used; however, if the probes are to be used in a biologically sensitive environment they must be made from chemically inert material.

The arrangement shown in Figure 4 suggests how the Hi-Low Switch may be used to turn on a buzzer or relay when the resistance of the soil rises above the trigger threshold of the circuit (when the soil becomes dry). When the plant is watered the resistance of the soil falls and the circuit returns to the original state (output switched off). It may be necessary to experiment with the probe spacing to obtain optimum results.

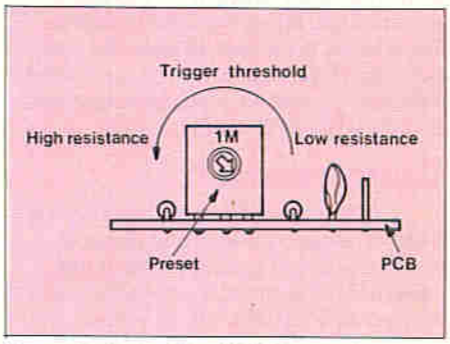


Figure 6. Trigger Threshold Setting.

Another interesting application for the Hi-Low Switch is the touch sensitive switch arrangement illustrated in Figure 5. A square of stripboard with the strips linked alternately is used as a touchpad. When the pad is touched, the drop in resistance between P3 and P4 triggers the circuit. If a buzzer is connected to the output of the module, the circuit can be used as a simple touch sensitive doorbell. In some applications it might be useful to connect a switch to P5, P6 and P7 to enable the required operating mode to be selected as and when necessary. Figure 6 shows relative settings of RV1 for high and low resistance trigger thresholds.

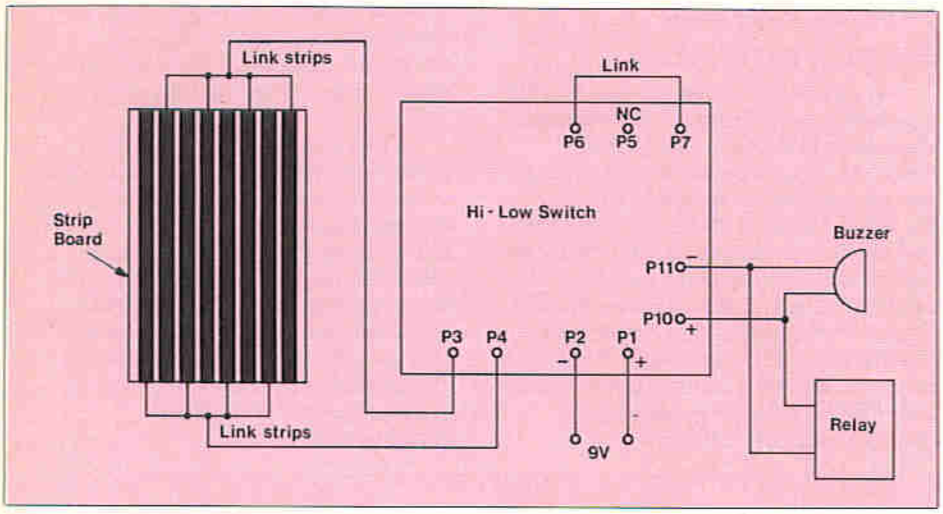


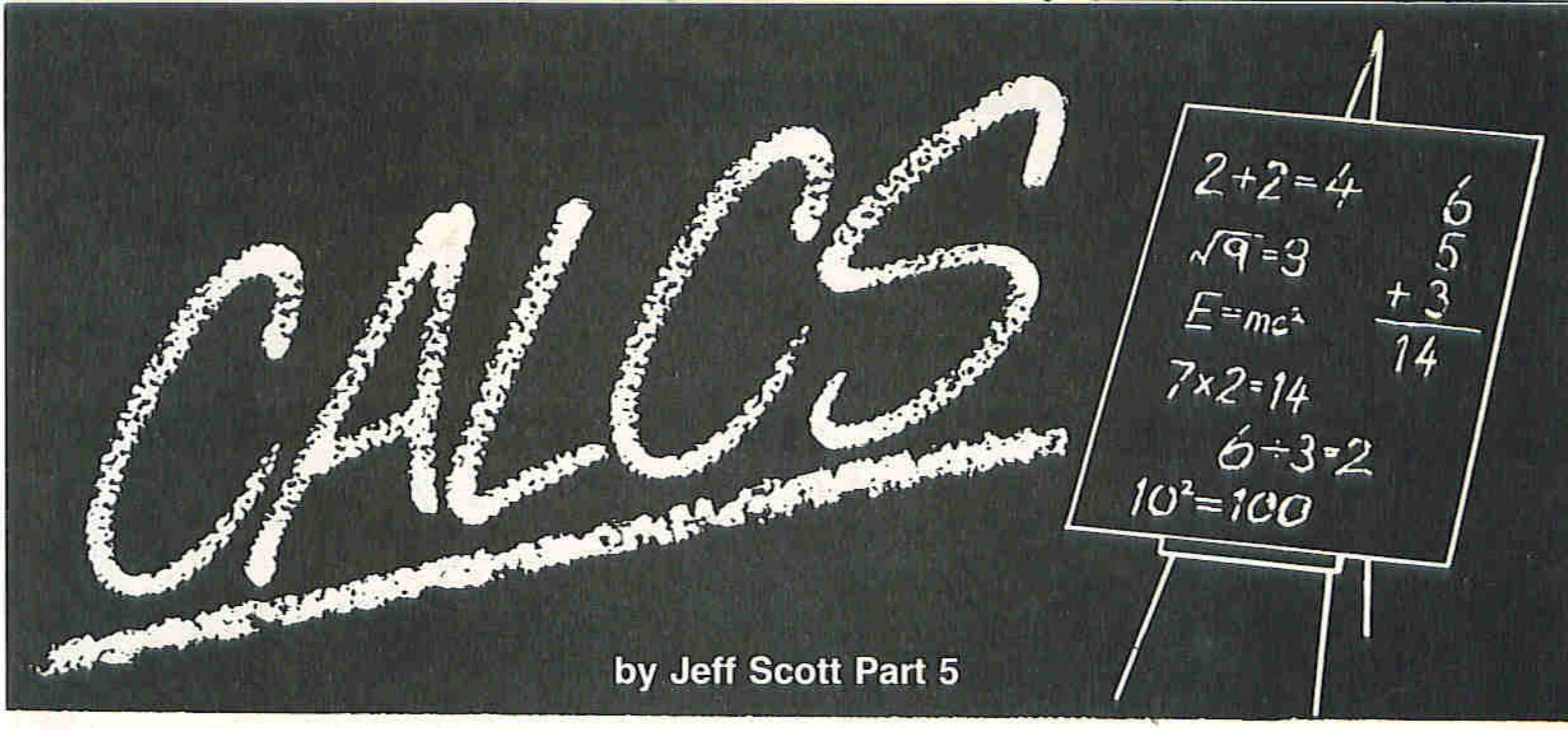
Figure 5. Touch Sensitive Switch.

HI-LOW SWITCH PARTS LIST

RESISTORS: All 0.6W 1% Metal Film			
R1	220k	1	(M220K)
R2,3,5,7	1M	4	(M1M)
R4,6	470k	2	(M470K)
R8	2k2	1	(M2K2)
RV1	1M Vertical Enclosed Preset	1	(UH22Y)
CAPACITORS			
C1	47μF 25V P.C. Electrolytic	1	(FF08J)
C2	100nF Minidisc	1	(YR75S)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
TR1	MPSA65	1	(QH61R)
TR2,3	MPSA14	2	(QH60Q)
LD1	Hibri LED Red Std	1	(WL84F)

MISCELLANEOUS			
	Printed Circuit Board	1	(GE08J)
	Pins 2145	1 Pkt	(FL24B)
	PP3 Battery Clip	1	(HF28F)
	Constructors Guide	1	(XH79L)
OPTIONAL			
	PT Buzzer	1	(FK83E)
	3A Min Relay	1	(YX96E)

The parts listed above, excluding Optional items, are available as a kit:
Order As LM89W (Hi-Low Kit) Price £2.60
The following item is also available separately:
Hi-Low Switch PCB **Order As GE08J Price £1.25**



Introduction

Trigononmetry is the study of the relationship between the sides and angles of a triangle. However, the applications and extensions of this are too numerous to be studied in one lifetime; from surveying to electronics and astronomy. We shall examine a few, particularly those pertaining to electronics.

The application of trigonometry is also extended to the study of mechanical vibrations, sound waves and electricity.

Since a right angled triangle fits into a circle (semi-circle to be precise), see Figure 1, trigonometric functions are also called

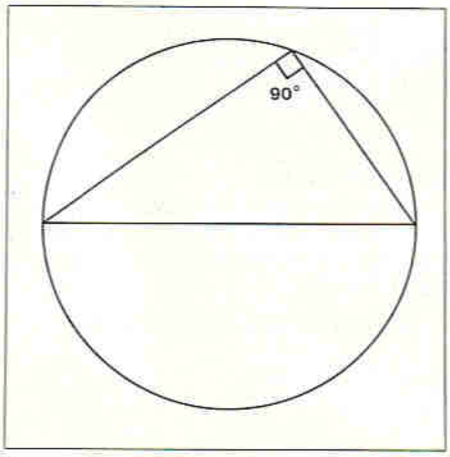


Figure 1. Right angled triangle in a semi circle.

circular functions. We shall concentrate on circular functions, though non-circular functions (hyperbolas, parabolas and ellipses) will be dealt with briefly at the end.

Some of the applications of trigonometry relevant to electronics is in Fourier analysis, which breaks down a complex wave into its components. The study of phasors, in phase and frequency modulation, is a useful application to radio.

Manipulating products of sines and cosines into sums and differences supplies the mathematical proof of how product detectors (mixers) work to convert a carrier and its modulating frequency into a sum and difference frequency at the output.

The application of vectors in surveying is just as useful in analysing current and voltage vectors. And the roll-off on sine and cosine curves is used in designing filters. Some of these applications will be dealt with in more detail later.

Fundamental Definitions

Figure 2 shows a right angled triangle.

There are six fundamental definitions called natural sines, natural cosines, natural

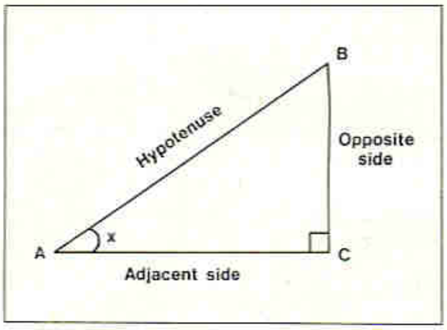


Figure 2. Fundamental definitions.

tangents, natural secants, natural cosecants and natural cotangents. These are called natural because they are associated with a circle as opposed to those connected with hyperbolas.

$$\text{sine } x = \frac{\text{opposite side}}{\text{hypotenuse}}$$

$$\text{cosine } x = \frac{\text{adjacent side}}{\text{hypotenuse}}$$

$$\text{tangent } x = \frac{\text{opposite side}}{\text{adjacent side}}$$

$$\text{cosecant } x = \frac{\text{hypotenuse}}{\text{opposite side}}$$

$$\text{secant } x = \frac{\text{hypotenuse}}{\text{adjacent side}}$$

$$\text{cotangent } x = \frac{\text{adjacent side}}{\text{opposite side}}$$

Sine is usually abbreviated to sin, cosine to cos, tangent to tan, cosecant to csc, secant to sec and cotangent to cot. The relationship between the preceding definitions is then as follows:

$$\csc x = \frac{1}{\sin x}$$

$$\sec x = \frac{1}{\cos x}$$

$$\cot x = \frac{1}{\tan x}$$

The graphs of these functions are shown in Figure 3, for one cycle of waveform. It can be seen that the sine and cosine waves are ninety degrees or $\pi/2$ radians out of phase with each other.

Pythagorean Identities

An interesting fact about the angles of a triangle is that they add up to 180 degrees or π radians.

Pythagoras's Theorem deals with a right angled triangle and states that; the square of the hypotenuse equals the sum of the squares of the other two sides. Therefore if two of the sides are known, the third side can be calculated.

For instance, in Figure 4, if AB = 5cm and AC = 3cm, to find BC:

By Pythagoras Theorem

$$AB^2 = AC^2 + BC^2$$
$$BC^2 = AC^2 - AB^2$$
$$BC^2 = 25 - 9$$
$$BC = 16$$
$$BC = 4 \text{ cm}$$

Similarly using the sine or cosine definitions, other sides and angles can be found. For instance, Figure 5 gives only the lengths of the two sides of the right angled triangle.

$$\sin x = \frac{BC}{AB} = \frac{3}{6} = 0.5$$

Using tables or a scientific calculator, the angle whose sine is 0.5 is 30 degrees.

Angle y can easily be found since the sum of the three angles add up to 180 degrees.

$$y = 180 - x - z$$
$$= 180 - 30 - 90$$
$$= 60 \text{ degrees}$$

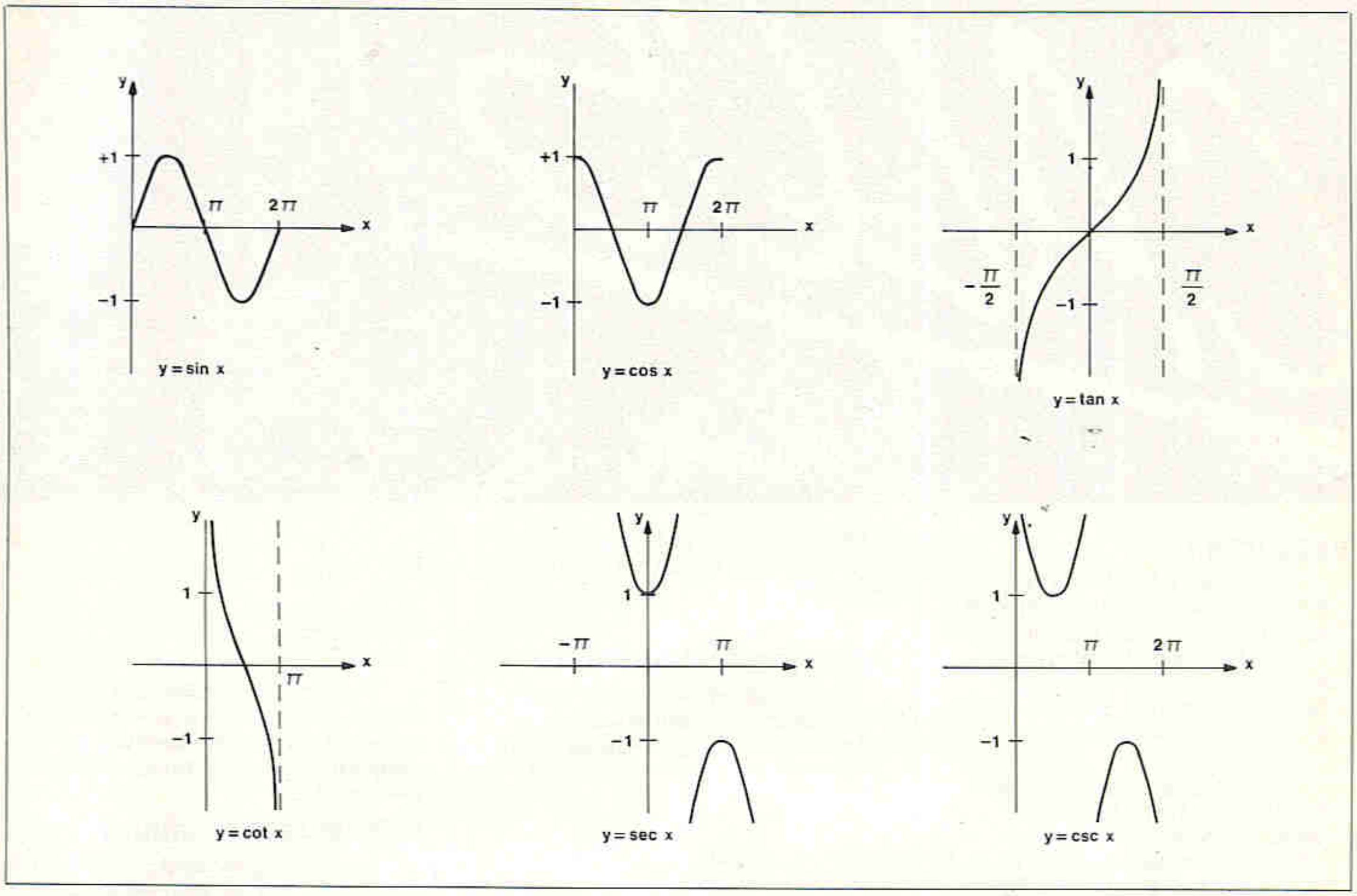


Figure 3. Graphs of basic definitions.

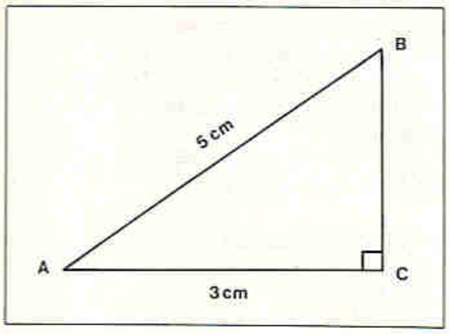


Figure 4. Pythagoras's theorem.

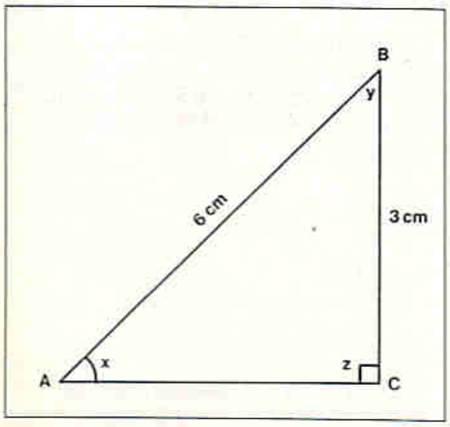


Figure 5. Using the definition of sine.

Finally side AC can be found either by Pythagoras theorem or by using the sine, cosine or tangent definitions. Using the tangent definition.

$$\tan x = \frac{BC}{AC}$$

$$0.577 = \frac{3}{AC}$$

$$AC = 5.196$$

And so the answers pop out like a pudding out of a pudding bowl. The interesting fact being that there is more than one way of arriving at the correct answer.

Three further Pythagorean identities will be stated here without proof.

$$\sin^2 t + \cos^2 t = 1$$
$$\tan^2 t + 1 = \sec^2 t$$
$$1 + \cot^2 t = \csc^2 t$$

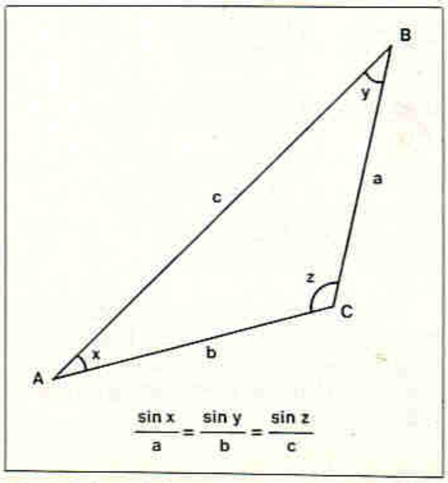


Figure 6. Law of sines.

Pythagoras was a Greek mathematician who lived around 500 B.C. and founded a school in southern Italy.

Law of Sines

Up to now we have dealt with a right angled triangle but there is a simple formula which helps in the solution of non right angled triangles.

Referring to Figure 6, the formula is:

$$\frac{\sin x}{a} = \frac{\sin y}{b} = \frac{\sin z}{c}$$

One only needs to know three of the values in order to find the rest.

Suppose $x = 20$ degrees
$y = 80$ degrees
$a = 10$ cm

$$\frac{\sin 20}{10} = \frac{\sin 80}{b}$$

$$\frac{0.34}{10} = \frac{0.98}{b}$$

$b = 28.96$ cm

However, knowing the values a, b and c or only the angles will not help. If only the lengths of the sides are known, the cosine law must be used.

Law of Cosines

The law of cosines relates the three sides to one of the angles.

$$a^2 = b^2 + c^2 - 2bc \cos x$$

This has important applications in surveying. With reference to Figure 7, suppose a surveyor wants to find the distance BC across a lake, he does not have to swim across if he is mathematically minded. A point A is picked and the distance AB, AC measured together with the angle x between them.

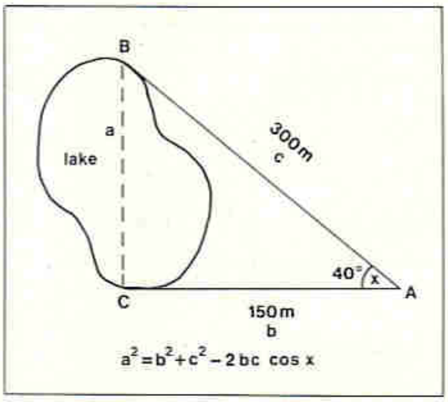


Figure 7. A surveying problem.

If AB = c = 300m
AC = b = 150m

x = 40 degrees

Then $BC^2 = a^2 = b^2 + c^2 - 2bc \cos 40$

$$a^2 = 22500 + 9000 - 68944$$
$$a^2 = 43556$$
$$a^2 = 208.7$$

Therefore BC = 208.7 metres

The above analysis is readily applied for analysing ac current and voltage vectors. If there are 2 voltages of 3V and 5V at an angle of 25 degrees, as shown in Figure 8 and we need to find the resultant.

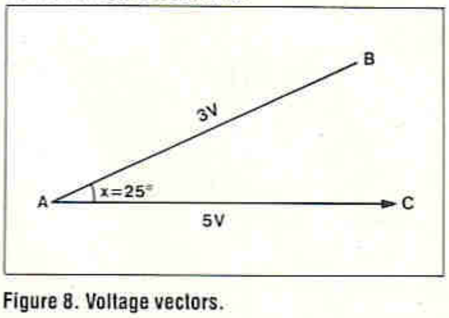


Figure 8. Voltage vectors.

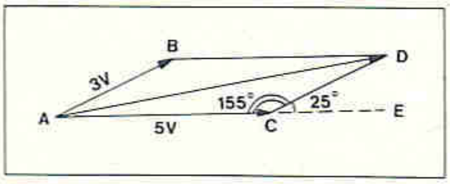


Figure 9. Parallelogram of forces.

The parallelogram of forces is drawn as in Figure 9, where CD is parallel to AB and of the same length. BD is parallel to AC and of the same length. The resultant voltage is AD. To find the length of AD we consider triangle ACD.

Since CD is parallel to AB, angle DCE is the same as BAC i.e. 25 degrees. Angle ACD is 180 − 25 = 155 degrees. Also, CD is 3V.

$$AD = AC + CD - 2\,(AC)\,(CD) \cos 155$$
$$AD = 25 + 9 - 2\,(5)\,(3)\,(-0.91)$$
$$AD = 34 + 27.3$$
$$AD = 61.3$$
AD = 7.81 volts

Now that the definitions are complete we can see the practical applications. Mathematics should be fun, not just an endless stream of meaningless formulae or a maze of figures, but a means to an end.

Application of Phasors to Frequency and Periodic Time

Figure 10 shows a rotating vector OA which rotates, ω radians per second. The diagram shows how the circular form can be represented linearly such that when the vector

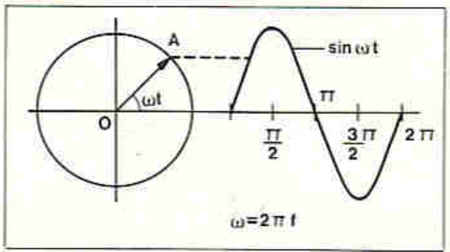


Figure 10. Circular to linear relationship.

has rotated π radians or 180 degrees, the sine wave has also completed a similar distance.

Suppose the rotating vector completes one revolution or 2π radians in T seconds.

Then $\omega T = 2$

or $T = \frac{2}{\omega}$

T is the periodic time or the time taken to complete one cycle.

If one cycle is completed per second, this is one Hertz. In general, the number of cycles per second is the frequency, f.

$$f = \frac{1}{T}$$

$$f = \frac{\omega}{2}$$

The angular velocity $\omega = 2\pi f$ radians per second.

Application to Fourier Analysis

The Fourier series attempts to define the components of a complex waveform. It is not intended to delve into the complexities of Fourier notations, but an example will serve to illustrate the point.

A square wave for instance, bears no resemblence to a sine wave, but Fourier analysis shows that it is made up of an infinite number of odd harmonics of the fundamental sine wave.

To prove this, Figure 11 shows pictorially how a square wave is built up from odd harmonics. By the time the third

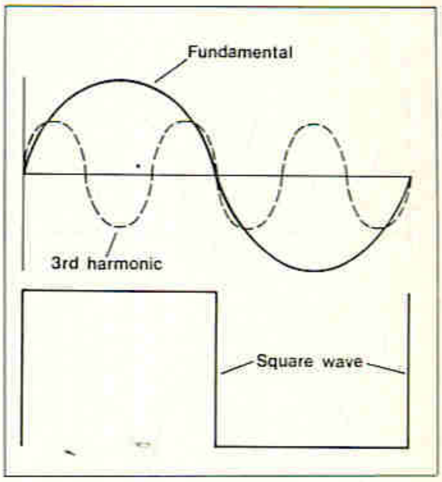


Figure 11. Building up a square wave.

harmonic is added, the combined waveform is already showing signs of turning into a square wave.

Application to Amplitude Modulation

In amplitude modulation, a modulating frequency (fa) amplitude modulates a carrier (fc) to produce at the output, the carrier frequency together with the sum and difference frequencies of the carrier and modulating frequency.

The general form of the output is:

fc + (fc − fa) + (fc + fa)

There are many such mixing processes in radio applications. The reverse process, for extracting the modulating frequency, is called demodulation and the detector circuit for extracting this frequency is sometimes called a product detector. The reason for this can be seen in the following sine and cosine formulae, where a product is transformed into a sum and difference.

$$\cos A \cos B = \tfrac{1}{2}\,[\cos(A+B) + \cos(A-B)]$$
$$\text{or } \sin A \sin B = -\tfrac{1}{2}\,[\cos(A+B) - \cos(A-B)]$$

There are many more sum and product formulae but the above serve to provide the mathematical justification for the mixing process.

Application to Phase Locked Loops

Where it is necessary to maintain a frequency e.g. a carrier frequency within close limits, a phase locked loop may be employed which compares the transmitted or received carrier against a reference source. The difference in phase is a representation of the drift in frequency.

OA is the vector representing the phase variation between carrier frequency and

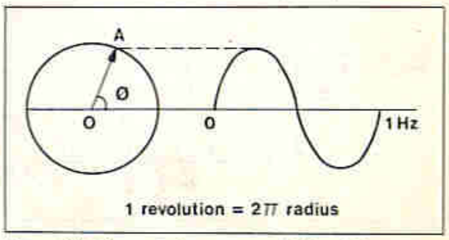


Figure 12. Phase to frequency relationship.

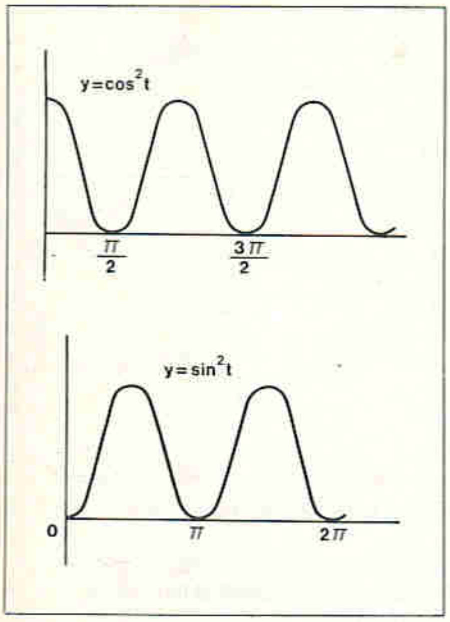


Figure 13. Sine and cosine squared waves.

reference frequency, if the relative rotation of OA is zero then the carrier is the same as the reference and the loop is locked.

On the other hand, if the vector rotates 2 π radians per second, the detector in the phase locked loop will sense that there is a difference of one cycle or 1Hz between the carrier and reference frequency. A correction can then be made. This may be understood with reference to Figure 12.

Application to Testing of Television Links

Pulse and bar testing are extensively used in testing television links. The bar is a rectangular waveform and the pulse is a sine squared waveform. Figure 13 shows sine squared and cosine squared waveforms. The effect is to raise the waveform such that all of it is above the x axis.

Height reduction of these waveforms shows attenuation and ringing shows phase distortion. Fourier analysis shows that a recurrent waveform can be represented by a series of sine and cosine waves, as harmonics of the fundamental. In a non recurrent waveform the fundamental tends to be zero.

A television picture can be represented by a step function (sudden change of shade) and a narrow pulse (small spot of light on a dark background or vice versa). The narrow pulse should contain only the frequency band of interest and therefore a sine square shape is chosen.

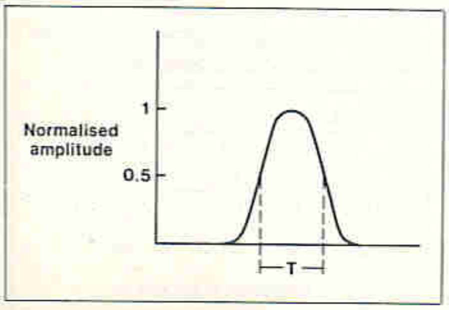


Figure 14. T pulse.

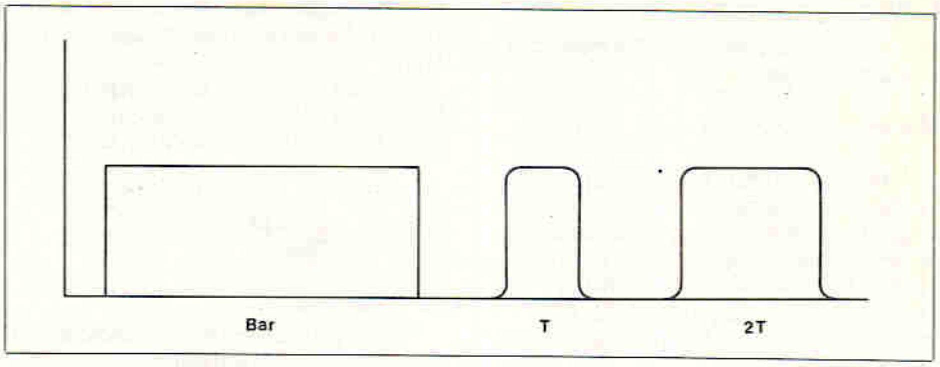


Figure 15. Pulse and bar.

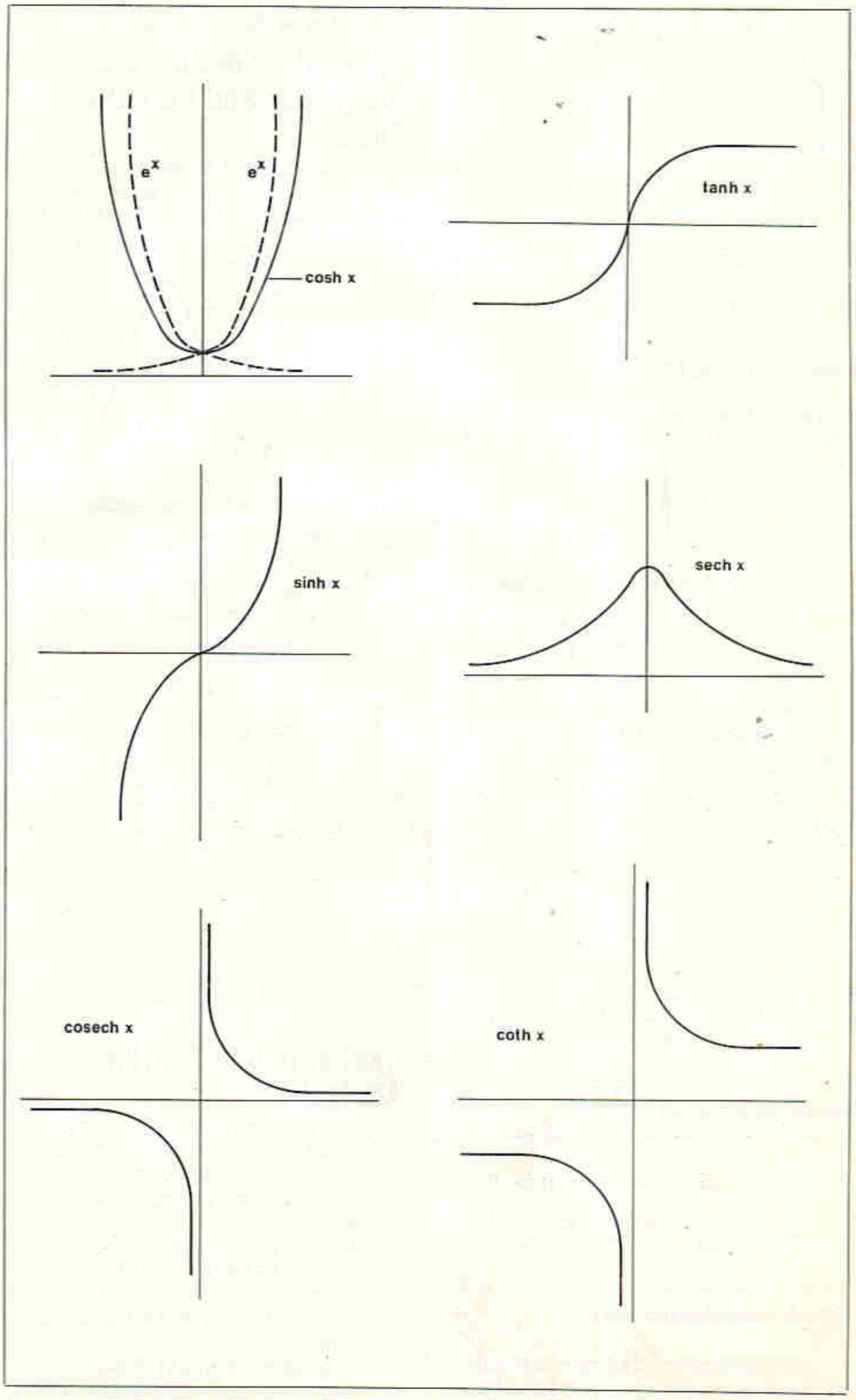


Figure 16. Hyperbolic functions.

Two alternate pulse widths are required. A narrow one of half amplitude duration T, Figure 14, where T is the width at half the pulse height. The period T is the reciprocal of twice the upper frequency limit of the television band width. So if 3MHz (monochrome) is transmitted:

$$T = \frac{1}{2 \times 3 \times 10^6}$$

$$= 1.6\mu s$$

Therefore, a T pulse is equal to a whole cycle of a 3MHz cosine wave starting and finishing at its negative peaks, with direct current added to raise the negative peaks to the zero line of the x axis.

A wider pulse of 2T is also used and the three waveforms are shown in Figure 15. The bar is useful for testing between 10kHz and 0.5MHz because of the large amplitude of waveform components. The 2T pulse is used for the 0.5MHz to 2.2MHz spectrum and the T pulse from 2.2MHz to 3MHz.

Hyperbolic Functions

The foregoing deals with circular functions since they are concerned with equations of a circle. There are other shapes, like hyperbolas which are used in the study of catenaries (a chain hanging from posts) and in the study of transmission lines.

Hyperbolic functions will be dealt with briefly.

The hyperbolic equivalents of sine, cosine and tangent are called sinh, cosh and tanh (pronounced shine, cosh and tank). The hyperbolic equivalents of cosec, sec and cot are cosech, sech and coth, The graphs of e^x and e^{-x} have been dealt with elsewhere and the definitions of the hyperbolic functions are based on these. Figure 16 shows the hyperbolic functions based on the following definitions.

$$\sinh x = \frac{e^x - e^{-x}}{2}$$

$$\cosh x = \frac{e^x + e^{-x}}{2}$$

$$\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

$$\text{cosech}\, x = \frac{2}{e^x - e^{-x}}$$

$$\text{sech}\, x = \frac{2}{e^x + e^{-x}}$$

$$\coth x = \frac{e^x + e^{-x}}{e^x - e^{-x}}$$

Figure 17 shows other interesting shapes compared to the hyperbola. The cardioid is typical of the basic wavefront radiated from an antenna.

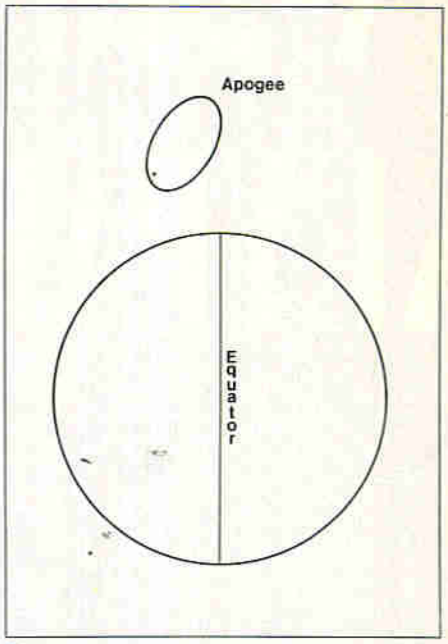


Figure 18. Elliptical transfer orbit.

The Ellipse

The ellipse is a useful shape in many branches of engineering. For instance, in launching satellites around the earth the satellite is placed in an elliptical transfer orbit, see Figure 18 and an apogee motor used to drift the satellite to its apogee, the highest point of the orbit so that it is directly above the equator.

Continued on page 55.

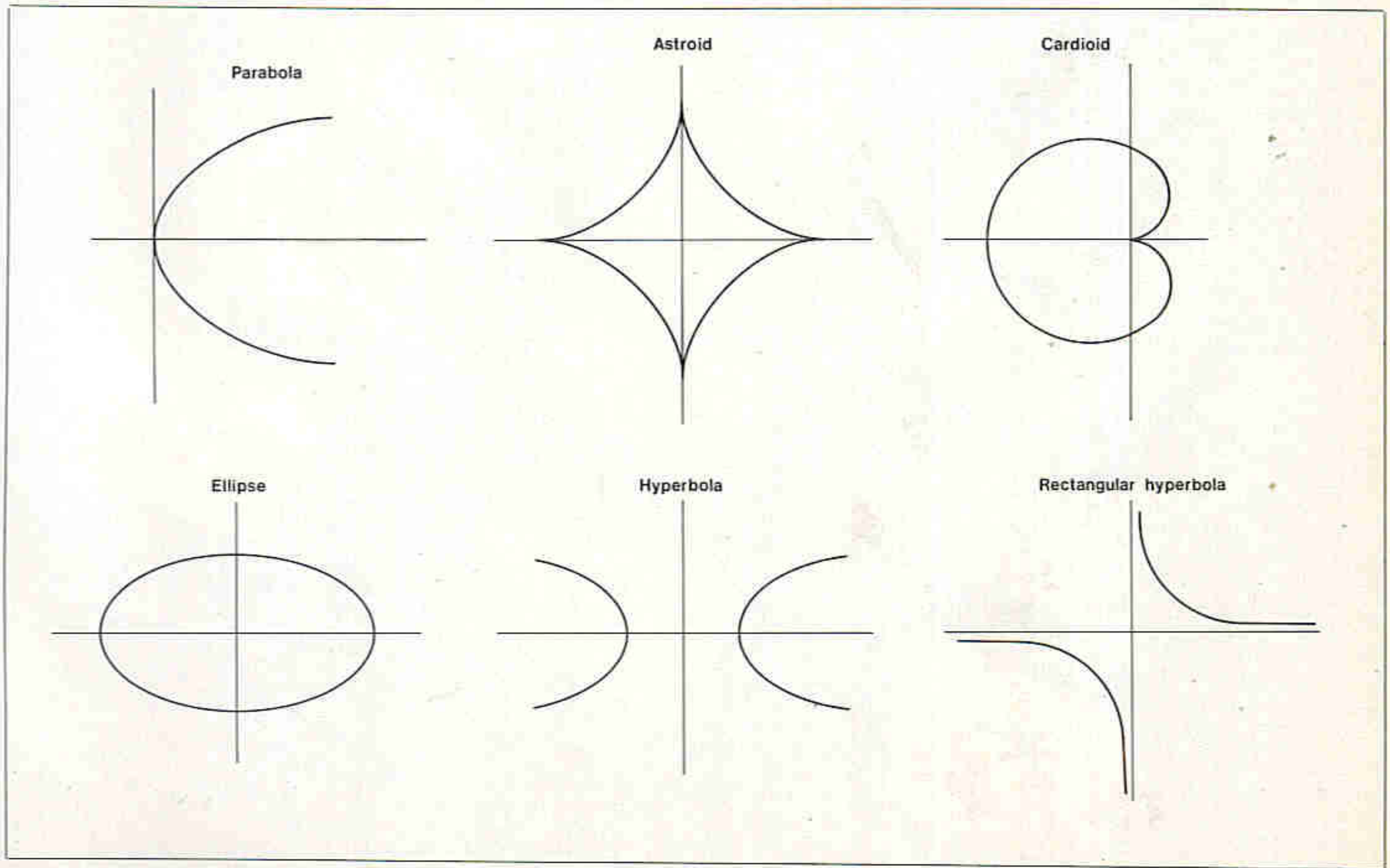
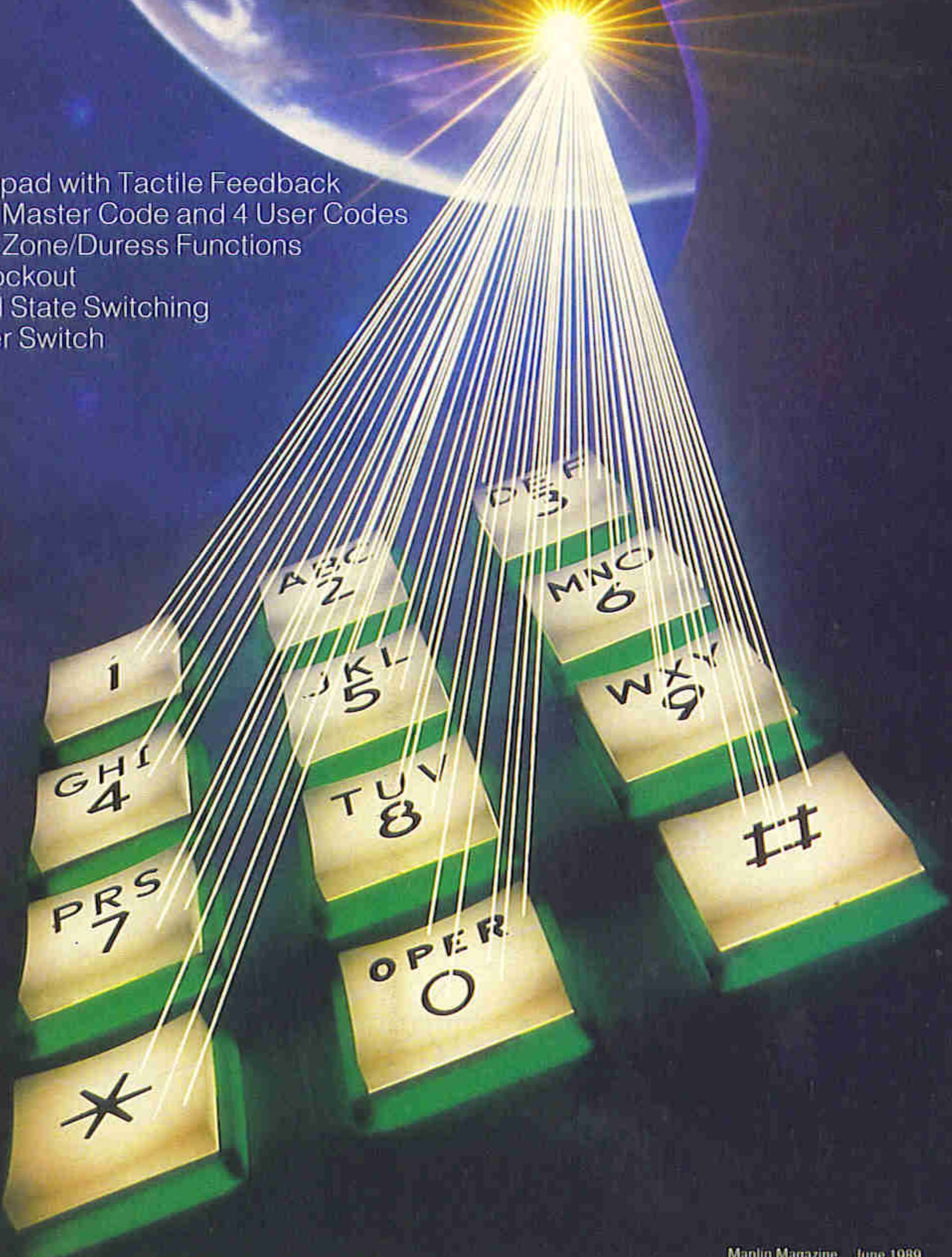


Figure 17. Other interesting shapes.

SA-218 'INTELLIGENT' KEYPAD

Reviewed by Dave Goodman

- ★ Membrane Keypad with Tactile Feedback
- ★ Programmable Master Code and 4 User Codes
- ★ Programmable Zone/Duress Functions
- ★ Wrong Code Lockout
- ★ Relay and Solid State Switching
- ★ 24 Hour Tamper Switch
- ★ Panic Alarm



2. BEEPER

A miniature on-board piezo sounder gives one short 'beep' every time a key is pressed and three short beeps after timeouts and invalid key entries. The sounder can also be externally operated by applying a voltage between +2.5V to +12V on pin 6.

3. KEY TIMEOUT

When any one of the twelve keys is pressed, a timing sequence is initialised which allows up to 2.5 seconds for further key entries. Every key entry re-initialises the sequence and a beep is given to signify the end of a timeout period. After timeout, previously stored key-values are cancelled so if the 2.5 second period is exceeded during a code entry, you will have to re-key the code in all over again from the beginning. This facility is necessary owing to the absence of 'cancel' or 'delete' keys and also offers a higher degree of security from un-authorised use.

4. WRONG CODE LOCKOUT

The number of key entries made within the 2.5 second timeout, in any continuous sequence, is monitored and if more than 30 key entries are made without a valid code sequence, the keypad will automatically lock-out for 30 seconds. Every key pressed during the 30 second lock-out period will re-initialise the 30 second timer and only when the timeout period has elapsed can the keypad be used as normal again.

Punching-in your personal code.

These are just a few of the many features available with this micro-controlled, Programmable Digital Keypad, which has been designed for use with alarm panels or for accessing control devices. The following article attempts to explain the range of available facilities in considerable depth and shows just what a 'clever little device' the SA-218 Keypad can be.

General Description

The Keypad case measures 114mm heigh x 78mm wide x 30mm deep and has been manufactured from white ABS plastic. Key operations are performed on a 12 way membrane keypad (0-9, star, gate) which has both tactile and audible feedback. I/O connections are made via a pre-wired, 18 way x 0.1" pitch female connector supplied with the unit. Access into the unit is made by loosening a hexagonal slotted screw with the allen-key provided and removing the rear panel. The manufacturers also supply two screws and wall plugs for mounting the unit, but you will have to find your own 5mm drill and elbow-grease (not supplied)!

Facilities

1. ARM/DISARM

Entering a 4 digit master code, or any of the four user codes, by keying in numbers from the keypad will activate a sequence of switched outputs and timing signals. These outputs can be used for controlling security and alarm panels or low power apparatus.

5. MASTER CODE

This is a programmable 4 digit code selected from keypad numbers 0 to 9 and any combination of those four numbers can be used. The SA-218 is supplied pre-programmed with master code 1-2-3-4. To re-program the master code you are required to press the star key twice, enter the old master code, enter function number 0, followed by a 4 digit master code of your choice:

e.g. ★ ★ 1234 0 4366 (no spaces of course).

In this example the current master code is now 4366.

6. USER CODES

Again, this is a 4 digit code (not the master code number!) and four separate (four digit) numbers can be programmed as required. Before a user code can be changed, the master code must first be entered. The system integrity is therefore maintained for as long as the master code is kept secret. To program user codes you are required to press the star key twice, enter the current master code, one of the function numbers 1 to 4, followed by a 4 digit user code of your choice:

e.g. ★ ★ 4366 1 0328 (no spaces!).

User code number 1 is now 0328. The remaining three user codes are programmed in the same way with function numbers 2, 3 & 4. User codes are an optional facility and unlike the master code, they need to be programmed in only as and when required. A user code can also be erased by entering ★ ★ master code and function number only, without making any further key entries. After the 2.5 seconds timeout has elapsed, any pre-programmed code stored at this function number will be deleted. Additionally, a user code holder could arm/disarm an alarm system and later on, the master code holder only could erase that user code - without having to rearm/disarm the system; this would prevent the user code holder from gaining further access to the system. Other pre-programmed user codes will still remain valid at this time, but they too could be erased in the same way!

Summary of two star (★ ★) function numbers:

0 = Master code
1 = User code No.1
2 = User code No.2
3 = User code No.3
4 = User code No.4

7. DURESS

Whenever the master or user codes are keyed in directly, relay change-over contacts are activated along with high and low transistor outputs. It is just possible that a master/user code holder may be forced to arm/disarm the system or hand over the code 'under duress' as it were. In this situation it may not be prudent to furnish an incorrect code as a ploy, therefore, the programmable duress option allows the system to be armed/disarmed as normal, but in addition the zone output, pin 9, also pulses low

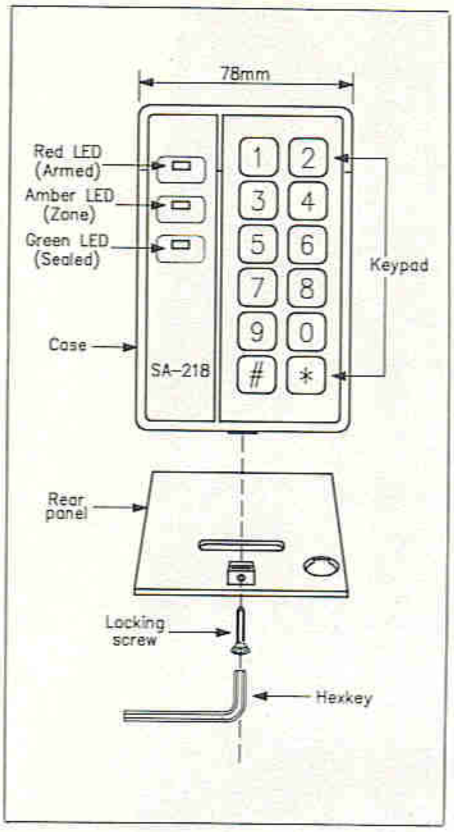


Figure 1. General layout of the SA-218 Keypad.

(approximately 0V) for 1 second following a 2.5 second delay timeout. A duress code is almost identical to the master or user code number, except for the last digit being incremented by one, but the first three digits always remain the same:

e.g. Master or user code normally 4366 becomes duress code 4367 = 436(6+1).

Where the last digit in the code is normally a 9, increasing it by one produces the number 10 (or 0 carry 1). A carry number has to be ignored otherwise the four digit code will become a five digit code - which is invalid:

e.g. Master or user code normally 6789 becomes duress code 6780 = 678(9+1).

A duress code is temporary and should not be programmed in, otherwise it will become a new master or user code. Duress codes can be used at any time when the zone, pin 9 - silent alarm, output is required and its operation is signified by the amber coloured ZONE led illuminating for 1 second. Note that further key entries are not accepted until after the timeout period has ended.

It should be noted that the duress facility cannot be accessed if 'zoning' has previously been selected as both duress and zone share a common output, pin 9. Similarly, the zone facility cannot be accessed if 'duress' has been previously selected - for the same reason.

Duress – Programming

Table A lists 10 gate (#) functions that can be programmed in with the master code only. Even numbered functions are related to the zone facility only whilst odd numbered functions relate to the duress facility only.

e.g. # 4366 1

The duress facility has been programmed by entering the gate key, followed by a current master code (not user code!) and function 1. Now if a master or user code is entered, the main switch outputs will operate for 0.5 seconds and then release again. Keying in a master/user related duress code has the same effect with the delay and zone pulse output operating as normal.

e.g. # 4366 5

Here the duress 25 second arm-time function has been programmed and the operation is similar to the first example, except that the main outputs switch for 25 seconds before releasing. Duress delay and zone pulse output operate as normal.

e.g. # 4366 9

In this third example the toggle/latch function is programmed. The main outputs switch and LATCH permanently (no arm-time) when a master, user or duress code is keyed in. The main outputs can only be switched back - TOGGLE - to their previous state by re-entering a master, user or related duress code again. Duress delay and zone pulse output operate as normal.

Key	Function	Arm Time
0	Zone	0.5 sec
1	Duress	0.5 sec
2	Zone	10 sec
3	Duress	10 sec
4	Zone	25 sec
5	Duress	25 sec
6	Zone	35 sec
7	Duress	35 sec
8	Zone	Toggle/Latch
9	Duress	Toggle/Latch

Table A.

8. ZONING

This term describes the process of arming or dis-arming a discrete area independently from the rest of the system. The SA-218 zone output is common to both the zone and duress facilities and has an open collector pull-down on pin 9. There are two different options for zoning as follows:

(i) Set or re-set the zone output and the main arm/disarm outputs.
(ii) Set or re-set the zone output only (no main arm/disarm outputs).

The star (★) key is used for selecting either option and is entered first, followed by a master or user code. To prevent the main outputs from operating, as option (ii), the star (★) key should be pressed a second time after entering the code:

e.g.(i) ★ 4366 Zone and main outputs activated.

(ii) ★ 4366 ★ Zone output activated only.

Zone – Programming

Either zone arm-time or toggle/latch functions can be programmed in from Table A using the # key, master code only and even function numbers:

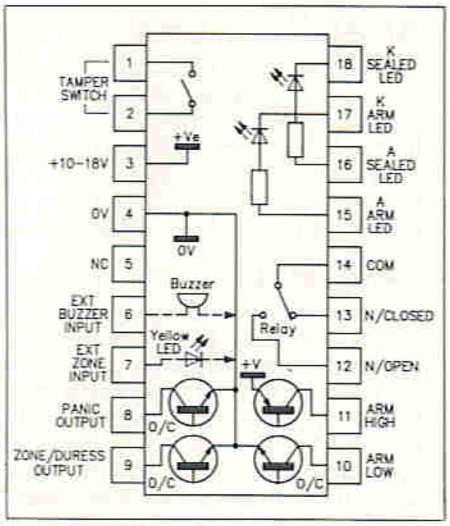


Figure 2. General functions of the SA-218.

e.g. # 4266 2

The 10 second arm-time zone facility is programmed by entering the gate key, followed by the current master code (not a user code) and function 2. Now when a master or user code is entered, the main switch outputs will operate for 10 seconds and then release again. Duress codes are invalid and will generate three beeps when entered and nothing else! If a star is first entered, followed by a master or user code, the zone output is immediately activated and 2.5 seconds later the main outputs will switch. After a further 10 seconds delay (total of 12.5 seconds) the main outputs ONLY will switch back to their original state, with the zone output remaining active. Keying in master or user codes will not affect the zone output status, therefore to change the zone output alone, enter a star, master/user code and another star. The front panel zone LED is illuminated when the zone output is active (set) only.

e.g. # 4266 8

Programming zone function 8 selects the toggle/latch facility and all operations are the same as for those in the previous example, except the main switch outputs will LATCH permanently with no delayed release. Entering a master/user code will TOGGLE only the main switch outputs to their original state and star master or star user codes will change the zone output status only. The zone LED is on when the zone output is active as stated earlier.

9. ARM, ZONE & SEALED LED's

Two of the three front panel mounted LED's are for connecting to external equipment only, but the third LED can be both internally and externally used as follows:

'SEALED' (green LED) anode pin 16, cathode pin 18.

'ARM' (red LED) anode pin 15, cathode pin 17.

Current limiting 560R resistors are pre-wired in series with each of the two LED's and are not required to be fitted externally.

'ZONE' (amber LED) used by the micro-controller to signify 'zone active', but can also be illuminated by externally connecting +2.5 to 12 volts to the buffered input 'EXT ZONE' pin 7.

10. PANIC ALARM

Pressing the star and gate keys (★ #) both together sets the open collector pull down 'PANIC' output low (approximately 0V) on pin 8 and is accompanied by 2 short beeps from the sounder. The output remains low until either or both keys are released.

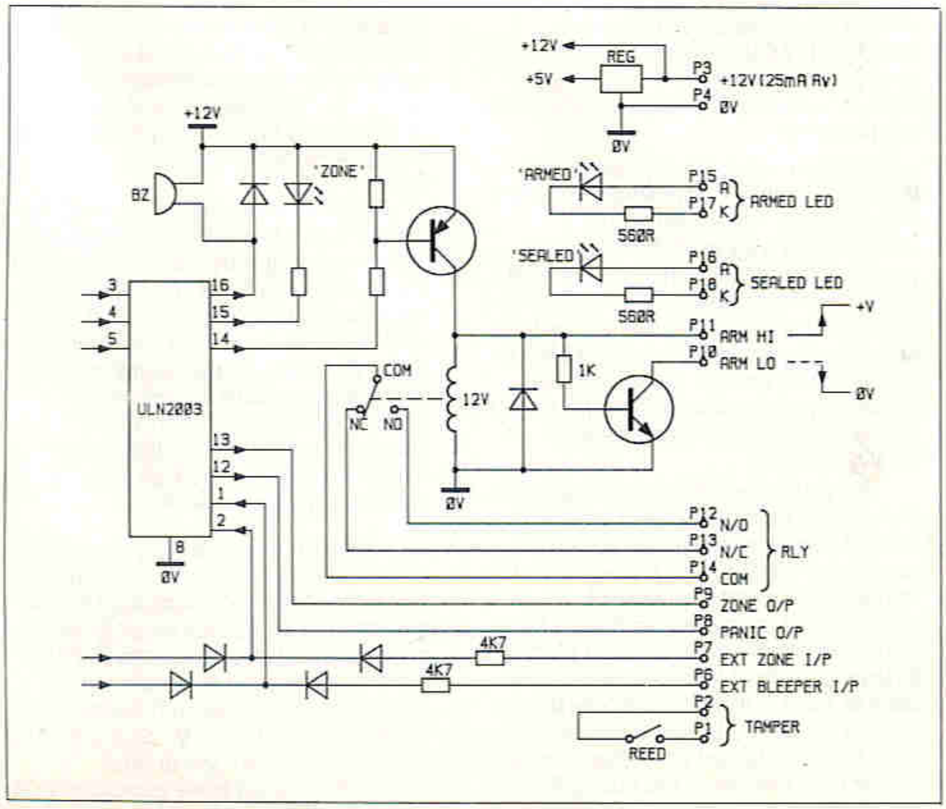


Figure 3. I/O connection circuit.

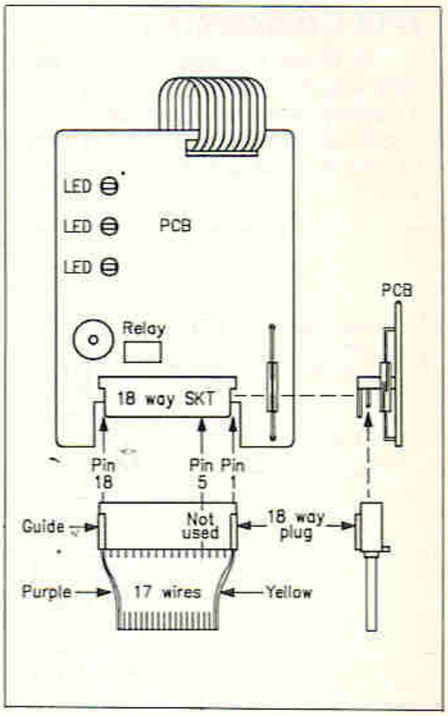


Figure 4. Mechanical fitting details of the I/O connector.

11. TAMPER ALARM

A miniature reed switch, fitted to the PCB, is activated by a magnet attached to the rear case panel. With the unit screwed down onto a flat surface, the magnet will hold the reed contact closed. If either the case front or the complete unit is subsequently removed, then the reed contact will open (break contact action). Connections to the reed contact are external on pins 1 and 2 only and the tamper facility is not monitored by the micro-controller or sounder at all.

12. DIRECT/PULSED OUTPUT

To select this mode, 2 links are required to be fitted onto the PCB in positions JW1 and JW2. Links can be mounted either onto the component side of the board, which means the module has to be removed by taking out the 3 mounting screws first, or onto the track side of the board as shown. With both links fitted, this facility offers a different zone operation and timeout as shown in Table B.

Key	Function	Arm Time
0	Zone	1 sec
1	Duress	1 sec
2	Zone	5 sec
3	Duress	5 sec
4	Zone	10 sec
5	Duress	10 sec
6	Zone	30 sec
7	Duress	30 sec
8	Zone	Toggle/Latch
9	Duress	Toggle/Latch

Table B.

Entering the star key, followed by a master or user code, instantly switches the main outputs and zone output, pin 9, for the timeout or toggle/latch option programmed in from Table B. The programming method remains the same as before and duress options are also valid.

I/O Connector

An 18 way, 0.1" mini-connector, pre-wired with 17 x 200mm long coloured wires, is supplied for making all input and output connections to the module. The wire colour coding and pin designations are shown in Table C.

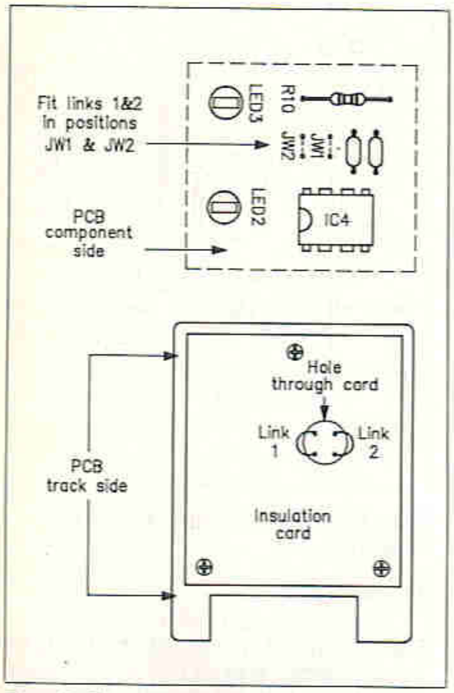


Figure 5. Fitting pulse option links.

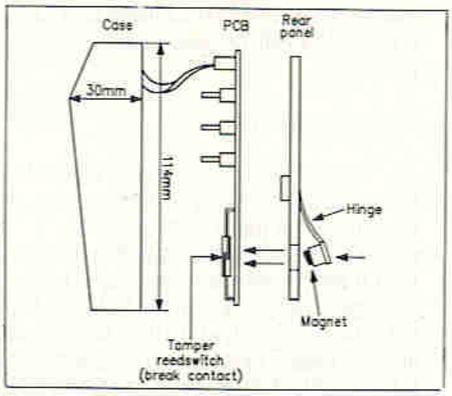


Figure 6. How the 'tamper' switch works.

Pin	Wire	Designation
1	Yellow	Tamper Switch
2	Orange	Break Contact
3	Red	PSU +12VDC Input
4	Brown	PSU 0V
5	N/U	Not Connected
6	White	Ext' Bleeper I/P
7	Grey	Ext' Zone I/P
8	Purple	Panic Output O/C Pull Down
9	Blue	Zone Output O/C Pull Down
10	Green	Arm Output O/C Pull Down
11	Yellow	Arm Output O/C Pull Up
12	Orange	Arm Relay N/O Contact
13	Red	Arm Relay N/C Contact
14	Brown	Arm Relay Common Contact
15	Black	Armed LED Anode (+)
16	White	Sealed LED Anode (+)
17	Grey	Armed LED Cathode (−)
18	Purple	Sealed LED Cathode (−)

Table C.

Specifications

Power Supply: 10 to 18VDC max
(Typ'12V - 25mA)
Armed & Sealed LED inputs: 2.5V to 12V Max
Bleeper & Zone inputs: 2.45 to 12V Max
Relay contacts: 1Amp at 12VDC
Open Collector outputs (O/C): 250mA Max
N.B. Pin 11 switches to the +V supply rail.

Self Test

A self test routine can be initialised by holding both the star and gate (★ #) keys down and then applying power to the keypad. All outputs are tested in sequence (the two keys can now be released!) twice, terminating with two beeps from the sounder. This is the cue to press all keys in turn, 123456789#★, and each will produce a single beep. If no problems are found, then two beeps are issued to signify this. On the other hand, should there be a fault then the beeper will sound continuously at the rate of 2Hz; the main outputs will also pulse at the same rate. An interesting effect encountered after running the self test routine is that the master code returns to 1234 and all previously programmed codes are reset.

Availability

The SA-218 keypad is obtainable from Maplin Electronics on mail-order or through their numerous shops. The ordering code is YT84F and the price just £29.95 inclusive of VAT.

TELECOMMUTING · · TELECOMMUTING ·

Continued from page 10.

home, thereby eliminating the distraction of children, pets or visiting friends. The telecommuter must also be able to resist the temptation to tackle the lawn mowing or repairing the garden gate. The psychological problem also extends to the withdrawal of team work. The individual could well miss the cut and thrust of business contacts and the ability to forge relationships".

Industry Reservations

It appears that not all industry authorities are in tune with the telecommuting movement. The authoriative magazine 'Comms Monthly' quotes Sir John Harvey-Jones, ex boss of ICI as saying "It is difficult for older people like me to comprehend. For my generation, a computer still tends to be thought of as a sort of calculator, and few of us are computer literate". This view is supported by a recent Quantum Research survey which found that although over half of those questioned would prefer to work independently, a large number remained concerned about the loss of human contact and team relationships.

Also Keith Marsden, divisional director of Hoskyns Network Services, is not totally convinced on the merits of telecommuting. "Telecommuting in theory is right. But savings on travel and office accommodation costs have to be balanced by the loss in team spirit. Companies such as Hoskyns need to have close interaction between our consultants – a shake down of ideas. These creative opportunities would be greatly missed and intellectual quality could be considerably diminished. Above all, jobs at home will need to be well defined and workers well disciplined".

Similarly somewhat dubious over the merits of telecommuting is John Sommerwill of Saffronrose. "Unless the cost of communications are substantially reduced, your home based telecommuter could run up telephone costs equivalent to his former commuting costs. Telecommunications is an expensive business, one best handled by the very high value worker". In any case John wonders if even the new digital network could sustain all the telecommuter generated telephone traffic.

Not surprisingly, Saffronrose highlights the technical ability factor. Even in fully manned offices, many workers are less than comfortable with their high tech equipment and need the comfort of close hand assistance and advice. Gordon Ross of PA agrees. High technology equipment is often frustratingly difficult for the non expert. The world he states is divided into PC literate and non-literate individuals, with the weighting being 98% who do have difficulties. Even so, Gordon Ross reminds us that many office PCs are not being used to their full capacity because of this skill and understanding gap.

Training and service maintenance will also be a major factor for the emerging generation of telecommuters. A friendly hot-line support service would seem essential to the well being and confidence of the home worker, but this factor says Saffronrose could be difficult and expensive to provide on such a wide range base of users.

Telecommuting may be inevitable, if only to avoid having that 19th nervous breakdown while commuting in from Norbury. But not all the consequences as yet appear to have been recognised. Sales of daily papers for a start will slump. Inner city house prices will also slump alongside a corresponding surge for the more desirable out of town house. Especially if it features a spare room. Marriages according to the Quantum survey could slump as it seems a high proportion of us meet our partners at work.

Despite the fact that many industry authorities believe that homes are about people, and people and technology do not mix very well, the EEC are presently funding a project aimed at creating 'Integrated Home System Standards'. The venture is being backed by such well known IT companies as Philips, GEC and Thorn EMI. So it should not be long before we are able to shout commands from our home workstation to the kitchen for a repeat order of toast, marmalade and coffee.

Exploring Radio

by Graham Dixey C. Eng., M.I.E.R.E. *Part 8*

Introduction

The short wave receiver recently described (Electronics No.29) offered a simple and inexpensive introduction to the world of short wave listening. No great performance could be claimed for it; nonetheless the speaker was found to be very lively at times, especially at night. The prime limitations are the need to keep juggling certain variables, especially the degree of reaction, in order to get the best from it. But that is the price of simplicity and a fair price it may be considered to be. Details of two coils were included in the original article and, if the dimensions were adhered to, between the two coils specified, it should have been possible to tune over the range of 3-16MHz, covering several of the amateur bands. However, there is also an interesting listening area somewhat below the lower limit of the original coils, in the 160 metre band, which covers 1.8-2.0MHz. The added interest in this part of the frequency spectrum arises because it is shared with maritime users and so, for those who can make best use of it, allows one to listen in to some marine traffic.

Obviously those best situated will be the ones living near the coast although, as is the usual way with short waves, reception is dependent upon time of day or night and ionospheric conditions, so anything can be expected. That's the fun of short waves.

What has been done in this design is to take the original short wave receiver and fit a new coil that will tune to the lower frequency waveband; a few other changes have also been made, largely concerned with providing a slightly more sophisticated tuning arrangement, as discussed below. Readers who built the original short wave receiver could, if they so wished, merely add the extra coil and perhaps include band switching. Some builders may have already added this latter refinement by switching between the two coils originally specified. However, the new coil is based upon a smaller capacity air-spaced tuning capacitor (365pF) instead of the original 500pF mica type. The reason for this is the desire to include an inexpensive slow-motion drive in the tuning arrangement; the friction of the mica tuning capacitor is too great to allow the slow-motion drive to function satisfactorily. Air-spaced tuning capacitors are much nicer to use anyway; in the author's younger days mica tuning capacitors were considered the poor relation - though they certainly aren't cheap these days!

Details of the new coil are shown in Figure 1. Notice the relative directions of the two windings. If reaction cannot be obtained it is possible that the connections to one winding need to be reversed. Coil formers are always a bit of a problem. They can be made by the method described in the original article, by winding thin card around a wooden dowel former, glueing it as you go, or sometimes a fortuitous piece of tube presents itself. One such

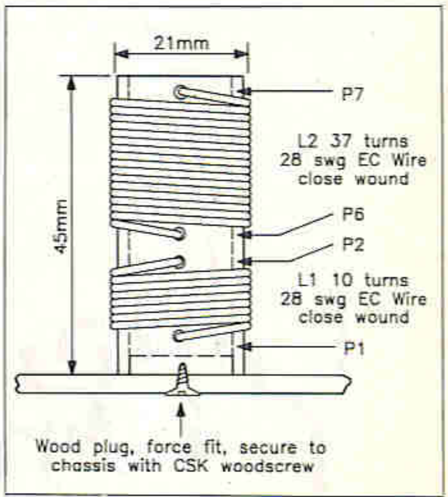


Figure 1. Coil winding details. Note that L1 and L2 are wound in different directions.

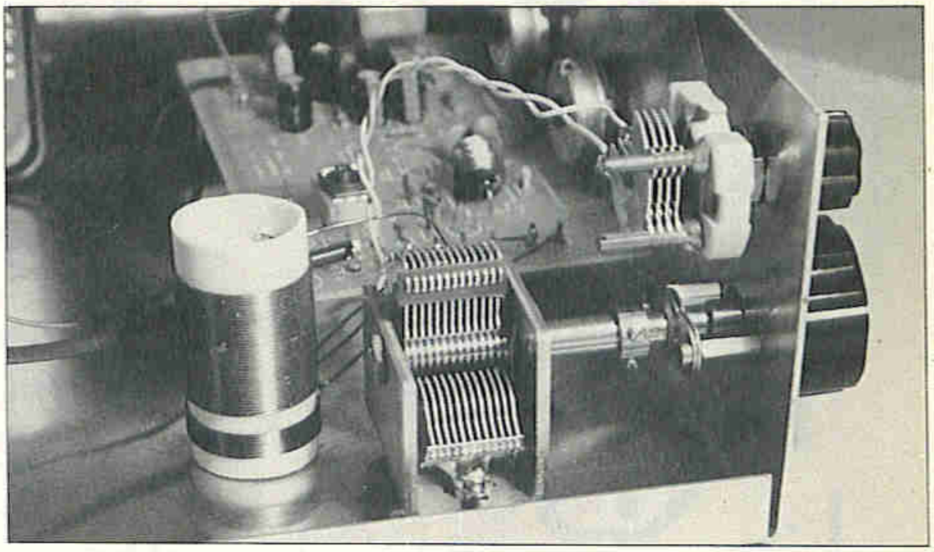


Photo 1. Tuning details.

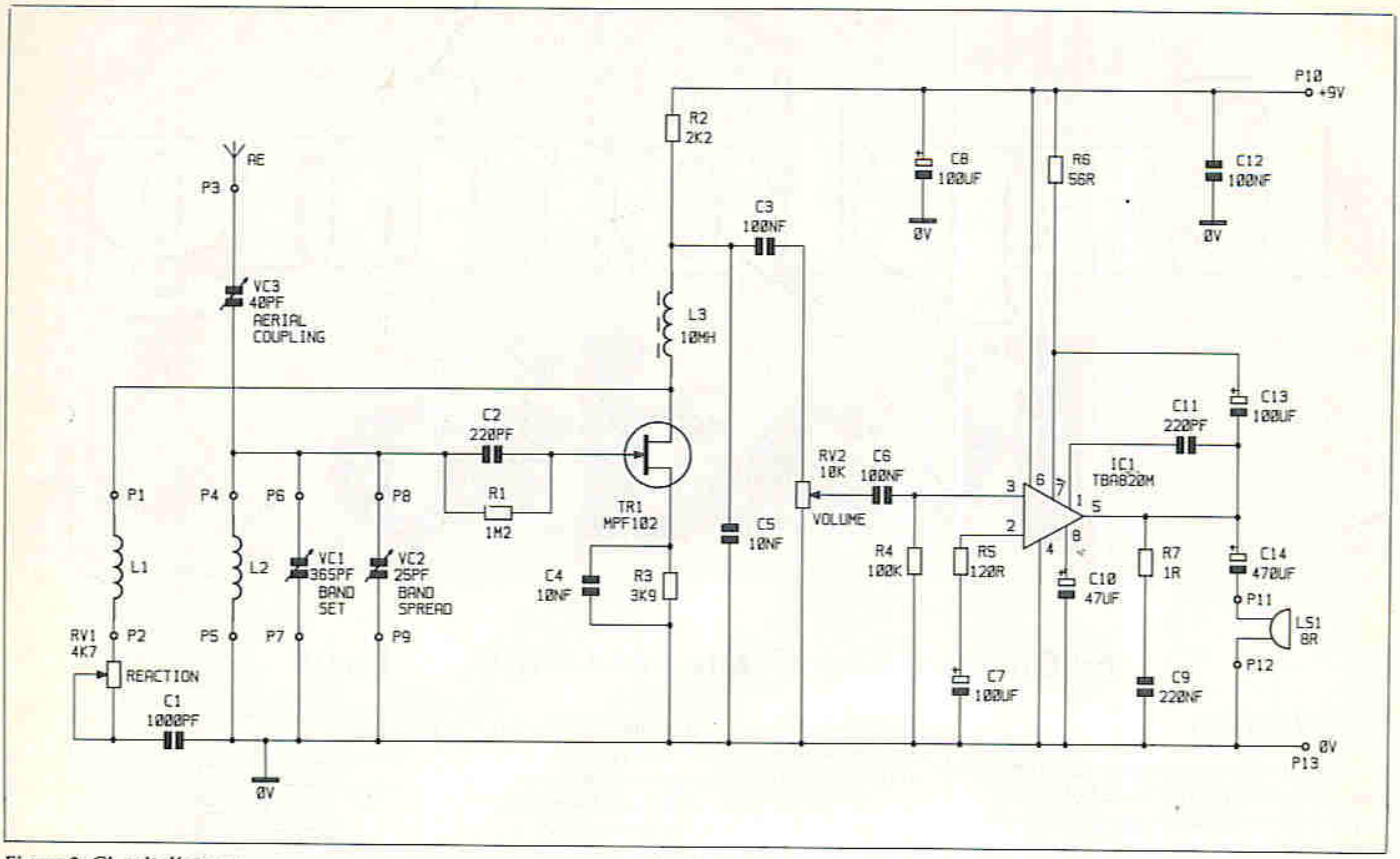


Figure 2. Circuit diagram.

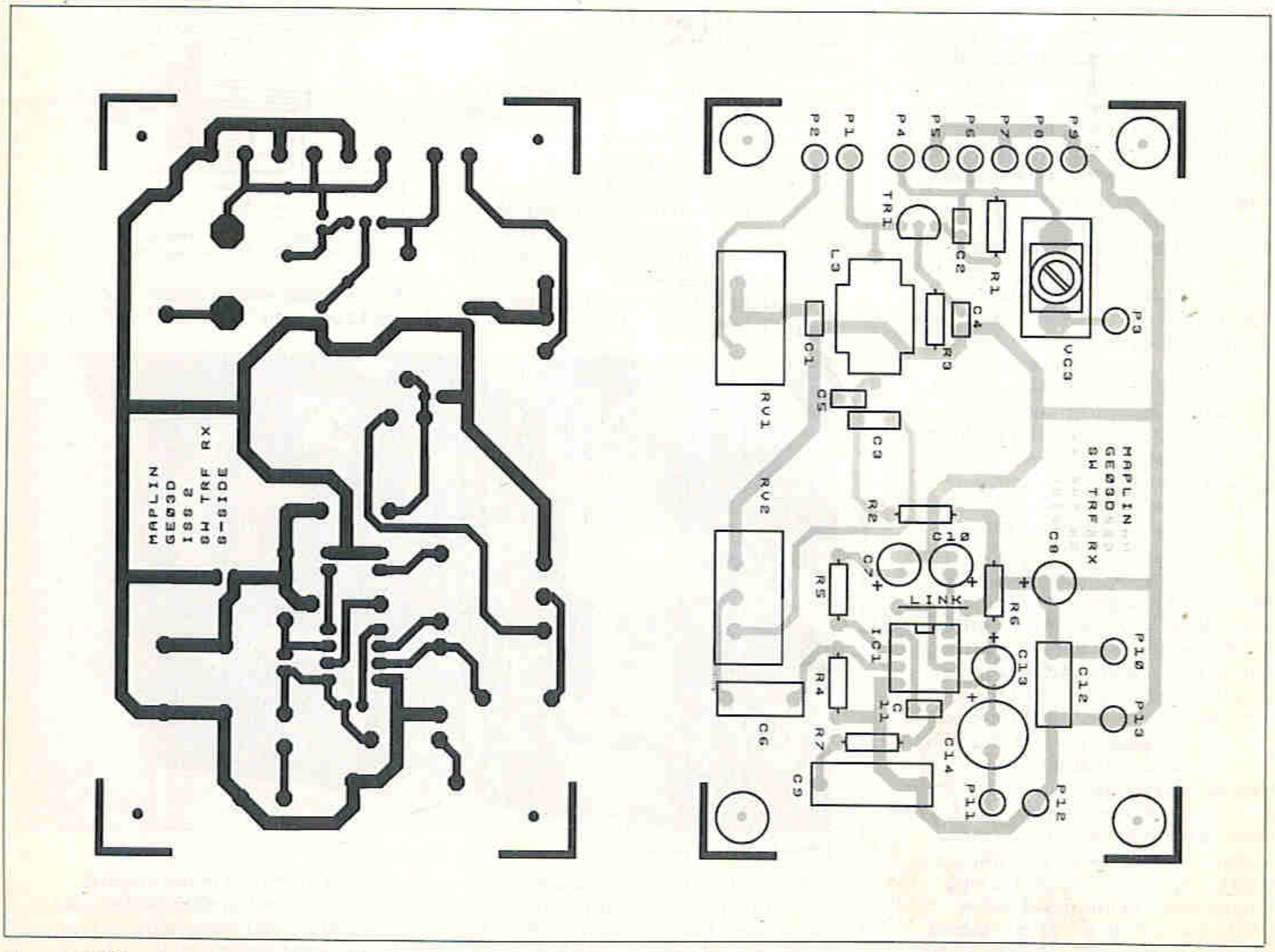


Figure 3. PCB layout.

possibility, that some may think an unlikely source, is a piece of plastic cold water pipe. Since this is so readily available and inexpensive, this is what has been used on this occasion. It can be fitted to the chassis by plugging the bottom end with a piece of wood and inserting a screw into a pre-drilled hole. This is also shown in Figure 1.

Photo 1 shows the new tuning arrangements with the slow motion drive fitted. This now means that tuning is entirely non-critical. Not only is the main tuning easier to use, but the bandspread can then be used for the fine tuning.

The circuit diagram (Figure 2) and PCB layout (Figure 3) are essentially the same as before, but are included here for completeness.

Any piece of equipment looks better if it is cased up (Photos 2 and 3) and a smart yet inexpensive case was chosen from the Maplin catalogue in this instance. This does make the aerial preset capacitor less accessible but the problem can be resolved by accurately locating its X and Y co-ordinates, so to speak, and drilling a sufficiently large hole in the top of the case, so as to allow a screwdriver to get at the preset when required.

Operating the receiver is exactly the same as for the original short-wave receiver. This is summarised as follows.

The aerial coupling capacitor should be set to the mid position, as should the 'bandspread' capacitor. The volume control should be set to or near maximum. The reaction control should be either fully anticlockwise or at least not more than halfway in its clockwise travel. The main tuning control (bandset) should then be rotated, listening for any activity; if none is found the reaction control should be progressively advanced (clockwise), rotating the bandset capacitor at the same time, until a station is heard. When one is received, the reaction control should be adjusted for optimum signal. Swinging the tuning control (using bandspread at this stage) should produce a whistle on either side of the station frequency. The setting of the aerial coupling capacitor affects the ability to obtain regeneration; it should be unscrewed slightly and tried again. On a station, screwing it in will often improve signal strength.

The inability to get regeneration at all may be due either to the reaction coil being connected in the wrong phase; its connections should be reversed. Or there may be insufficient feedback, in which case either the number of turns on L2 should be increased or it should be wound closer to L1, even over the last turns of this coil. Some trial and error may be necessary to get the best performance but that is to be expected in this game.

Overall, it was felt to have been a worthwhile exercise and a satisfactory rounding off to the series.

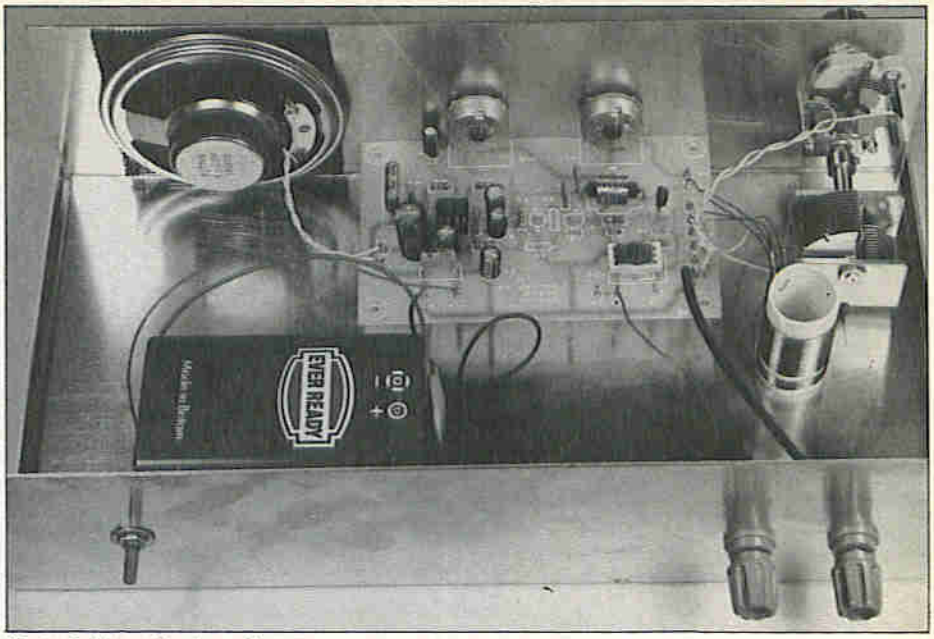


Photo 2. Mounting board into a case.

Photo 3. Possible finished design.

TRF MARINE BAND RECEIVER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1	1M2	1	(M1M2)
R2	2k2	1	(M2K2)
R3	3k9	1	(M3K9)
R4	100k	1	(M100K)
R5	120Ω	1	(M120R)
R6	56Ω	1	(M56R)
R7	1Ω	1	(M1R)
RV1	4k7 Pot Lin	1	(FW01B)
RV2	10k Pot Lin	1	(FW02C)

CAPACITORS

C1	1000pF Ceramic	1	(WX68Y)
C2,11	220pF Ceramic	2	(WX60Q)
C3	100nF Minidisc	1	(YR75S)
C4,5	10nF Minidisc	2	(YR73Q)
C6,12	100nF Polyester	2	(BX76H)
C7,8,13	100μF 10V P.C. Electrolytic	3	(FF10L)
C10	47μF 25V P.C. Electrolytic	1	(FF08J)
C14	470μF 16V P.C. Electrolytic	1	(FF15R)
VC1	365pF Variable	1	(FF39N)
VC2	25pF SW Trimmer	1	(FF44X)
VC3	40pF Trimmer	1	(WL71N)

SEMICONDUCTORS

IC1	TBA820M	1	(WQ63T)
TR1	MPF102	1	(QH59P)

MISCELLANEOUS

L1,2	See Text	–	–
L3	Choke 4.7mH	1	(UK80B)
	P.C. Board	1	(GE03D)
LS1	L/S Lo-Z 778	1	(YW53H)
	Mini Ball Drive	1	(HB42V)
	Knob K7A	3	(YX01B)
	Knob K7C	1	(YX03D)
	8 Pin DIL Socket	1	(BL17T)
	Veropins 2145	1 Pkt	(FL24B)
	PP9 Battery Clip	2	(HF27E)
	EC Wire 0.375mm 28swg	1	(BL38N)
	Constructors Guide	1	(XH79L)

The following part is available,
but is not shown in our 1989 catalogue:
Order As GE03D (SW TRF PCB)
Price £3.95

LOGIC IC TESTER

★ *Use with IBM PC-XT-AT, Amstrad 1512-1640 and clones*
★ *Tests TTL & CMOS logic IC's*
★ *Full service program, library & PASCAL information on floppy disk*

Reviewed by Dave Goodman

This article looks at an IC Tester designed as an insertion card for IBM-PC-XT/AT and compatibles. The IC Tester is able to carry out logic function tests on nearly all CMOS and TTL standard components, accommodated in DIL packages up to 20 pin. This article also introduces the service program, used to test over 500 standard components. Figure 1 gives a block schematic of the system.

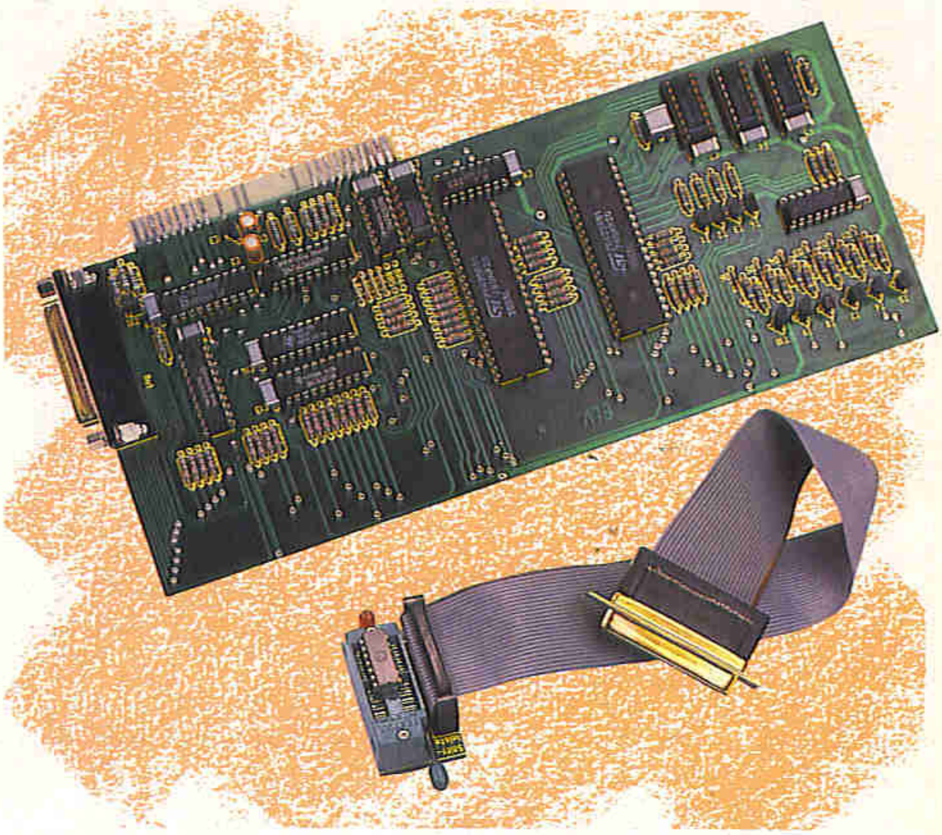
Introduction

It is often necessary to check the operation of logic IC's, new or used (and out of circuit!). When dealing with simple gate circuits, this can be done without too much trouble. However, as the operating mode of IC's becomes more complex, then checking out circuits, using simple tools such as switches and LEDs, becomes much more troublesome. The IC Tester has been developed to bring about quick and simple testing of the operating mode of these standard components. Nearly all components in the standard TTL and CMOS range, up to 20 pin DIL package size, can be tested. IC's are simply inserted into the 20 pin 'ZIF' test socket, starting from the lower pin 10 and 11 positions, growing towards pin 1 and leaving any remaining pins unused. Naturally, the system is suitable for use with related LS, HC and HCT families, but voltage controlled oscillators and PLL devices, e.g. CD4046, 74624..., are excluded from this system. These IC's would have increased the complexity of the project quite considerably as they require several supply voltages and analogue input signals.

An analogue switch IC is used to check monostable multivibrators and connects the required resistors and capacitors for the time constants to the appropriate pins. The IC Tester thoroughly checks the logic behaviour of the components under test. With different IC's the connection pins can have different designations, such as:

- Voltage Supply +5V
- Voltage Supply Ground
- Logic Output 'H' or 'L'
- Open Collector Output
- Tristate Output
- Data or Control Input

These conditions can be set up with the circuit and the software contains all necessary data to enable the program to automatically search for a particular IC in the library. This ensures that the voltage supply is connected to the correct pins in the package at the correct time, otherwise the IC could be destroyed if the wrong voltage were applied.



Slot-in card, test socket board and IDC cable.

The Circuit

The circuit is comprised of two parts; Figure 2 shows the complete address decoder and Figure 3 shows the separate stages for driving IC's that are to be tested. The address decoder has two principle functions: firstly, the eight data lines (RD0-RD7) must be buffered and secondly, the storage device and buffer described below must be selected. A bi-directional bus driver IC11, type 74LS245, takes care of the data buffering and the I/O read line IOR determines the direction of data flow. The driver is enabled via an address decoder, IC15 type 74LS688. The IC Tester requires a connected I/O address range of 16 bytes with individual addresses selected by A0 to A3 and the main address by A4 to A9, which are fed to the comparator IC15. The required address range is pre-set by fitting links BR1 to BR6. When the main address is sent by the PC's central processor, the 8-bit comparator, IC15 output-pin 19, goes low and enables IC14B. Dependant on A2 to A3 of the PC bus, one of the three outputs from IC14B (Q0 to Q2) goes low. Q0 and Q1 select one of the PIO devices IC1 or IC2, and Q2, together with the I/O write line (IOW), enables IC14A via the OR gate IC13C. The three IC14A outputs, Q0-Q2, then clock data into the appropriate latch, IC8 to 10, which are selected from address lines A0 and A1. These address lines are buffered via OR gates IC13A, B. The reset control line is inverted by IC12A and connected to the M1 inputs of IC1 & IC2. Two NAND gates, IC12B & C derive an I/O access signal (IORQ) from the I/O write and read lines IOR and IOW. The complete IC Tester is made up of several, separate logic units as follows:

- voltage supply for the IC under test.
- simulation of the logic conditions.
- RC combination for monostable multivibrators.
- load switch for the drive outputs.

With reference to Figure 3, the positive supply voltage for the test IC is selected via decoder IC4, R29-40, T5-10, then to the appropriate pins on the ZIF test socket. When one of the six voltage supply lines is selected, one of the diodes, D1 to D6, is forward biased and the red LED, mounted next to the test socket, conducts via R41-43 and T11. Whilst the LED is on, the IC under test should not be extracted (or inserted) from the ZIF socket!

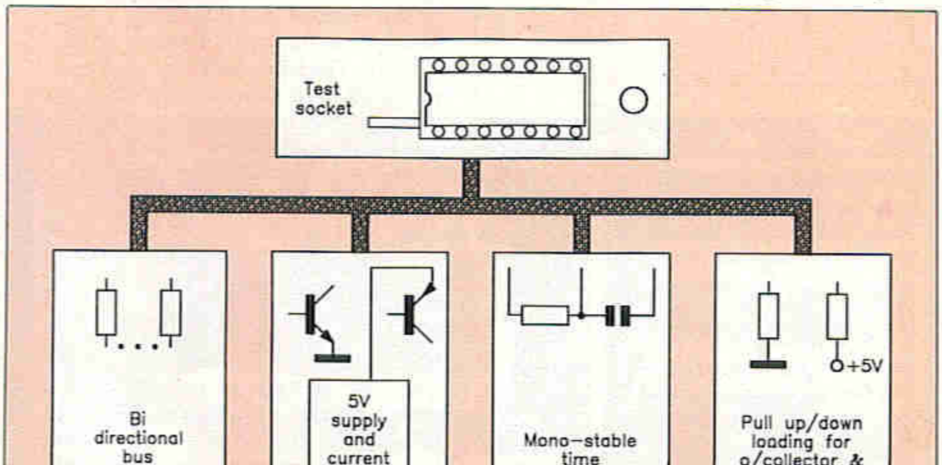


Figure 1. Block schematic.

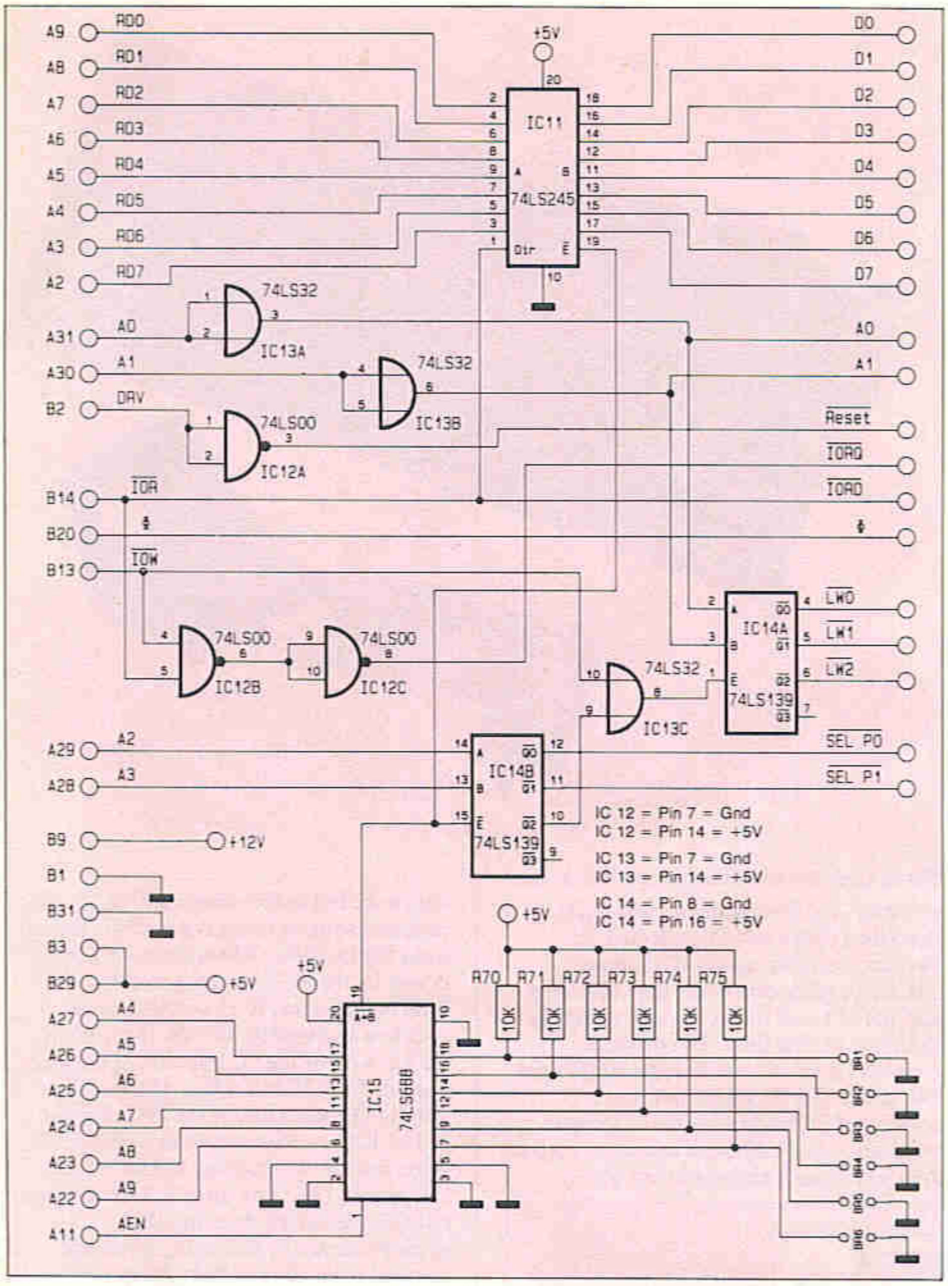


Figure 2. Address decoder circuit.

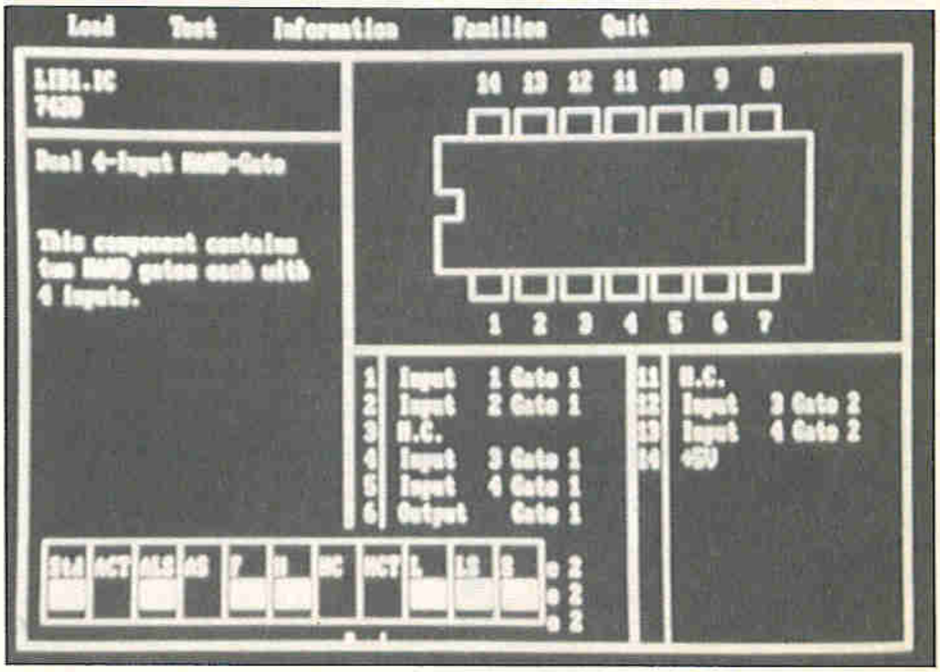
The positive rail voltage (+5V1) is supplied by voltage regulator IC3, from the +12V supply, and has been added as a precaution to prevent any short circuit in the IC under test from causing the internal 5V supply voltage of the computer to break down. This could have immeasurable consequences for the power supply unit of the PC! Regulator IC3 limits the maximum short-circuit current to approximately 100mA. The negative supply voltage, i.e. the ground for the IC under test, is connected to the appropriate pin of the test socket via one of the four transistors T1 to T4. The two Z80 PIO devices, IC1 and IC2, represent the heart of the circuit. These IC's, belonging to the Z80 family, have a great advantage in that the I/O lines can be configured, bit by bit, as either inputs or outputs. In this way it is possible, for example, to switch pin 1 on the test socket to input and pin 2 to output etc., something which is often necessary.

Current limiting resistors R1 to R20 protect the PIO's in case of a short circuit when testing IC's. To test monostables, different RC combinations can be connected to the appropriate pins of the monostable under test, from the analogue circuits of IC5-7 (CD4051). The values of C3 and R47, which set the time constants, are chosen to enable all devices to be checked. The RC combination can be switched on with the control line INH, which is connected to pin 6 of the three ICs. With the three select lines on pin 9, 10 and 11, one of the seven connection modes for the RC combination is chosen. The outputs of the tri-state latches, IC8 to 10, are controlled by the output enable line on pin 1 (OE) on each device. If this control line is low then the 20 outputs of IC8 to IC10 are at a high or low level, depending on the previously latched data word. This logic level is sent to the accompanying pins of the test socket via load resistors R49 to R68 and the response of the IC under test is then interrogated through the inputs of both PIO's via R1 to R20.

Custom Software

Extensive custom software is supplied on a 5.25" x 360k floppy disk and contains various data banks. A file named README.IC, found on the disk, gives a complete description of the program and explains how to install it into a hard disk. This file can either be called up onto the screen by entering TYPE README.IC or printed out by entering COPY README.IC LPT 1:. The complete test software is menu guided and therefore extremely easy to operate. To start the software ICTEST and RETURN must be entered. After that the rest is self-explanatory.

The software can be run with all standard video cards e.g. Monochrome, Hercules or EGA. When the program is started the software automatically searches for the installed IC Tester card – the I/O base address for the IC Tester is normally at 300H. The whole software package is able to pick out and test over 500 different



Typical IC information supplied in the program.

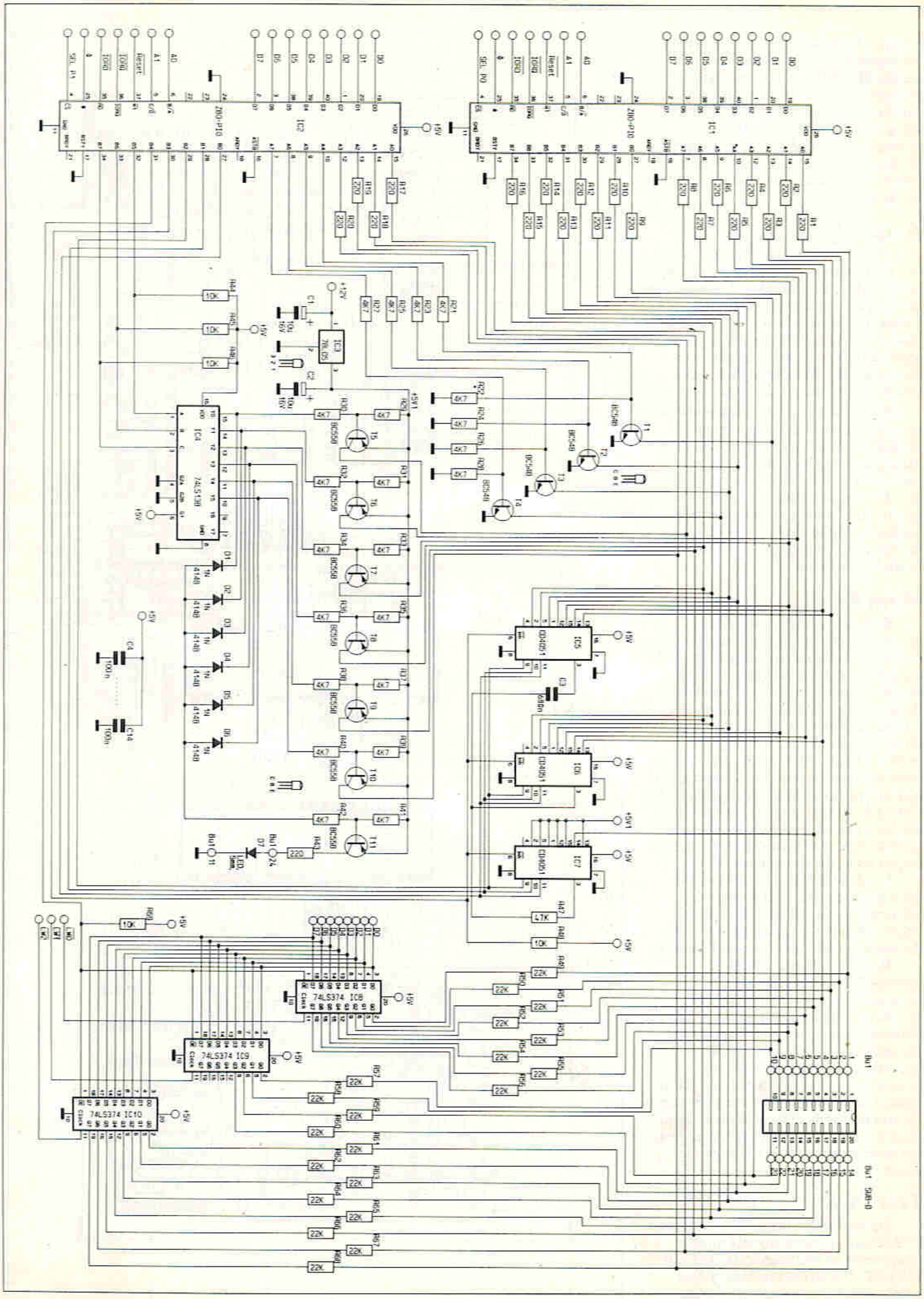


Figure 3. Output driver stage.

IC types. In addition, IC's which are not yet registered can be entered for testing; the file README.IC contains precise instructions for doing this. The software will also function without the hardware being installed. In this instance, the software can be used as a reference for the IC pin outs, because for every IC able to be tested, a pin connection diagram is printed on the screen.

Assembly

The complete IC Tester consists of two PCB's which are coupled via a 25-way ribbon cable and connector. The main part of the circuit is accommodated on a 235 x 110mm double-sided, plated-through-hole, PCB. A 25-pin D connector, fitted onto the main PCB, provides the connection to a 46 x 24mm PCB, onto which the ZIF test socket is mounted.

Note: Once IC's have been soldered into plated hole PCB's, it is extremely difficult to remove them again without damaging tracks and pads; therefore, we advise you to fit IC sockets to facilitate easy IC removal in the event of error or failure. As IC sockets are not normally supplied, Maplin have added them to the kit versions, but they are not fitted to the ready-built versions.

Main PCB

Referring to Figure 4 fit all 14 IC sockets onto the board, ensuring that their notched ends are correctly aligned with the legend; IC1 & IC13 are a tight fit and it may be necessary to file the corners down slightly. Solder them all in position and snip off surplus ends. Mount the diodes, D1-6, and identify and insert all 75 resistors. Capacitors C1 & C2 are polarised types and must be positioned correctly and take care not to break the leads from C3 to C14. Due to the IC sockets, some of these polylayer capacitors may be a tight squeeze! Solder all components fitted thus far and insert the eleven transistors.

Do make sure that components are fitted as close to the PCB as possible, otherwise they are likely to foul other boards when the module is inserted into the expansion slots at the back of your PC.

Mount the 25-way female D connector onto the PCB, from the component side, solder this and any remaining components and finally trim off the excess wire ends; insert the IC's and the main module is then complete. A close inspection of all tracks and joints is especially necessary on this project, as the chances of soldering errors are high. Scrub the area first with a PCB solvent and stiff paint brush, to remove accumulated flux; this often removes small whiskers and solder particles.

Test PCB

Figure 5 shows the small test socket PCB layout and there are only three components on this board: St1, Sk1 and LED D7. Due to the small size of this board a case has not been incorporated. Insert D7 with the anode lead into the hole

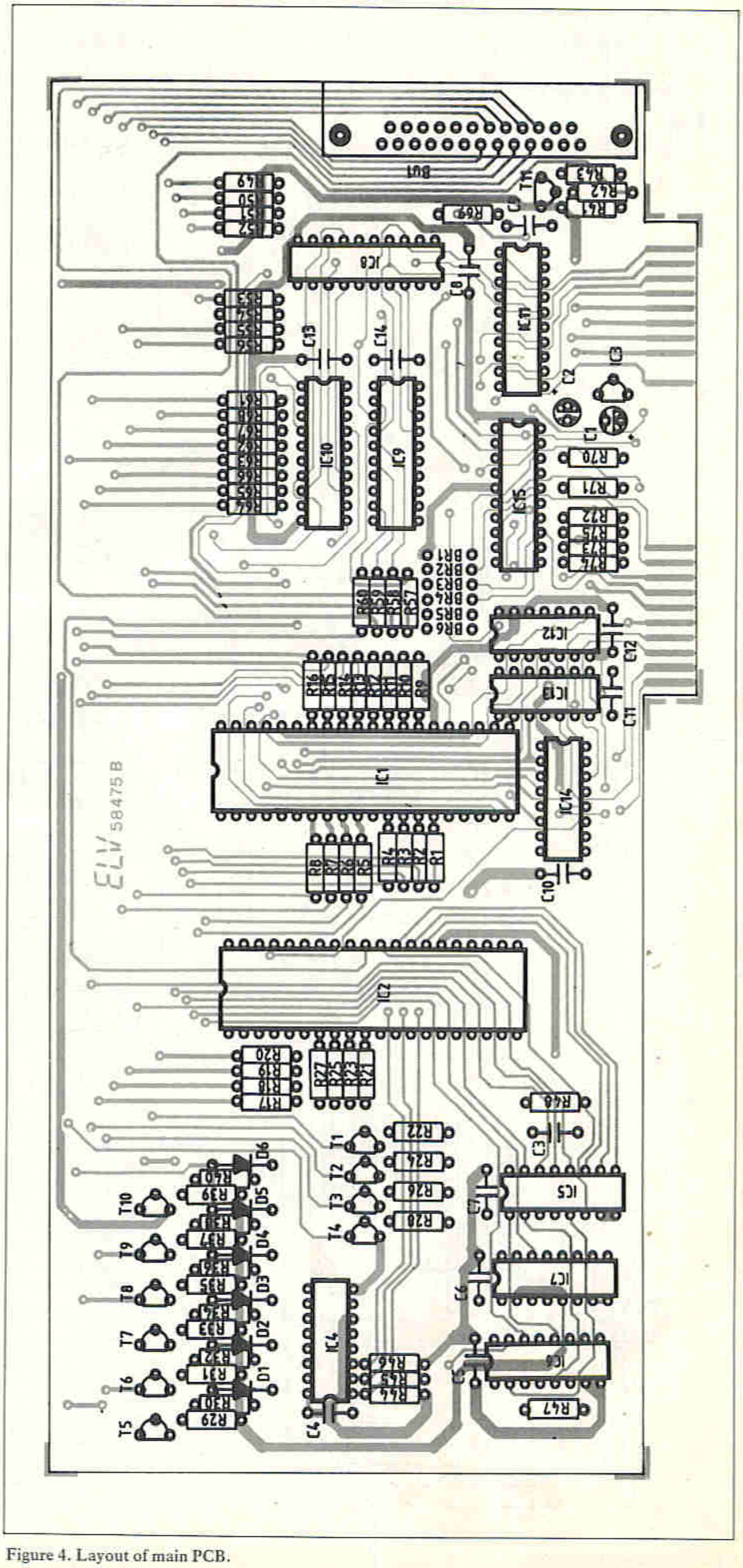


Figure 4. Layout of main PCB.

nearest to the letters 'D7' printed on the PCB; the 2 x 13 way IDC plug can be positioned either way around, but the ZIF socket is inserted with the locking arm positioned at the top end of the PCB – away from the LED. Carefully solder the three items in place, cut off excess LED wires and inspect as before.

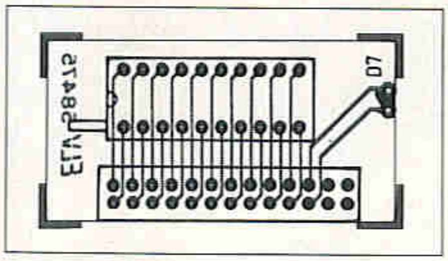
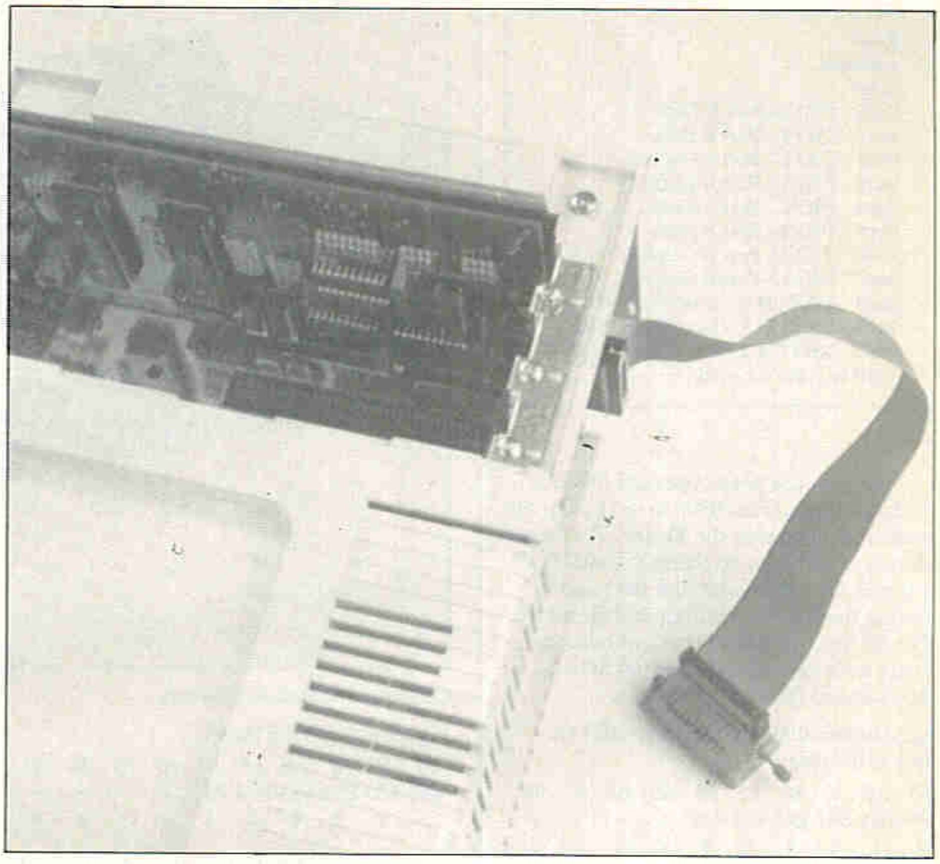


Figure 5. Test socket PCB.

IDC Connector

A 25-way ribbon cable connects the internally mounted main module to the external test module. The cable assembly may be supplied ready made, or you may have to fit plugs and sockets onto the cable yourself. In this case, Figure 6 shows how the connectors are fitted and to do this, crimp the 25-pin D plug and the 26-pin IDC connector onto the ribbon cable, leaving the 26th wire un-connected as shown.



Main pcb mounted in PC.

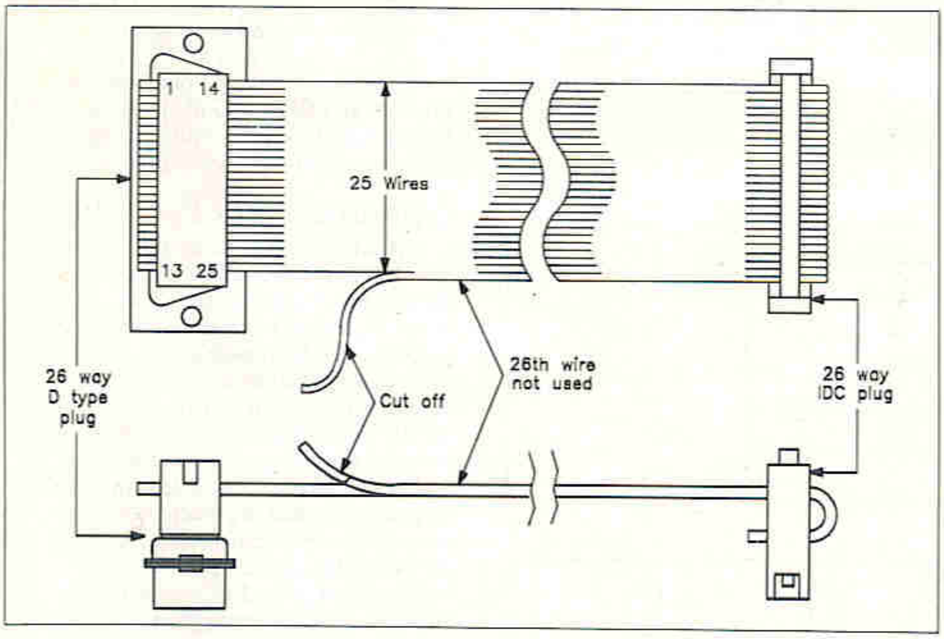


Figure 6. Connecting cable.

Address (Hex)	Function	Address (Hex)	Function
000 . . 00F	DMA Controller	2F8 . . 2FF	Second Serial I/F
020 . . 021	Interrupt Controller	300 . . 31F	Prototype Card
040 . . 043	Timer/Counter	320 . . 32F	Hard Disk Controller
060 . . 063	System Register	378 . . 37F	Parallel Printer I/F
080 . . 083	DMA Register	380 . . 38F	SDLC Interface
0A0 . . 0BF	NMI Interrupt Register	3A0 . . 3AF	Reserved
0C0 . . 0FF	Reserved	3B0 . . 3BF	Printer & Mono Adaptor
100 . . 1FF	Front Panel Controller	3C0 . . 3CF	Reserved
200 . . 20F	Games Port	3D0 . . 3DF	Colour Graphic Adaptor
210 . . 217	Additional Unit	3E0 . . 3E7	Reserved
220 . . 24F	Reserved	3F0 . . 3F7	Floppy Disk Controller
278 . . 27F	Second Printer	3F8 . . 3FF	Serial Interface

Table 1.

On the back panel of the computer you will find a blanking panel. This should be removed and cut out to suit the position where the PCB is to be inserted. PC clones, such as the Amstrad 1512 and 1640, generally have a sliding cover on the side and should not be cut. Figure 7 shows the blanking panel cut out.

Address Selection

Before the Tester can be put into operation, the bridging links for the I/O operating address must be fitted and soldered in. Table 1 lists the various I/O devices and the addresses designated to them on the IBM PC.

To explain the setting of the I/O address decoder, consisting of links BR1 to BR6, the address 300 (hex) – the base address for the IC Tester – will be used. As the system requires a universal I/O address range of 16 bytes, the I/O base address must only be decoded once. The base address must always be a number divisible by 16 and the result of this is that the last position of the address is 0. The first figure of the I/O address can be 3 at the most (links 5 & 6) as the 16 bit I/O address range of the IBM PC is decoded with only 10 bit, i.e. maximum 400H. This 3 is binary set with links BR5 and BR6. The second figure, which can have a value from 0 to F, is binary positioned via BR1 to BR4. In our example, for the I/O base address 300H, the bridges BR1 to BR4 must be closed with a wire link and the bridges BR5 and BR6 remain open. Table 2 shows the distribution of the 16 I/O addresses on various devices in the Tester.

Base Address (hex)	
0xx0	PIO 1 – Port A Data
0xx1	PIO 1 – Port B Data
0xx2	PIO 1 – Port A Control
0xx3	PIO 1 – Port B Control
0xx4	PIO 2 – Port A Data
0xx5	PIO 2 – Port B Data
0xx6	PIO 2 – Port A Control
0xx7	PIO 2 – Port B Control
0xx8	LATCH 0 – Load Pin 1 to 8
0xx9	LATCH 1 – Load Pin 9 to 12
0xxA	LATCH 2 – Load Pin 13 to 20
0xxB to F are not used	

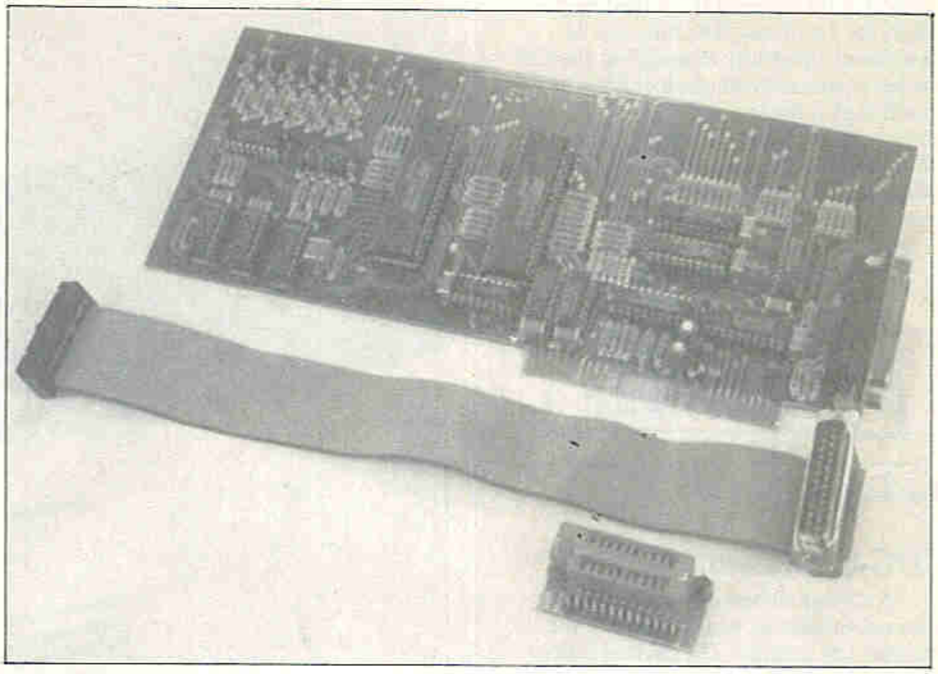
Table 2.

Usually, the prototype card I/O area of 32 addresses, from 0300 to 031F, should be used for accessing the Tester. The base address of 0300 can be changed to 0310, if required, by leaving out link BR1 and altering the start-up configuring file on the disk. In fact, the links represent reverse binary code and should be fitted for a 0 and removed for a 1.

e.g. Address 0300 (hex), (links BR1 to BR4 fitted only):

A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
BR6	BR5	BR4	BR3	BR2	BR1	–	–	–	–
1	1	0	0	0	0	x	x	x	x

To remain within the address range 0300 to 031F, links BR2 to BR4 only are fitted for address 0310:



Completed pcbs and cableform.

e.g. Address 0310 (hex)

A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
BR6	BR5	BR4	BR3	BR2	BR1	–	–	–	–
1	1	0	0	0	1	x	x	x	x

The disk file ICTEST.CFG will need to be changed when the default address is altered; this file holds the current hardware address and also a reference file in ASCII format. Either the TYPE function or a word processor can be used for reading this file. After loading DOS, insert the disk supplied and create a new file as follows:

```
A> copy con ictest.cfg      (return)
   $0310                    (return)
   ictest.ref               (return)
   (Control key, Z key, return)
```

The file is saved and overwrites the previous ICTEST.CFG file with the new base address 0310. You will note the use of a ($) symbol for hex coded addresses!

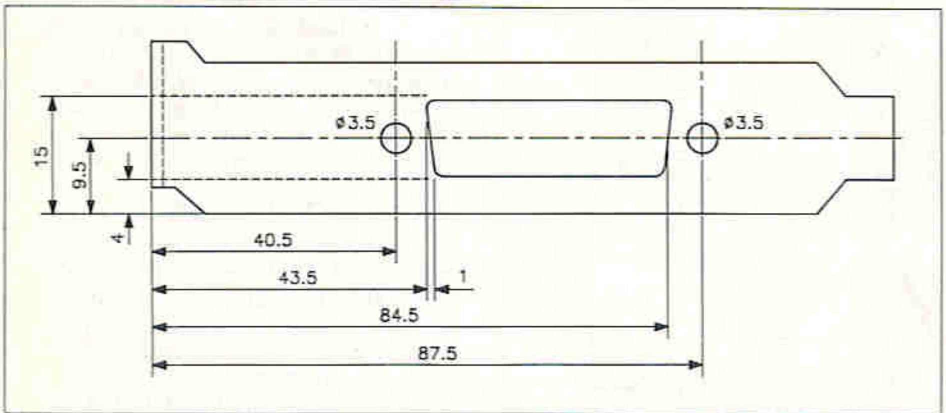


Figure 7. Blanking panel cut outs.

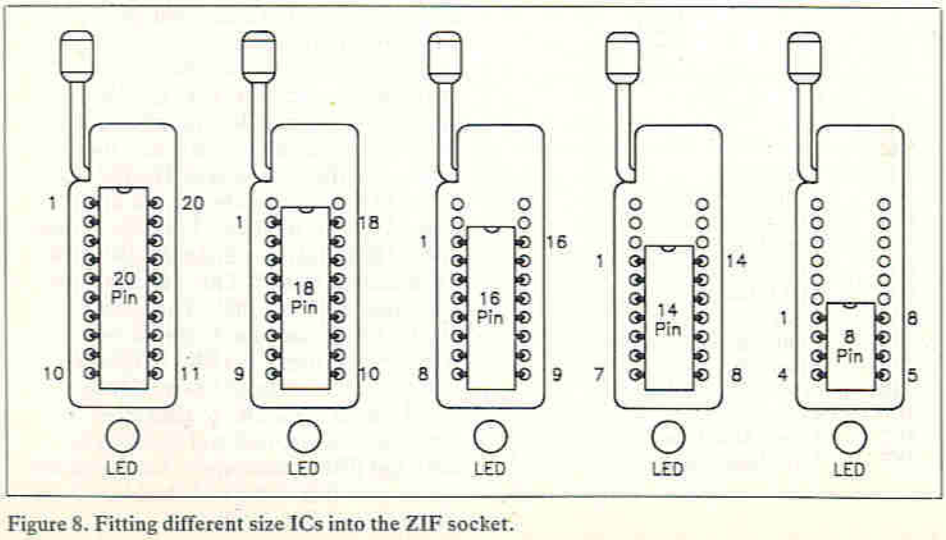


Figure 8. Fitting different size ICs into the ZIF socket.

Operation and Function

After placing the insertion card into the intended slot in the PC and connecting the small PCB with the flat cable, the case of the PC should be closed. As soon as the computer has been switched on and the operating system (DOS) loaded, the service program can be started by entering 'ICTEST' and pressing 'RETURN'. The program then takes over control of the operation. The IC's under test must always be inserted so that the notch points towards the lever arm on the test socket. If the IC has less than 20 pins then it is inserted next to the LED, as shown in Figure 8. The software consists of various modules. The actual program is an interpreter, which gathers the data of individual ICs from various data files. New IC's, which come onto the market, can therefore be added. Exact instructions are contained in the file 'READ.ME'. To shorten the loading time of the disk the complete program should be transferred to a hard disk and started from there.

Cost

The IC Tester is available from Maplin Electronics in two forms; as a kit of parts (including additional IC sockets) at £69.95 order code LM83E, and in ready-built form at £129.95 order code XM17T.

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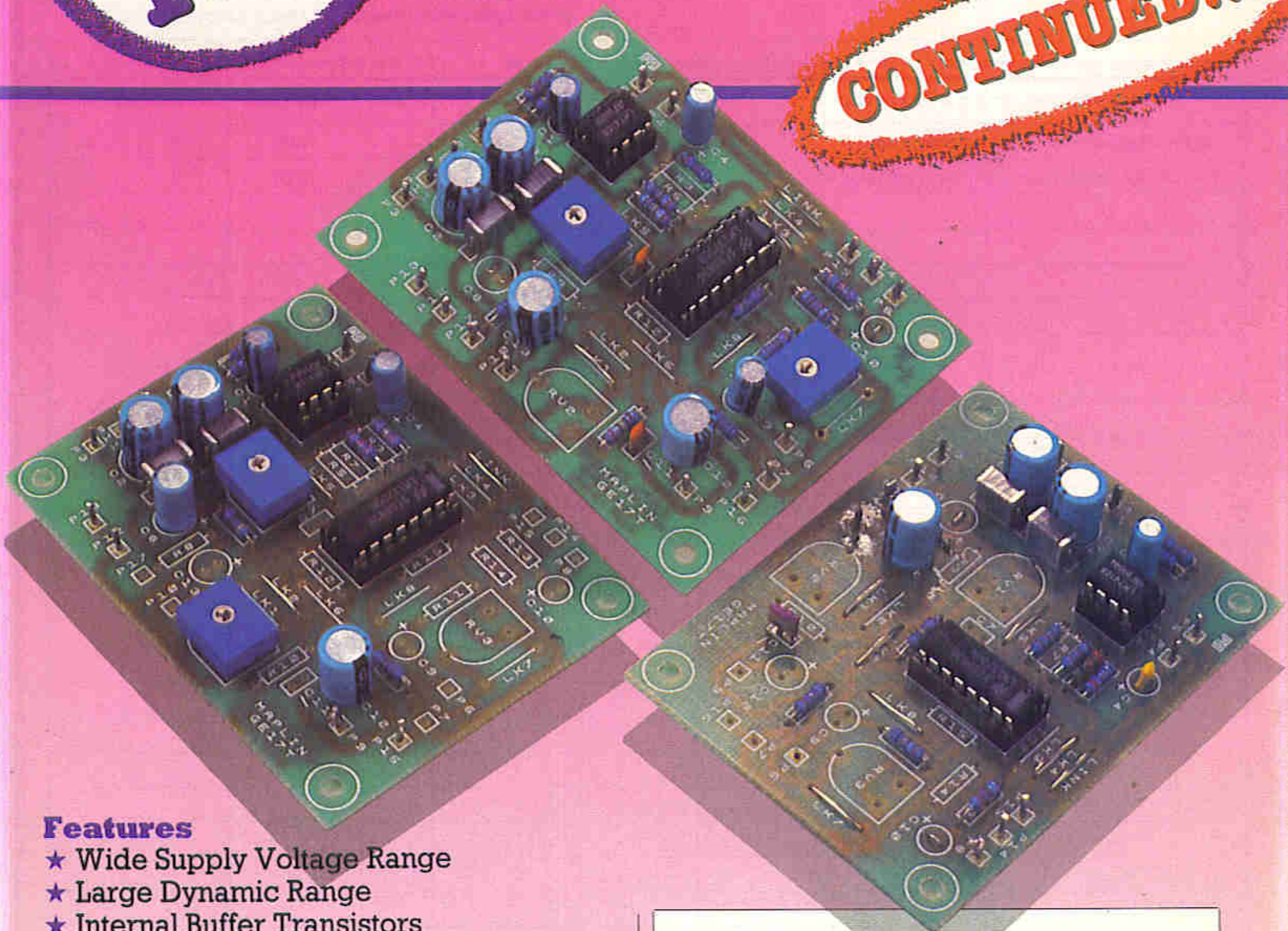
DATA FILE

LM13700 DUAL TRANSCONDUCTANCE OPERATIONAL AMPLIFIER

CONTINUED...



Features

- ★ Wide Supply Voltage Range
- ★ Large Dynamic Range
- ★ Internal Buffer Transistors
- ★ PCB Available

Applications

- ★ Voltage Controlled Amplifiers (VCA)
- ★ Automatic Gain Control (AGC)
- ★ Pulse Width Modulation (PWM)

Introduction

The LM13700 is a dual transconductance operational amplifier incorporating linearizing diodes to reduce distortion at high output levels. Two internal darlington buffer transistors, designed to suit the dynamic range of the amplifiers are included in the package. Both amplifiers share the same supply connections, but are otherwise completely separate. Figure 1 shows the IC pinout and Table 1 shows the electrical characteristics of the device.

Voltage Controlled Amplifiers

Figure 2 shows the basic Voltage Controlled Amplifier configuration. Preset resistor

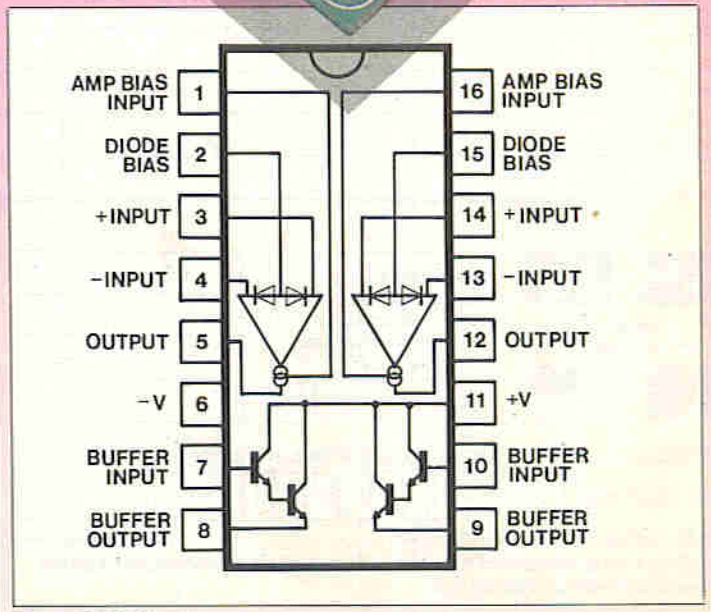


Figure 1. IC Pinout.

Parameters	Operating Conditions	Minimum	Typical	Maximum
Power Supply Voltage:		±2V		±15V
Differential Input Voltage:				±5V
Amplifier Bias Current (Iabc):				2mA
Diode Current (Id):				2mA
Input Offset Voltage:	Iabc 5μA	0.4mV	4mV	
Forward Transconductance (gm):	-	6700μS	9600μS	13000μS
gm Tracking:			0.3dB	
Peak Output Voltage: Unloaded, Iabc 5μA-500μA				
Positive:		+12V	+14.2V	
Negative:		−12V	−14.4V	
Common Mode Range:		±12V	±13.5V	
Input Resistance		10kΩ	26kΩ	
Slew Rate:	Unity Gain Compensated		50V/μs	

Note: Above specifications based on Supply Voltage ±15V, Amplifier Bias Current (Iabc) 500μA, Operating temperature 25°C and pins 2 & 15 open circuit (unless specified).

Table 1. Electrical Characteristics of LM13700N Transconductance Op-Amp.

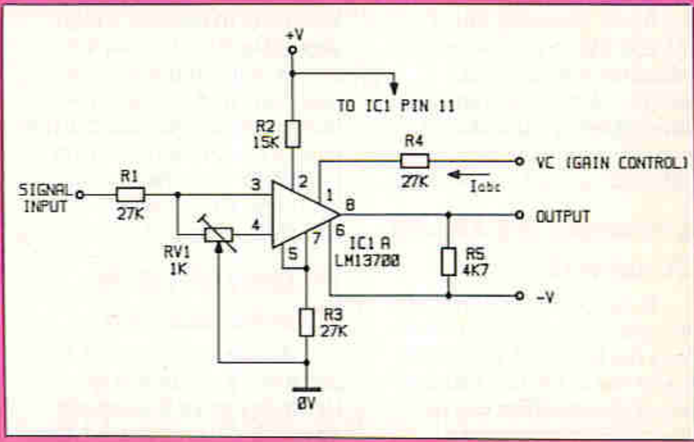
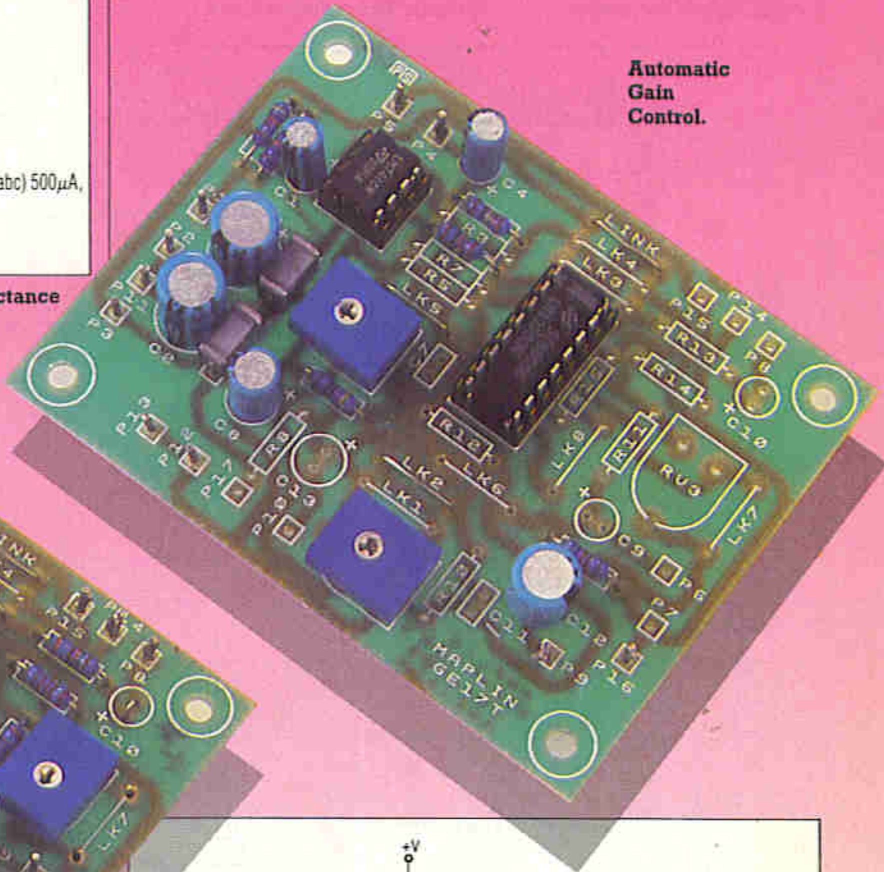
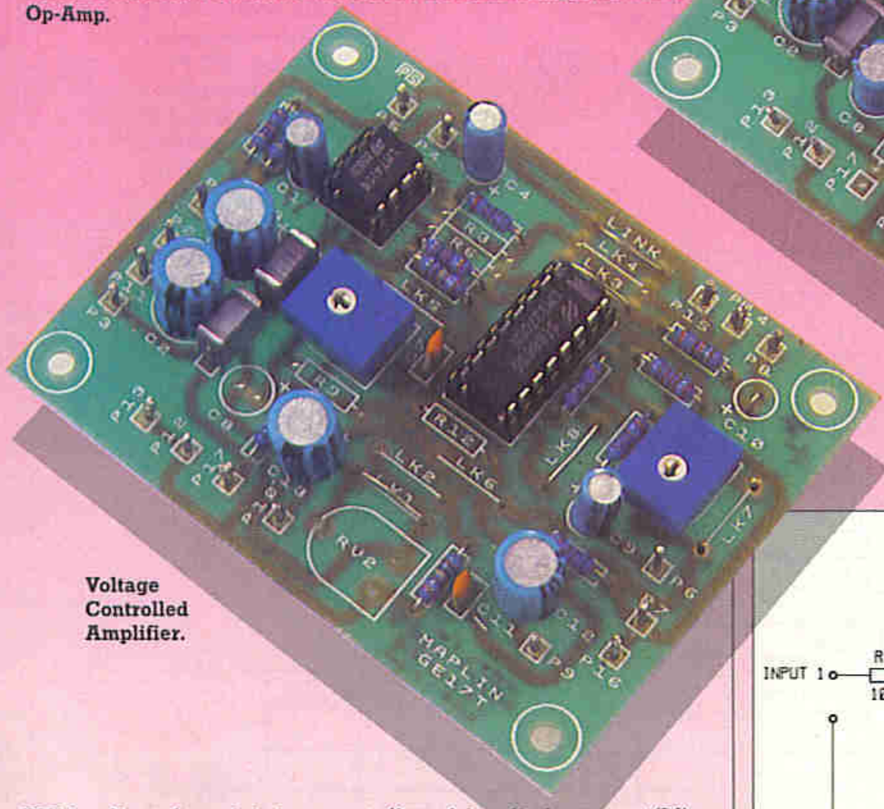


Figure 2. A Typical Voltage Controlled Amplifier (VCA).



Automatic Gain Control.



Voltage Controlled Amplifier.

RV1 is adjusted to minimise the effect of the control signal on the output. The gain of the amplifier is determined by the control voltage (Vc). In order to achieve optimum signal to noise (S/N) performance, amplifier bias current (Iabc), should be kept as high as possible. The linearizing diodes help to prevent increased distortion at high output levels. It is recommended that the linearizing diode current (Id) is kept relatively high to enhance the effect of the diodes; a diode current of 1mA is suitable for most purposes.

The two amplifiers in the LM13700 package are very closely matched, making the IC ideal for stereo volume control applications as illustrated by the circuit shown in Figure 3; this circuit typically provides a channel to channel gain tracking of less

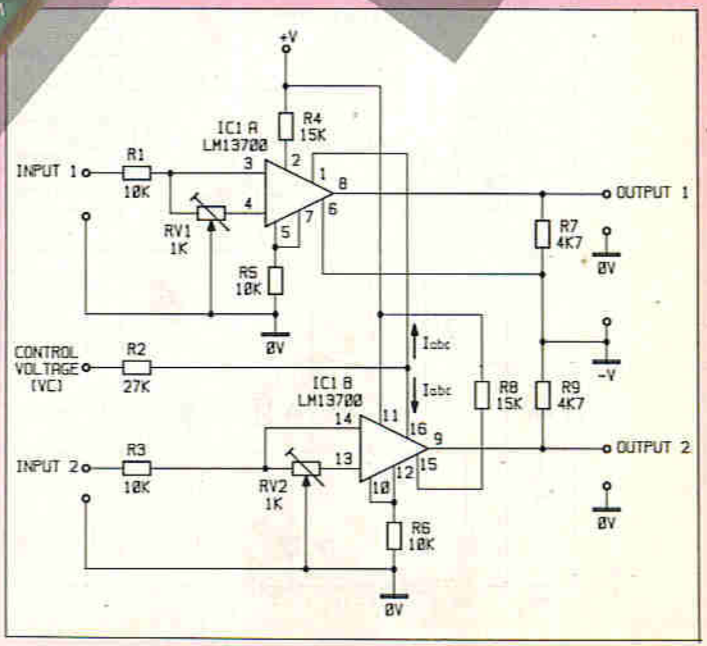


Figure 3. Stereo Volume Control.

than 0.3dB. Preset resistors RV1 and RV2 are adjusted to reduce the output offset voltage to a minimum and if the amplifier is capacitively coupled, these may be replaced by fixed resistors.

Automatic Gain Control

Figure 4 shows a typical example of an AGC amplifier using the LM13700; this circuit makes use of the fact that the gain of the amplifier can be controlled by varying the linearizing diode current as well as the amplifier bias current. When the output voltage (Vo) reaches a high enough level to turn on the output buffer transistor, the rise in current through the linearizing diodes reduces the gain of the amplifier so as to hold Vo at a constant level. The output amplitude level is adjusted using RV1.

Pulse Width Modulation

A typical example of a pulse width modulator is shown in Figure 5. A square wave (clock) is applied at the input and the circuit produces an output of variable pulse width. The pulse width is determined by the control voltage (Vc) and the value of capacitor C2.

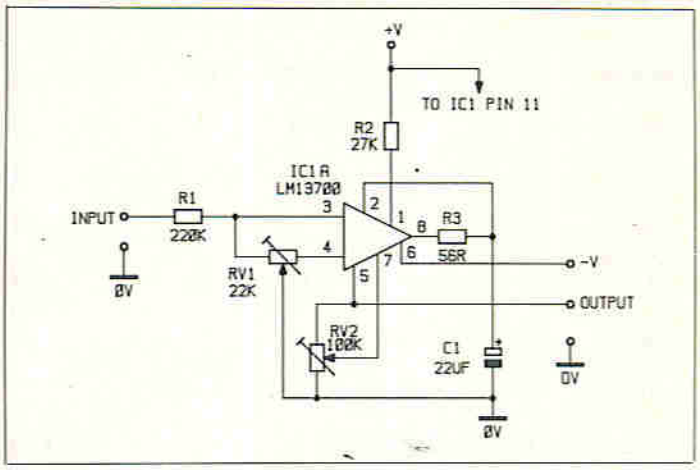


Figure 4. An Example of an AGC Amplifier.

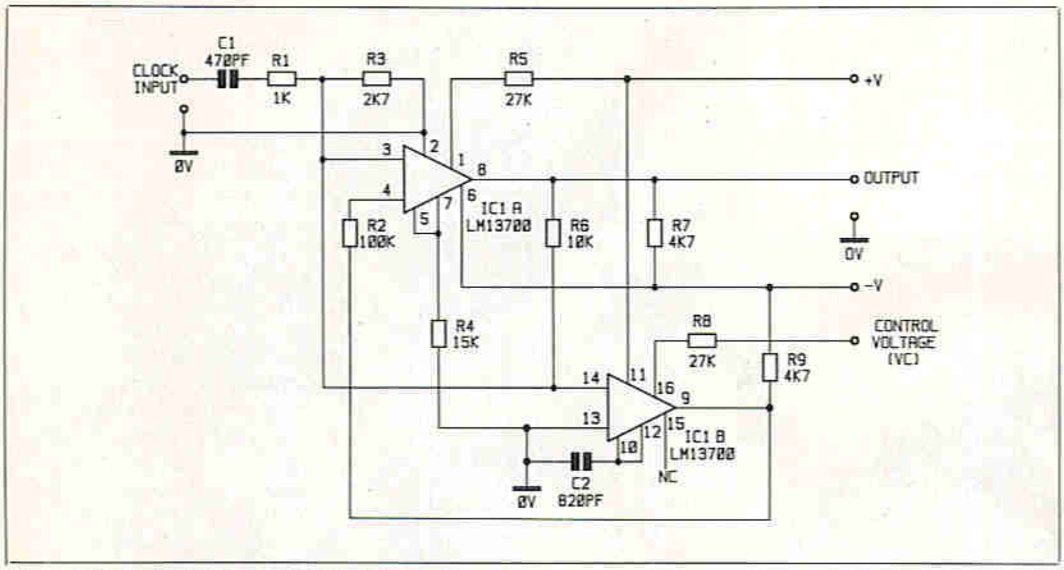


Figure 5. A Typical Pulse Width Modulator.

IC Power Supply Requirements

The LM13700 IC is designed to be powered from a split rail supply and the device operates over a wide range of voltages between ±2V and ±15V. For optimum performance and to prevent instability, it is important that adequate decoupling is used close to the IC. Amplifier current consumption depends on individual applications, but is generally no more than a few mA.

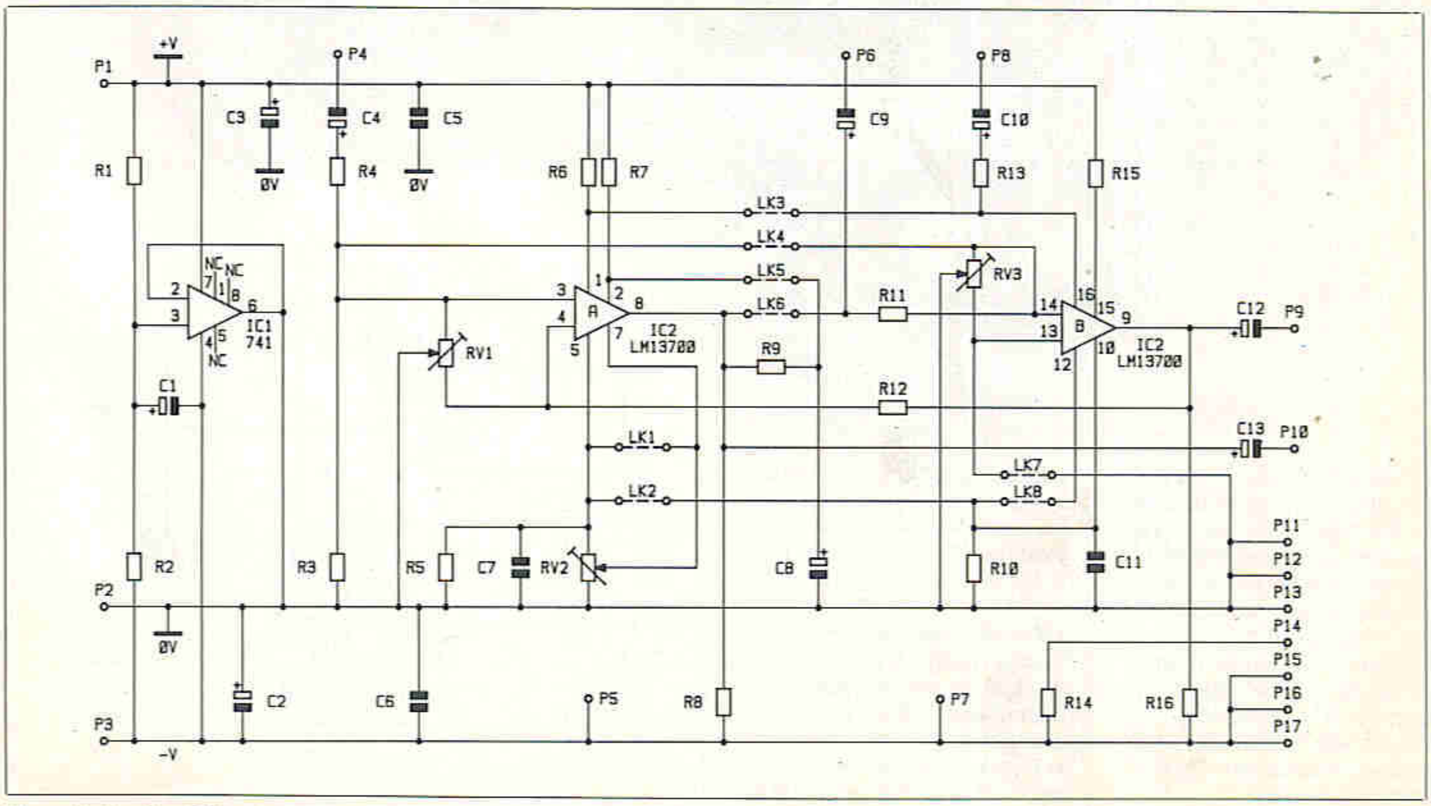


Figure 6. Combined Circuit Diagram.

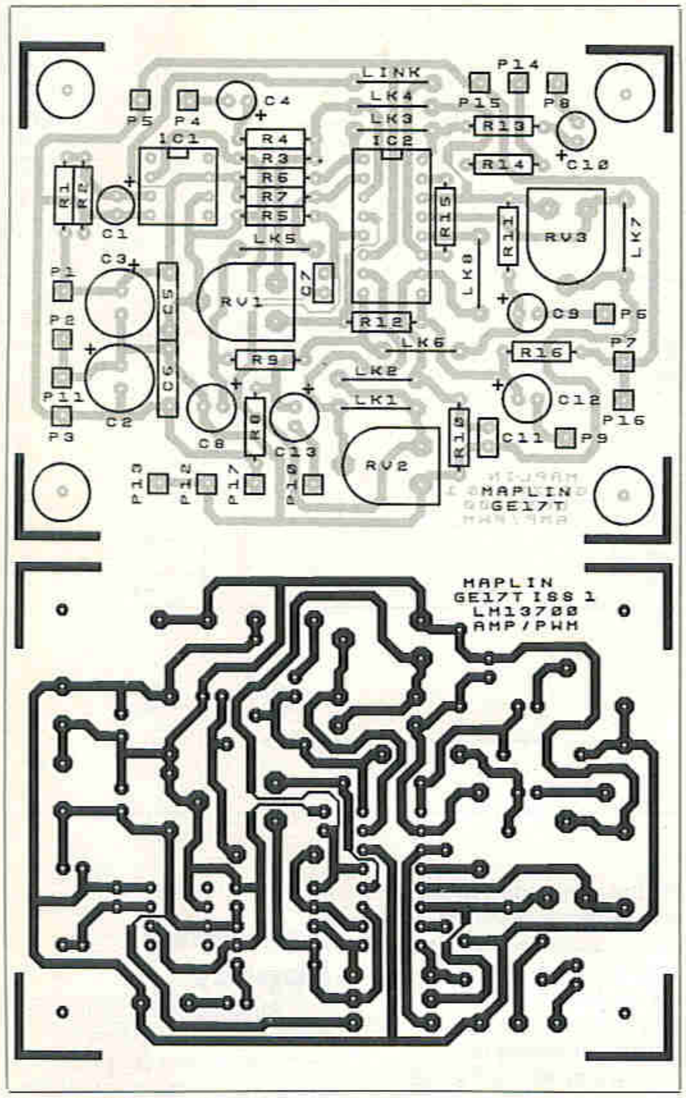


Figure 7. PCB Layout Diagram.

Printed Circuit Board

A high quality, fibre glass, multipurpose PCB with printed legend is available for three simple applications of the LM13700; the circuits that can be built using the PCB are a Voltage Controlled Stereo Amplifier, an AGC Amplifier and a Pulse Width Modulator. Any one of the three circuits may be constructed on the same printed circuit board. Figure 6 shows the combined circuit diagram that was used to produce the PCB and Figure 7 shows the component layout diagram. All three circuits have been designed using additional components (R1, R2, C1, and IC1) to allow operation from a single rail power supply. When being operated from a single rail supply, the input voltage may range from approximately 4V to a maximum of 30V.

Figure 8 shows the circuit diagram of the Voltage Controlled Stereo Amplifier. Power supply connections are made to P1(+V) and P3(0V). Preset resistors RV1 and RV3 are included in the circuit to allow adjustment of output offset voltage and these should be adjusted for symmetrical clipping. As a general guide, for most purposes it is sufficient to set each preset to the centre of its travel. Input signals are applied to P4(i/p), P5(0V) and P6(i/p), P7(0V), with outputs being taken from P9(o/p), P16(0V) and P10(o/p), P17(0V), respectively. The gain of the amplifier is controlled by a positive voltage (maximum 30V), applied to P8(Vc) and P15(0V); if required, this voltage may be derived from the supply rail using a potentiometer (a suitable value is 10kΩ). Resistor R14 provides the option of setting a minimum control voltage when a potentiometer is used and this component should be chosen to suit the application or omitted as appropriate. If R14 is used, the ACW (anti-clockwise) end of the potentiometer track should be connected to P14 instead of P15.

Figure 9 shows the circuit diagram of the AGC amplifier. Supply connections are made to P1(+V) and P3(0V). Input signals are applied to P4(i/p) and P5(0V) and the output is taken from P9(o/p) and P16(0V). Preset resistor RV1 should be adjusted for symmetrical clipping and as a general guide this preset should be set as accurately as possible to the centre of its travel. The amplitude at which the AGC action occurs is determined by the setting of RV2.

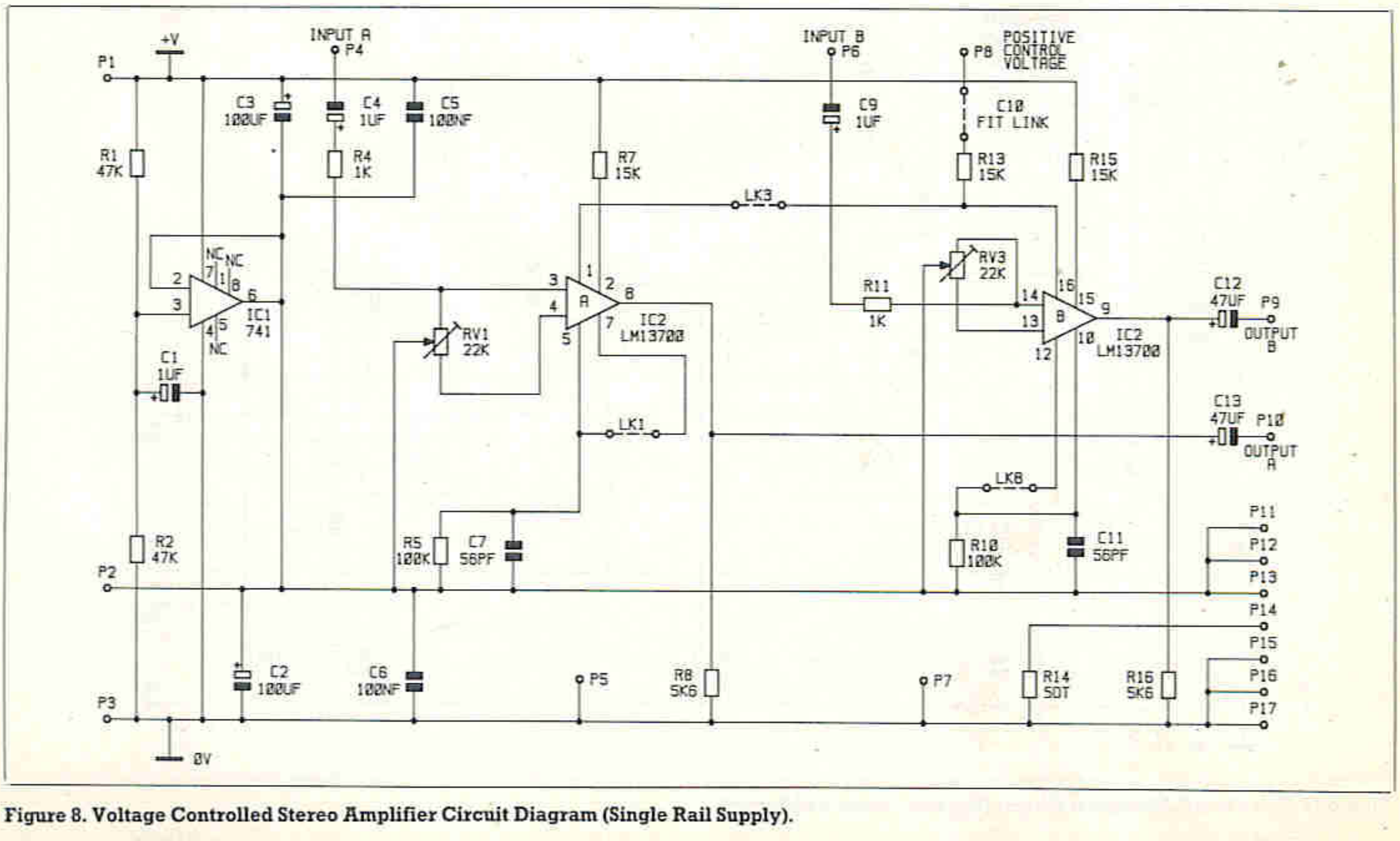


Figure 8. Voltage Controlled Stereo Amplifier Circuit Diagram (Single Rail Supply).

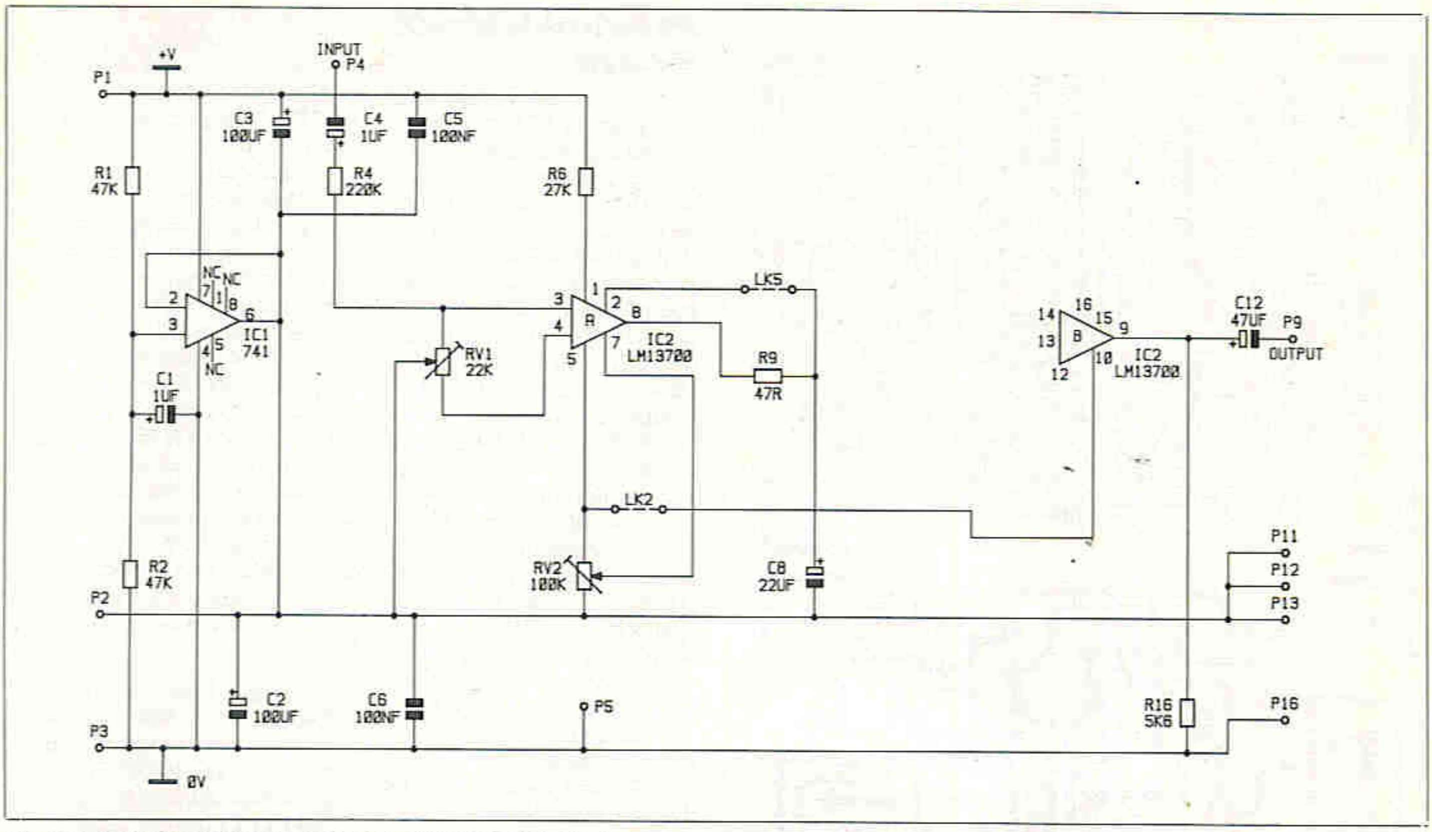


Figure 9. AGC Amplifier Circuit Diagram (Single Rail Supply).

Figure 10 shows the circuit diagram of the Pulse Width Modulator. Power supply connections are made to P1(+V) and P3(0V). For a squarewave input applied to P4(i/p) and P5(0V), the circuit produces an output of variable pulse width on P10(o/p) and P17(0V). The pulse width is determined by a control voltage applied to P8(Vc) and P15(0V). Although the control voltage is usually directly coupled for most purposes, provision for capacitive coupling is provided by C10; this capacitor is therefore normally linked out. The pulse output is capacitively coupled since the IC output does not swing all the way to 0V; alternative methods of coupling may be used to suit individual applications.

Split Rail Supply

Although the circuits are designed to be used with a single rail power supply, all three circuits can be modified

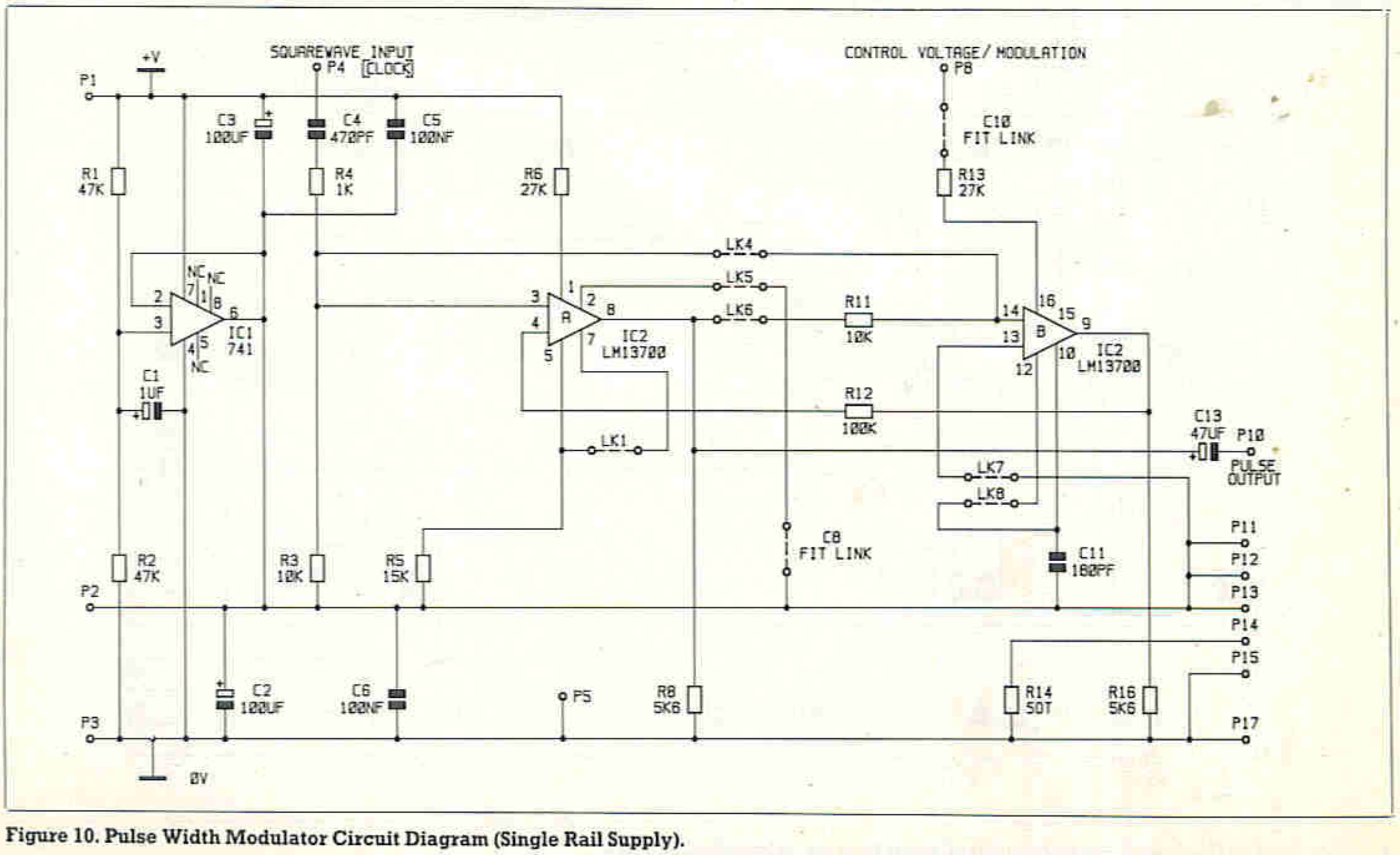
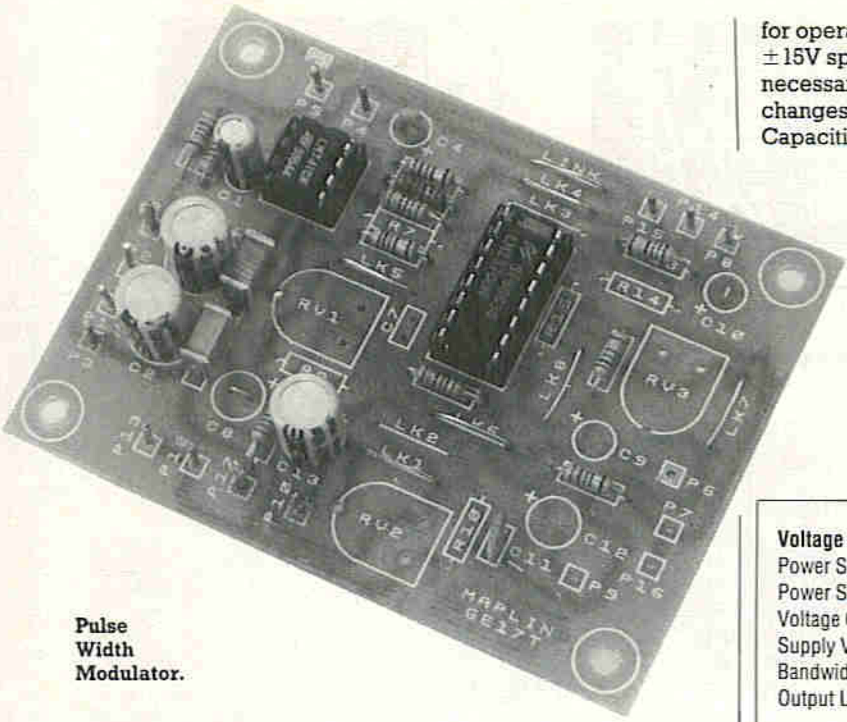


Figure 10. Pulse Width Modulator Circuit Diagram (Single Rail Supply).



Pulse Width Modulator.

for operation from a ±2V to ±15V split supply; the necessary component changes are shown in Table 2. Capacitive output coupling may be required for the AGC amplifier depending on the application.

NOTE: For split rail operation, *power supply* connections are made to P1(+V), P2(0V) & P3(-V) and *signal* 0V connections are made to P11, P12 and P13 (instead of P15, P16 and P17).

Figure 11 shows some typical performance characteristics for the LM13700 and Table 3 shows the specification of the prototype circuits built using the PCB.

Circuit	Do not fit these components	Fit links in place of these components
Voltage Controlled Stereo Amplifier:	R1,R2,C1,IC1	C12,C13
AGC Amplifier:	R1,R2,C1,IC1	C12
Pulse Width Modulator:	R1,R2,C1,IC1	C13

Table 2. Circuit Modifications for Split Supply Operation.

Voltage Controlled Stereo Amplifier	
Power Supply Voltage	4V to 30V DC
Power Supply Current	18mA at 30V
Voltage Gain (Control Voltage = 30V, Supply Voltage = 30V)	25 (28dB)
Bandwidth (-3dB)	20Hz to 25kHz
Output Load	10kΩ
AGC Amplifier	
Power Supply Voltage	4V to 30V DC
Power Supply Current	10mA at 30V
Output Load	10kΩ
Pulse Width Modulator	
Power Supply Voltage	4V to 30V DC
Power Supply Current	14mA at 30V
Output Load	10kΩ
Frequency Range	50Hz to 40kHz
Maximum Control Voltage	30V

Table 3. Specification of Prototype Circuits Built Using the PCB.

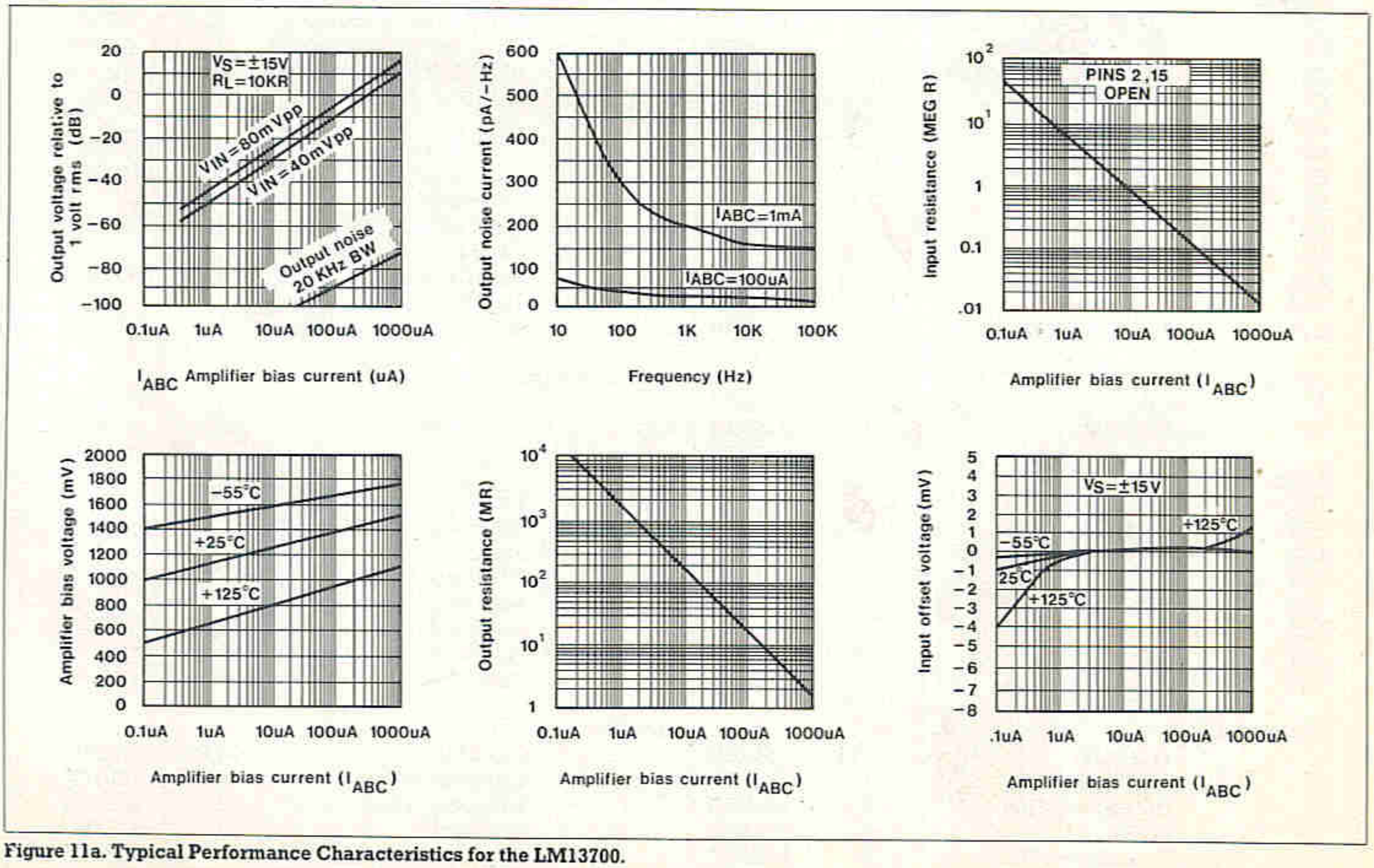


Figure 11a. Typical Performance Characteristics for the LM13700.

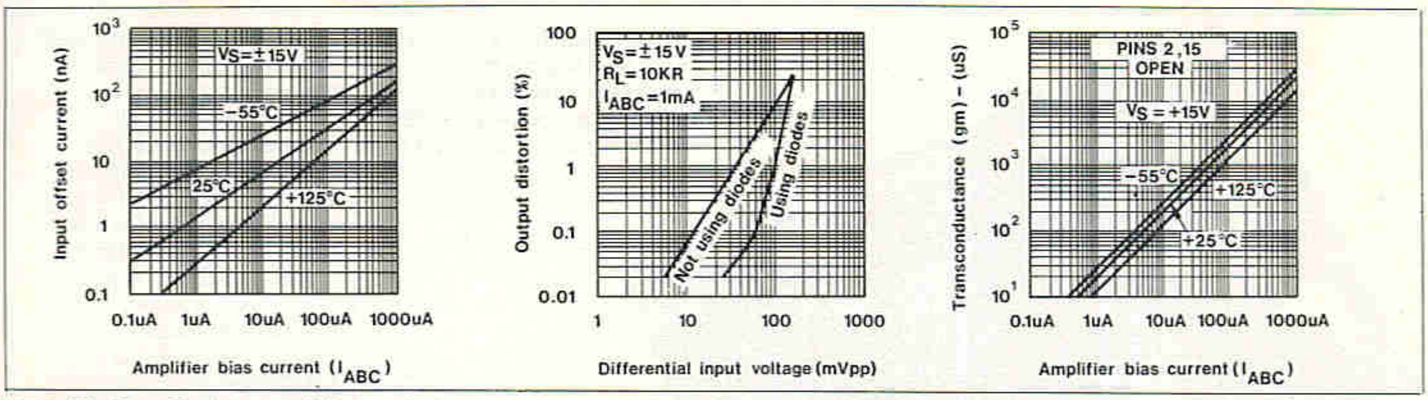


Figure 11b. More Performance Characteristics.

PULSE WIDTH MODULATOR PARTS LIST

Resistors: All 1% 0.6W Metal Film			
R1	47k	1	(M47K)
R2	47k	1	(M47K)
R3	10k	1	(M10K)
R4	1k	1	(M1K)
R5	15k	1	(M15K)
R6	27k	1	(M27K)
R7	Not Fitted		
R8	5k6	1	(M5K6)
R9	Not Fitted		
R10	Not Fitted		
R11	10k	1	(M10K)
R12	100k	1	(M100K)
R13	27k	1	(M27K)
R14	SOT		
R15	Not Fitted		
R16	5k6	1	(M5K6)
RV1	Not Fitted		
RV2	Not Fitted		
RV3	Not Fitted		
Capacitors			
C1	1μF 100V PC Electrolytic	1	(FF01B)
C2	100μF 35V PC Electrolytic	1	(JL19V)
C3	100μF 35V PC Electrolytic	1	(JL19V)
C4	470pF Ceramic	1	(WX64U)
C5	100nF Polylayer	1	(WW41U)
C6	100nF Polylayer	1	(WW41U)
C7	Not Fitted		
C8	Fit Link		
C9	Not Fitted		
C10	Fit Link		
C11	180pF Ceramic	1	(WX59P)
C12	Not Fitted		
C13	47μF 50V PC Electrolytic	1	(JL16S)
Semiconductors			
IC1	μA741C	1	(QL22Y)
IC2	LM13700N	1	(YH64U)
Links			
LK1	Fitted		
LK2	Not Fitted		
LK3	Not Fitted		
LK4	Fitted		
LK5	Fitted		
LK6	Fitted		
LK7	Fitted		
LK8	Fitted		
Miscellaneous			
	Pins 2145	1 Pkt	(FL24B)
	DIL Socket 8 Pin	1	(BL17T)
	DIL Socket 16 Pin	1	(BL19V)
	PC Board	1	(GE17T)
	Constructors Guide	1	(XH79L)

STEREO VCA PARTS LIST

Resistors: All 1% 0.6W Metal Film.			
R1	47k	1	(M47K)
R2	47k	1	(M47K)
R3	Not Fitted		
R4	1k	1	(M1K)
R5	100k	1	(M100K)
R6	Not Fitted		
R7	15k	1	(M15K)
R8	5k6	1	(M5K6)
R9	Not Fitted		
R10	100k	1	(M100K)
R11	1k	1	(M1K)
R12	Not Fitted		
R13	15k	1	(M15K)
R14	SOT		
R15	15k	1	(M15K)
R16	5k6	1	(M5K6)
RV1	22k Hor. Ecl. Preset	1	(UH04E)
RV2	Not Fitted		
RV3	22k Hor. Ecl. Preset	1	(UH04E)
Capacitors			
C1	1μF 100V PC Electrolytic	1	(FF01B)
C2	100μF 35V PC Electrolytic	1	(JL19V)
C3	100μF 35V PC Electrolytic	1	(JL19V)
C4	1μF 100V PC Electrolytic	1	(FF01B)
C5	100nF Polylayer	1	(WW41U)
C6	100nF Polylayer	1	(WW41U)
C7	56pF Ceramic	1	(WX53H)
C8	Not Fitted		
C9	1μF 100V PC Electrolytic	1	(FF01B)
C10	Fit Link		
C11	56pF Ceramic	1	(WX53H)
C12	47μF 50V PC Electrolytic	1	(JL16S)
C13	47μF 50V PC Electrolytic	1	(JL16S)
Semiconductors			
IC1	μA741C	1	(QL22Y)
IC2	LM13700N	1	(YH64U)
Links			
LK1	Fitted		
LK2	Not Fitted		
LK3	Fitted		
LK4	Not Fitted		
LK5	Not Fitted		
LK6	Not Fitted		
LK7	Not Fitted		
LK8	Fitted		
Miscellaneous			
	Pins 2145	1 Pkt	(FL24B)
	DIL Socket 8 Pin	1	(BL17T)
	DIL Socket 16 Pin	1	(BL19V)
	PC Board	1	(GE17T)
	Constructors Guide	1	(XH79L)

AGC AMP PARTS LIST

Resistors: All 1% 0.6W Metal Film

R1	47k	1	(M47K)
R2	47k	1	(M47K)
R3	Not Fitted		
R4	220k	1	(M220K)
R5	Not Fitted		
R6	27k	1	(M27K)
R7	Not Fitted		
R8	Not Fitted		
R9	47R	1	(M47R)
R10	Not Fitted		
R11	Not Fitted		
R12	Not Fitted		
R13	Not Fitted		
R14	Not Fitted		
R15	Not Fitted		
R16	5k6	1	(M5K6)
RV1	22k Hor. Ecl. Preset	1	(UH04E)
RV2	100k Hor. Ecl. Preset	1	(UH06G)
RV3	Not Fitted		
Capacitors			
C1	1μF 100V PC Electrolytic	1	(FF01B)
C2	100μF 35V PC Electrolytic	1	(JL19V)
C3	100μF 35V PC Electrolytic	1	(JL19V)
C4	1μF 100V PC Electrolytic	1	(FF01B)
C5	100nF Polylayer	1	(WW41U)
C6	100nF Polylayer	1	(WW41U)
C7	Not Fitted		
C8	22μF 50V PC Electrolytic	1	(JL12N)
C9	Not Fitted		
C10	Not Fitted		
C11	Not Fitted		
C12	47μF 50V PC Electrolytic	1	(JL16S)
C13	Not Fitted		
Semiconductors			
IC1	μA741C	1	(QL22Y)
IC2	LM13700N	1	(YH64U)
Links			
LK1	Not Fitted		
LK2	Fitted		
LK3	Not Fitted		
LK4	Not Fitted		
LK5	Fitted		
LK6	Not Fitted		
LK7	Not Fitted		
LK8	Not Fitted		
Miscellaneous			
	Pins 2145	1 Pkt	(FL24B)
	DIL Socket 8 Pin	1	(BL17T)
	DIL Socket 16 Pin	1	(BL19V)
	PC Board	1	(GE17T)
	Constructors Guide	1	(XH79L)

The following item is available,
but is not shown in our 1989 catalogue:
LM13700(2) PCB **Order As GE17T Price £4.45**

Calcs Continued from page 31.

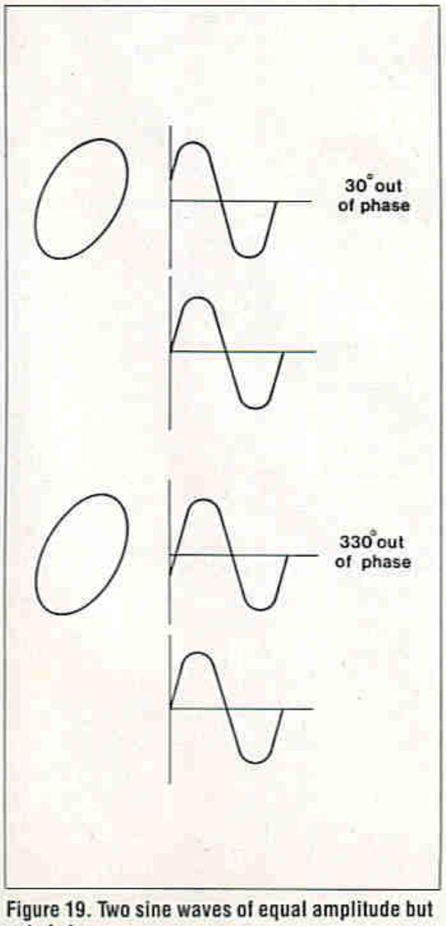


Figure 19. Two sine waves of equal amplitude but out of phase.

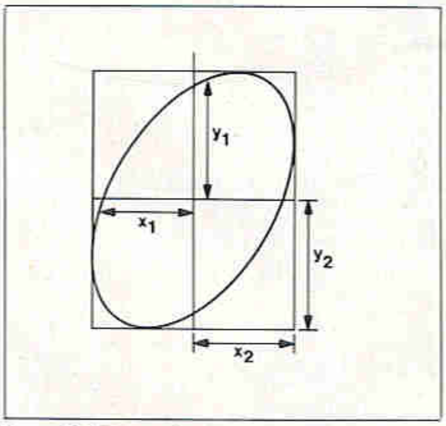


Figure 20. Phase calculation.

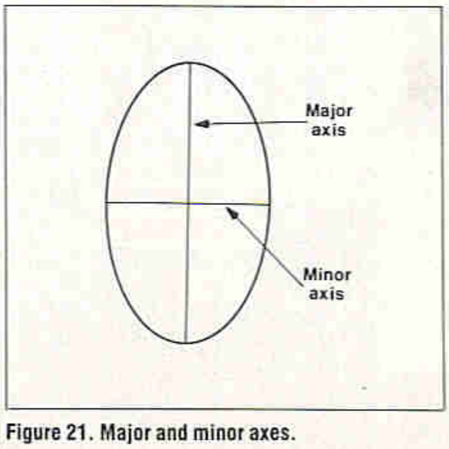


Figure 21. Major and minor axes.

When two sine waves are combined in an oscilloscope, various shapes like straight lines, circles and ellipses are formed depending on the relative phase of the two waveforms and amplitudes. If the amplitudes are equal, ellipses are formed when the waveforms are 30 degrees or 330 degrees out of phase, Figure 19.

If two signals of the same frequency are out of phase, the phase can be calculated from the ellipse, Figure 20, as follows:

$$\sin\Theta = \frac{x_1}{x_2} = \frac{y_1}{y_2}$$

The values of x and y are read from the graticule of the cathode ray oscilloscope screen. The ellipse, Figure 21, has 2 axes, the major axis and the minor axis.

Conclusions

The applications of trigonometry are many and varied, from surveying to Fourier analysis. We have also looked at applications involving amplitude modulation, phase locked loops and testing of television links.

Although trigonometry is connected with the relationship between the sides of a triangle and the angles and equations of a circle, there are non circular functions which also have their uses. The hyperbola and ellipse were investigated in some detail.

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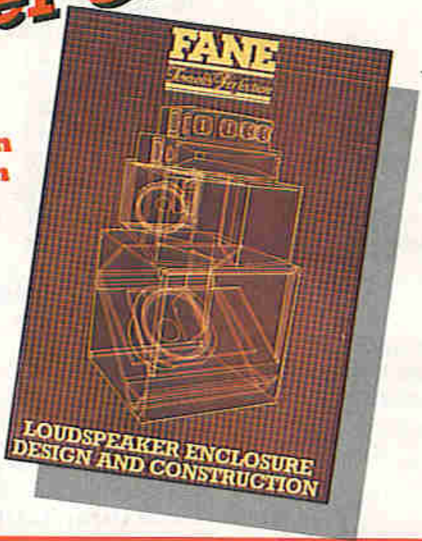

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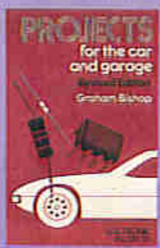

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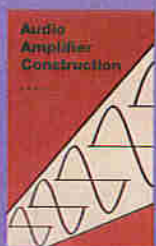

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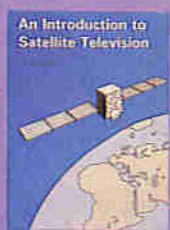

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VIDEO CAMERA WINNERS

In the last Maplin Winter Collection brochure were details of a special free to enter draw, everyone who received a 'Winter Collection' and who placed an order over £10 with Maplin was given a special number. Everyone who took part received a free gift, but depending on the number, some special prizes were to be won. Anyone with a number ending in zero, received a high quality Kodak 3 hour video cassette. Anyone with a number ending in two zeros, received a Casio fx-82c scientific calculator. Anyone with a number ending in three zeros, received a Panasonic AM/FM radio/cassette personal stereo and headphones, and for FOUR fortunate people whose numbers ended with 4 zeros, they received the superb gift of a Fuji colour video camera. This superb prize is one of the very latest hand-held cam-corders featuring CCD imaging, built in electronic viewfinder, autofocus, motorised zoom, integral microphone, electronic video titling and long play, which gives 3 hours recording on one tapé. Truly a superb prize, the four winners are pictured here, being presented with their prizes.

THE WINNERS: Mr. Mark Jenkinson from Worcester, Mr. Mark Pearson from Birmingham, Mr. John Frewer from Welling and Mr. Francis Rayns from Leicester.

Presentation to Mark Jenkinson by David Snoad.

Mark Jenkinson has been a mail order customer for 4 years and was very surprised at the levels of stock held at our shops. He is a student at Bristol University, studying Electronic Engineering. His 3rd year project is a computer model which investigates and identifies interference in PCBs. He is very pleased to have won the camera and says that movie making can now be added to his many hobbies. Mark was presented with his prize at the Bristol shop.

Presentation to Mark Pearson by Keith Evans.

Mark Pearson has been a keen electronics hobbyist since school and has built many of Maplin's electronic projects over the past five years. He mainly uses mail order, but sometimes visits the shop were he says the service is excellent. He enjoys hill walking and rock climbing and hopes to be able to put his video camera into use by recording some of his expeditions. Mark was presented with his prize at the Birmingham shop.

Presentation to John Frewer by David Snoad.

John Frewer has been a customer for the last few years and his interest stems from liking to take things apart, although he promises not to do the same with his new video camera! He is particularly interested in Hi-Fi, car maintenance, rock climbing and photography. John has tried using cine film in the past but wasn't to happy with the results, so he is pleased to have the chance of using some of the latest video equipment, with which he hopes to have more success. John was presented with his prize at Head Office.

Presentation to Francis Ryans by Keith Evans.

Francis Rayns has been a mail order customer for 10 years and has always been more than happy with the service Maplin has given. He designs his own circuits, mainly for control and security systems. He likes sport in general and as his wife is a keen horsewoman, they both attend many local gymkanas. The video camera looks set to record these events but he has promised to edit out any unexpected saddle departures! Francis was presented with his prize at the Nottingham shop.

LOUDSPEAKERS THE FIRST 111 YEARS

by J.M. Woodgate B.Sc.(Eng.), M.I.E.R.E., M.A.E.S., M. Inst. S.C.E.

Part 5

The Uncertain Eighties

The beginning of this period found the Second Hi-Fi Revolution in rapid growth. By 'revolution', I mean the promoting of products described as 'high fidelity', and in fact varying from really good to really 'iffy', by mass-market manufacturers to the general buying public. This was much more evident on the Continent than in this country, mainly because there is more segregation between the mass-market and that for hi-fi in Britain. It is rare to find a specialist hi-fi retailer, who does not also sell television, and even refrigerators, on that somewhat larger island to the east of us. I once came across a specialist hi-fi shop in Brussels. The windows were full of British goods (Quad, Meridian, KEF etc)!

The Rack Racket

Virtually every mass-market manufacturer and importer offered a range of amplifiers, tuners, cassette decks and record playing units, with or without a 'rack' or cabinet of some sort. All these systems needed loudspeakers, and the majority of those sold here were made in Britain. Most of the cheaper ones, not worthy of the name 'hi-fi', were assembled by the enclosure manufacturers, and more than a few were designed by them, too! This resulted in some bizarre errors, such as a bass-reflex design that was produced in very large numbers with a port that was five times smaller in diameter than it should have been, probably due to the slipping of a decimal point on a manufacturing drawing, and the re-interpretation of the resulting ten times too small diameter (which was obviously silly) as a radius. Since most of these loudspeakers were probably placed on the floor, behind furniture, it is not surprising that the error went largely unnoticed.

Money on the Switchback

Apart from these trifling technical difficulties, the importers had a hard time with the switchbacking of exchange rates. How can you decide what price to sell your product at, if the price you have to pay for it is changing by over 10% in a few weeks? Big and powerful companies could hedge against exchange rate changes by buying Yen or US Dollars ahead, but this tied up cash that ought to be used for constructive ends. They could also, to some extent, force retailers to accept price rises, whereas less powerful suppliers would be faced with demands for compensation or piles of returned merchandise. In that sort of jungle, the small British specialist manufacturer was reasonably safe if he had a group of committed retailers, who would not use against him all the power that the market was giving them. Nevertheless, several could not survive.

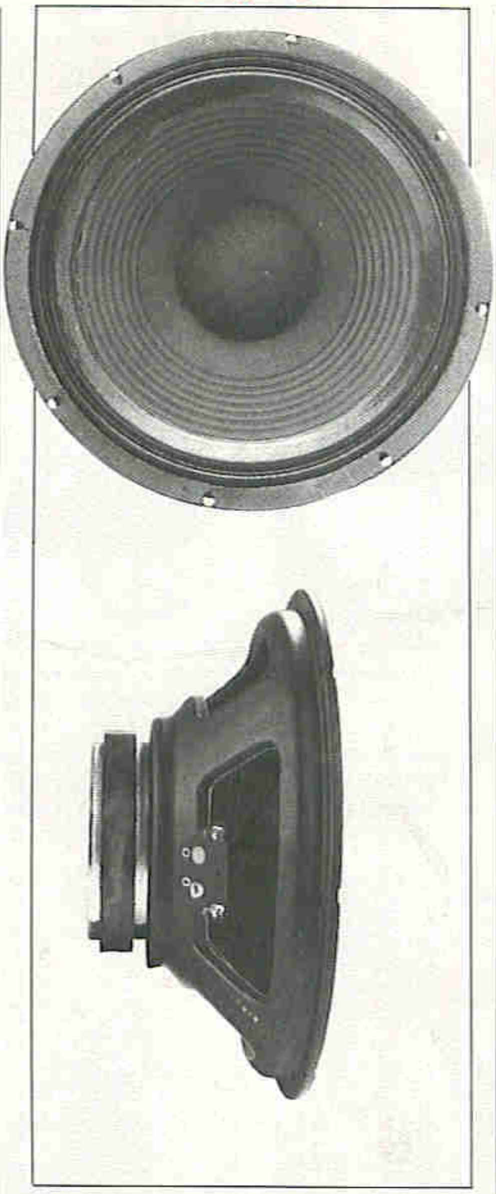

Photo 1. Typical 12 inch 100W modern-day loudspeaker.

Bass Bins and Weird Horns

In the field of sound reinforcement, the column loudspeaker was beginning to be ousted by the 'cluster', a group of direct-drive bass boxes (bins), used in conjunction with treble, and sometimes mid-range, horn-loaded pressure drivers. Similar systems, some very large, were in regular use outdoors for pop-concerts, amid continual strife with local governments about noise nuisance. It is much easier to control overspill with the traditional (250Hz to 5kHz) straight or folded horns used for speech, than with the systems used for music reproduction, because the latter have a much broader directional response in the vertical plane. Much of the development in this decade has been concerned with the design of horns with controlled (and fairly broad) directional characteristics which are largely independent of frequency.

Up the Dipole

Research papers were a little thin in the early 80's, perhaps a reaction to the flood of new results and ideas that had been published in the previous ten years. R.J. Newman of Electro-Voice wrote on dipole radiators (open baffles) and indicated the lines along which future research might lie. Six years later, the Celestion '6000' sub-woofer system used the same principles, plus some newer and more exclusive ones, and is still available today. Marshall Leach drew attention to the need (so obvious when explained) to allow for the phase-response of the drivers themselves when designing a system for an overall flat acoustic response. Both these papers were published in the Journal of the Audio Engineering Society in 1980.

Very nearly worth the AES annual subscription are the comments by George L. Augspurger on loudspeaker patents, which appear in the AES Journal. Serious patents are treated seriously, of course, and Mr. Augspurger is always willing to see virtue, if present, in the most inexpertly drafted patent specification. But the real gems are his caustic comments on the more lyrical and subjective specifications that are based on theories of sound generation and propagation which run contrary to all experience. In 1981, he reveiwed a patent by Harwood, Yeo and Stebbings, which has proved to by very controversial, and highly profitable for the legal profession. It concerns the use of certain plastic materials for the cones of direct-radiator loudspeakers, and attempts to cover materials with certain specified mechanical properties. Legal wrangling over possible infringement by some manufacturers has been going on for several years, and may not be over yet. In the same year Lipshitz and Vanderkooy turned their penetrating gaze on subjective testing. Do we hear what we think we hear, especially when we hear 'depth, air, graininess (and/or) liquidity'? The authors' answer was, 'Not unless you can measure it as well', but the paper did little to stem the tide of subjectivism, which still so profitably exploits the gullible punter by pressing him to buy, for example, gold-plated fuses and cables at upwards of £50 per metre.

Another development of unquantifiable value was the Japanese pre-occupation with exotic materials for loudspeaker diaphragms. Of course, they can spend their research money as they please, but it does not seem that a good return has been obtained. The membrane cone may be 'old hat' (in appearance, as well!), but it is remarkably good when compared with the alternatives so far developed.

Digital Sound Arrives

The big market news of 1982 was, of course, the launch of CD. It can't be said that this was very expertly handled, but the large number of companies and individuals involved made it very likely to be a disaster, which it by no means was. Of course, there was immediate controversy, with some people who saw their future as committed to analogue discs making statements that must be very embarassing now. CD had little immediate impact on loudspeakers, although there were some silly attempts at slogans like 'digital – ready'. One might as well say, 'Bananorama-ready'!

Crossovers and Cluster Design

In 1982, research papers veered towards crossover networks in the hi-fi field, with the publication by Adams and Roe of a paper on computer-aided design, which won numerous Brownie-points. At the same time, calculation methods for the design of cluster systems for auditoria began to appear. Later in the year, Allison and Villchur addressed the problem of Doppler frequency-modulation distortion in loudspeakers. They concluded that is was 'inaudible in multi-way systems', but without quantifying the limiting conditions: would it be inaudible with a very small bass driver, like the original Goodmans Maxim, for example? At the same time, M. Gander proposed the measurement of loudspeaker frequency response in the open air by placing both the loudspeaker and the microphone itself on flat reflecting ground. The paper shows some results which look very plausible, and any method which does not require an anechoic room is bound to be welcomed. Another of these methods was proposed by Professor Josef Merhaut; this is the 'reciprocity method', which is also used for the precision calibration of measuring microphones. Merhaut's paper (JAES Dec. 1982) is worth reading for its clear explanations of the matrix representation of 4-pole networks and of the concept of reciprocity itself.

Specify with Care, or you may Pay Heavily!

One of the most interesting papers of 1982 was Keele's examination of the design route from a system specification to a specification for the low-frequency driver of the system. Notably, he introduced the cost dimension (approximately proportional to magnet energy for the systems considered; this would not apply at very high energies) and showed that an unequalised vented system costs about three times as much as a closed-box system of the same specification in terms of low-frequency cut-off, sensitivity and driver diameter. However, if the systems are specified in terms of cut-off frequency, enclosure volume, maximum diaphragm excursion and acoustic power output, the vented system can be five times cheaper than the closed box! Clearly, it pays to specify the system with care, and to understand that sensitivity is expensive, while amplifier power is quite cheap.

As the Products get Smaller, so Does the Market

By 1983, the Second Hi-Fi Revolution was beginning, not so much to peter out as to commit suicide. As a reaction to price-pressure, manufacturers cut down on the decorative material content of the electronic products (which may well cost more than the 'works') by introducing 'mini' and 'micro' systems. While their small size was initially attractive, they proved difficult to operate (of course) and did not inspire as much pride of ownership as the larger systems had done. After a while, the size settled down at 'midi', about 40cm wide, which is a sensible compromise, and has remained there until now. There was, of course, a demand (from the manufacturers' marketing departments, not from the public!) for 'micro' loudspeakers to go with the minute-electronics boxes. While these were made, they were generally recognised as less than satisfactory except as accessories for personal cassette players. Budget products legitimate enough to be reviewed by 'Hi-Fi News' were available from just under £100, while the Celestion '600' two-way system with an enclosure constructed from honeycomb-reinforced panels was available at £650 a pair. 'Mid-price' was regarded as the £150 to £200 range. It is interesting to note that Tannoy began to enjoy a high degree of acceptance in Japan at this time, with their award-winning 'Westminster' dual-concentric horn-loaded design, which did not prove anywhere near as popular in Britain; of course it was very expensive, and still is, at £3400 a pair!

The Arrival of 'Fred'

Undoubtedly, THE event of 1983 was the launch of the new Quad Electrostatic, the ESL63, which had been known as 'FRED' during its 20 year development. Starting from the easily-demonstrated fact that an unstressed membrane (such as a piece of cling-film) is acoustically transparent, Peter Walker reasoned that if the membrane could be made to move exactly as it would if the sound to be reproduced electrically were actually being produced acoustically behind it, the correct sound field would be produced in the room. The membrane would behave exactly as a window into the auditorium. This could be achieved electrostatically by feeding suitably shaped electrodes on the membrane with correctly-timed versions of the audio signal. The results, in terms of uncoloured reproduction and freedom from distortion were, and still are, very impressive indeed. It is only a pity that the laws of physics do not permit a smaller physical size.

Arrays, Clusters and more on Crossovers

Research papers in 1983 were a mixed bag, with few very large, contributions. Greiner and Allie considered the detailed effects of operating similar, but not identical, drivers, close together physically and in series or parallel electrically. The results show that such drivers should be matched for main resonant frequency, be all in the same enclosure, and preferably be connected in parallel pairs. Lipshitz and Vanderkooy wrote on crossover networks including time-delay: this paper includes a good review of recent previous work which is very useful. Greiner and Schoessow produced some useful results on the effect of driver tolerances on equalised closed box systems, while Janse and Kaizer introduced the concept of 'Wigner distribution' to electroacoustics. This is a mathematical tool for describing the response of a loudspeaker in time and frequency, and is thus allied to Heyser's work on time-delay spectrometry. It is, however, even more difficult to interpret in practical terms.

Loudspeaker Resembles Retreating Elephant

Smith, Keele and Eargle (of JBL) published a paper on the design of new (recording-studio) monitor systems incorporating one of the constant-directivity horns mentioned previously. This distinctive device, with its 'biological' curved surfaces, has certainly created a great deal of interest. Although the authors seem to imply that the design ought to be more acceptable to 'audiophiles', the use of a 384mm (15 inch) driver up to 1kHz would still appear to cause a significant change of directivity in the cross-over region. K.O. Ballagh wrote on the effect of wall reflections, showing that positions can be found giving extended low-frequency response without loss of smoothness in the response at higher frequencies. These concepts are currently being more intensively investigated by an international team, including one of the leading British manufacturers.

New offerings from KEF . . .

One of the events of 1984 was the release by KEF of the R104/2; one of the most interesting facts about this product was that practically the only similarity with the earlier model was the number! The original R104 was a two-way system with a passive radiator, while the new model had two bass drivers, two midrange and one dome tweeter. The bass driver system was particularly intriguing; both drivers were located inside the enclosure, so that, apparently, no direct radiation could occur. The upper driver faced into a sealed box and was backed by a ported chamber, while the lower was backed by a sealed box and faced the ported chamber. These drivers were driven in opposition, and their chassis were coupled by a rigid metal rod to eliminate virtually all relative motion. The port did not act in the same way as in a normal reflex box: rather it formed, with the air-mass in the chamber, a (Helmholtz) band-pass filter to support the upper bass output. At very low frequencies, the radiation from the bass drivers actually was audible directly through the port. Another feature of the design was that it included impedance-correcting networks which gave it a practically constant 4 ohm impedance at all frequencies (not necessarily purely resistive, though). This was intended to make the unit easier to drive, which it did – provided the amplifier was happy with a constant 4 ohm load. They all should have been, but some did get very hot!

. . . and Rogers

Another new product at this time was the Rogers LSB1 sub-woofer system. This had the great advantage of simplicity, consisting of two 16.5cm drivers in one enclosure, intended to be fed one from each channel of a stereo system. The enclosure also contained the crossover components for the satellites, which would normally have been Rogers LS3/5A's. The general feeling was that rather better drive units could have turned a good product into an excellent one.

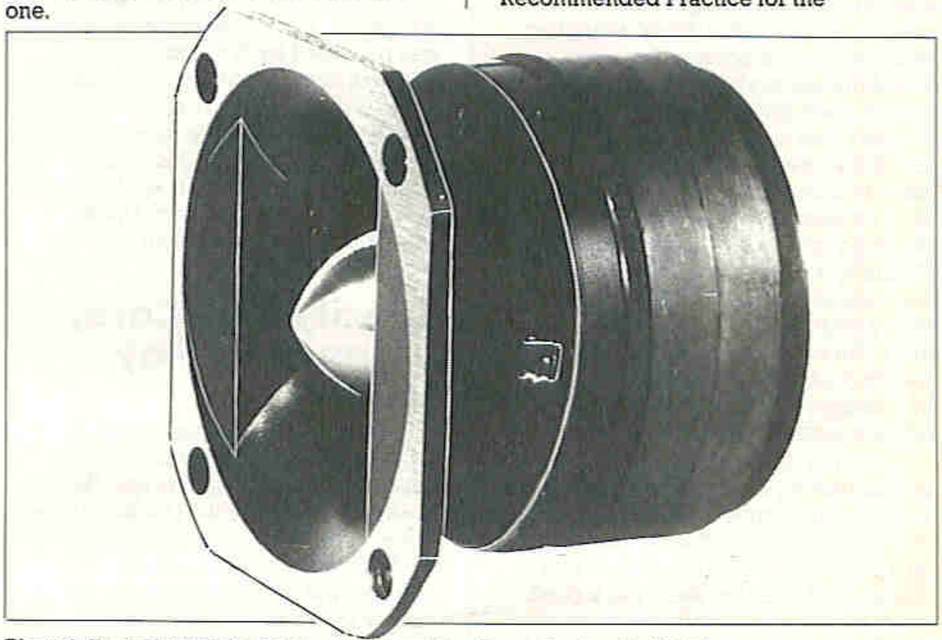

Photo 2. Typical 250W 'Bullet' tweeter capable of reproducing the high frequencies in PA, disco, organ and sound amplification systems.

The Canadian Connection

Research reports in 1984 were mostly free of major surprises. R. Normandin, of Canada's National Research Council, wrote on equalised vented box systems incorporating an amplifier with negative output impedance. This technique can produce considerable bass extension, but works best if the driver has a greater permissible cone excursion than its normal application would require. As driver design methods improve, this sort of (often useful) unbalance in specification is becoming rarer. The appearance of this paper was an indication both of the growth of high-quality loudspeaker design and manufacture in Canada, and the considerable degree of Government support that it was receiving. No problems (then) about the funding of 'near-market' research in Canada! J.M. Kates produced a paper which described a method of including some of the effects of early room reflections in an adjusted frequency response curve of a loudspeaker. The practical problem with this is that the resulting curve is so complex that is difficult to deduce anything more than very general results from it. Lipshitz and Vanderkooy, however, deduced from a very complex analysis the eminently practical result that a system using a non-minimum phase crossover network cannot be made minimum phase by displacing the drivers along the axis of the system. The best that can be done is to produce a 'better' (perhaps, but how to tell?) non-minimum phase response.

AES Produces Model Specification

Also published in 1984 was the AES Recommended Practice for the specification of loudspeaker components. The title does not make it clear that the scope of this industry standard is restricted to sound reinforcement products. It attempted to introduce some much-needed uniformity and discipline into manufacturer's specifications, so that prospective buyers did not have to be continuously on the look-out for specmanship and significant omissions. The problem with all standards of this type is that they cannot be enforced, and manufacturers that gain advantage by ignoring the rules tend to prosper from it. The standard seems to have had little impact outside the USA.

Patents, an Unsuspected Source of Innocent Merriment

G. L. Augspurger had some trenchant comments on three recent patents. A ported double-chamber enclosure, which the patent described as an improvement on a 2 cubic foot design having a flat response to 41Hz at an efficiency of 8% (!), was described as 'working almost as well as a properly tuned ported enclosure of the same volume'. A large flat electromagnetic driver, which the patent appeared to claim not to generate a back e.m.f., was supposed to be placed close to a wall so that the unwanted back radiation could 'squish out round the edges'. The language of the patent was described as 'numbing'. On a ribbon driver, Mr. Augspurger commented 'When magnets were relatively cheap, hi-fi purists spent their spare hours inventing new electrostatic loudspeakers. Now that the cost of magnetic materials has multiplied, interest has shifted to the ribbon loudspeaker. This . . . is one of the least efficient in terms of making use of a given magnet's potential, and thus has the desirable attribute of conspicuous consumption . . .'. So much truth in so few words!

Ribbons and Bose

1985 opened with Stan Kelly writing in great detail about the histories of ionic and ribbon loudspeakers in 'Hi-Fi News', and a review by Martin Colloms of the unique Bose '901' system. This product first surfaced in the early '70s, and was much criticised by British pundits. Nevertheless, it survived, mainly due to very strong promotion. The concept is based on the idea that in an auditorium, the ratio of reverberant to direct sound energy is in the region of 1/8 in the best part of the listening area. The system therefore has eight rearward facing 105mm full-range drivers, in two reflex enclosures, and one similar forward-facing unit, also reflex loaded. There is, however, no reason to suppose that exciting reverberation in the listening room, which adds to and confuses the ambient reverberation already present on the recording, is in any way the route to realistic reproduction. It would only be correct if the original recording had been made in an anechoic room, similar in size to the listening room! The system comes with an equaliser which provides vast amounts of bass and treble boost, thus demanding the use of a high-power amplifier to avoid any chance of peak-clipping. It produces lots of bass from quite a small enclosure, but the sound is highly coloured and does not represent a true copy of the original, however impressive it may be. Meanwhile, another American company (AR) took several steps back in time to the old German 'raumklang' idea in the form of a large system that reflected delayed signals off the side walls of the room.

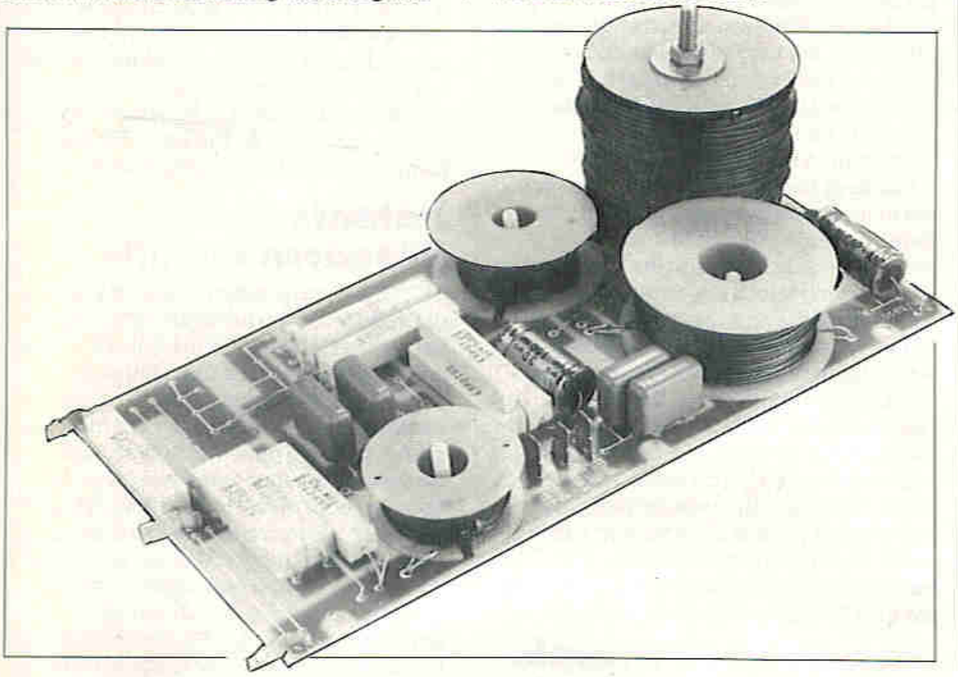

Photo 3. Typical crossover unit.

Sell First and Modify Later

Very many new products were launched in 1985, and the range of performance covered ran from incredibly poor to very good indeed. The problem facing a private individual who wants to form an independent opinion is that of access to the products: only the technical staff of a large dealer and reviewers commissioned by specialist publications are likely to be able to carry out the extensive comparison and objective test that are required. A further complication is that all the reviews are coloured by idiosyncrasies, including blatant subjectivism. Nevertheless, it is clear from reported objective test results that several products released with prominent brand-names were ill-conceived. This is a common consequence of being in too much hurry to produce a new model just because the competition have. And professional designers really have little excuse for not evaluating the competition properly; begging, borrowing or buying samples and testing them is a legitimate development expense, and don't let any accountant tell you otherwise!

Full-range Ribbons

In September 1985, the Apogee 'Scintilla' full-range ribbon loudspeakers arrived in Britain. Very large and very expensive, these products are a demonstration of what can be achieved with unlimited effort. They are so large that, as far as I know, no serious attempt has been made to produce an anechoic frequency-response. But it was generally accepted that they scored heavily for low distortion and coloration, while having greatly extended bass response and maximum output compared with the Quad ESL63, the only product which could really be used as a reference in this context.

How to Listen

Probably the most significant paper of 1985 was Floyd Toole's offering on meticulously-controlled listening tests. This very long and exhaustive paper describes the very long and exhaustive procedures that have to be used to produce reliable results from listening tests. (So what chance do you have at a dealer's showroom on a Saturday afternoon?). A complementary paper, by Gabrielsson and Lindstrom, independently demonstrated the validity of the methods used by Toole.

Another important paper was a report by Lawrie Fincham of ten years refinement in the impulse testing of loudspeakers, followed by another paper on the audible effects of group-delay at low frequencies, an inherent consequence of the steep fall in l.f. response in a complete hi-fi system due to the cumulative effects of all the individual l.f. roll-offs. Some of us remembered the Reverend N. Bonavia Hunt, whose promotion of d.c. coupling had been a feature in the technical press 40 years earlier.

New Year: More New Models

The following year (1986) saw a new batch of products, mostly from established manufacturers. The market was not at all kind to new ventures, although the big discount houses were beginning to pull back from offering hi-fi, and to go up-market with more suitable products for the mass-market at the same time. The main impression of all these products was that there was very little obvious difference in design, but that designers were all too prone to delude themselves when listening to the sounds that the latest brain-child produced. There was just not enough 'sideways looking', i.e. the unbiased evaluation of competitors' products. One product which was really different was the 'Phobos' from Jim Rogers. This had a 300mm cylindrical cabinet, about 200mm deep, with a 110mm base unit and a horn-loaded tweeter mounted in one end-face. It had an in-built equaliser for use with a sub-woofer or as rear speakers in a surround-sound system.

Perhaps too unconventional in appearance, it seems to have had little impact; certainly much less than the JR149.

Another New KEF

Mid-year saw the launch of the KEF R107, using the same bass-driver principle as the R104/2, together with a dedicated semi-adjustable equaliser called 'KUBE' (KEF Universal Bass Equaliser, geddit?). General conclusions were that this was a very good loudspeaker indeed. The mid-range and treble units were housed in pods on the top of the main enclosure, as in the previous R105 design, although the R107 pods could not be tilted.

More on Listening

F. Toole (Canada) returned to the AES Journal pages in early 1986 with a two-part paper on the relation between objective and subjective results. This was highly controversial, because the conclusions were directly at variance with the opinions of several groups of designers and reviewers in the USA, and much more in agreement with more sensible (i.e. non-subjectivist) commentators in Britain. Later in the year, T. J. Holmes wrote on an old, and generally discredited, concept, the enclosure loaded with a resistive port. While not, it appears taken up commercially, this idea could be interesting for private experimentation.

New Ideas in Boxes

Early 1987 brought the use of fibre-reinforced concrete as an enclosure material, favoured by some Scandinavian suppliers, and a much more complex new development from B and W. Termed 'Matrix', this was a method of dividing up the internal volume of an enclosure into stiff-walled cells which were nevertheless acoustically all in communication. The main problem with this seems to be the control of the losses in the enclosure. If the 'holes' in the cell walls are too small, they act as acoustic masses and the effective cabinet volume decreases too much with rising frequency. Somewhat larger holes might still present too much acoustic resistance at all frequencies, resulting in too low a Q and a drooping l.f. response. Larger holes still could compromise the stiffening effect of the cells, and lead to multiple mechanical resonances.

A welcome development was the reappearance of British-made transmission-line (labyrinth) loudspeakers, from TDL, a reincarnation of IMF (no, not MFI!). While this technique is most applicable where a large, costly enclosure can be allowed, many people consider that the special sound of the bass reproduction is worth every penny and cubic metre. Somewhat more surprising was the launch of three German-made products in the UK. It is generally held in Britain that German ears are totally different and very strange, at least if they like German loudspeakers! It should be noted that some excellent drive-units are made in Germany, but no professional designer seems to be able to produce systems that rate above C in the British market. Nevertheless, these 'Canton' products are still on the market.

Transatlantic Trouble

Much the same trouble occurs with products from the USA; in some cases we know why. Those designers use methods which predictably give results that would not be considered acceptable in Britain (such as very uneven axial frequency response). But very few other designs elicit much support; the 'Spica' two-way closed box system, with its triangular prismatic cabinet, received an encouraging review but, perhaps because of the near £600 price, it seems not to have created a stir. The same fate befell the Gale 210 and 220, which represented their attempt at extending the following which the original GS402 had attracted, into a low price (and bigger volume) range. Yet another American offering was the Magneplanar 2.5, a modern-day hybrid 'Blatthaller'/ribbon design, having membrane radiators for the bass and mid-range, with a ribbon tweeter. Tape conductors fixed edge-on to the membranes dipped into magnet gaps in a perforated carrier-plate. Apart from low distortion, the accuracy was not what one would expect for the £2000 price-tag in this country.

New Driver Principle

One interesting American product that surfaced here was the Intersonics 'Servodrive'. This probably represented the first practicable new low-frequency transducer principle for very many years. While using conical cones (in pairs), the normal moving-coil linear motor was replaced by a rotary motor with an ironless armature, and the drive to the cones was achieved by an ingenious belt system, see Figure 1. This gave a moving system with low enough inertia to be able to respond up to about 150Hz, and with theoretically unlimited amplitude (in contrast to the 30mm or so limit for a moving-coil motor). Developed originally to study the long-distance infrasonic communication of elephants (this article seems to be infested with them!), the drivers were offered in both horn and baffle-loaded versions, and were capable of enormous sound levels down to frequencies not much exceeding 10Hz. The inventors of this transducer also patented a linear motor drive with a very long coil, fed from sliding contacts at each face of the magnet top-plate; thus the only active part of the coil was that which was in the magnetic field. This allowed much longer excursions without any of the normally inevitable loss of efficiency. It remains to be seen whether this principle can be put into a practical form that can be reliably manufactured.

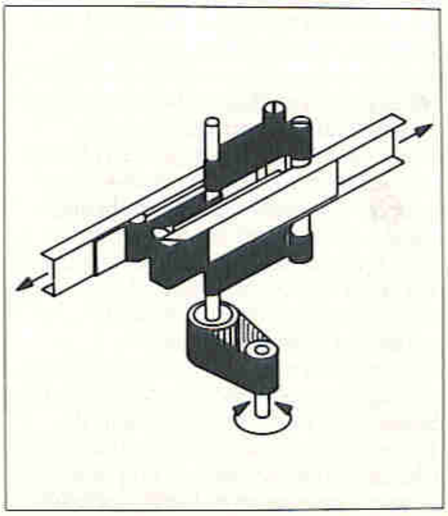

Figure 1. The ingenious rotary-to-linear motion converter used in the Intersonics 'Servodrive' loudspeaker driver.

Patents and Research Results

G. L. Augspurger reviewed a patent of Dr. Bose, which he clearly considered very clever. The KEF R104/2 and R107 use two drivers and three chambers to achieve a low-frequency band-pass characteristic. Dr. Bose claimed that one driver, facing a ported chamber, and backed by another tuned to a frequency about an octave above or below the front chamber, also produced a band-pass characteristic. Indeed it does, and this is a way of achieving high efficiency and good cone loading for sub-woofer applications. Clearly, the upper cut-off frequency has to be low, because there is no direct radiation from the drive unit. It should be noted that, although the Bose hi-fi loudspeakers have not received much praise from critics in this country, their sound-reinforcement products are very widely used.

Loudspeakers with (nearly) No Ohms

A paper which has been often quoted was by M. Otala and P. Huttunen, on the peak current requirements of loudspeakers. It had previously been recognised by many people that amplifiers which could deliver high peak currents, much more than the rated power and impedance would imply, did not produce the occasional distortions on some programme material that other amplifiers did. Otala and Huttunen explained why this should be, which was valuable, but then deviated into synthesising equivalent circuits from impedance measurements, which is tedious and difficult, and searching for worst-case test signals, which was most unwise. This immediately obscured the real point in a flood of argument about whether the test signals were realistic and, if they were, how often (in a million years?) did they occur in real programme. You can demonstrate the effect if you have a source of 4kHz square waves, an 8 ohm moving-coil tweeter, a 5µF capacitor and an oscilloscope. Feed the square waves into an amplifier and connect the tweeter to its output. Connect the scope across the tweeter and look at the square wave output. Now put the 5µF in series with the tweeter, with the scope still across the tweeter. Barring some complication due to the voice-coil inductance, the peak voltage across the tweeter, and hence the peak current through it, will be found to have nearly doubled, although the 5µF has INCREASED the amplifier load impedance at 4kHz to over 11 ohms, and cannot have reduced the impedance, even at the harmonic frequencies present in the square wave signal!

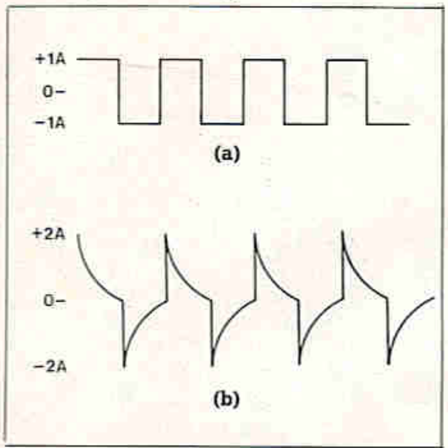

Figure 2. How a crossover network (in this case, a simple series capacitor) can increase the peak current demanded by a drive unit. (a) Current waveform without capacitor, (b) Current waveform with (critical-valued) capacitor and the same total voltage applied.

Armchair Critic or Kitchen Cynic?

More and more as the 80's draw to a close, the true state of the art is being obscured by subjectivism. It is all very well for designers to bamboozle non-technical 'Journalists' (the quotes are an apology for applying the name of a respectable profession out of context) by talking nonsense. This has been going on for ages; I remember hearing Donald Chave sending one up in that way, but it can't be defensible to treat the people, whose money is financing your continued existence, in the way P. T. Barnum did. Part of the problem is in finding reasons to claim that company X's new two-way closed box system with a 150mm bass driver and a dome tweeter is any different from, let alone better than, any of the other 3000 similar designs. So it's particularly welcome when something new comes along.

Something New

Recent developments in magnets have led to the production of neodymium-iron magnets of unprecedented energy. This has enabled KEF to build a tweeter on the front of the pole-piece of a bass driver, this producing a coaxial system, called 'Uni-Q' and apparently implying constant directivity, without the problems of boring a tapered hole through the pole-piece or obstructing the bass cone radiation with the tweeter magnet structure. This system must surely produce a much better stereo image than separated (non-coaxial) drivers.

For the rest, you can take your pick from horrible-sounding products at huge prices, stands that cost more than a decent complete system, and cables the thickness of your finger and the cost of a heart-transplant. Oh, and in there somewhere are a few products that are really good value for money.

Realistic Research

In contrast to what is happening in the market, research is progressing sensibly. Peter Baxandall published early in 1988 his deliberations on measuring the current and voltage capabilities of amplifiers, which are now on the way to being adopted as an international standard method of measurement, and, more controversially, the results of some measurements of peak current demand by loudspeakers on real programme signals. Fielder and Benjamin examined the design criteria for sub-woofers, based on psychoacoustic considerations (i.e. what limits are set by human hearing perception), which is the only sound basis for high-fidelity design. D. Birt (BBC) tackled the fascinating subject of direct voice-coil derived motional feedback, and showed a solution to the problem of the resistance changes of the voice-coil with temperature. This paper includes quite complete practical design details. J. A. M. Nieuwendijk reported on the design of ribbon tweeter and mid-range units; this paper is perhaps obscured by the results of Wigner distribution measurements, which are very difficult to interpret in detail.

The 112th Year

I didn't think, when I started this series, that it would run well into another year. Since it has let's take a look at the current scene, courtesy of the invaluable Buyer's Guide in 'What Hi-Fi?'. It would not claim to list absolutely every loudspeaker on sale in Britain, but it does list 43 products below £100 a pair (lowest £49, but is it hi-fi?), 72 products between £101 and £150, 71 between £151 and £200, 80 between £210 and £300, 68 between £301 and £450 and no less than 182 above £450 (highest £45 000, yes, forty-five-thousand, but will you really **like** it?), or a grand total of 516 models, all lined up for you to choose. And that doesn't include Maplin's home-constructor designs, either!

Wind Speed & Direction Modules

When testing these modules, it is possible that incorrect codes are generated thus giving false direction or speed data. If problems such as this are experienced, then carefully re-check the sensor (SN1-5) alignment and change the values of resistors R1, R3 & R6 as follows:
R1 (560R) to 1k, R3 (330R) to 680R, R6 (330R) to 680R.

Also, after assembly, check that the encoder disc assembly is not able to move up and down within the housing as this will cause erratic code generation; it may be necessary to fix the ball races in place with lock-tight or similar adhesive.

'Hello Who's Calling?'

Bell's first telephone

by J.K. Hearfield Part 5

Loudspeaking Telephones

Back when Victoria was queen, telephones were a novelty. Not even their most enthusiastic promoters ever dreamed that they would one day become as commonplace as cornflakes. The only instruments available were based entirely on Bell's original work, and these primitive telephones were expensive and insensitive. They clearly posed no threat to the established message carriers. Western Union was at that time the largest communications company in the United States; when offered the Bell patents, they turned them down.

But the idea caught on, and 'telephonic exchanges' began to spring up almost overnight in major American cities. Western Union decided they had been a little hasty, and asked their technical consultant – one Thomas Alva Edison – to please invent a better telephone. It took him five days. When the Edison Loudspeaking Telephone was demonstrated in London in 1879, Bernard Shaw commented that it was "A telephone of such stentorian efficiency that it bellowed your most private communications all over the house, instead of whispering them with some sort of discretion."

Maybe he exaggerated just a little. Edison's telephone was louder than Bell's, but both were rather less efficient than a modern instrument. It was to take another fifty years of development before the first true loudspeaking telephone was produced.

The Post Office Electrical Engineers Journal for April 1934 reported that 'a loudspeaker telephone' had been developed in the research laboratories. Radio was, of course, by then well established as both a communications and a broadcast medium, and some Post Office customers were beginning to demand a system that would allow more than one person at a time to listen to telephone conversations.

The block diagram of Figure 1 shows the general structure of a voice-switched loudspeaking telephone. Incoming signals from line are amplified and fed to a loudspeaker, whilst local signals from the microphone are amplified and fed to line. The key problem is this: how are the

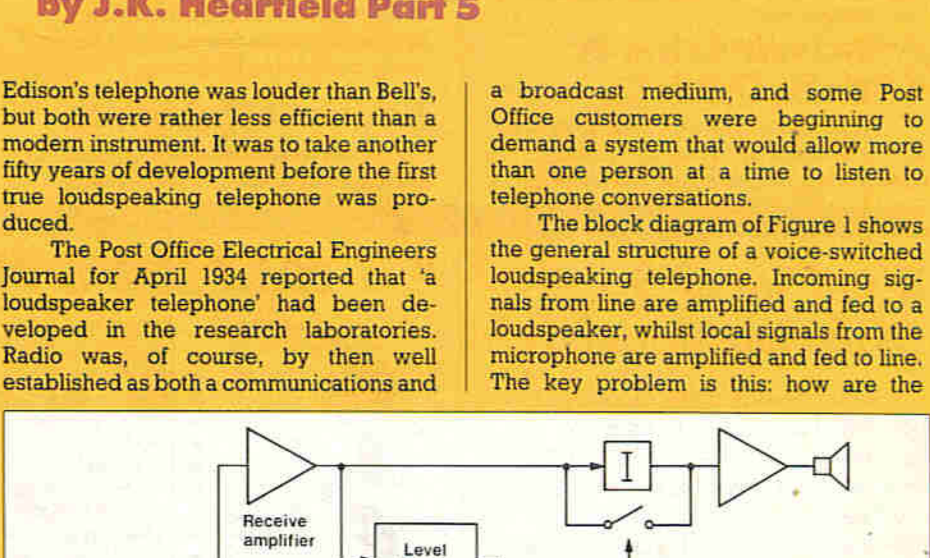

Figure 1. A voice-switched loudspeaking telephone needs some form of level-controlled attenuation.

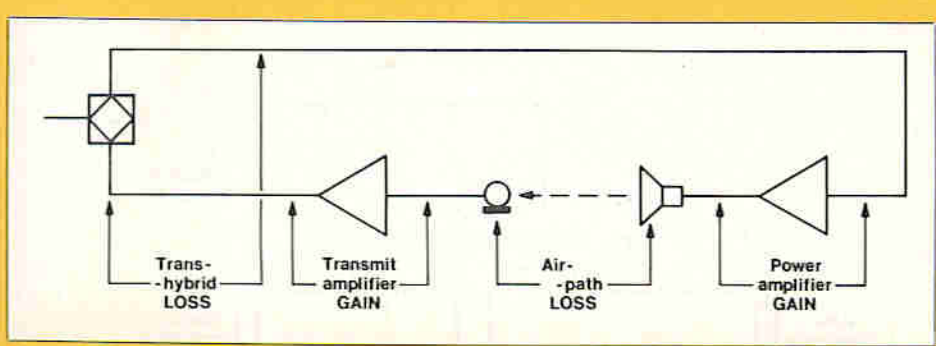

Figure 2. The loop will oscillate unless the total loss is greater than the total gain.

amplified signals from the microphone prevented from being further amplified and re-broadcast from the loudspeaker, thereby setting up a closed-loop positive-feedback circuit that howls like a dog at the moon?

Figure 2 shows the loop stripped to its essentials. Clearly, to avoid oscillation the total loss around the loop (through the hybrid and the air) must be greater than the total gain (through the amplifiers) – in other words, the 'loop gain' must be less than one. If this were not so, any signal present anywhere in the loop would be amplified and re-amplified without limit. The system would oscillate, or 'howl'.

Since the amplifier gains are directly under the designer's control, the real problem is how to ensure that the loss is high enough. The airpath loss depends on factors like the distance separating the loudspeaker and microphone, the degree of reflection from room surfaces, and so on. The trans-hybrid loss is a little more complicated, and to understand why, we must look at how hybrids work.

Hybrids

A hybrid is really just a special kind of ASTIC (Anti-Sidestone Induction Coil, for new readers). It is an ingenious way of converting a 2-wire circuit into a 4-wire circuit. Signals coming from line are split equally between the Receive Amplifier and the balance impedance, whilst signals from the Transmit Amplifier split equally between the line and the balance impedance (Figure 3). No energy passes from the Transmit Amplifier directly to the Receive Amplifier – the so-called 'trans-hybrid loss' is infinite. The hybrid is actually a uni-directional transformer. The circuit is like a balanced bridge, though, and it only works perfectly when the impedance of the line happens to be exactly the same as that of the built-in balance impedance. Unfortunately, this is not often the case, because the impedance of a line depends (amongst other things) on its length and termination, and neither of these can be guaranteed. So in practice, the trans-hybrid loss is usually much less than infinite.

Practical hybrids used to be built by interconnecting a pair of identical high-quality audio transformers as shown in Figure 4. The idea is that the Transmit signal, applied to winding A2, causes signal voltages to appear across this transformer's other two windings (L2 and B2). These signals cause currents to flow in the corresponding windings on the other transformer (L1 and B1), but the connections to T1 are so arranged that the flux caused by the current in L1 is exactly equal and opposite to the flux caused by the current in B1. As a result, there is no net flux in T1's core, and hence no voltage developed across winding A1. In other words, the trans-hybrid loss is infinite. The currents flowing in windings L1 and B1 obviously depend on the impedances on the line and balance circuits, and for these currents to be equal the line and balance impedances must be equal too.

It is also possible to make a hybrid more cheaply, using just one transformer. In Figure 5, the Transmit Amplifier drives a load consisting of one winding of the centre-tapped secondary and the balance impedance, in series. The transformer causes a voltage to appear across the 'receive' winding which is equal to that applied across its 'transmit' winding, as shown. The Receive Amplifier input voltage thus consists of two components in series, one due to the 'receive' winding, and the other to the voltage drop across the balance impedance caused by the Transmit Amplifier. If these two voltages are exactly equal and opposite to one another (that is, in antiphase), the net Receive Input voltage is zero, and so the trans-hybrid loss is infinite. But for this to happen, the Transmit Amplifier must split its output voltage equally between its transformer winding and the balance impedance. The voltage across the transformer winding depends on the (transformed) impedance of the line as seen by the Transmit Amplifier, so it turns out once again that balance depends on having the 'correct' line impedance. One advantage of this circuit is that the actual line impedance (about 600 ohms) can be

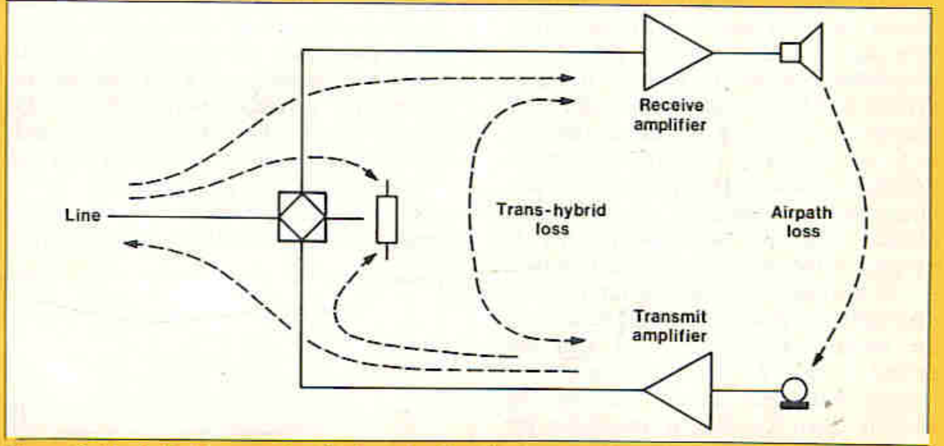

Figure 3. The hybrid converts a 2-wire circuit to 4-wire.

Photo 1. The LST1.

transformed up to (say) 10k ohms, allowing smaller and hence cheaper capacitors to be used in the balance network.

Hybrids can even be made using op-amps. Figure 6 (a) shows how it's done, whilst Figure 6 (b) illustrates the bridge-like nature of the circuit. Since an op-amp has an output impedance of effectively zero, the line is terminated in (and driven from) the impedance Z1. In the simplest case, Z1 and ZL are equal. Both are complex impedances, of course, but since they are equal, the non-inverting input of A1 (the Receive Amplifier) sees a signal that is exactly half that being output by A2 (the Transmit Amplifier). So the bridge is balanced by making Z2 and Z3 equal too. The circuit is deceptively simple – designing a real hybrid is vastly more complicated than this, for all sorts of reasons to be examined in a later article.

The First Loudspeaking Telephone

Meanwhile, back in 1934, the first commercial UK-designed loudspeaking telephone was taking shape. The clever idea behind its design was the concept of 'voice switching'. Since for stability there should be more loss in the speech path than that provided by the hybrid, the designers decided to include circuitry that allowed the system to decide for itself whether it was supposed to be transmitting or receiving. Depending on its decision, extra attention was switched into either the receive path or the transmit path (Figure 1 again). A simplified block diagram of the system is given in Figure 7.

It worked like this. Speech from the microphone was amplified and passed via the controlled attenuator A1 and the hybrid to line. At the same time, a dc voltage was derived from the outgoing speech, (zero for silence, maximum for loud speech) and this was used to disable the power amplifier. Separate outputs were in turn derived from the power amplifier, and used to control the attenuators. With the power amplifier held 'off' by outgoing speech, attenuator A1 was switched to its low-loss mode, and attenuators A2 and A3 switched to give high loss. The system switched over when the user stopped talking, allowing speech from line to pass through to the loudspeaker. It was (and still is) very important to get the time-constants right in these control loops. Too short a time-constant would cause the system to switch from transmit to receive and back again in the tiny intervals between words. Too long a 'hangover' time would result in the system not switching back to receive until after the person at the distant end had started to speak. The optimum hangover time was found to be about 500ms.

This system also included an ingenious extra feature. "The successful development of this instrument", said the 1934 POEE Journal, "has only been made possible by the application of a new device in voice-operated switching systems, which enables either listening party to 'break in' at will." The designers had realised that if two loudspeaking telephones were connected together via a high-loss line, each telephone would automatically give priority to its own user. So if they both talked at once (not an unlikely phenomenon for loudspeaking telephone owners) neither would be aware that the other was talking, and each would assume that what they had said had been heard. The system would be in 'lock-out'. To prevent this, two extra control paths were added (shown dotted in Figure 7). They worked by greatly reducing the hangover time whenever speech in the 'wrong' direction was detected. For example, if the loudspeaking telephone user was talking, so that the system was in 'transmit' mode, any incoming speech signal present at the Receive Amplifier's output was sensed and used to re-enable the Power Amplifier by effectively short-circuiting the 'disable' signal coming from the Control Amplifier. As a result, the distant end could (in theory, anyway) actually interrupt.

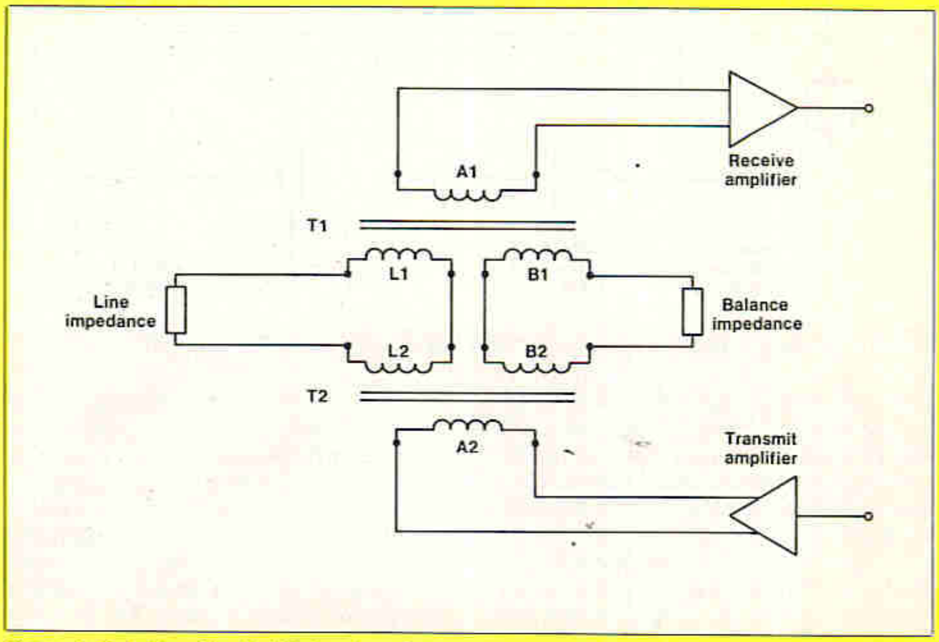

Figure 4. Hybrid realised with two transformers.

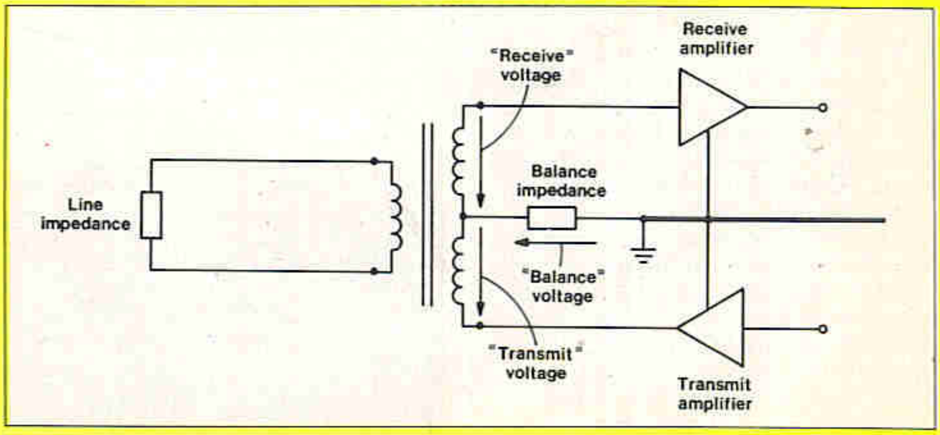

Figure 5. Single-transformer hybrid realisation.

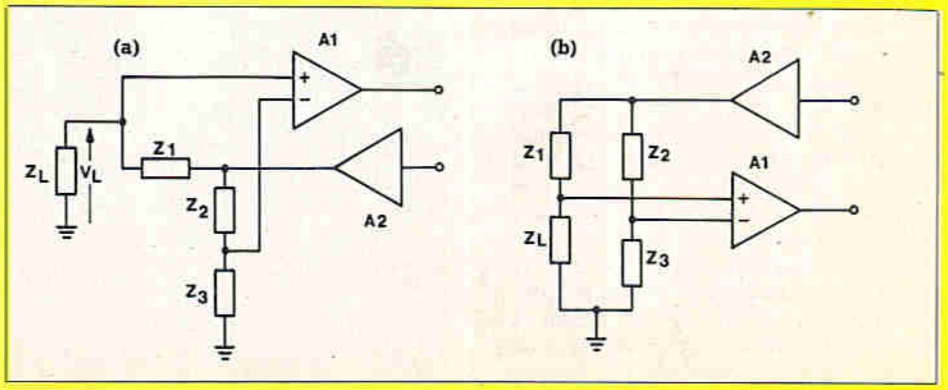

Figure 6. (a) A hybrid can also be built using op-amps since it is really no more than a balanced bridge. (b) At balance $Z_1/Z_L = Z_2/Z_3$.

The equipment itself was a complex piece of engineering. The loudspeaker and moving-coil microphone were mounted side-by-side in a Bakelite case measuring 12 × 6 × 5 inches, intended to sit on a desktop next to the telephone, whilst the electronics was tucked away out of sight in a separate steel box. The circuit included 6 valves and no fewer than 12 transformers!

Several units were built and installed. They were used mainly to provide conferencing facilities, but some did find their way onto chief executives' desks. Unfortunately, the equipment proved unsuitable for the public network, and its use was restricted to internal calls on private branch exchanges.

Loudspeaking Telephone No. 1

Not the first – just the first with a number. The LST1 was designed in the mid-1950s (yes, it really did take 20 years for the Post Office to decide to try again) and from the outset was intended to be a standard telephone, capable of being connected to any PO line.

Because of the difficulties experienced with voice switching in the pre-war design, it was decided that this time the acoustic stability problem would be tackled from a different direction. The loop (Figure 2) was to be made unconditionally stable by ensuring that the airpath loss and the trans-hybrid loss were always sufficiently large to prevent howl-round. The designers hoped by this means to produce a cheap, straightforward, easy-to-use system that would fit neatly into the Post Office product range, and there is no doubt they succeeded.

The airpath loss was made large by the simple expedient of putting the microphone and loudspeaker in separate cases, and telling users to keep the two units always at least two feet apart. Each was styled to resemble the standard 700-type telephone, more or less. The loudspeaker unit was little more than a Type 706 telephone with a speaker instead of a dial. The handset was retained, for privacy when the user needed it. The microphone unit also housed the dial and two lever keys, one to switch the system on or off and the other to give 3 preset volume-control settings. The (transistor-based) amplifiers and hybrid were built into a separate wall-mounted box. Photograph 1 illustrates the arrangement, and Figure 8 shows how the system was partitioned.

The trans-hybrid loss also had to be kept high under all conditions, and this proved much more difficult to do. The line impedance seen by a telephone varies during the process of setting up a call, and when it finally settles down it may be some way away from its nominal value of 600 ohms. The impedance depends mainly on the length of line between the telephone and its local exchange, though, as does the standing current flowing through the telephone from the exchange battery. The Type 706 telephone used this standing

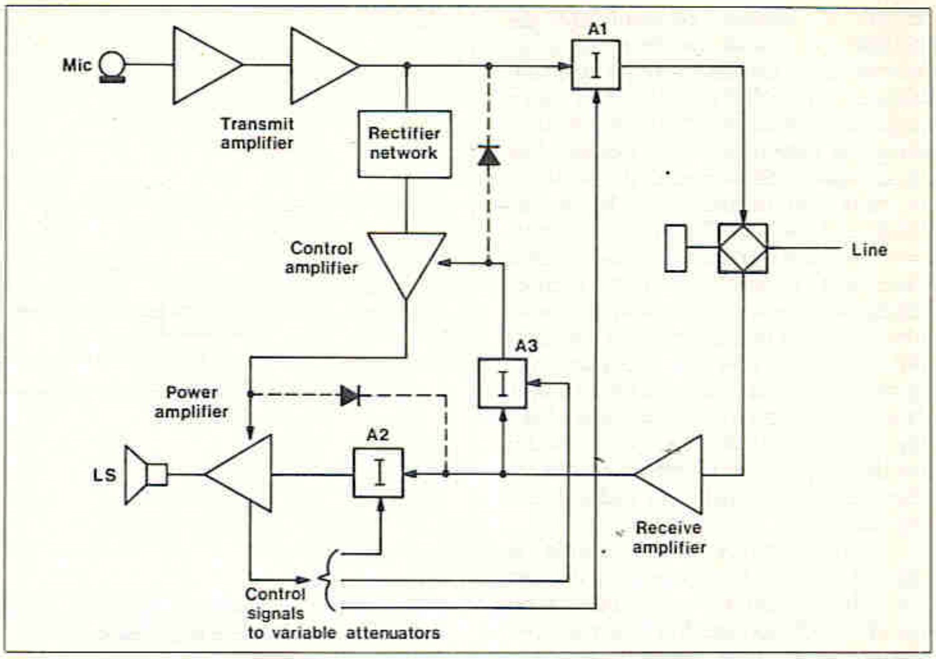

Figure 7. The first voice-operated loudspeaking telephone (A1, A2, A3: controlled attenuators). Dotted lines show the 'break-in' control paths.

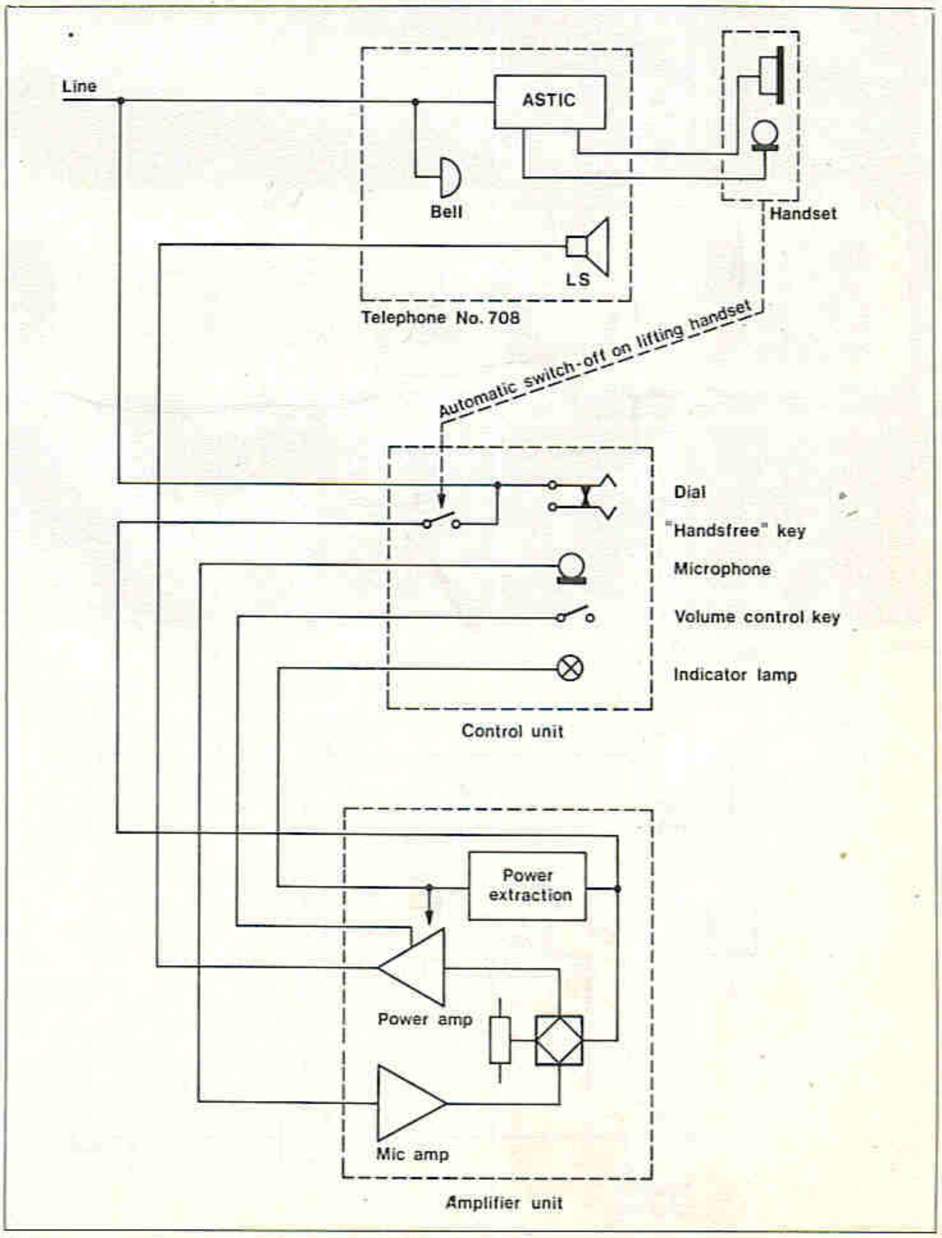

Figure 8. The loudspeaking telephone No. 1 consisted of three separate units.

current to control automatically the loudness of speech on short lines (as described in the last article) and the designers of the LST1 decided to adopt a similar approach in solving their problem. Instead of controlling loudness, the line current was made to control the values of the input and balance impedances, as shown in Figure 9. The circuit did give some improvement, and it didn't cost much, but it was far from perfect. Installation involved adjusting a preset volume control (inaccessible to the user) until the system was just stable with the volume control in the middle position. Many users must have found out the hard way just how readily the system would oscillate if it got the chance, particularly when the person at the other end was also using an LST1.

It seems almost inconceivable in today's climate of tight regulation that the Post Office would allow into service an item of equipment that they knew, sooner or later, would burst into uncontrollable oscillation at some unknown frequency or power level. Twenty years ago this was considered no more than a minor inconvenience.

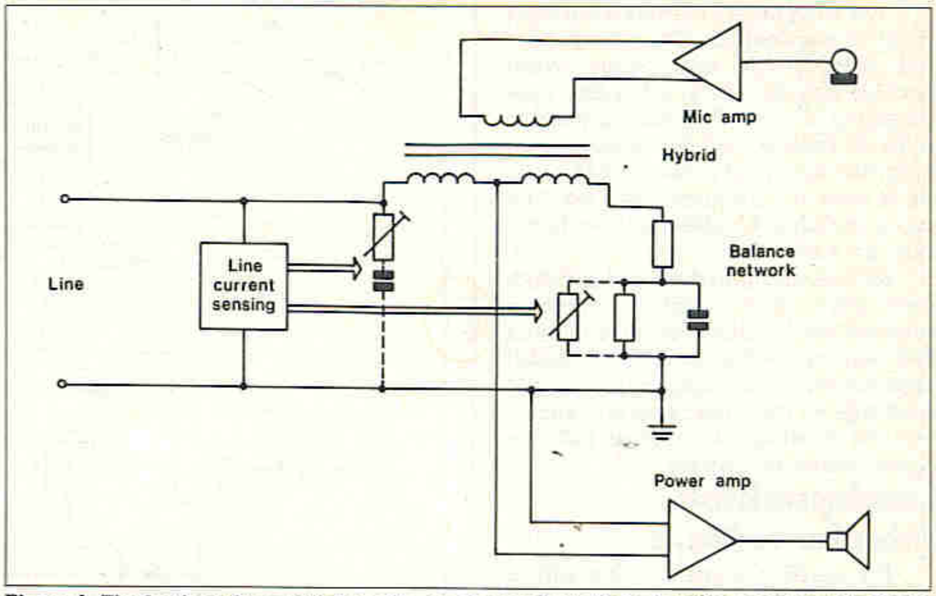

Figure 9. The loudspeaking telephone No. 1 adjusted its balance impedance automatically to cope with different line impedances.

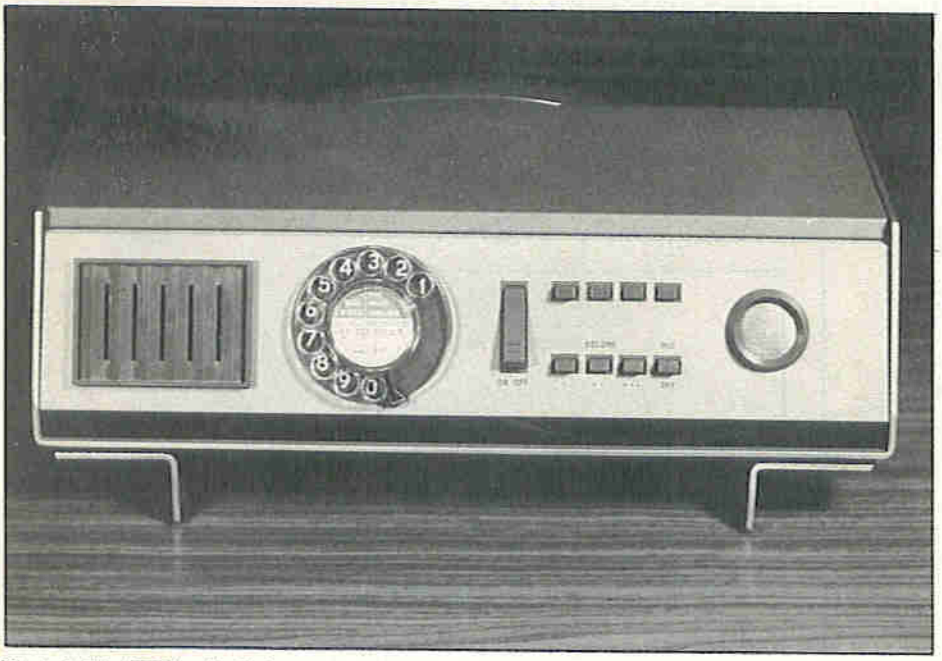

Photo 2. The LST4 with dial.

Loudspeaking Telephone No. 4

The LST1 was introduced in 1960, and was closely followed by two variants. The LST2 was a voice-switched LST1, and the LST3 was a waterproof LST1 (for use in hospitals). In 1966, the Post Office launched a brand-new system: the LST4. This quickly became their main loudspeaking telephone product.

As Photographs 2 & 3 show, the LST4 was an impressive item of desk furniture, particularly in its Executive version with a polished wood trim. It was almost 18 inches long by 9 inches deep, and weighed a hefty 15lb. The microphone and loudspeaker were set one at each end of the front panel, about 15 inches apart, with the on/off switch in the centre and the keypad (or dial) and volume control keys occupying the remaining space. A handset hung on the back of the unit, out of sight.

Conceptually, the LST4 was a straightforward voice-switched design. Its block diagram, shown in Figure 10, is quite similar to Figure 1. The comparator decided whether the transmit or receive signal was the stronger, and the latch then locked the system into either transmit or receive mode until the comparator told it to switch over again. Since the transmit signal was invariably stronger than the receive signal, this meant that the LST4 user could interrupt whenever he felt like it, in the certain knowledge that he would be heard, whereas the person at the other end was compelled to wait meekly until he was allowed to talk. The LST4 was very popular with executives.

The switched attenuator circuit is shown in Figure 11. With the control voltage near earth, the transistor is off and so the diodes are reverse-biased. The only signal path between input and output is via the large resistance, which is chosen

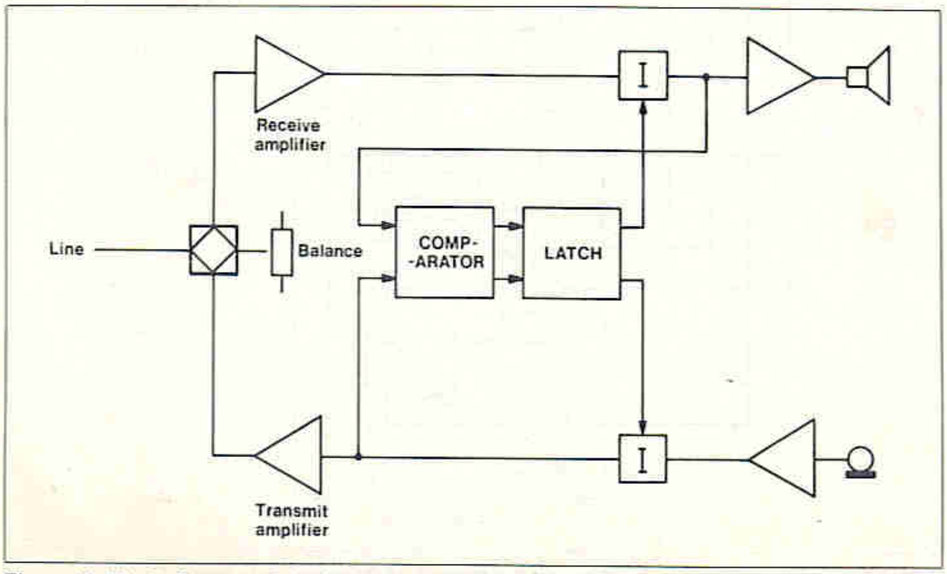

Figure 10. Block diagram of the loudspeaking telephone No. 4.

Photo 3. The LST4 with push buttons.

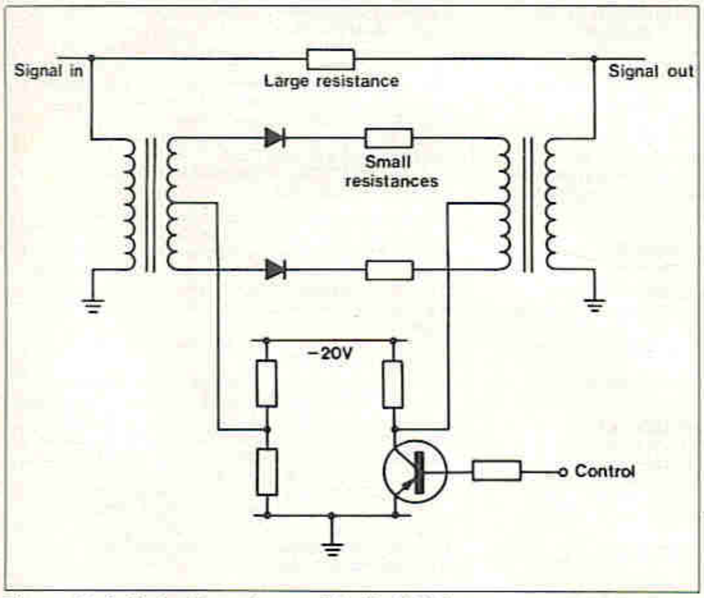

Figure 11. Switch attenuator used in the LST4.

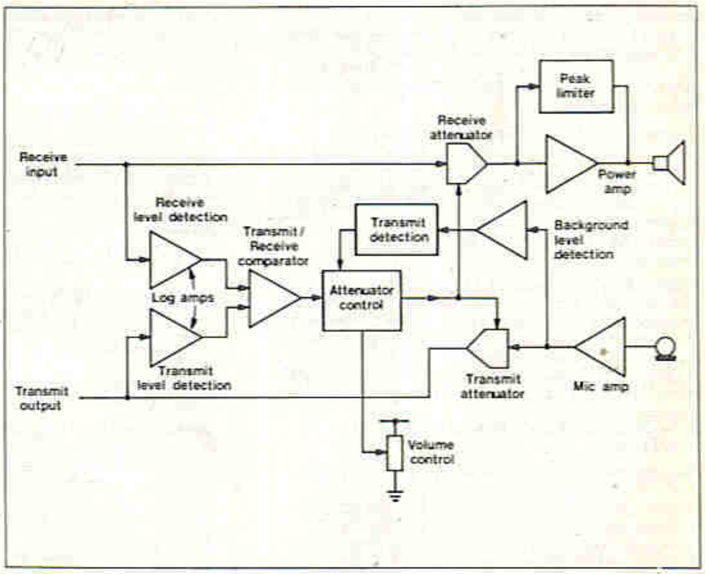

Figure 12. An integrated circuit speakerphone (the Motorola MC34018). This device is intended to be used in conjunction with other circuitry to make a loudspeaking telephone.

to give the required amount of attenuation. However, when the control voltage goes sufficiently negative to turn the transistor on, the diodes become forward-biased. The small resistances then shunt the larger one, reducing the attenuation.

Unlike the LST1, which usually derived its power from the telephone line, the LST4 was designed to use an external 50 volt dc supply. This could be provided by a power unit connected to the mains if need be, but since most LSTs were connected to PBXs (private branch exchanges) it was often cheaper to use the existing PBX 50 volt battery.

Modern Designs

Loudspeaking telephones are becoming increasingly common today, mainly because all the clever electronics can be packaged into a single low-cost integrated circuit. A typical example is the Motorola MC34018, whose block diagram is shown in Figure 12. This device is intended to form the basis of an add-on module to convert an ordinary telephone into an LST. Although it offers a performance considerably better than the earlier discrete component LST designs, in essence it does the same job in much the same way. The attenuators are actually variable-gain amplifiers, driven in a complementary fashion such that as the gain of one is increased, the gain of the other is decreased, with the total gain remaining constant. An interesting extra feature is background level detection. By averaging the room noise, and using this level as a threshold, the system automatically adjusts to compensate for noisy environments.

Photographs were kindly provided by British Telecommunications plc.

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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 CPC464, 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*.

FSK Demodulator – Continued from page 23.

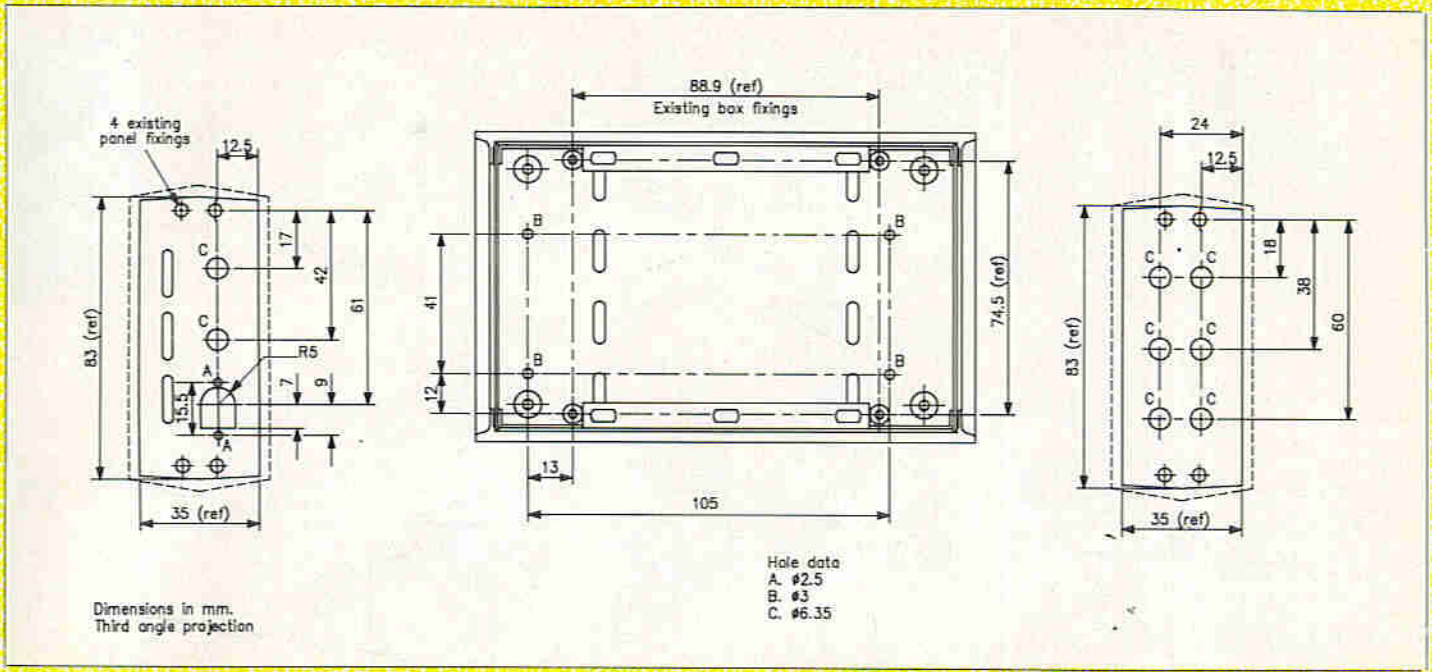


Figure 11. Box drilling details.

The majority of amateur stations use 45.45 Baud and with your hardware/ software set to this, intelligible text should now be displayed on the screen. If the text is garbled it may be because the received tones are reversed, to correct this simply switch S2 from normal to reverse. If, after trying these settings, the data is not being resolved, it is likely that the transmission is at 50 Baud and again could be normal or reversed. When the lock LED is in a stable lit condition you can switch on S1. This will allow the data to pass to your computer only while this condition is present and as soon as the lock fails the data will be inhibited. The reason for this is to prevent the screen from filling up with meaningless random characters. The lock can fail if:

1. The RTTY signal is too weak.
2. The demodulator shift and RTTY signal are not the same.
3. The received tones are off frequency.
4. A strong interference signal swamps the demodulator.

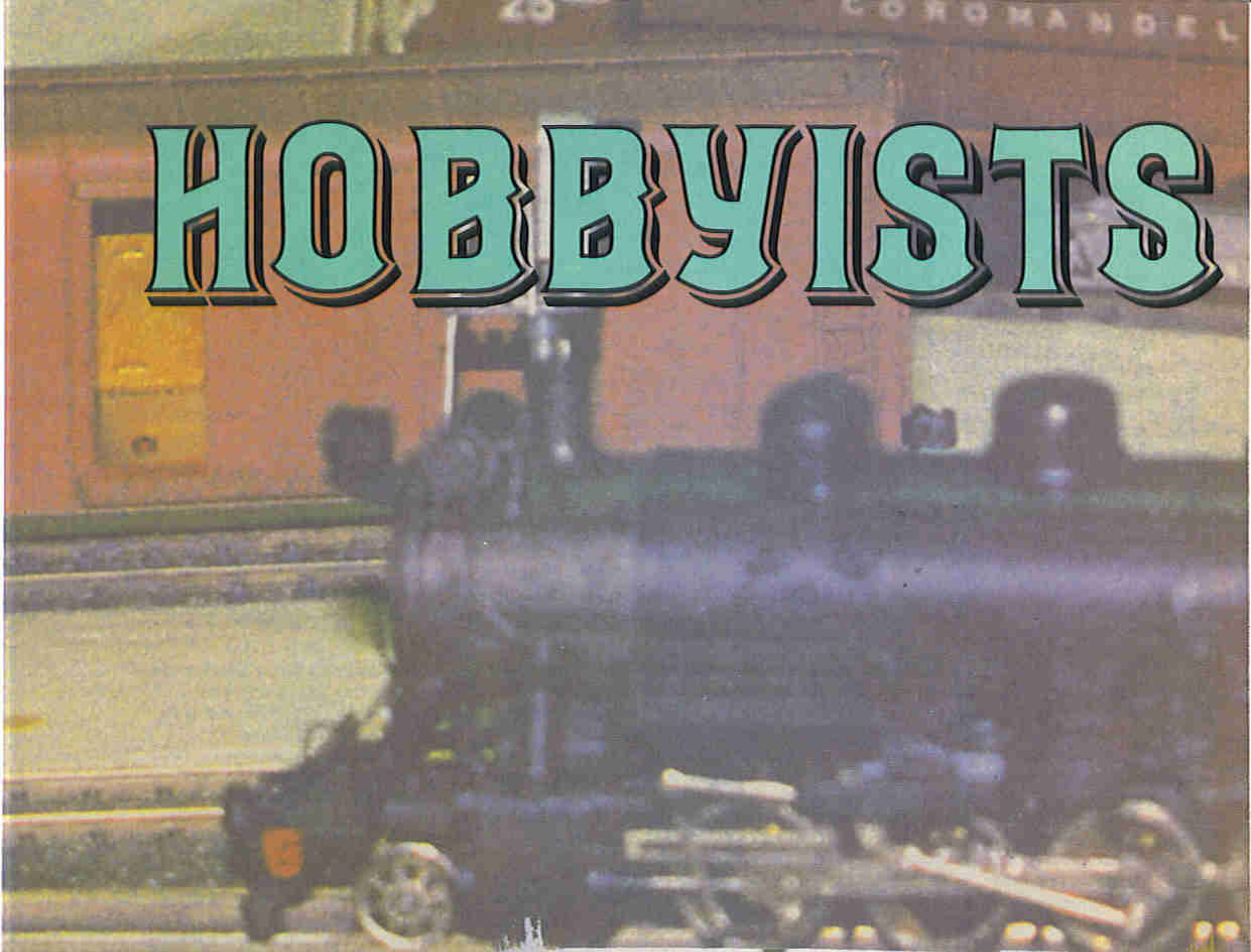
When tuning-in RTTY signals with a different shift to the one set on the demodulator the lock cannot be used. So tuning can only be guided by the response of the data LED and the text displayed on the screen. However, if you wish to maintain the lock facility on all shifts, one method would be to run three demodulators in parallel with a data select switch, see Figure 10.

If you would like to learn more about the subject, I would recommend contacting, The British Amateur Radio Teledata Group (BARTG), 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. Ferrell and published by Gilfer Associates Inc.

RTTY (FSK) DEMODULATOR PARTS LIST

Resistors: All 0.6W 1% Metal Film			
R1	2k7	1	(M2K7)
R2	470k	1	(M470K)
R3,4	4k7	2	(M4K7)
R5	510k	1	(M510K)
R6	100k	1	(M100K)
R7	68k (R7 SEE TEXT)	1	(M68K)
R7	120k (R7 SEE TEXT)	1	(M120K)
R7	270k (R7 SEE TEXT)	1	(M270K)
R7	47k (R7 SEE TEXT)	1	(M47K)
R7	82k (R7 SEE TEXT)	1	(M82K)
R7	180k (R7 SEE TEXT)	1	(M180K)
R8	18k	1	(M18K)
R9	120k	1	(M120K)
R10,11	470R	2	(M470R)
RV1	5k 22-Turn Cermet	1	(UH24B)
Capacitors			
C1,3	100nF Poly Layer	2	(WW41U)
C2	10nF Disc	1	(BX00A)
C4,7,9,12,13	100nF Minidisc	5	(YR75S)
C5	10nF Poly Layer (SEE TEXT)	1	(WW29G)
C5,6	27nF Poly Layer (SEE TEXT)	2	(WW34M)
C5,6	33nF Poly Layer (SEE TEXT)	2	(WW35Q)
C5	39nF Poly Layer (SEE TEXT)	1	(WW36P)
C5	47nF Poly Layer (SEE TEXT)	1	(WW37S)
C5	68nF Poly Layer (SEE TEXT)	1	(WW39N)
C6	22nF Poly Layer (SEE TEXT)	1	(WW33L)
C8	8n2F Poly Layer	1	(WW28F)
C10,14	22µF 16V P.C.Electrolytic	2	(FF06G)
C11	2µ2F 100V P.C.Electrolytic	1	(FF02C)
Semiconductors			
IC1	XR2211CP	1	(QY43W)
IC2	TLC555CP	1	(RA76H)
IC3	74HC132	1	(UB29G)
RG1	uµ78L05AWC	1	(QL26D)
D1,2,3,4	1N4148	4	(QL80B)
LD1	LED Green	1	(WL28F)
LD2	LED Red	1	(WL27E)
Miscellaneous			
S1,2	Sub-Min Toggle A	2	(FH00A)
PL1,2,3,5	Minicon Latch Pl 2way	4	(RK65V)
PL4	Minicon Latch Pl 12way	1	(YW14Q)
SK1,2,3,5	Mncn Ltch Hsg 2way	4	(HB59P)
SK4	Mncn Ltch Hsg 12way	1	(YW24B)
	Minicon Terminal	2 Pkts	(YW25C)
	P.C. Board	1	(GD94C)
	Veropin 2145	1 Pkt	(FL24B)
	DIL Socket 8 pin	1	(BL17T)
	DIL Socket 14 pin	2	(BL18U)
	Constructors Guide	1	(XH79L)

The parts listed above are available as a kit, (which is not shown in our 1989 catalogue).
Order As LM95D (RTTY Demodulator Kit) Price £16.95
The following item is also available separately:
RTTY Demodulator PCB **Order As GD94C Price £3.80**



HOBBYISTS

Many people enjoy spending their spare time constructing and operating model railway layouts and I am sure that most people have seen some of the superb layouts on show at railway exhibitions, which are staged throughout the country at various times during the year. Anyone who has an interest in model railways has probably envied some of the large and detailed layouts that were on show. For a few fortunate people, who have the time, space, expertise and perseverance, these magnificent feats of engineering and modelling can be realised in their own homes.

John McEnery and Peter Bawcutt are two such dedicated people, they crossed paths, quite by chance, at a local camera club meeting and their differing, but complimentary skills proved to be an ideal combination for creating many a young boy's dream; a fully working scale model of a railway network. John devises, designs and develops electronic circuits and control systems, which allow precise control and simple operation of the numerous items of rolling stock. Whilst Peter has directed his expert skills into engineering the layout, rolling stock, and designing and constructing many detailed buildings for the layout. The complete railway network

Peter Bawcutt & John McEnery

is built into the purpose converted attic of Peter's house. For John and Peter, both of them being retired, railway modelling is an ideal way to spend time creatively, demanding both forethought and painstaking attention to detail, as Peter demonstrated by explaining about the colour signals: "Originally the signals were fitted with miniature 'grain of wheat' filament bulbs, these are

IN ACTION

Reported by Robert Ball A.M.I.P.R.E.

Photo 1. Travel terminus and trains.

awkward to replace if they blow, so it was decided to substitute them with miniature LEDs. Normally, the condition of the signal is only visible frontwards from a relatively narrow viewing angle, to enable the signals to be seen from the control centre, the viewing angle was made wider by fitting the LEDs further forward." I asked both of them how they acquired their skills, and discovered that Peter spent most of his working life in the Middle East, involved with oil operations and engineering projects. Whilst John's expertise comes from his electrical and electronic engineering background, specialising in industrial process control systems. He remarked about the advances in electronic technology over the years, from valve technology, through transistors, leading onto integrated circuits and computers.

Peter originally started the laborious process of track-laying in 1979, incidentally there is an incredible 100 metres of track used in the layout! John became involved in 1980 and jointly, work on the layout has been continuing ever since. So far, all the track has been laid, with the inclusion of the electrically operated points and signals. The buildings have been constructed, namely; the main terminal building, offices and communications centre (featuring microwave communications dishes), engine sheds, signal box, generator shed, platform and diesel depot. To further add realism to the layout, other track-side necessities, such as the turntable, maintenance area, fuel storage tanks, pump house, fuelling point, water tower and freight terminal, have been included.

The original objective of the layout,

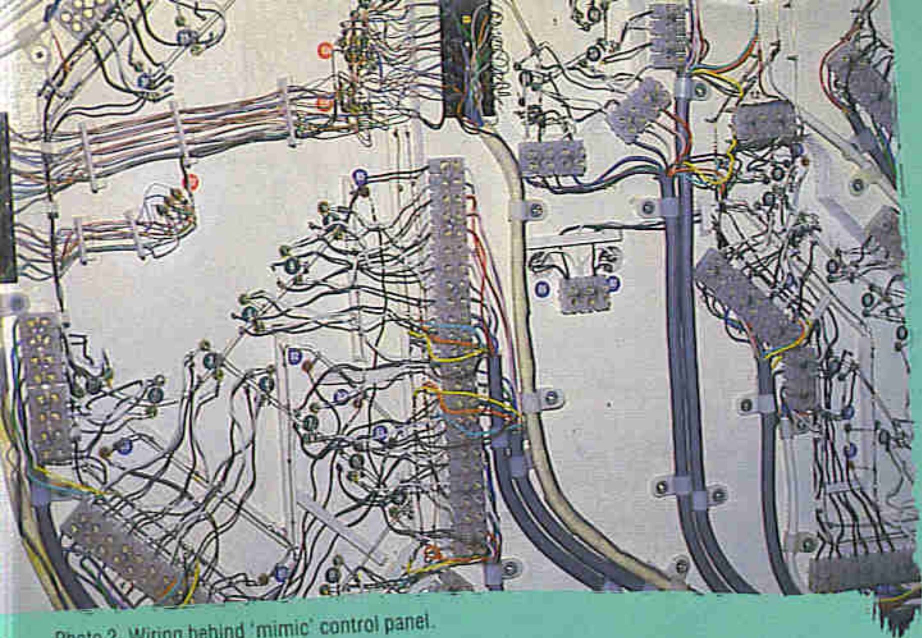


Photo 2. Wiring behind 'mimic' control panel.

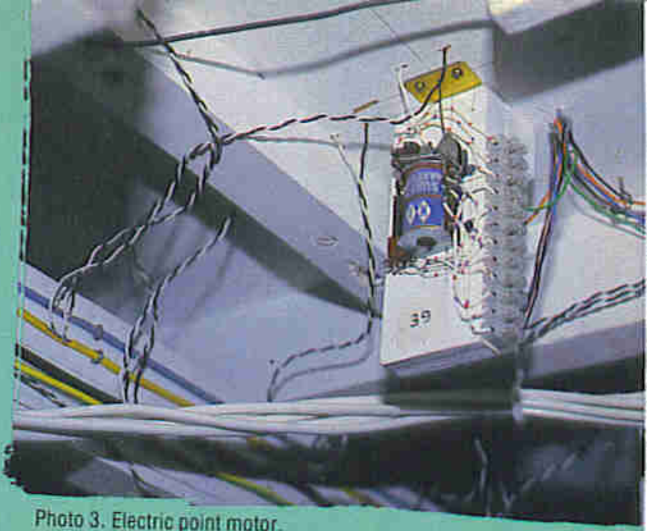


Photo 3. Electric point motor.

Photo 4. Decoupler control unit.

Photo 5. 'Mimic' control panel and Maplin digital train controller.

was to portray the operation of a small railway network in business and making a profit! Another high priority requirement was to have a relatively simple to operate control system, which permits one person to operate the system. The simplicity of operation is due to careful and thoughtful planning, and to some extent it is easy to overlook the amount of effort involved in creating such an amazingly detailed layout. Visitors, myself included, are normally 'itching to have a go at driving the trains!' Peter commented that it is usually the youngsters that manage to 'get the hang' of operating the layout without any difficulties, while the adults quite often have problems, forgetting to set the points and other similar things. Apparently, one particular 60 year old lady from the village is the exception to the rule, she has a particular knack at smooth starts and stops and shunting goods trains in the freight terminal! Quite early on in the planning stage, it was decided that the layout would be fully manually controlled, rather than having a computer control system, as this is much more interesting (fun!!) than just watching trains being controlled automatically.

One of the problems of modelling an existing railway network, is that the railway enthusiast is somewhat tied to the things that must be included or cannot be included, as some smart person will always comment on the fact that 'Kings Cross doesn't have an engine shed for Steamers'. To get over this problem Peter came up with the ingenious idea of creating an imaginary island, supposedly located off of the coast of Sri Lanka, he said that: "It gives us the opportunity to include just what we want to have on the layout, and not have to worry about sticking to what an established network has in terms of rolling stock and buildings. Some people who have seen the layout and map of the island think it is actually a real island. As the climate is hot, all the buildings have been constructed with this in mind, plenty of ventilation, sunshades and verandas to keep the sun off the sides of the buildings and off the windows. In similar hot climates, the buildings are painted white, for this reason so are the ones on the layout." The imaginary island is called Coromandel, after which the railway is named, not surprisingly a 'Coromandel Railway', the Capital of the island is Rajapalaiyam, where the main rail centre is situated. Theoretically the island is 17,023 square miles in area with a 'ghost' population of Tamil speaking inhabitants, estimated at 6,379,284 (1988). Such attention to detail really does give the impression that the layout is modelled on a real island railway, I must admit I was fooled. (Oh well, I never was any good at geography anyway!).

The nerve-centre of the layout is the control area, and it is from here that all the operations of the railway are controlled. Immediately facing the 'Operations Manager' is the 'mimic' control panel, which clearly depicts the layout in white on a black background, the status of the points, signals and whether there are trains in the sidings is

Photo 7. Steam shed.

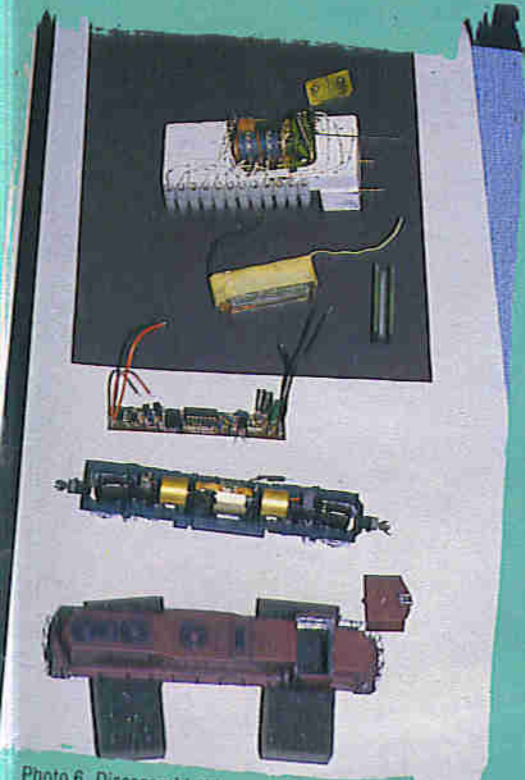


Photo 6. Disassembled locomotive, point motor, and decoupler.

Photo 8. Freight terminal.

indicated on the control panel by miniature coloured LEDs. Control of the points and signals is achieved by touching brass contact pins on the control panel with a probe, this completes an electrical circuit and sets the appropriate point or signal. Although this is a simple system, it is easy to use, effective and above all very reliable. The photographs show the intricate wiring behind the hinged control panel. The panel itself is metallic in appearance, but is in fact thin ply-wood, this is supported, to make it rigid, by a skeleton of thick ply-wood, again this can be seen from the photographs. Peter described some of the stages involved in the construction of the 'mimic' control panel, it clearly required a great deal of planning and the result is very impressive indeed. Above the panel is a 24 hour clock which runs at scale speed, this allows time-tables to be scheduled, there are no late trains on the C.R. Network! Immediately in front of the control panel, on the right hand side, is the control unit for the trains. The control unit is based on the Maplin Digital Multi Train Controller, details of which may be found on page 269 of the current catalogue, and full constructional details are given in Projects Book Two. I asked Peter and John why the Maplin system was chosen over the Hornby Zero One system; "Quite simply, the reasoning is that the Maplin system is favourably priced, can be tailored to exactly what we want and also there is the added bonus of the enjoyment of constructing the control system ourselves." On the left hand side of the control panel, there is an ominous looking black box, with a large red push button and a rotary switch, this is used to operate the electrically operated decoupling facility. A number of decouplers are situated near the platform and in the shunting area of the freight terminal, I was very surprised at the ease with which trains could be coupled, uncoupled and shunted, this was greatly assisted by the excellent low speed handling of the locomotives provided by the Maplin controller. The electrically operated decoupling units are home made and are built out of machined cast iron blocks, around which is wound a coil of enamelled copper wire. A neat feature in the sidings is the use of an optical detection system which allows sensing of the presence of trains in the sidings, this is indicated by red LEDs on the control panel and proves very useful for positioning trains in the sidings without having to turn round in the 'drivers seat'. John commented on further improvements, "At the moment, cadmium sulphide photoconductive cells are used for the sensing, I hope to use some kind of proximity detector in the future, as these can be more easily concealed."

I looked underneath the layout, which revealed the miles (well almost!) of wiring in cabling looms. These cables provide power to the track, control signals to the point-motors, signals and decouplers, and return signals from auxiliary contacts on the points and train presence detectors. All the wiring is very neat, with cables and terminal blocks numbered and labelled to facilitate easy

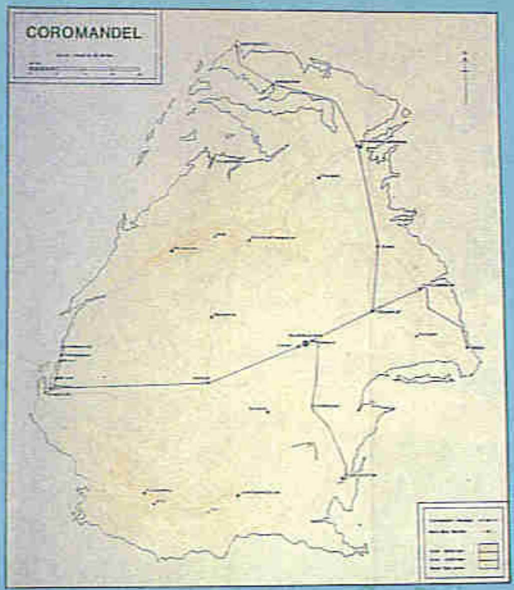


Photo 9. 'Coromandel' island map.

Photo 10. Diesel shed.

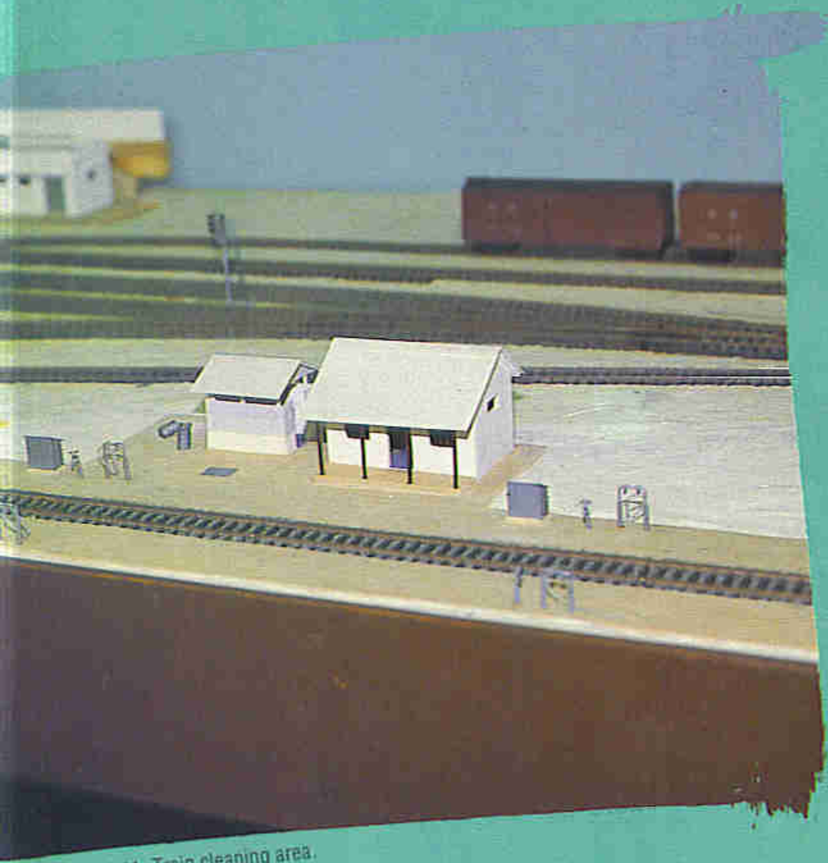


Photo 11. Train cleaning area.

Photo 12. Travel terminus.

tracing of wires. One particularly interesting idea is the use of remote sensing on the points, this is provided by a set of auxiliary contacts on the point motor, which means that the LEDs on the control panel indicate the true condition of the points, if a point jams, this can be seen from the control panel; a good safety feature which prevents de-railments. Whilst I was examining the wiring, John and Peter passed on a few tips. "One of the problems that often plagues model railway layouts is poor electrical conductivity, causing the trains to stop, this can be due to a number of reasons, high resistance connection between sections of track, dirty track and dirty electrical contacts on the trains. This can be easily solved by running a pair of wires in a loop around the length of the circuit, effectively a low voltage 'ring main', the wire should be thick to avoid voltage drop due to resistance. At intervals, feeders can be taken from the loop pair and connected to the track. To keep the track clean, cover the layout when it is not in use; sheets of newspaper laid across old coffee jars is a simple but effective solution. Cleaning the track itself, if it becomes necessary, should be carefully done, use very fine emery paper. A lot of people use a coarse grade, all this does is score the surface and trap dirt. The locomotives themselves should be kept clean and all the electrical contacts and mechanical bearings kept in good order."

With the amount of attention to detail, it is not surprising it has taken years of work to build the layout. Peter mentioned, "The next task is to concentrate on the scenery, now most of the track, buildings, and electronics are complete." Apart from the layout itself, which boasts over 200 items of rolling stock, 16 powered locomotives and railcars and 5 unpowered, 46 electrically operated points and 11 signals, the control panel is a masterpiece of planning and engineering. Model railways proves to be an ideal area to combine mechanical engineering skills and electronics. The result can be very impressive indeed.

New Products

Pocket LCD Colour TV

This amazing pocket sized colour TV uses the latest state-of-the-art LCD and SMT technology to give you a crystal clear colour picture on its V49mm flat LCD display, with electro-luminescent backlight. Measuring just 130 x 81 x 31mm and weighing 330g, it has electronic auto search tuning with an on screen tuning indicator and a telescopic aerial. Other controls are ON/OFF, Volume, Brightness and Colour. The internal loudspeaker gives good quality sound reproduction and for private listening a headphone jack socket is provided. There are also inputs for an external aerial and 6V DC from a special mains adaptor or car adaptor. Power requirements, 4 off AA sized alkaline cells (FK64U), battery life is approximately 3 hours.

Supplied with 4 test batteries (1 hour life) and a soft case. TV is compatible with UK standard PAL system 1 transmissions.

Order As YT76H (Casio TV-400)
Price £99.95

LCD Colour TV

This desk-top colour TV uses the same technology as the Pocket LCD Colour TV (left) but features a larger V66mm flat LCD display. The TV measures 93 x 92 x 47.5mm and weighs 425g, it has electronic auto search tuning with an on screen tuning indicator and a telescopic aerial. Other controls are ON/OFF, Volume, Brightness and Colour. The internal loudspeaker gives good quality sound reproduction and for private listening a headphone jack socket is provided. There are also inputs for an external aerial and 9V DC from a special mains adaptor or car adaptor. Additionally there is an audio/video input jack, which allows the TV to be used as a high quality colour monitor, for example, with a colour video camera. Power requirements, 6 off AA sized alkaline cells (FK64U), battery life is approximately 4 hours. Supplied with 6 test batteries (1 hour life), an earphone and a soft case. TV is compatible with UK standard PAL system 1 transmissions.

Order As YT77J (Casio TV-6500)
Price £149.95

LCD Colour TV 12V Car Adaptors

These 12V car adaptors allow both of the LCD Colour TVs (YT76H & YT77J) to be operated off 12V DC from a car cigarette lighter/accessory socket, thus conserving internal battery life.
YT79L (for use with YT76H): Output: 6V DC, Input: 12V DC.
YT81C (for use with YT77J): Output: 9V DC, Input: 12V DC.

Order As YT79L (Casio CA-K65)
Price £14.95
Order As YT81C (Casio CA-K90)
Price £14.95

LCD Colour TV Mains Adaptors

These AC mains adaptors allow both of the LCD Colour TVs (YT76H & YT77J) to be operated off 240V AC mains, thus conserving internal battery life.

YT78K (for use with YT76H): Output: 6V DC, Input: 240V AC.
YT80B (for use with YT77H): Output: 9V DC, Input: 240V AC.

Order As YT78K (Casio AD-K65)
Price £19.95
Order As YT80B (Casio AD-K90)
Price £19.95

Video Camera Colour Monitor Adaptor

An innovative adaptor kit for use with the LCD Colour TV (YT77J only), which allows it to be used as a monitor on a colour video camera. The adaptor kit contains a swivel bracket, shoe mount, inter-connecting lead, two cable adaptors and a small cross point screwdriver. Now at last, recordings can be monitored in full colour.

Order As YT82D (Casio OS-51M)
£34.95

Pocket Sized Personal Computer

Personal computer, with Enhanced BASIC and 116 built-in scientific, mathematical and statistical software utilities. The computer has 8k bytes of memory on board which is expandable to 40k bytes with an optional memory (RAM) pack. The character display is in the form of a 32 column by 2 line LCD dot matrix display, with a contrast control and has a very wide viewing angle for ease of use. The computer doubles as a 51 function scientific calculator and also includes a multi-function data bank. The powerful BASIC interpreter allows variable names up to 15 characters long and n-dimension arrays. As well as the optional RAM pack, there is also a multi-purpose interface unit for communicating with the outside world. Dimensions 196 x 85 x 15mm (including cover).

Supplied complete with a protective cover, batteries and a 406 page manual.

Order As YT74R (Casio FX-850P)
Price £89.95

Multi-Purpose Interface

A plug-in multi-purpose interface unit for use with the FX-850P personal computer, this interface features industry standard, parallel Centronics printer interface and serial RS232C interface. The unit also allows connection to a cassette tape recorder for program and data storage. This unit dramatically increases the versatility of the FX-850P personal computer and opens up a wide range of possible applications. Supplied with batteries, interface leads are dependant on application and for this reason are not included, however a range of accessories is available.

Order As YT75S (Casio FA-6)
Price £79.95

32k Byte RAM Pack

A plug-in 32k byte RAM expansion unit is available for use with the FX-850P personal computer, this expands the memory capacity to 40k bytes.

Order As JL90X (Casio RP-33)
Price £39.95

Accessories

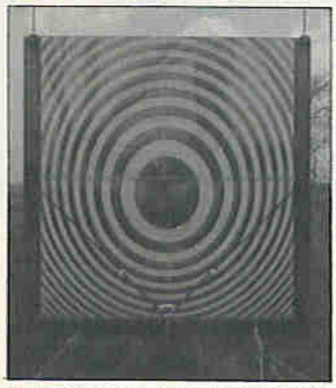
14 way to 36 way parallel Centronics printer cable:	FV93B	Price £8.95
RS232 male to male cable:	JC12N	Price £7.95
RS232 male to female cable:	JC13P	Price £7.95
RS232 wiring box:	YP79L	Price £9.95
RS232 jumper box:	YP78K	Price £5.75

NEWS REPORT

Nothing New Under the Sun

In our constant quest for up-to-the-minute information on Satellite TV, our intrepid reporters have braved travel against all odds (33 mile M25 traffic jams!) to gather the latest news... Much of the news recently has concentrated on the activities of Astra and BSB satellites and their respective aerials, with comments, news reports and advertising flying back and forth like punches in the Bruno – Tyson fight. Each company is singing its own praises over the number of channels available, variety of programming content and technical superiority; has anyone seen a working BSB Squarial yet? Recent information about BSB indicates plans to increase the number of transponder channels used, this suggests less transmission power and a corresponding (large) increase in the size of the Squarial. BSB has still to secure production rights on the Squarial, the company that developed the novel miniature aerial, Fortel and industry as a whole is fast thinking that BSB has become a victim of its own hype. Moral – don't let the advertising people make promises you cannot keep.

Whilst all the attention has been focussed on Astra and BSB, a small company, Mawzones Ltd, based at Ashwell in Hertfordshire, has developed a new range of satellite reflectors that look set to take the market by storm. Their product has been under development for many years and it just-so-happens that increased interest in satellite, particularly satellite TV, has coincided with the launch of their product, the Mawzone Zone Plate. The Zone Plate has many



applications in the field of satellite and microwave communications, including provision of low cost C Band aerials for 3rd world countries, giving access to international communication satellites. The conventional satellite receiving equipment requires a parabolic reflector (dish) to collect and focus the radiated signal from the satellite, even now, with high power satellite transponders, the receiving dish still has to be of fairly large proportions, and is at best un-sightly. Many arguments are ensuing with residents, local authorities and environmental protection groups about the siting of satellite dishes. Legislation currently states that a satellite receiving aerial over 90cm requires planning permission and that only one receiving aerial may be installed, (you cannot have separate Astra and BSB aerials). The Mawzones Zone Plate is completely flat and works on a very old principle discovered by the French Scientist A. J. Fresnel over 160 years ago! The optical Fresnel lens is in common use and can often be seen on the back-window of buses and caravans to increase the field of view from the rear-view mirror. The lens is flat and features an arrangement of concentric rings. The effect can also be applied to microwave signals and in this application lends itself to focussing the Ku band microwave signals from satellites. The Planar Fresnel Zone Plate is constructed on a durable sheet of plastic, on to which is printed a metallized pattern of concentric rings. The exact shape of the rings or ellipses depends on geographical location, the contours are calculated from very complex mathematical formulae, needless to say a computer is used. A range of 10 'preferred' patterns is sufficient to cover all requirements, the appropriate one being selected for each installation. The concentric rings are alternating regions of transmissive media and reflective media for the microwave signal. The effect of this is to diffract the signal and the resulting electromagnetic interference pattern brings the microwave signal to a focus. Depending on construction the Zone Plate can be transmissive, i.e. the signal is focussed behind the Zone Plate or it can be reflective, i.e. the signal is focussed in front of the Zone Plate, this also gives extra signal gain and therefore for a given satellite transmission power, a smaller reflective Zone Plate is require than with the transmissive type. The Zone Plate effectively replaces the dish with an entirely flat plate which can be fixed flush against a wall or roof (either flat or sloping) the plate can be painted to match the background and therefore is bound to win favour with everyone who is environmentally conscious or simply hates the sight of a conventional dish. It must be remembered that the Zone Plate is just the reflector part of the aerial and not the receiving element itself. The signal is actually 'picked up' by a unit called a Low Noise Block Converter (LNB) attached to which is a feed horn which directs the signal onto the receiving element. Another distinct advantage which is exhibited by the Zone Plate is the wide acceptance angle for the incoming signal, consequently alignment is much easier than for a conventional, highly critical dish. The signal is down converted from 10.96 to 11.70GHz (Astra) by the LNB, to 0.96 to 1.70GHz, which is then fed via the downlead to the receiver unit. Initial reactions to the Zone Plate from many people were that of incredulity, 'how can a piece of plastic with rings on it receive satellite TV?'. Having attended official demonstrations at the DTI's Satellite Monitoring Station at Baldock, Hertfordshire, it can be confirmed that the Zone Plate does work. Watch this space...

Aircraft Phone Home

In a venture which would no doubt appeal to 'ET', it is now possible to 'phone home' from the confines of your BA Jumbo Jet. Skyphone is a satellite based telephone service which uses Racal Decca terminals and GTE airbase cordless handsets. The service which makes use of the global system of Inmarsat satellites, is expected to go fully commercial on a number of airlines later this summer.

Pocket-Sized PC at A Pocket-Sized Price

Atari made the news at this year's 'Which Computer? Show' with the introduction of the British designed, pocket PC, selling for under £200 (just!). The 80C88 based workstation weighs in at 450 grammes (with batteries) and is fully MS DOS compatible. The result of a two year development period, the IBM compatible hand-held computer, The Atari Folio,

features a large screen, standard QWERTY keyboard and a long battery life. Applications software includes a Lotus 1-2-3 compatible spreadsheet, diary, calendar and alarm clock, address and phone book. Folio makes use of a credit card sized memory card for data and program storage and has a capacity of up to 128k Bytes – equivalent to 50 pages of A4. The company hopes to sell over 500,000 of the Japanese produced units over the next twelve months. Atari have joined the office and home PC market by introducing a range of IBM compatible desktop PCs to complement their top selling range of ST computers. The range, designated PC 2 to PC 5, also includes the PC Folio. The PC 2, based on the 8088 Intel processor running at 8MHz, has 512k Bytes of RAM, EGA, CGA and HGC graphic modes built in, an internal 30M Byte hard disk, 5.25 inch floppy disk drive, mouse controller, 2nd drive port and 4 expansion slots. The specifications rise with the numbers (as does the price!) culminating in the PC 5 based on the 80386 32 bit Intel processor, running at 16MHz, with 1M Byte of RAM, an internal 60M Byte hard disk, 5.25 inch floppy disk drive, mouse controller, real time clock and 4 expansion slots. Optional video cards are VGA, EGA, CGA, MDA and HGC. Prices range from £550 to £2,600 exc VAT.

Meanwhile, other major 'Which Computer?' highlights include a 25MHz 80386 computer from Zenith, and a new laptop computer from Samsung. The laptop, which comes with a smart carrying case, has a single 32M Byte hard disk and a 3.5 inch floppy disk drive and can be expanded from 1M Byte to 4M Bytes.

IBM Break More Memory Chip Records

In our last issue, 'News Report' featured the high speed CMOS circuits, with parts some 300 times smaller than a human hair, developed by IBM. Their laboratory teams however have not been relaxing. The 'true blue' company has now developed a practical prototype 128k Bit SRAM (Static Random Access Memory) with the fastest data rate yet reported – more than six billion bits of data per second. The chips record data rate, results from 'pipelining' a technique that treats data like a stream of marbles rolling through a tube. Unlike most memory chips that can only do one thing at a time; receive information (write), or send (read) the new IBM chips can do them simultaneously. Data can be written or read into this pipelined chip in five billionths of a second – the chip's cycle time. Access time is 6.5 billionths of a second – the time it takes data to go through the 'pipe'. Modestly for IBM, the company mentions than "Others in the semiconductor industry had thought such an unlikely achievement unlikely or impossible at the speed achieved by the IBM chip".

Crossed Lines

The latest update on telephone numbering (see our previous two issues) are that BT is now planning to divide London into two zones, central and outer, using the numbers 071 and 081 (respectively). But one industry expert thinks that the authorities should take the opportunity to examine the whole UK telephone numbering system. Martin Griffiths who is currently converting his medieval barn in Penrhos, Hereford, into a high tech conference centre, says that otherwise, our carphones, cordless phones, home and office units, will find themselves being automatically connected to a Chinese take-away, the Channel Tunnel excavation teams or with luck, the MAPLIN CAShTel service. With ever more telephone services jostling for numbers, a radical rethink is necessary if we want to avoid 21 digit personal numbers.

Sky High Cards

There may be yet another card to add to your collection of 'plastic', along side of the Access and AmEx cards, with the new Sky TV Smart card. The microchip embedded card will record subscribers use of Sky satellite channels when a subscription service is introduced later this year.

France Scores in Telephone Costs Survey

Should ET and friends decide to touch down in Europe, they would be well advised to select France as their landing zone. A new study from OFTEL reports that France has by far the lowest telephone prices of the four main European business countries. West Germany also scored well in the survey, with the UK and Italy completing the cost tariff league.

Advanced Pin Printer

Claimed to be the world's first 48 pin dot matrix printer, the Epson TLQ4800 is a heavy duty, continuous run machine which has a print resolution of higher than most laser printers. The new Epson has a draft speed of 300 cps and a letter quality speed of 100 cps, both at 12 cpi. Ten print styles are available and there are 14 international character sets. The price of producing high quality Dear Sir... letters is an equally high £2,199.

Facts on Fax

Facsimile sales continue to amaze the industry. According to the Federation of Microsystems Centres who know about such things, fax sales are averaging 1,000 every working day. This means that by 1990, the number of UK users could be nudging the one million mark. Contributory growth factors says Cannon (UK), one of the UK's leading suppliers of fax equipment, include highly competitive pricing, user friendly technology (if the boss can use a photocopier, then he will qualify for a fax proficiency badge) and compact, reliable equipment. Meanwhile, news from the States, courtesy of the ever vigilant Federation, suggests that with a three second transmission speed for an A4 size page now feasible and with the emerging range of fax machines able to tell the difference between voice and data calls as well as acting as an answering phone and interfacing with a PC, fax is proving to be the office automation pace-setter.

Shock (Horror) Report

Did you know – or suspect – that nylon tights, knickers and slips can blow your micro? No? Well a six month survey into such matters have reported that loose nylon tends to be dry and when rubbed together, can generate a charge of several thousand volts. It can only take a few hundred volts to kill a microchip. Although nylon undies have been known to send men wild, this is the first report of knicker generated static affecting desk top micro's, says fashion designer, Kathryn Arora. Her low-tech solution: Wear cotton underwear if you want to avoid a shocking time at the keyboard.

Chit-Chat

At least Martin's car telephone will not find itself connected to a BT Chat Line. Earlier this year, the corporation suspended the heavily criticised service, pending finding a long term solution to the associated problems. One such solution on the cards, suggests Martin would be the introduction of credit card dialling. More a case of 'pay now and chat' rather than 'chat now and pay later'.

Once BT has got its much delayed digital network up and running, such a charging facility could become commonplace, not just chat lines but all interactive charging services such as reservation bookings and high street shopping. Martin does however welcome the move by BT to pay customers £5 for every working day that installation or repair of a telephone line is delayed beyond the second day. In particular, the accepted liability of up to £1,000 per line for residential customers and £5,000 for businesses where actual financial loss can be proved. It looks like BT's legal department could be in for a busy time.

Big Sound – Big TV

Sharp have just announced a new TV set into their range, with one of the key selling points being much improved sound performance over normal TV receivers.

The new Sharp large screen TV incorporates two loudspeakers, plus a built in 'Super Woofer' amplifier circuit. There are also separate output terminals for connecting external speakers. The internal amplifier is rated at 50 Watts MPO (17.7 Watts RMS) per channel. The big screen, fully remote control 99 channel TV set features a sleep timer to switch off the TV should the sound level at the end of transmission fail to keep you awake. An interesting feature, one not necessarily recommended when watching Wimbledon tennis, is a channel flashback, which allows you to 'volley' between two channels. Recommended price is £499.

Good News at last for Amstrad

Amstrad look like bouncing back from what has proved to be a disappointing trading year – profits were off 16% – by resourcing manufacturing facilities and introducing new products. The company has moved some of its Taiwanese manufacturing operation to China and Malaysia; implementing local component sourcing procedures in Europe and developing a range of domestic telephone equipment in Spain. Meanwhile, Amstrad are getting to grips with its satellite dish products, which are now reaching the high street stores.

Compaq Gets the Vote

In two separate industry polls, Compaq Computers has been voted supplier of the year. Products highlighted were the Deskpro 386/25 and SLT/286 portable. Compaq is now forecasting that the European PC market can be expected to double by 1992 at which stage it will equal the size of the US market. Good news for IBM who hold a near 30% of the market share; Olivetti with 9%, Apple 8% and Compaq itself with 7%.

A Load of...

The chips were certainly stacked against one of the worlds best known computer companies, Honeywell, when it joined forces with the French computing group, Bull. Before you could say 'world-wide information systems', Honeywell became Honeybull. Now it is to be known as plain Bull. The company admit that the word bull is not one associated with high-tech and digital dynamism. To help spread the new image, Honeywell – sorry! Bull – has been spending over £1m promoting the Bull message over poster sites and much of the national and computer press.

Soldering On

Multicore Solders have developed a range of standard optimum grade solder creams which are suitable for most SMT operations. Applications covered include all standard tasks in surface mounting electronic components on printed circuit boards and hybrid circuits by screen/stencil printing, automatic dispenser or hand application. The Multicore product is approved by the Ministry of Defence, BT and many international standard forming organisations.

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 8th June 1989.

VARIOUS FOR SALE

RADIO and other bits sale, BBC computer system, FT902DM system, HF-portable manpack, 40ft mast, portable masts, Sony ICF7600D, PK88, 4CX250Bs. May swap for PC1512/1640, Norfolk/Suffolk/Yorkshire, S.A.E. for lists to CLASSIFIED (Box 10), Maplin Electronics, P.O.Box 3, Rayleigh, Essex. SS6 8LR.

TELEQUIPMENT DM64 Storage oscilloscope. £220 Tel: 01-568-6014.

MEGGER METERS Two, both are model 70143, one is nearly new and the other for spares £60 o.n.o. Also ac/dc 0 to 0.5A ammeter in case, old model 5938522. Mr S. Fowell. 5 Woodward Road, Dagenham, Essex. RM9 4SH.

BEARCAT SCANNER BC950XLT. 29-54MHz, 118-174MHz, 406-512MHz, 806-956MHz 12V base/mobile, one month old, unwanted present, £200. Tel: Keith (0272) 685767 (evenings).

XLR AUDIO LEADS & PLUGS, 12 socket XLR stage box, 4 core H/D lighting cable, Maplin noise gate, Multicore audio cables, Amstrad ROM board (Maplin), Amstrad 6128 computer, offers? Tel: (0928) 581429.

ELECTRONIC TV VIDEO ENGINEERS LIBRARY. For sale at crazy prices, S.A.E. for list. Robinson. 10 Bramble Way, Beehive Park, Leavenheath, Nr Colchester, Essex. CO6 4UN.

6 MAPLIN LASER TUBES. Brand new and unused – from unfinished project. Cost £70 a piece. Will sell for £45 each. Cheques to A. Charity, 2 Riverside Park, Northwich, Chesire. CW8 1DS.

OSCILLOSCOPE. Crotech 3132, 20MHz, dual trace. Top quality, as new. £200 o.n.o. Also Signal generator. Sine/square, 13Hz-200kHz. Good quality. £35 o.n.o. Tel: (0782) 783310.

FOR SALE. B/W Sharp video camera £40, R TOR video & tapes (faulty) £15. 70 cm Tx + 10W P.A. (needs modifications) £55. Fidelity stereo turntable & speakers £8. All for £100, P & P extra. Tel: M. B. Partridge (0606) 888863.

MAPLIN GOLFBALL Printer interface board (GB97F) all Rs and Cs fitted. Abandoned project – only £15. Tel: Ian (0965) 20033.

BARGAINS!!! Commodore / Spectrum computer games, over 40% off retail prices, 500 original games. Also VHS movie videos. Send S.A.E. for price list. Simon Duvnjak 49 Ivy Road Leicster. LE3 0DF.

CUPBOARD CLEARANCE. ICs ,capacitors, resistors, veroboard etc. £5 per pack, please indicate any preference to pack contents. Orders to C. Ashley, 7 Grafton Road, Ellesmere Port, Cheshire. L65 2BD.

MAPLIN MOSFET AMP, good working condition £25, also Denco coils, D.P. green ranges 3, 4, 5 three only, £1 each. M. Payne, 294 Whiteleas Way, South Shields, Tyne and Wear.

TWO SOLARTRON CD1183 Oscilloscopes. 1) CRT o.k., but timebase faulty. 2) Believed unserviceable. Ideal for spares valves, etc. Offers welcome. Please write to G. Mays, Rayford, Chobham Road, Knaphill, Woking, Surrey. GU21 2TD.

GREEN LEDs (YY46A) 6p each and RED (YY45Y) 8p each & S.A.E. to William Goss, Traxx, 9 Ranelagh Gdns, Southampton, Hants. SO1 2TH.

COMPONENTS. Due to storage problems I have to get rid of many components, ICs, transistors, resistors, capacitors etc. Send S.A.E. for details to J. Bellarby, 13 Westfield Rd, Stonehaven. AB3 2EE.

SCANNER. Signal R535 V/UHF Air Band. 108-142MHz, 220-306MHz inc. mobile aerial £190. Also REALISTIC PRO30 66-88MHz, 108-136MHz, 138-174MHz, 380-512MHz, hand held £120. Tel: Keith on Bristol (0272) 685767 (evenings).

HUGE LIST OF MAPLIN and other projects, built and working & lots of odd bits. Must sell – moving house! Ring me and I will post a list. Richard 01-949-6020.

LEAK STEREO 20; Varislope preamp (both working); Leak Throughline stereo tuner faulty; Radford SCA30 amp and Armstrong 526X £200 o.n.o. Tel: (Southend) 0702 76019.

UM1286 Modulators £3.50 each, MC1377 RGB to composite video ICs £3.50 each, 13 pin Atari monitor plugs £2.00 each. Tel: 0743-240226.

BUGS! Miniature FM Transmitters, match box size, built to order, tested and working. £10 c.w.o. to K. K. Cheuk, 71 Cunningham Road, Doncaster, South Yorkshire. DN1 2BP.

MINOLTA 7000 & 4 lenses 28mm-210mm & flash & back 70. Used once. Boxes & manual. Offers? Tel: Leslie 089 081 529 (evenings). Swap or cash. (need new scope).

LEAK THROUGHLINE 3 stereo tuner black & silver £25. Heathkit 'scope mains transformer. part no. 54/536. New £10. Tel: 0342 842617 (Surrey).

COMPLETE MAPLIN BURGLAR ALARM KIT. Includes everything needed bar cable and contacts. Genuine reason for sale, excellent condition, worth £150, will accept any reasonable offer. Tel: 0203 329723.

CLEARING OUT, Powertran Vocoder, Maplin 4600 synth, Garrard 401 & SME arm, N1700 video. Offers? Tel: 01-805 2566.

MAPLIN ROBOT (XJ06G). Fully assembled and tested. As new condition. Complete with remote control and manuals. £25 o.n.o. F. Wright, 29 St Andrews, Houghton-le-Spring, Tyne and Wear. DH4 5NT.

COMPUTERS

ATARI 400/800, data cassette, BASIC, games, ZX81, ZX Spectrum & software, speech synth, microdrives, Acorn Atom, Ace Forth micro, RAM pack, '81 RAM pack. Airmec valve voltmeter (very old), assorted radio valves. Michael Tel: (0604) 56380.

RIBBONS (unwanted auction lots): Amstrad PCW9512 nylon, 5 for £12. 8mm film: Group 709: 6 for £11. Group 2686: 4 for £2.50. Worth recassetting at this price. Post incl. Tel: 0209 890688.

COMMODORE 64, MPS801 printer, 2 cassette decks, joystick, over £250 worth of original software and loads of books, magazines and accessories. Excellent condition, only £200. Tel: Nottingham (0602) 892043.

PHILIPS P2012 CPM2.2 PORTABLE. Built in twin 720k floppies and 9 inch green screen. Wordstar, calcstar, cardbox, ABASIC, EBASIC, TTY, lots of PD software, 50 blank disks. Complete with manuals. With silver reed daisywheel printer and ribbons. £350. Tel: 0929 462634 (Wareham, Dorset).

SPECTRUM+, Microdrive, Interface 1, Serial 8056 Printer (Full width), Cassette recorder, Cheetah Joystick, M/D cartridges, tapes, books, magazines, etc. Paid £400, will accept £200 o.n.o. Jonathan White, Tel: (0872) 865176.

MUSICAL

BAKER 12 inch deluxe speaker, foam surround, never used £10. WB 10 inch cambric cones. Good condition £14 pair. All post paid, original boxes. Write to Mr Cox, 1 Hollincross lane, Glossop, Derbys. SK13 8JQ.

CASIO SK1 SAMPLING KEYBOARD and mains adaptor £40 o.n.o. or swap for any electronic/computer bits. Tel: (0443) 408270 or (0432) 353956.

FOR SALE, Maplin Matinee organ built up. Slight fault on auto rhythm section. Very good condition, all manuals and stool inc. £200 o.n.o. Tel: Lowestoft (0438) 581129.

CASIO CZ-230S Preset synth 100 voices MIDI compatible. Boxed with manual £95 carr extra. Tel: 0436 71181.

RHYTHM CHIPS Hammond 'U30' £10. Maplin M254 & M251 £15. Divider Chips TDA 1008 – 12 off £10. Seon Smyth 'De Porres', 67 East Princes St, Helensburgh. G84 7DG. Tel: 0436 71181.

5600S SYNTHESISER partly built includes case all boards but needs finishing. Selling due to change in interests. £500. £450 if collected. Tel: 0780 64331. Ask for Sean Watson. Working hours only.

WANTED!

WANTED BOOK to buy. Easy add on projects for the Vic-20 etc. Code BP134. Author Owen Bishop, send details to Michael Kay, 27 Fyfields, Pitsea, Basildon, Essex. SS13 1HJ.

WANTED, circuit diagram/handbook for Cossor 4100 oscilloscope. Tel: Jon Lees (0603) 400516 daytime, 783434 evenings.

WANTED. Service book or copy for Sharp 10P – 18H TV/Cassette/Radio, esp. mechanical details. Tel: Tim on 0482-881978.

WANTED: Circuit diagrams for ZX Spectrum, Telequipment Servicescope oscilloscope, BBC B second processor. Any other information appreciated. R. Clark, 29 Knightscroft Ave, Rustington, West Sussex. BN16 2HN.

WANTED – Sinclair ZX81 ROM disassembly, (Ian Logan) & Understanding your ZX81 ROM (Logan) and any other machine code books for the ZX81. Call Ian 031-339-2163.

WANTED. GPO induction coil No. 14 and instrument cord No. 222 for telephone restoration. M. Alder, Laurel Cottage, Brewery Lane, Thrupp, Stroud, Gloucestershire GL5 2EA. Tel: 0453 884451.

WANTED. Acorns radio control servo type AS 1 or type AS 2. Also servo lead extension cable to fit this type of servo connector. Good price paid. Mr Thompson. Tel: 0723 584028.

WANTED. Copy of book 'Interfacing the Apple' also details of FAX. Packet or other radio software. Please contact. L. Elstone. 21 Crescent Gardens, Ivybridge, Devon.

WANTED. R.C.A. AR88 audio output transformer. Part no. K901666-501. Tel: Nottingham 282818.

WANTED. Quad, Leak or Rogers stereo amplifier and/or tuner. Mr Nott, 47 Roseberry Crescent, Great Ayton, North Yorkshire. Tel: (0642) 723204.

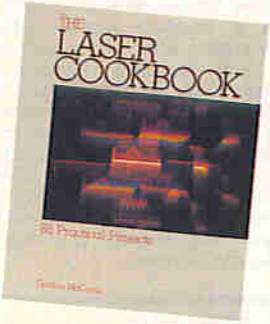
WANTED. Heathkit oscilloscope model OS-2, circuit diagram and/or manual required. Buy or loan to copy. Reasonable expenses met. Tel: 051-220-0440 6PM-9PM.

WANTED. Mains transformer for Heathkit CRO model no. 10-104 tx part no. 54-285. Tel: 0766 522471 after 7PM.

THIS IS A DESPERATE plea for transistor tuning coils 2, 3, 4, 5T Red, Blue, Yellow or White. I can't get hold of them anywhere. Please will someone help? Phone 0767 81680.

WANTED, to buy a main motor for AKAI c/tape recorder model GXC-41D. This model is very old. Contact Mr Elvis Mein, Foret Noire, Mahe, Seychelles, Tel: 21807.

NEW BOOKS



The Laser Cookbook 88 Practical Projects

by Gordon McComb

Inexpensive projects that span a wide range of practical uses. From phone lines and videodiscs to surgical procedures and optical computing – the laser is one of the most important inventions to come along during this half of the 20th Century. This book gives you this opportunity to investigate, first hand, a relatively new and evolving science. With this book you can create and experiment with simple to advanced level lasers that have real, practical applications! The 88 laser based projects presented here are geared toward the workshop experimenter on a limited budget. Spanning a wide range of disciplines, the projects vary from experimenting with laser optics and constructing a laser optical bench to using lasers for light shows, gunnery practice, even beginning and advanced holography. High quality laser art illustrates instructions and detailed project parts lists put all the information you need to get started right at your fingertips! There is even information on electronic construction techniques... how to buy laser components... when to buy surplus or new... and how to get what you really want! Many of the topics covered are ideal for science projects as well as teaching tools for anyone interested in learning how lasers work and what they can do. Gordon McComb is an avid laser hobbyist and electronics experimenter. He has written over 1,000 magazine articles and a dozen books. Please note that this is an American book and references to mains voltages obviously do not apply in the UK.

1988. 404 pages, 189 x 234mm, illustrated. American book.

Order As WS35Q (Laser Cookbook) *Price £14.25NV*

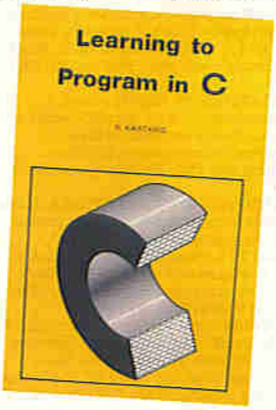
Basic Electronics

by David Parsons

This book introduces the reader to the main areas of electronics, to electronic components (and how they are used in systems), to fault finding and to safety in electronics. Basic Electronics provides a good entry point into electronics from an absolute beginners level, with many diagrams, pictures and simple exercises and questions (answers in back of book).

1988. 96 pages. 297 x 210mm, illustrated.

Order As WS37S (Basic Electronics) *Price £4.25NV*



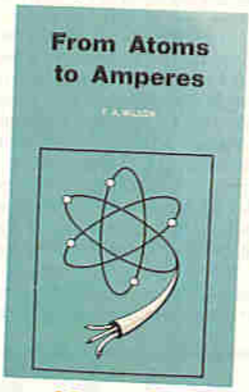
Learning to Program in C

by N. Kantaris

This book is a guide to C programming. C statements are introduced and explained with the help of simple, but completely working programs. Graded problems are set at the end of each chapter, some with a financial or scientific bent, so that the users can choose their own level of problem difficulty on which to practice with some additional choice in preference of the field of application. Full working solutions appear at the back of the book.

1989. 128 pages. 198 x 130mm, illustrated.

Order As WS38R (Learning to Program in C) *Price £4.95NV*



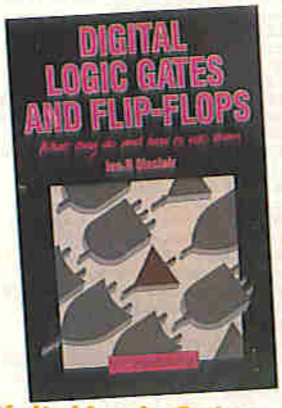
From Atoms to Amperes

by F. A. Wilson

This book explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever. Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Plank and other scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much? Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.

1989. 244 pages. 178 x 110mm, illustrated.

Order As WS39N (From Atoms to Amperes) *Price £3.50NV*



Digital Logic Gates and Flip-Flops

by Ian R. Sinclair

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by R. A. Penfold

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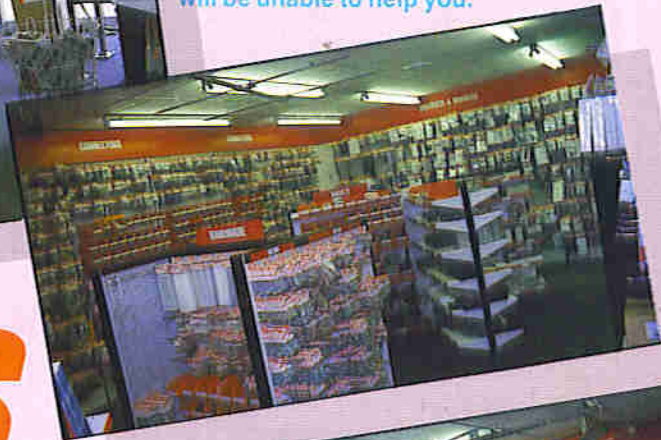

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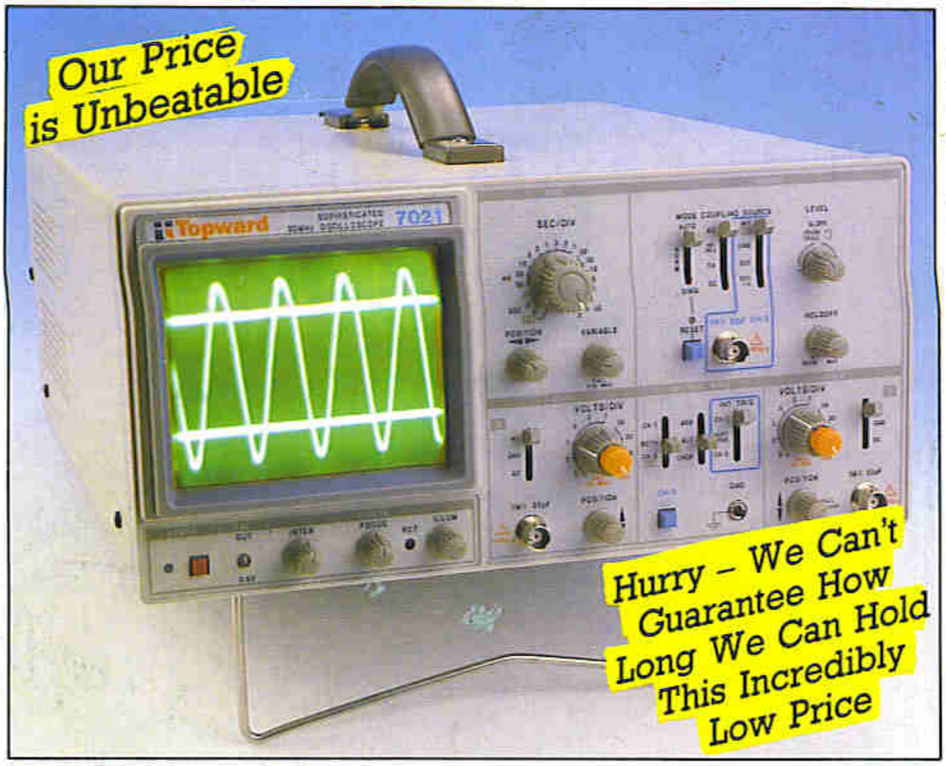

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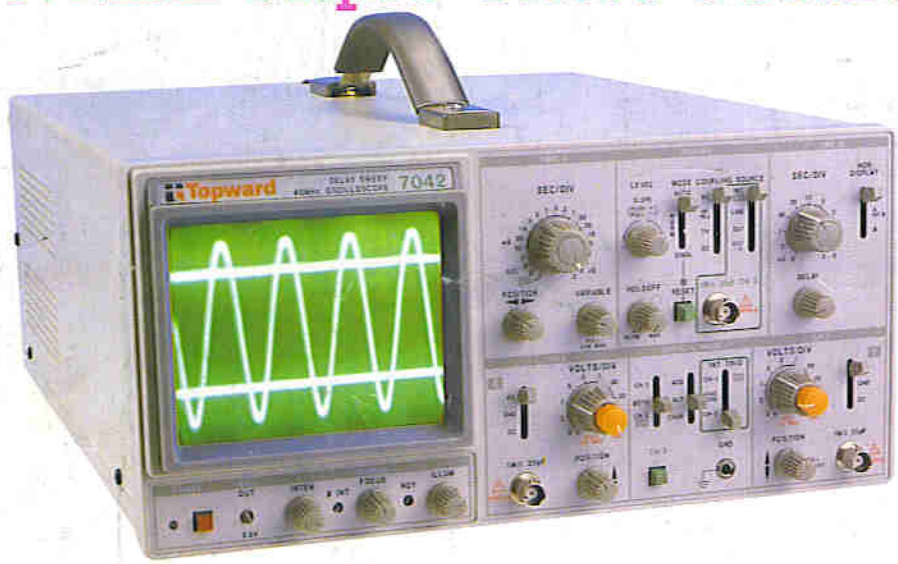

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